Architecture, Design and Conservation
Danish Portal for Artistic and Scientific Research

Aarhus School of Architecture // Design School Kolding // Royal Danish Academy

3D City Model and Urban density

Tournay, Bruno

Publication date:
2010

Document Version:
Early version, also known as pre-print

Link to publication

Citation for pulished version (APA):
Tournay, B. (2010). *3D City Model and Urban density: Danish examples*.

General rights
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal ?

Take down policy
If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Download date: 19. Apr. 2024

ARKITEKTSKOLEN AARHUS

Designskolen Kolding

Det Kongelige Akademi

Center of Urban Planning
Bruno Tournay

Milano the 10th of may 2010

Paper for Working group 1 under COST action TU0801, Sub-domain: Urban Morphology

Title: 3D City Model and Urban density, Danish examples.

1. Project or research area presentation

This study and discussion of sustainability and urban density is performed in autumn 2008 by the Centre for Urban Planning at the Danish Royal Academy of Fine Art, School of Architecture commissioned from the Urban and Environmental Planning agency. It is a part of broader studies from the Ministry Environment, and is complemented by studies of a number of other aspects of sustainability and urban development.

The study aims to contribute to a pragmatic discussion of how Danish cities can develop in a more sustainable direction. The focus of the study is to investigate a series well-known Danish housing types with various densities, and assess their relevance and functionality in relation to different aspects of sustainability. The project asses 10 different settlements located in different geography and urban structure contexts in Denmark.
To discuss the problems dealing with a not very accurate defined sustainability concept, the report is organized with an introductory section, containing a brief summary of the conceptual and theoretical discussion that within the last 20 years occurred on the concept of sustainability and its relation to urban structure and urban planning.
Then a section follows explaining and arguing for the chose of the examples, the survey methods and the comparison techniques used in the concrete case studies.
The next section contains data and comments on the examined examples and comparisons between them.
The report ends with a series of conclusions and a discussion of the perspectives and issues related to urban density.

2. Related works and publications

The project was published in 2009 and is available on the site of the Ministry of Environment at the address:
http://www.blst.dk/NR/rdonlyres/1A4B568E-F851-4718-8527-61843FD08A4D/90547/taethed_bog_til_nettethw.pdf

The report is in Danish. A list of used references can be found on page 19.

3. Description

Each of the 10 examples are described and rendered on the basis of a 3D model of the houses and 3 different geographic frames (maps in 2D) around the settlement.

Building typology

The building typologies are rendered in an axonometric (parallel) projection based a 3D model of the houses, so that it becomes possible to compare the dimensions and the relationship between building, street and garden. Building typologies is rendered within a framework of 30 x 30 m, so that differences in building sizes, among the various examples became immediately apparent.

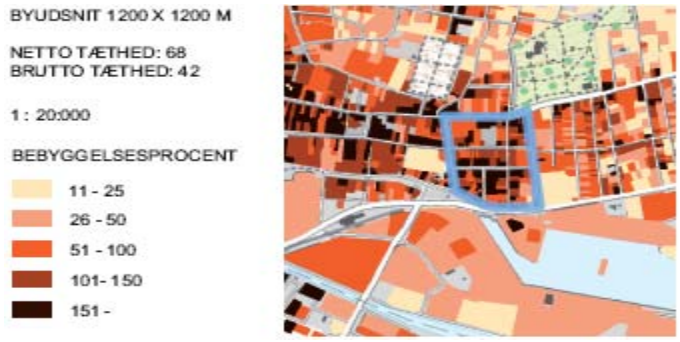
Search Box 1: Focus area.
The focus area identifies and isolates the building typologies from the surrounding neighbourhood.

The build density is calculated both as net and gross densities. It provides, through the difference between net and gross densities details about the morphology – whatever a high net density is compensated by large outlays of open space, or whatever a large gross density shows the absence of open spaces.


Net density: 126, gross density 91

Search Frame 2: 1200 x 1200 m
The settlement that is in the focus is then pasted into a search frame of 1200 x 1200 m.
Typology actually operates apparent only when they are included in the larger urban context.
The size of the search area is chosen so that it covers what is commonly
regarded as comfortable walking distance.

1200 m search area also almost coincides with the quantitative and qualitative requirements that apply in the various Urban Village models.
Within this framework net and gross density are calculated, and the daily functions in terms of institutions, schools, shopping, recreation opportunities and access to good public transport are plotted If within this search frame appear a wide range of features that support daily life, there is a certain probability that the area meets the requirement to the potentially sustainable city.

