t?f

The Why Factory

City Accelerator

Increasing speed by adaptability in the city

Lara Tomholt

City Accelerator

Increasing speed by adaptability in the city

City Accelerator
Graduation project

by Lara Tomholt
www.laratomholt.nl
student nr: 1353357

Part of The Adaptive City graduation studio

Delft University of Technology
Master Architecture, Urbanism and Building Sciences
The Why Factory

Mentors

Ulf Hackauf
Adrien Ravon
Winy Maas
Huib Plomp
Suzanne Groenewold

7 November 2014

CONTENTS

PART 1

WHY ACCELERATE?

TRAVEL

Why do we travel?

In understanding why people travel, Mokhtarian and Salomon start with the question: **"Which came first, the activity or the trip?"** [1] They explain: "Measuring an individual's affinity or liking for travel is a fundamental first step in this process. [...] Obtaining a reliable measurement of travel liking, however, is a non-trivial matter. This is because **an individual's expressed affinity for travel is likely to be a composite of positive utilities for three different elements**, in unknown and varying proportions. These three elements are conceptually distinguishable but empirically apt to be confounded" [2].

"They are:

- **The activities conducted at the destination**
- **Activities that can be conducted while travelling.** In reporting an affinity for traveling, individuals may in part be considering the utility of activities they can conduct while traveling. In some cases, it is in fact the 'anti-activity' (or the absence of other activities) that is important – that is, the ability to use the time for relaxing or thinking, including 'shifting gears' mentally between the origin and destination activities and roles. When utility is derived from activities conducted while traveling, the question becomes, **how easy or likely is it to conduct those same activities in connection with a non-travel or lower-travel alternative**? If the answer is "not very", the individual may still prefer the higher-travel alternative for its multitasking opportunity.
- **The activity of traveling itself"** [3]

"Travel is a derived demand, at least as an absolute. We do not dispute the principle that most travel is derivate, but we also argue that **humans possess an intrinsic desire to travel**, a point previously made by a number of researchers in a variety of disciplines and geographic locations. The paradigm of travel as a derived demand requires that we view the destination/activity as generating the trip, when on some occasions it may be the desire to travel that prompts the invention of a spatially-removed activity to satisfy that desire."[4]

"Another, whimsical but potentially useful, way to help make the distinction – in either the conceptual or the empirical context – may be to apply the '**teleportation test**'. The question is, "if you could snap your fingers or blink your eyes and instantaneously teleport yourself to the desired destination, would you do so?" In circumstances where an expressed utility for travel actually derives completely from the activity at the destination (the first element), a person should not hesitate to eliminate the undesired travel while still achieving the desired spatial separation from the origin. In circumstances where utility is derived from multitasking while traveling (the second element), the answer might depend on the perceived ability to accomplish the same tasks without the travel. In circumstances where there is a utility to traveling itself (the third element), a person would choose to travel even if a teleportation alternative were available." [5]

Mobility trends

105

23

2012

2050

"We project that by 2050 the average world citizen will travel as many kilometers as the average West European in 1990. Today, world citizens move 23 billion km in total; **by 2050 that figure grows to 105 billion**." [4]

"In 1977 Geurt Hupkes calculated that people make a constant number of trips a day: five."[1]

"On average, humans spend a **fixed amount of their daily time** on travelling: **the travel time budget (TTB)**. Time-use and travel surveys from numerous cities and countries throughout the world suggest that **TTB is approximately 1.1 hour per person per day**. While the TTB is constant on average, many variations are evident when examining the behavior of small populations and individuals. Travel time budgets are higher in congested cities; Londoners, for example, spend 30% more time traveling than do people in spacious Scotland." [2]

"A fixed travel time budget requires that the mean speed of travel increases in proportion to the projected rise in total per capita mobility. **More distance must be covered within the same period of time**. A person also spends a constant share of time for travel on average; as total mobility rises, travelers shift to faster modes to remain within the fixed travel time budget of 1.1 h per person per day." [3]

"Globalization – the growing economic integration of nations around the world – is the most obvious of the trends identified with the communication revolution." "Until the last century or so, the opportunity for economic integration derived entirely from the available transportation because communication independent of transportation did not exist. Now an independent and versatile communication is a precursor, serving to establish motivation for transportation, which ten serves the role of enabler." [5]

"Some studies have claimed that tele-commuting could eliminated peak period road congestion. However, others have been more cautious in their claims. While substituting with that particular work activity at that time, there may be secondary effects that largely offset this. In particular:

- In the longer term, part-time tele-commuters may choose to locate further from their workplace, substituting fewer, longer trips for daily shorter ones, so that total VMT on a weekly or monthly basis may not be reduced.
- Non-work travel may increase and take up some – or all – of the saved commuting time: if the 'constant travel time budget' hypothesis were strictly applied, then this would be the logical outcome." [6]

Importance of mobility

"Both historical experience and logic suggest that transportation that has high costs or is unreliable, slow, or difficult to use will result in both lower economic productivity and constrained social activities. As transportation improves these constraints drop away, more preferences are realized, and the city becomes **more efficient economically** and, on average, can reasonably be expected to be a **more satisfying place to live** [1].

Yet we see transportation and communication **widening peoples' worlds** by providing both better information and better physical access to alternative ways of living, allowing and motivating folks to **transcend the boundaries** of suburban, racial, in town, or rural ghettos, enabling all to grasp opportunities for variegated living. That is how transportation helps shape cities; it enables the realization of desires for change [2].

