Computer-generated urban Structures

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How does it come to particular structure formations in the cities and which strengths play a role in this process?

On which elements can the phenomena be reduced to find the respective combination rules?

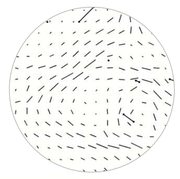
How do general principles have to be formulated to be able to describe the urban processes so that different structural qualities can be produced?

With the aid of mathematic methods, models based on four basic levels are generated in the computer, through which the connections between the elements and the rules of their interaction can be examined. Conclusions on the function of developing processes and the further urban origin can be derived.

The direct or indirect sense of this work is to inquire how the parameters that have generated existing urban structures can be transformed into mathematical controlling terms to achieve a new comprehension of the urban development. The results build the basis for the experimentation with the structural attributes. Furthermore the basic and efficient producing alternative solutions can be enabled and effectual mathematic models can be created. From these mathematical models urban developing processes can be simulated, interpreted and prognosticated.

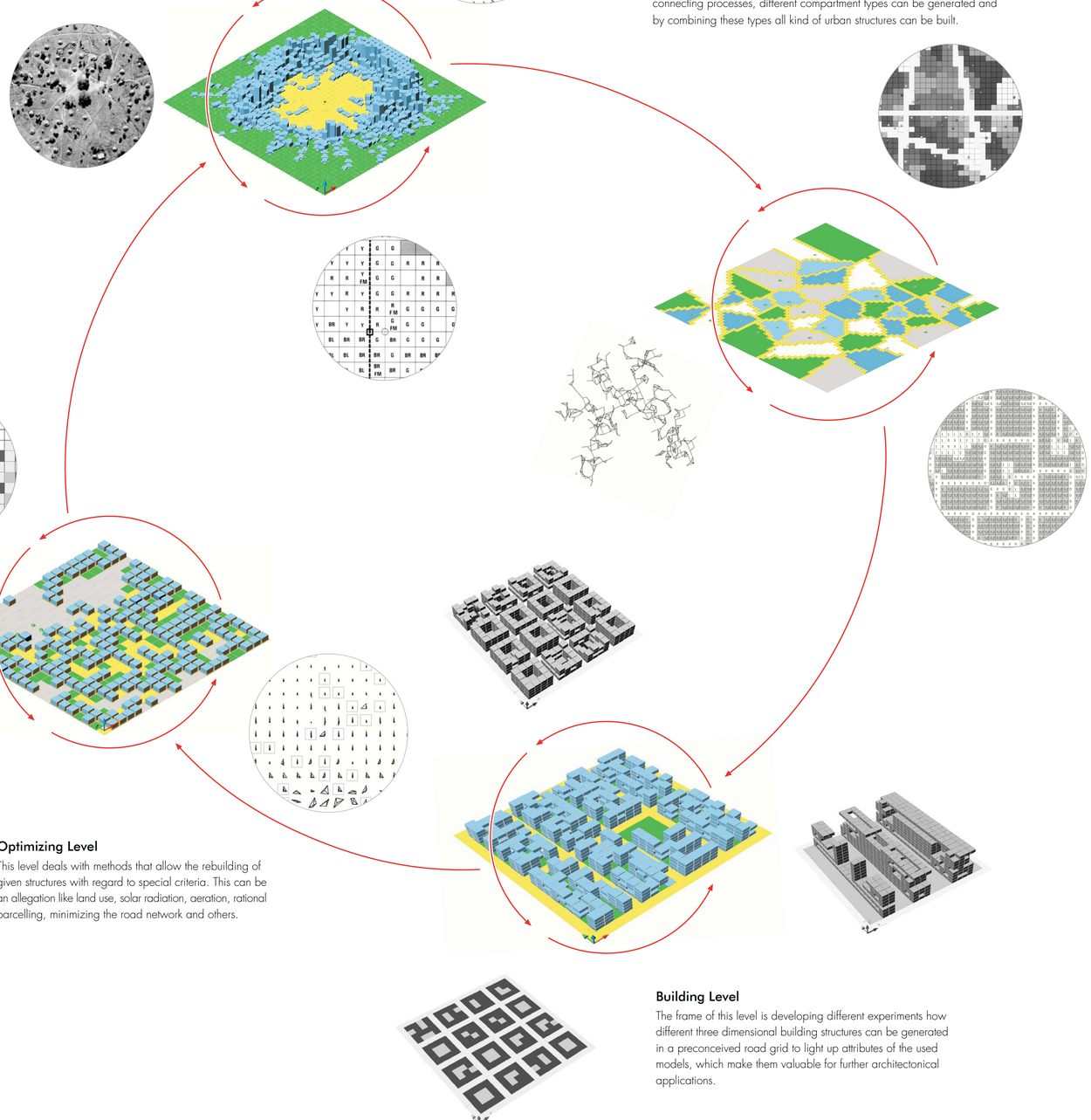
Information Level

The information level is a possibility to work up these information that can not be reduced on elementary components. These components have to be assumed as given. There the contextual basis can be found which the system of the superior levels accesses like a databank to modify their parameters.



Developing Level