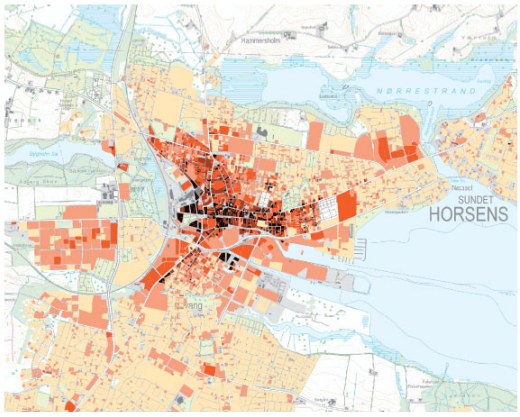


Search Frame 7000 x 7000 m
In the next phase the example are placed within a search frame
of 7000 x 7000 m.
This search frame is selected for following reasons:

The size is chosen so that it contains the distances within which it
is comfortable to move by bike. That is between 3 to 5 km. The second reason is that 7000 x 7000 m slice can hold the whole urban area (except Copenhagen and Aarhus). The comparison is in that way possible between the different examples.

Within the search framework the densities are measured in three different ways: 1) as floor lots area ratios, 2) as person by ha, and 3) as working place by ha. By comparing these three representations, some clear indications com out of the structure and potential sustainability and densification for the respective cities.
Densities, calculated as floor and plot area ratios, indicating how far out in the urban
the relevant densities rows. 7000 m sample also shows what opportunities are located
in the studied examples.
Densities calculated as a resident and working place provides an overview of
how the city is structured - for example on housing and jobs are separated into
different places or mixed.

HORSENS



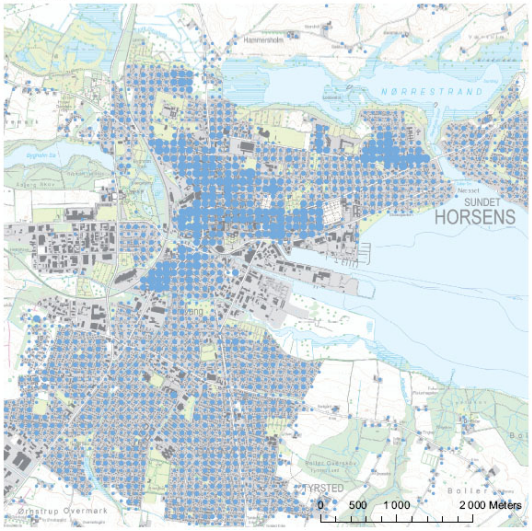
1 : 40:000

BEBYGGELSESPROCENT

- 11 - 25
- 26 - 50
- 51 - 100
- 101 - 150
- 151 -

HORSENS

Befolkning pr. hektar



1 : 40:000

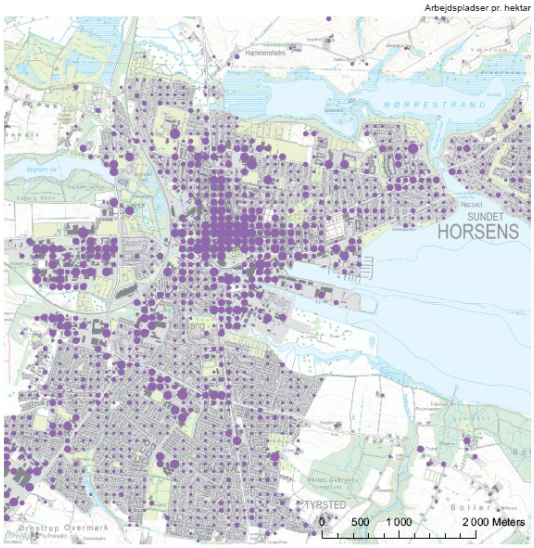
BEFOLKNING

Indbyggere pr. hektar

- 1 - 25
- 26 - 50
- 51 - 100
- 101- 150
- 151 -

HORSENS

Arbejdspladser pr. hektar



: 40:000

ARBEJDSPLADSER

nsatte pr. hektar

- 1 - 4
- 5 - 19
- 20 - 49
- 50 - 199
- 200 -

3D and analysis of urban density

The user is in this project a specialist, an urban planer and the purpose is to analyse urban density in relation to sustainability. The project is moving from the housing type up to city level.