Nearly **all the productive or social processes of working and living involve transportation**, either as an integral part of the process itself or in the activities on their periphery. Better transportation enables improvement in almost all these processes, often dramatically and often in ways not now imagined. It lets us **do old things in new ways or entirely new things**. So advancements in transportation can make our collective future better over time in ways that transcend the transportation itself. That is where the real payoffs are: what transportation can do to improve all the other aspects of our lives.[3]

"Waves of transportation developments have enabled (1) larger markets that (2) opened opportunities for greater specialization, larger capital investments, and for process innovation in general, (3) thus giving us new ways to do old things better as well as entirely new things. Better personal transportation has widened the scope of social, commercial, and institutional interaction. We reiterate that the key word is enabled, not caused: transportation improvements do not cause things to happen but make it possible for them to happen in response to other motivations." [4]

Value of travel time savings

What are VOT and VTTS?
"The value of travel time savings (VTTS), often abbreviated as 'value of time' (VOT), is of central interest in transport research." [1]

"The Value of Travel Time (VTT) refers to the cost of time spent on transport, including waiting as well as actual travel. It includes costs to consumers of personal (unpaid) time spent on travel, and costs to businesses of paid employee time spent in travel. The Value of Travel Time Savings (VTTS) refers to the benefits from reduced travel time costs."[2]

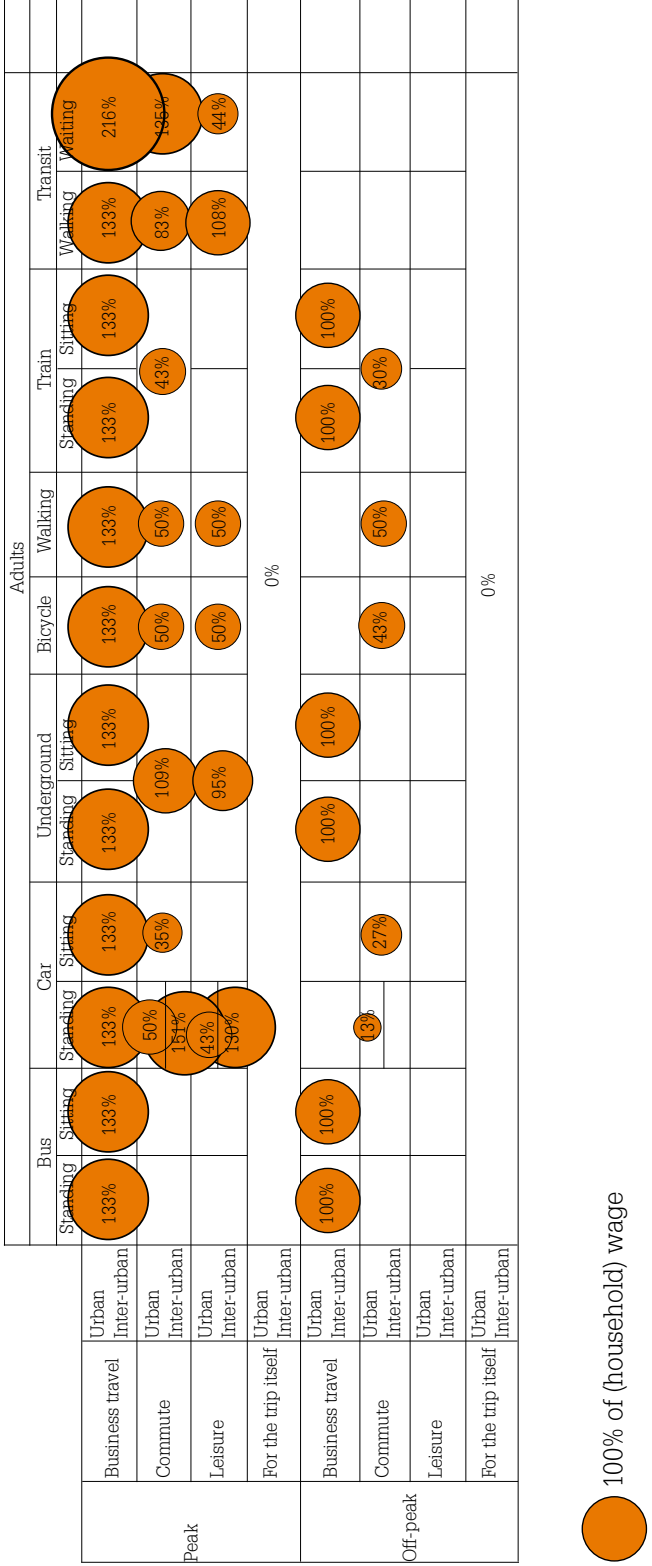
Conducted studies on VTTS
"The valuation of travel time has for many years been a significant feature of transport research."[3]

The **value of travel time** depends on:

- trip **length** (the value of time increases with the distance travelled)
- trip **purpose** (business travel, commuting, leisure travel, other)
- type of **vehicle** and **comfort** level of the journey
- type of **person** (age, family type, income) [4]

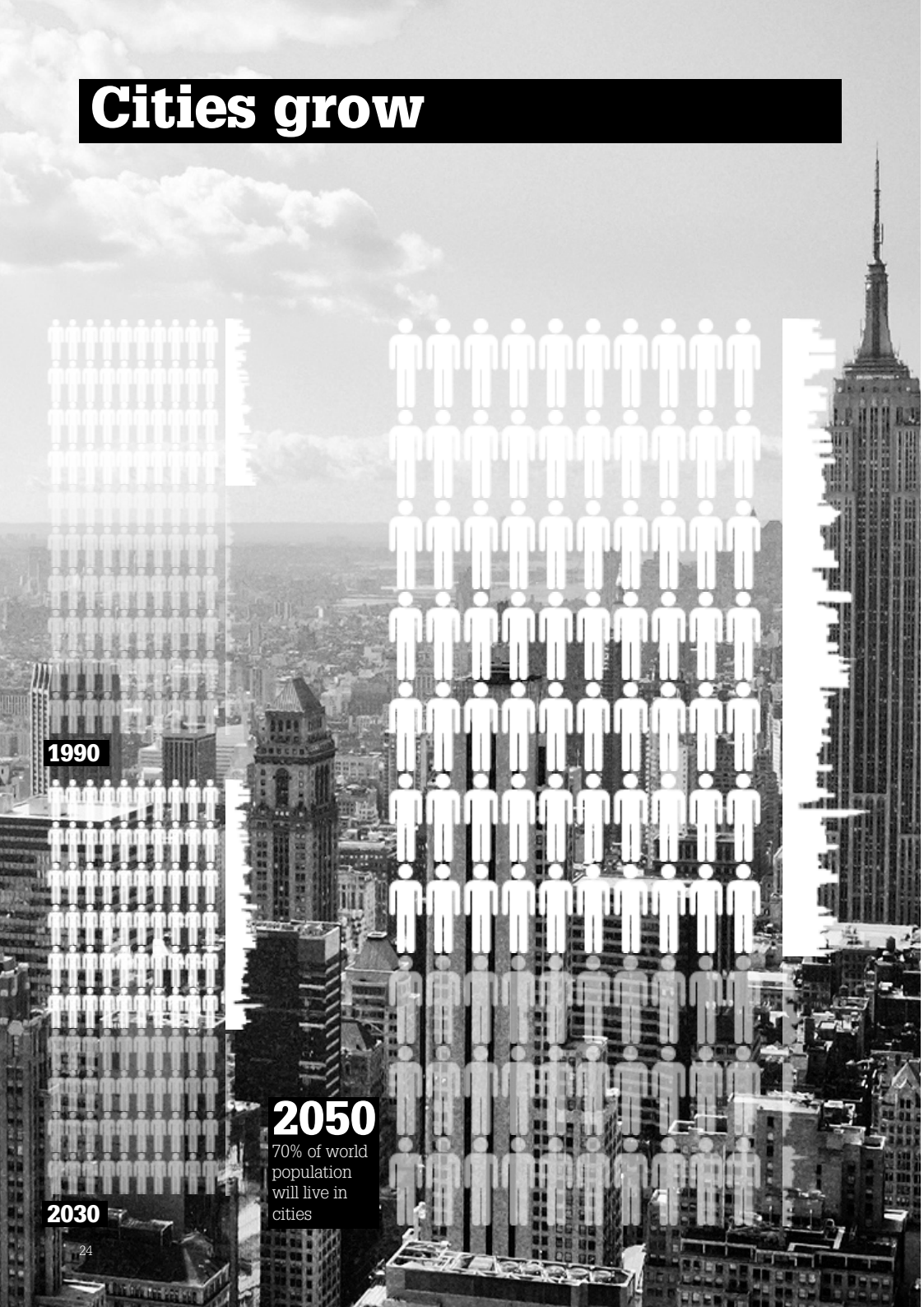
"The VTT is often expressed as a percentage of a persons/households wage or as an amount of money per hour." [5]