One of the main structuring elements of a city is the organisation of the road network, which is closely connected to parcelling. By controlling connecting processes, different compartment types can be generated and by combining these types all kind of urban structures can be built.



Optimizing Level

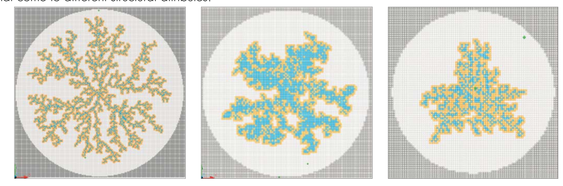
This level deals with methods that allow the rebuilding of given structures with regard to special criteria. This can be an allegation like land use, solar radiation, aeration, rational parcelling, minimizing the road network and others.

Building Level

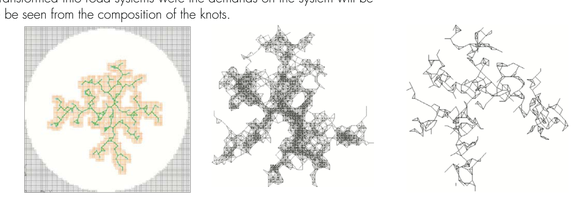
The frame of this level is developing different experiments how different three dimensional building structures can be generated in a preconceived road grid to light up attributes of the used models, which make them valuable for further architectonical applications.

Road System

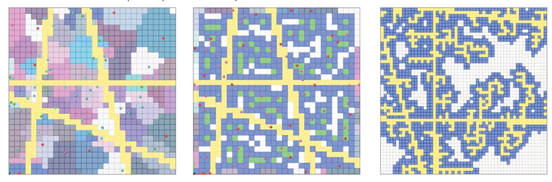
To generate the developing system, we inquired in the first step the behaviour of connecting systems around the controlling parameters that come to different structural attributes.



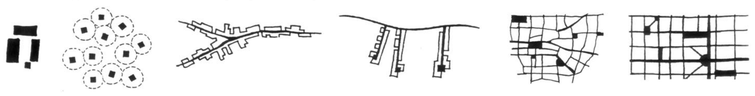
These generated systems will be transformed into road systems were the demands on the system will be extended, which can for example be seen from the composition of the knots.

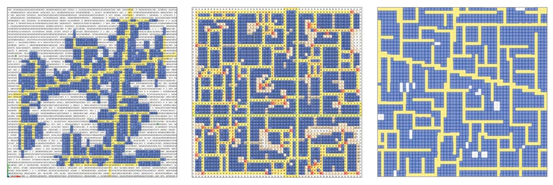


The introduction of the different agent types which have different agglomeration qualities is leading to the six "Feldtypen" of Klaus Humpert by means of whom the complete spectrum of city structures can be produced.

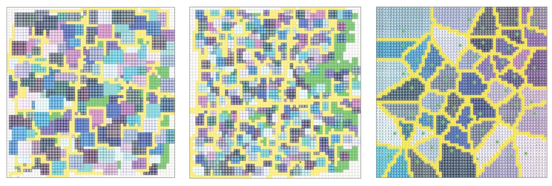


The Six Feldtypen : Nukleus, Cluster, Wegelagerer, Ausleger, Vernetzer, Plan



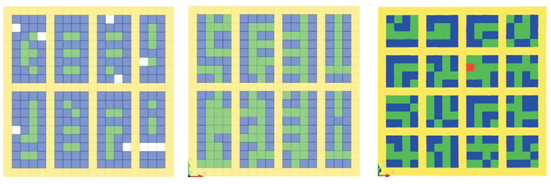


During the examination a closed connection can be proved between the road system and the parcelling structure.