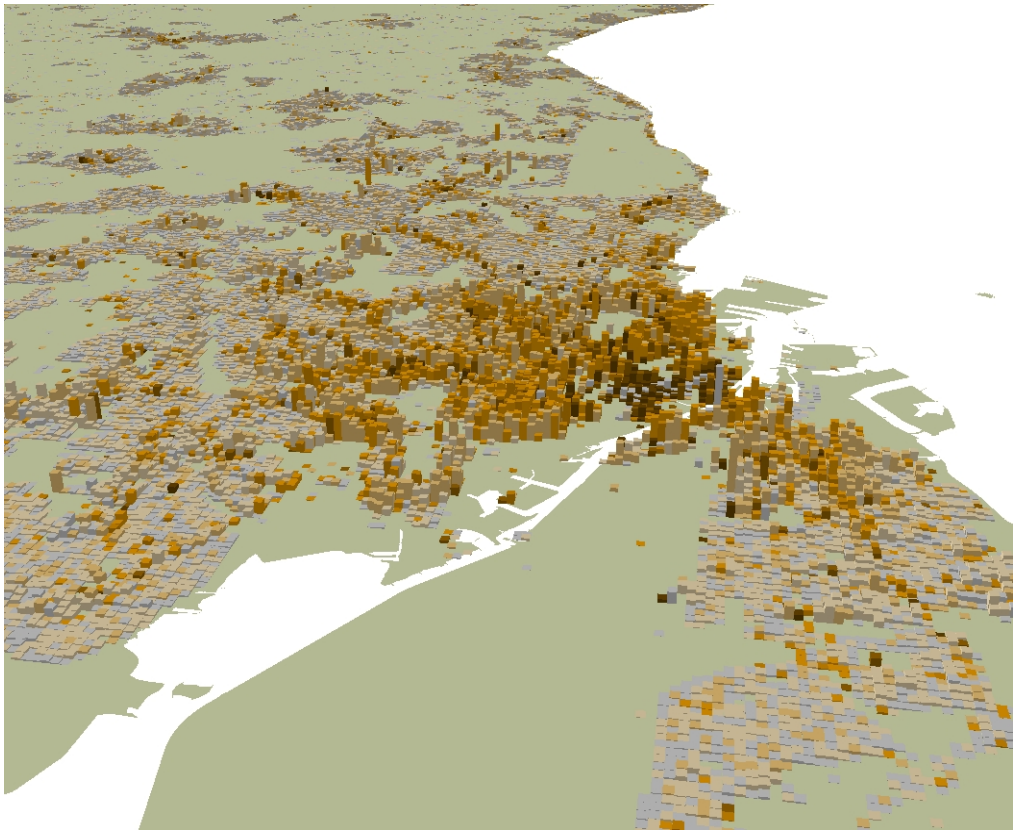
At the lower level (the housing typology) the 3D model is an easy way to show the differences between typologies. The 3D model has to show the buildings with windows and entrance, street and more or less private green spaces.

At the other upper levels the project used only 2D representations, like maps, but the maps are showing more than 2 dimensions. Colours are used to show the 3rd. dimension, which is often an attribute to physical or not physical objects.

The project makes an extended use of the “cell approach” to describe and compare different variables spatial relationship. This is an interesting method when different spaces have to be compared, because the cell method is independent of the different administrative and statistical divisions that make comparison difficult. Every data that can be referenced to an address can use the “cell approach”.

Rendering data in 3 dimensions can help understanding the subject, especially when the topic is about urban density. In the figures below are 2 examples where the 3rd dimension can be used to show density (in Copenhagen).

The first figure shows the parcels density as the 3rd dimension, where colour and height represent density of parcels. The second one shows the number of peoples living in each 100x100m cell, which is represented by the height of the column, and the number of working places witch is represented by the colour of the cell. More high and dark is the column more dens and integrated are the residential and working place.



Conclusion

The use of 3D city model is quite obvious to describe the different type of settlements, but more difficult when non physicals objects have to be introduced in the analysis of urban development like sociologic or economics variables.

The cell based method is an interesting way to go. When working in 3D the cell is a cube (or a “voxel”). In the map world the cell is an object with an ID. The ID is the UTM-coordinate of the cell. In the 3D world the name of the cube should be the lower left corner of the cube in the 3D space. All the data which address is inside the cube can then be summarized and then be shown without exposing individuals (person, enterprise etc.).

At the European level there is initiative to coordinate data in a way they can be compared across borders and historical or political differences (INSPIRE).

Denmark has no tradition for building cities with high building. It is still easy to analyse the urban morphology on the basis of 2D data, but in other big city that is not enough.

This example can be used as a conclusion. In some cities the public transports are quite effective. Your apartment is may be 4 minutes from the metro station and there you may wait less than 2 minutes to get the metro but you have to wait 10 minutes to get the elevator down to the street. 2D analysis of density and accessibility (ex. services) are not accurate enough.

The 3D coordinate of the addresses and the cube/voxel should be part of the 3d city model. The principles of the cube/voxel can be used in many other fields than urban morphology and urban sociology, ex air quality, noise etc.

In the 2D world there is to methods: the vector model and the raster model. Both have there own advantages that is also true in the 3D world.