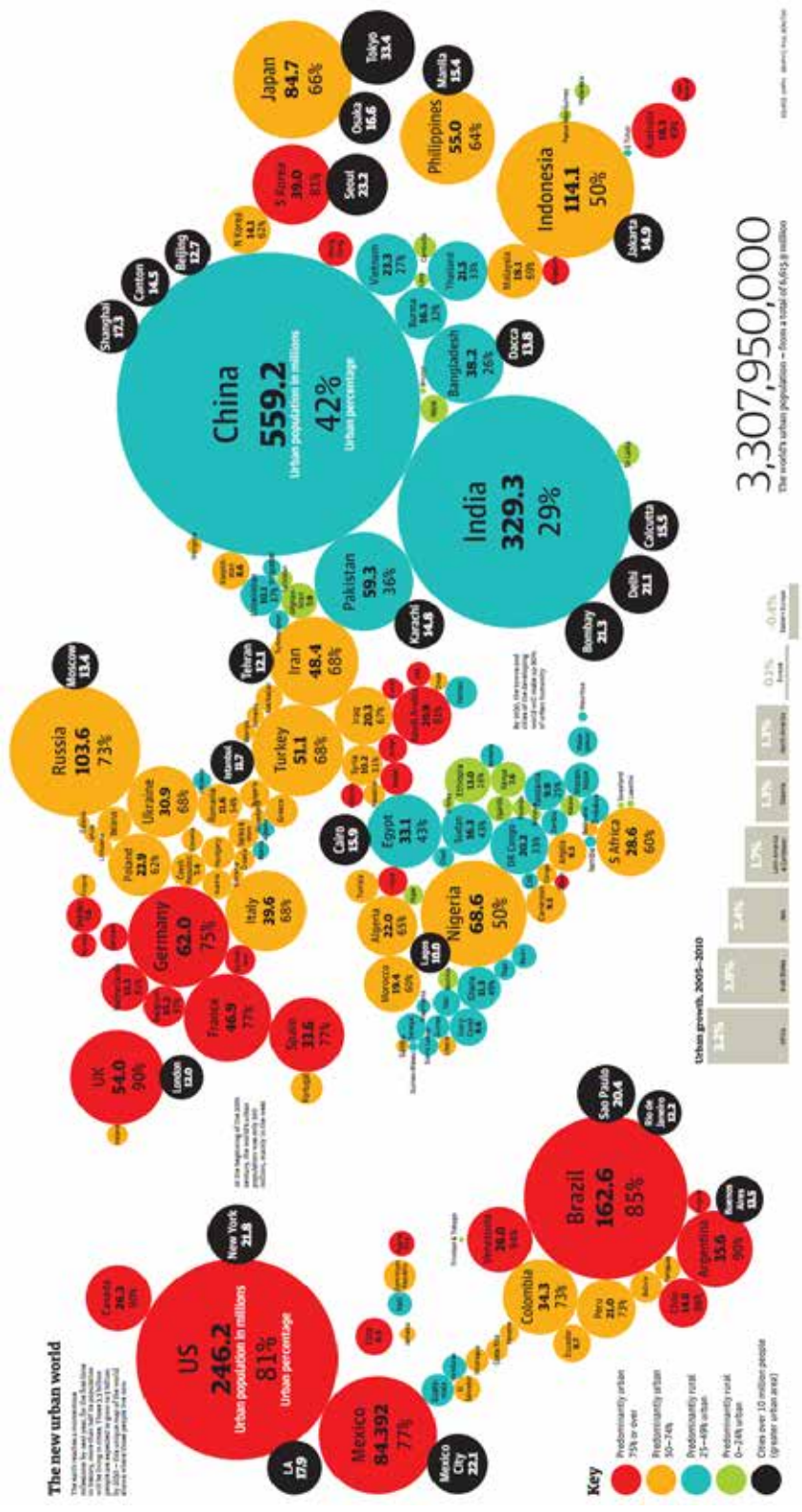
"Reliability of the vehicle or transportation service also plays a key part in peoples value of travel time." [6]



WHY ACCELERATE THE CITY?