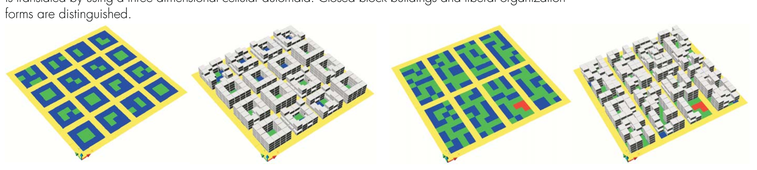


Building

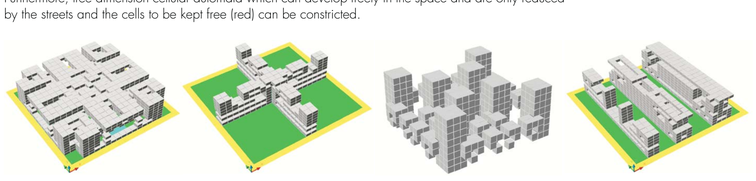
To generate three dimensional building structures cellular automata have been used. In the first step the cell to be build on (blue) of a parcel in dependence on the free neighbours (green) were defined. The size of the parcel that is deduced of the road system (yellow) plays an elementary role.



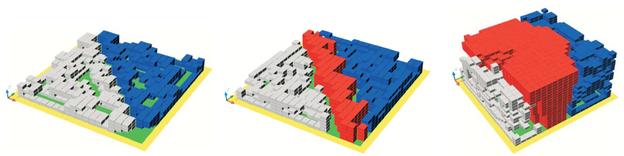
On the basis of the structuring of the parcels the character of the laminar specification of a spatial structure is translated by using a three dimensional cellular automata. Closed block buildings and liberal organization forms are distinguished.



Furthermore, tree dimension cellular automata which can develop freely in the space and are only reduced by the streets and the cells to be kept free (red) can be constricted.



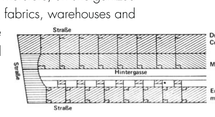
In the last step, systems for the separation distance will be examined, whereby statistic fields are used or dynamic cells (red) are introduced. They are created in-between where two building structures are approaching.



Historical Differentiations of urbanism Factors

Industrial Revolution

The peripheries did not exist of land expansions carefully planned in advance but it was an empty space which, through a number of initiatives, realized irrespective of each was covered with different buildings. Therefore, an unorganized next to next district aroused with luxury quarters, slums, fabrics, warehouses and technical areas. The size of the distance to the neighbouring building was an indication for the social condition.



Two outlines of the new districts enclosed Manchester. From Friedrich Engels



Figure from BENEVOLO [03], S. 792: A working-class area located between railroad bridges in London (Engraving from Gustave Doré,1872).

The modern City

The studies of the ground plan, its orientation, its functional arrangement, generated new models of building orientation as well as rou and to arrange parallel line buildings which were developed, to save money, by orthographically laying roads to the living ways or arrangements of huge buildings composed free in the space that were surrounded by green spaces and as well to concepts of the "superblocks" and later the neighbourhood unity – an accumulation of apartments with the necessary accommodation and common need facilities, like shops and schools, free of traffic and bounded by green spaces.



Figure from ALBERS, S. 230: housing development in Hengelo/Niederlande, 1956.



Figure from ALBERS, S. 233: parts of a structure in Berlin, Märkisches

The post liberal City of the 19.Century

Method or Construction for inner urban areas:
The design of the apartments was organized into the road network and the building line, which were defined by the planning. Blocks arose according to parcels, orientated on economical conditions.

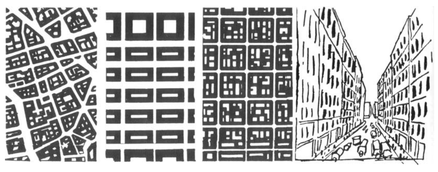


Figure from BENEVOLO, S. 814: Two drawings of Le Corbusier: the "Straßenkorridor" (on the right) and three town types, which were designed after the model of these "Straßenkorridors" (Paris, New York and Buenos Aires)

Two methods of constructing of the outskirts:
– a development of small density. This means a small number of houses for the upper class.
– buildings of high density with less expensive, multi-storey terraced houses for the lower classes.

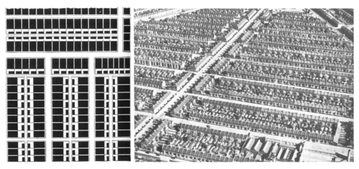


Figure from BENEVOLO, S. 818: Example of the settlements at the periphery of English towns which have been laid out in accordance with the 1875 passed regulations: The efforts to build houses as profitable as possible led to an extreme uniformity of these settlements.

Post War Development

Some examples of the multifarious developments since the Second World War are as follows:
The major projects of the sixties could be realized with public engagement because the administration had huge areas on their exposal, whereby it was possible to realize unique plannings by ignoring personal ownings. It was not necessary to orientate oneself on the size of parcels. The roads were separated by their functions and sometimes were organized on several levels:

- The public local traffic in the inner cities was organized underground.
- The roads for traffic and the parking area were organized on the ground.
- The sidewalks and bicycle lanes were one level higher and above the motorised traffic

Therefore the ground level lost its function as municipal area of the live and was transformed to secondary space.



Figure from ALBERS, S. 40: Development scheme Dulsberg, Hamburg, 1919



Figure from ALBERS, S. 41: Development scheme Römerstadt, Frankfurt, 1926.

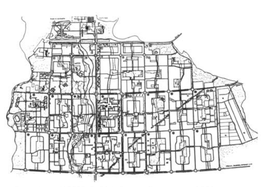


Figure from ALBERS, S. 214: Plan of Chandigarh, 1951.

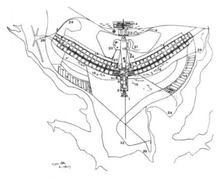


Abbildung aus ALBERS, S. 215: Gesamtplan von Brasilia, 1958



Figure from ALBERS, S. 230: housing development in Hengelo/Netherlands , 1956.



Figure from ALBERS, S. 234: Terraced grouping in the Olympic village , Munich, 1968.

Structural Elements

Development

The following principals of buildings can be diverted:
- The block building that is surrounded by roads with a closed block building that separates the public road and the almost private inner block areas. Its extreme opposite is:
- The strictly parallel line buildings developed by orthographic roads along the line discharging into the lines
- A variation is the development of two neighbouring lines as a common court while the following spaces between the line buildings are defined in a private character.
- Transit forms between these two basic models mainly conceptualized on the special effect frequently conceived with different heights of the main buildings.
- A grouping of unattached buildings mainly point houses which must be limited in their amount though its formal effect shall not be lost, its extreme formation is.
- The main building that is conceived on a formal effect with an up to three-digit number of apartments.

Parcelling

It is in accordance with the division of an area into parts whose buildings are described by specified rules.

Parts of Structure

The buildings that have to be placed on field exist on several elements that can be connected to larger combinations. More complex elements can be combined to "game stones".

Separation Distance

An authoritative criterion for the definition of upper limits of the usage was and is the exposure and the ventilation of the apartments.

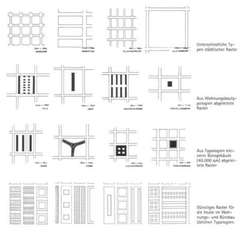


Figure from Arch+: Der Sprawl

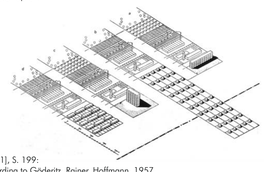
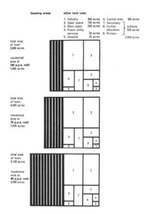


Figure fromALBERS [01], S. 199:
area allocations according to Göderitz, Rainer, Hoffmann, 1957.
The area shares per inhabitants and with that the extension of the town varies with the form of the residental buildings in which in addition allotments are provided for storey apartments.



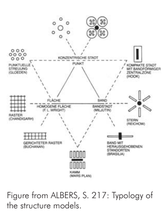


Figure from ALBERS, S. 217: Typology of the structure models.