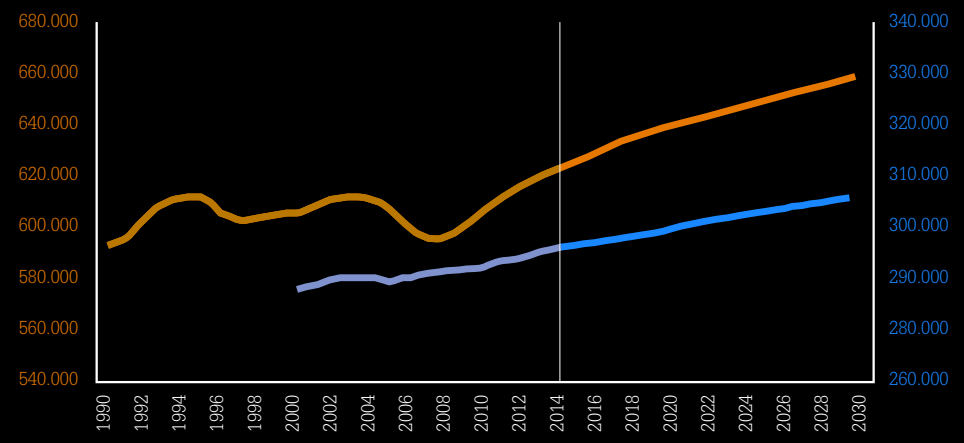
Cities grow





With an urban population of 81%, The Netherlands will be in the top 10 most urbanised countries.

Rotterdam grows



The number of inhabitants of the city of Rotterdam will increase in the coming 15 years. On average, each year, the population will increase with about 2.400 people. At the same time the housing stock will also increase.

Urban travel increases

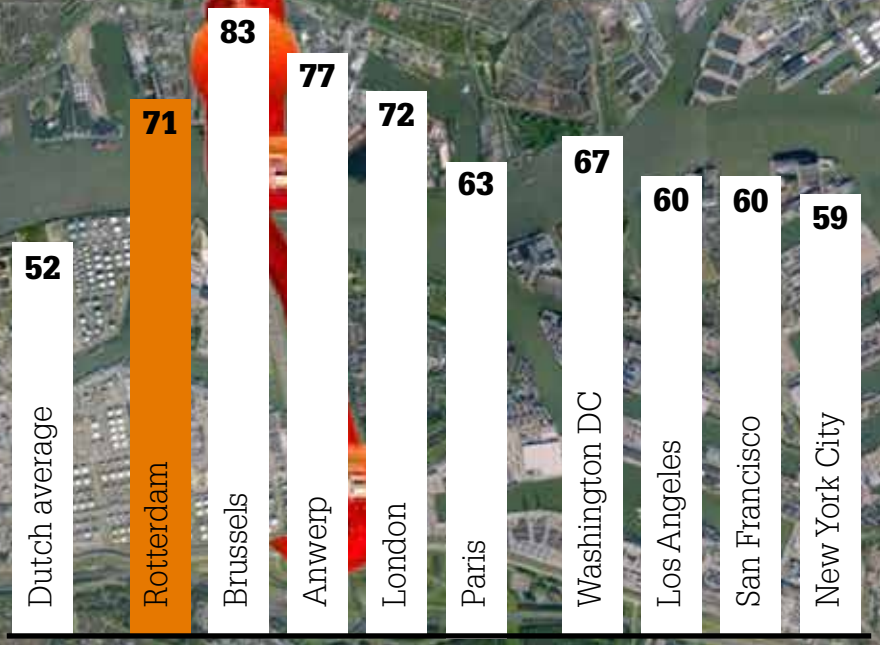
As a result of growing cities, urban travel is expected to triple by 2050.

Congestion increases

On average, each car driver in the Netherlands spends about 52 hours in traffic. Rotterdam is the most congested city of the Netherlands in which each car driver spends about 71 hours in traffic. With that amount of time, Rotterdam is the fourth congested city of Europe, after Brussels, Antwerp and London. Drivers in Rotterdam spend more time in traffic than car drivers in Washington DC, Los Angeles, San Francisco and New York.

Congestion in urban areas is dominantly caused by commuting patterns and little by truck movement.

By 2050 the average time an urban dweller spends in traffic jams will be 106 hours per year, 3 times more than today.



Hours per year spent in traffic jams per driver

Polluted streets due to congestion

Due to travel, and congestion in particular, pollution increases in our cities. Rotterdam has the second most polluted street of the Netherlands, and 8 of the 20 most polluted streets in the Netherlands are situated in Rotterdam.

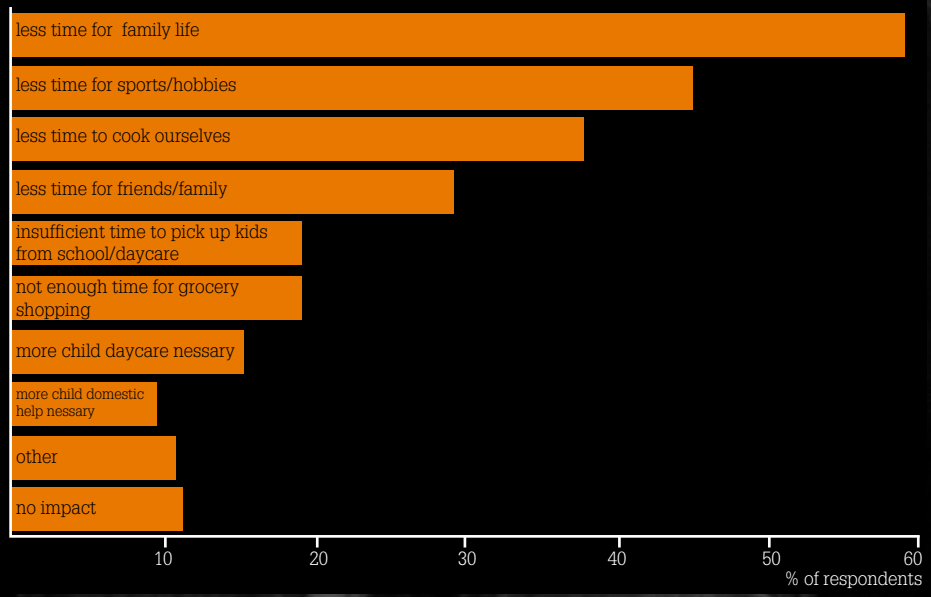
Top 20 most polluted streets in the Netherlands and their NO_2 values (microgram/m³).

The 8 most polluted streets in Rotterdam.