Abbildung aus ALBERS. Alternativen der Flächenansprüche für die neue Stadt Hook, 1961. Die Wohndichte - auch hier als einzige Variable angesetzt - bestimmt die Gesamtstadtfläche zwischen den Extremen von rund 1450 und 2060 ha.

Application and development Possibilities

First Thesis

Huge construction projects are primarily developed by private investors. The public hand retires mainly from its responsibility. This is the reason why economic points of views are in the foreground and urban development qualities and social interests are treated secondarily.

- ⇨ A strategy has to be found to convince the investors interests and to nevertheless convey the architectonic qualities from which the public benefits.
- ⇨ An economically optimal usage of the property has to be ensured. This means greatest possible agriculturally productive lands in dependence of GRZ and BGF as a basis for profitable buildings.
- ⇨ Therefore we have to develop a computer programme that fulfils these restrictions and at the same time uses these requirements as a strategic basis for the derivation of high quality spatial configurations, i.e. does not try to overcome the monotonous standard solutions with aesthetics but with economic arguments.
- ⇨ The reversed argument that the architects make themselves superfluous can not be valid because of the written thoughts at the beginning of the chapter. Furthermore, the architects have dissociated themselves from this activity field and left the decision competence to the project developers and general over-recipients.

Second Thesis

From the economic compulsions a shortening of the planning periods arises for the development of the project developments. Therefore, a standardised design process usually accesses standardised solution patterns instead of searching for an optimal and demanding conception. The quality optimization in competitions remains a rare reason for private investors.

- ⇨ The use of the computer as a creative planning instrument under correct application improves beside the quality also the rationality of the design process.
- ⇨ Once the rules (genotypes) are found for a structure which has proved also in the practice, these rules can be used for a further planning. The development of the planning, however, depends on the environment so that the result (Phenotype) can be distinguished.
- ⇨ Through this it becomes possible to go back to proven solution samples without exhausting oneself in flat copies. Merely the characteristics of a design are taken.
- ⇨ By the strategies of combination and selection several successful rules can be deduced to reach further optimized solutions.

Third Thesis

The instruments of the development scheme can confirm the way of use and distribution and make rudimentary specifications for a spatial design over making limits and lines and the usage code numbers. The development scheme is derived in the best case of an urban development competition, taken place in the front-end.

- ⇨ The structural rules for a development scheme can be decided on the parameters of the program, by means of those rules the possibilities of the constructability can be defined. (Genotypes and Phenotypes)
- ⇨ Distance areas and building limits can be solved far more flexible if one makes the parameters dependent of each other and the primary sense of these rules derives on the calculation of the exposure and simultaneously makes the building possibilities obvious. A good example is Watanabe Sun Good city centre.
- ⇨ The expenditure of energy for the construction and use of a way system or a building structure can be calculated and optimized.

Fourth Thesis

The social consequences prove only after the realization of the projects. The social utopian approaches of the classic modern age have let their weaknesses get visible in the apartment and settlement making primarily after their putting into action.

- ⇨ The developed models can be extended by social components, whereby social processes, provided that they are statistically ascertainable, can flow into the simulation.
- ⇨ This offers the possibility of looking at the thought of the participating planning from another point of view. It is no longer necessary to include the wishes and needs of the future users in particular what, due to the fact that these usually are often not confessed at the time of the planning, led to the failure. The stochastic processes of social dynamics can be simulated by means of agent systems.
- ⇨ The spatial planning can be examined with its social consequences through this and the modelling of social processes the other way round serves as a basis for the spatial planning.

Fifth Thesis

Since only the great metropolises have to reckon with a permanent increase in population, besides the new planning of municipal areas strategies for the reorganization and the restructuring of existing city structures will become increasingly necessary up to the re-building in future. This means that it is necessary to operate within the complex, municipal structures and various possible developments have to be.

- ⇨ All relevant data of existing structures can be comprehended over the information level.
- ⇨ These serve as a basis for the restructuring after new aim criteria by means of the optimization level which makes possible a deconstruction and rebuilding.
- ⇨ As described in the Fourth Thesis variances can be scrutinised for their social effects.

Besides the rational analysis of the pragmatic applications it is a special concern to us to reach new spatial configurations to make the municipal space more exciting with the suggested method.