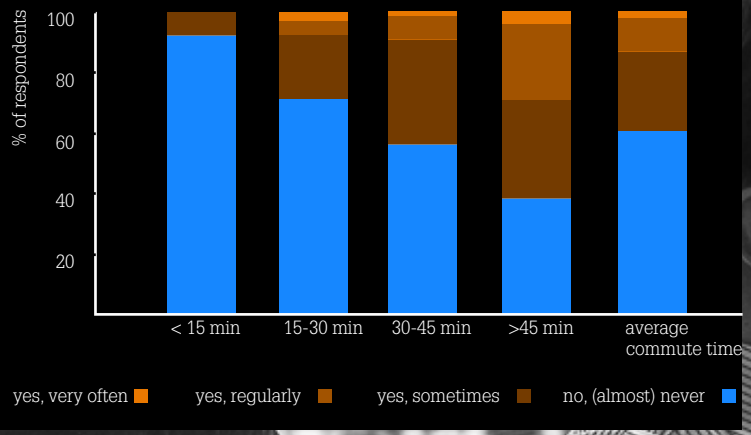
Travel time: waste of time?

16% of railway travellers consider their journey a waste of time, 60% of consider their journey partly a waste of time. 60% of the people say commuting makes them spend less time on family life.

Impact of commuting on private life



Do we experience stress from our own commuting or from that of our partner?



40% of the people sometimes or often experience travel stress from commuting themselves or the commuting of their partner. The longer the trip, the higher the stress level.

Travel stress

Travel time in life time

Total years in our lives we are awake.

If we eliminate all travel time during our lives, we gain 3,9 years in our lives to spend on other activities.

*based on a life expectancy of 77,3 years (Dutch average)
*based on an average travel time per day of 73 minutes
* based on 8 hours of sleep each night

How can we reduce travel time?

We can use faster vehicles. Travel speed increases with new vehicle technologies. But what if not only vehicles, but also the city itself could get us faster from starting point to destination?

Introducing the mechanism to reduce travel time: the City Accelerator.

Research questions

What if the city could reduce travel time?

1.
How can the city reduce travel time as much as possible?

2.
How much can the city reduce travel time?
How much of the 3,9 years will we be able to spend on other things than travel?

3.
What would the city and life in the city look like then?

Three case studies will answer these questions: case study city of Rotterdam, case study apartment and case study neighbourhood.

PART 2

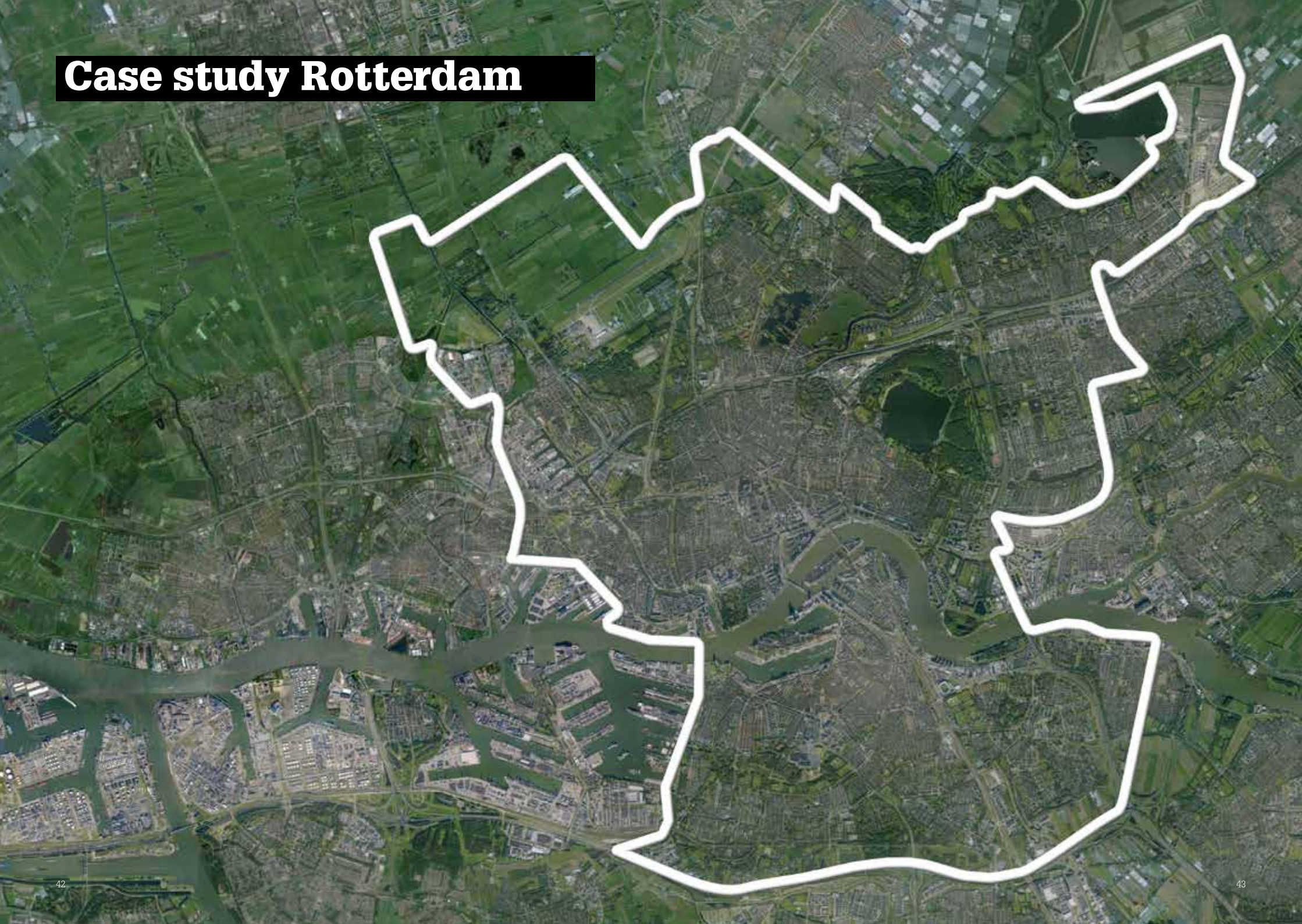
CASE STUDY ROTTERDAM AND TOOLS

CASE STUDY BASELINE

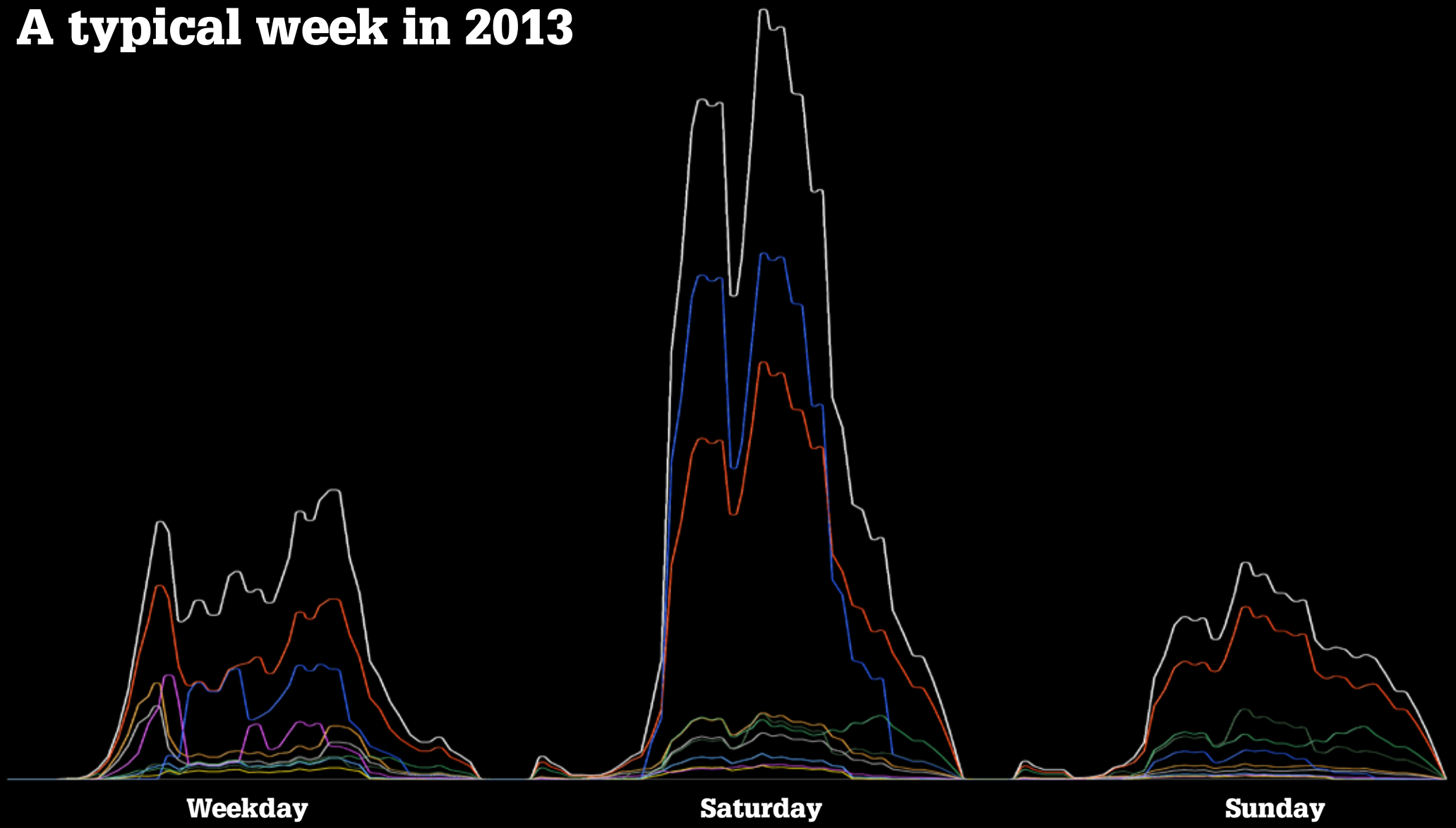
Case study Rotterdam

The Rotterdam council border (2013) (dotted line). Rotterdam's large harbour is part of the Rotterdam council. The case study border (continuous line) defines the part of Rotterdam which is comparable to other cities, and this part of Rotterdam is therefore suitable to research.

Case study Rotterdam



A typical week in 2013



Movements in the city in total (white line) and to and from each of the nine main functions in the city.

Note: if the research is extended by adding differences between workweeks versus holiday weeks, differences in months or seasons and trends for future years, the research results could be even more interesting.

A typical week in 2013

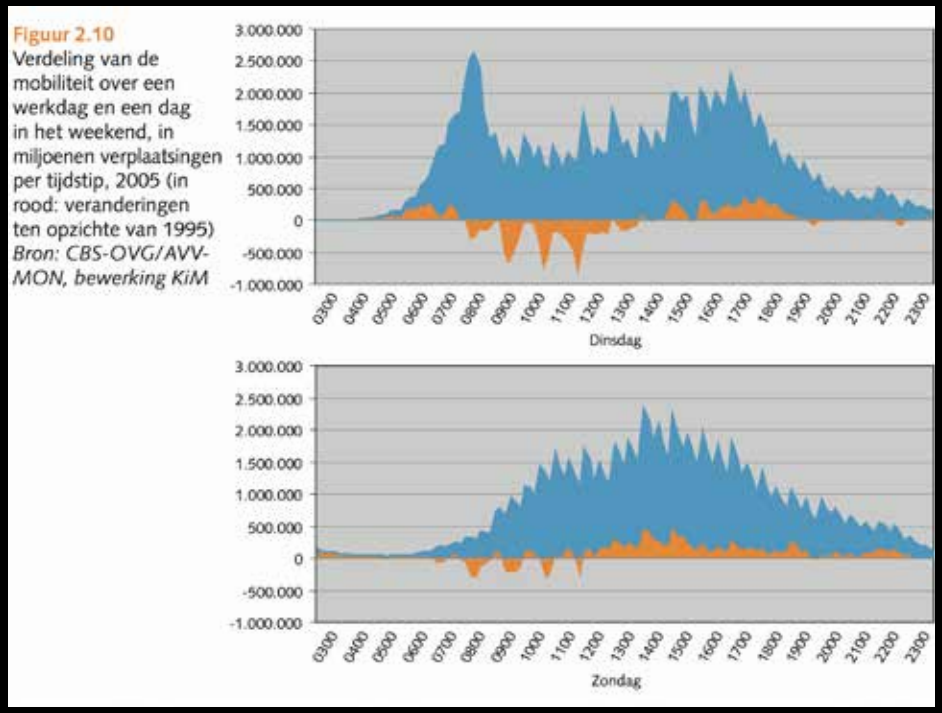
Where does the data for the typical week come from?

They are estimations based on national mobility patterns applied to the city of Rotterdam.

Data from Mobiliteitsbalans 2007 (see image) combined with data from CBS on mobility motives (see image) results in proportional intensities for the connections between healthcare, shops, education, housing, other, leisure, industry and offices. This result could be used as a basis for any city.

This basis is adapted to the city of Rotterdam by subdividing these proportional intensities over the 45 subparticles (based on the amount of particles for each type), adapting intensities to (for example) function opening hours, and multiplying the intensities with the number of inhabitants of Rotterdam.

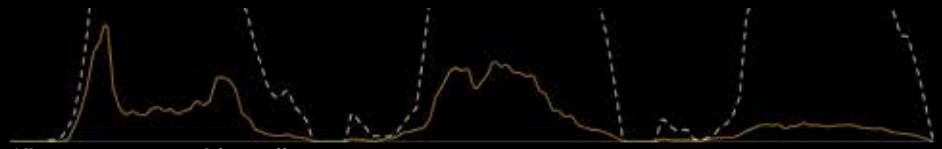
Mobility motives, total number of trips for each motive [1]



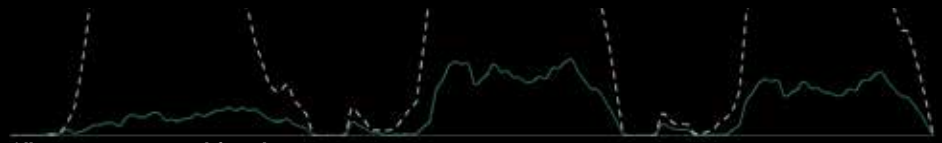
Mobility spread over a working day (top) and weekend day (bottom) in amount of movements at each time during the day. [2]

Movements to and from each of the nine main functions in the city

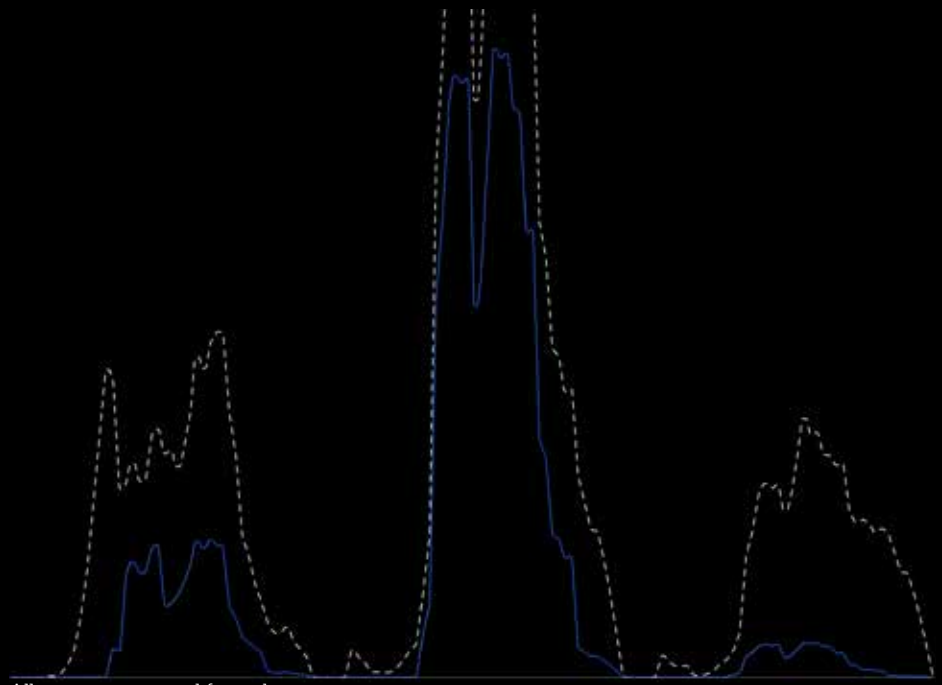
The white (dotted) line indicates the total amount of movement. These graphs display the ratio's of the movements. These ratios are a Dutch average and could thus be applied to any Dutch city. Therefore the graphs do not contain absolute values of movement.



All movements to and from offices

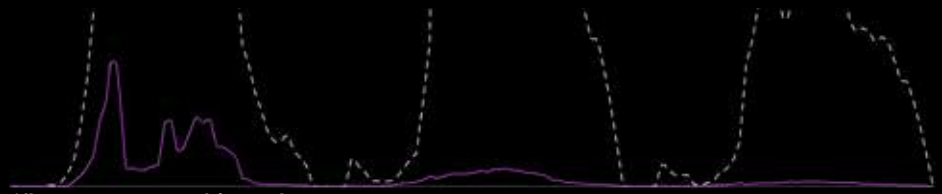


All movements to and from leisure

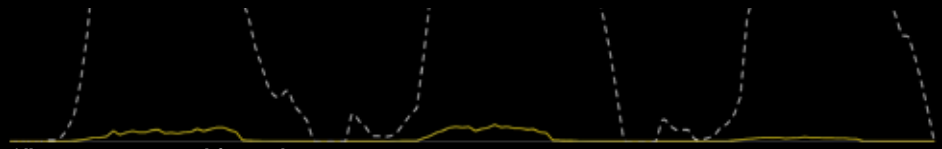


All movement to and from shops

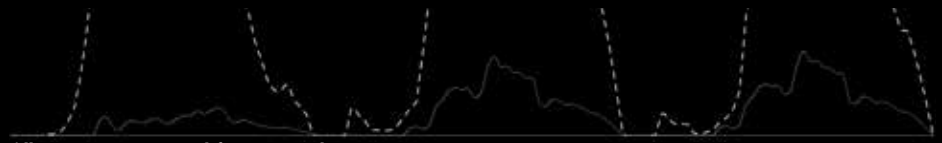
All movement to and from healthcare



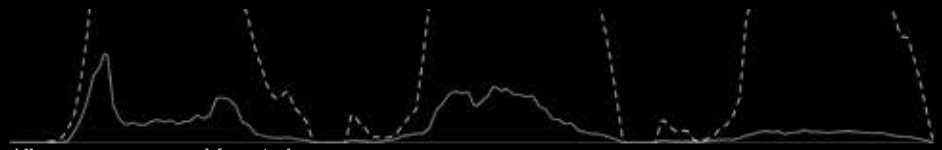
All movements to and from education



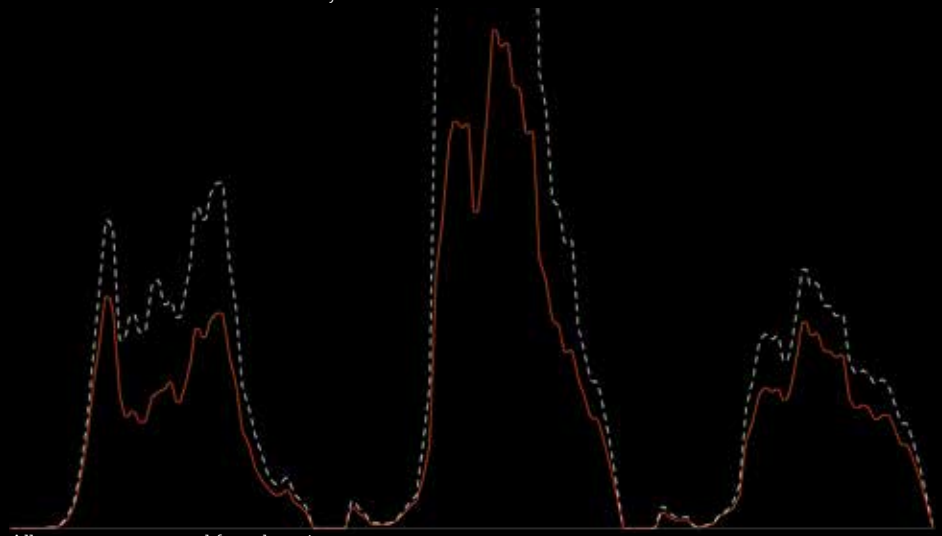
All movements to and from other



All movements to and from agriculture



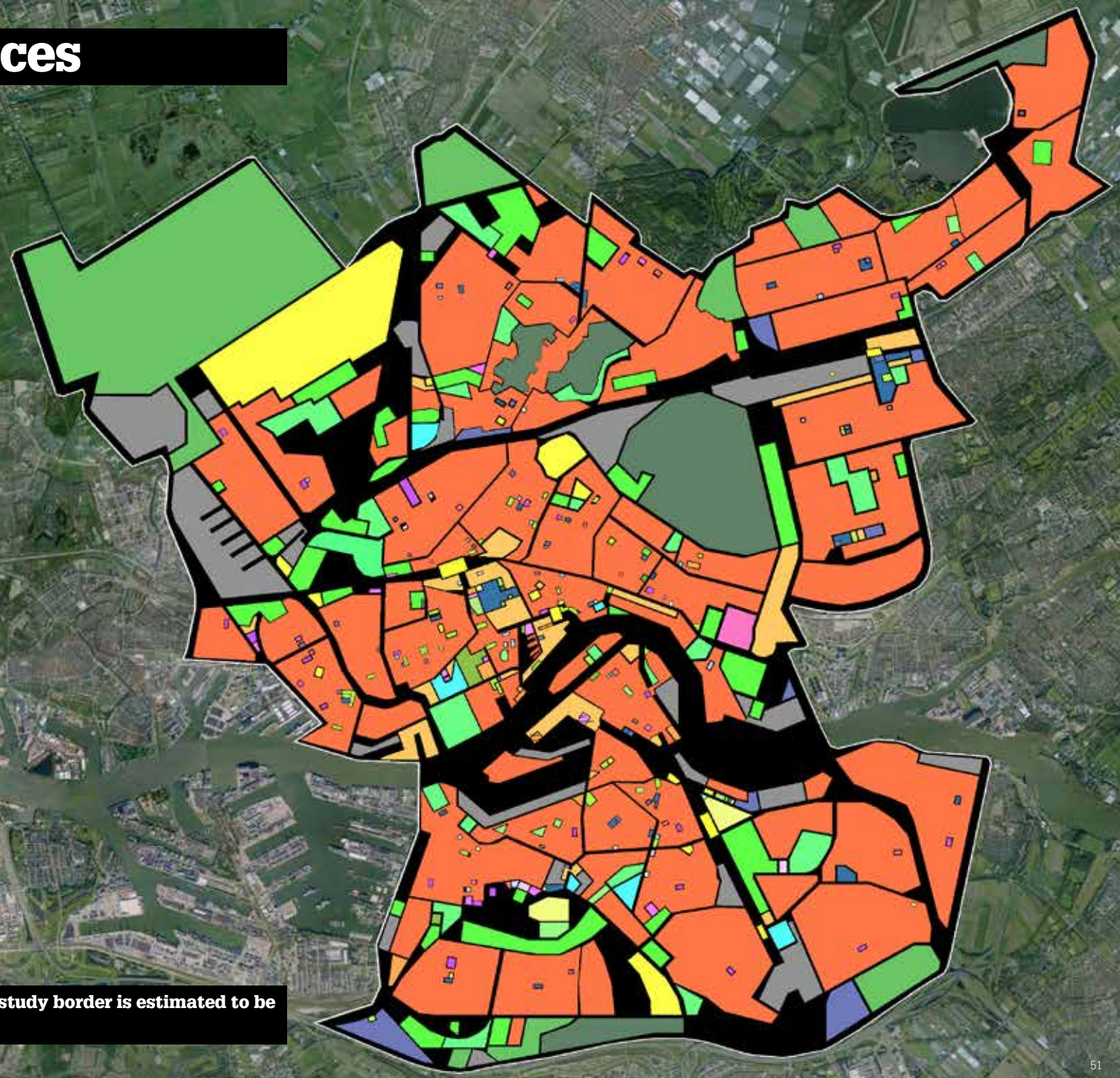
All movements to and from industry



All movements to and from housing

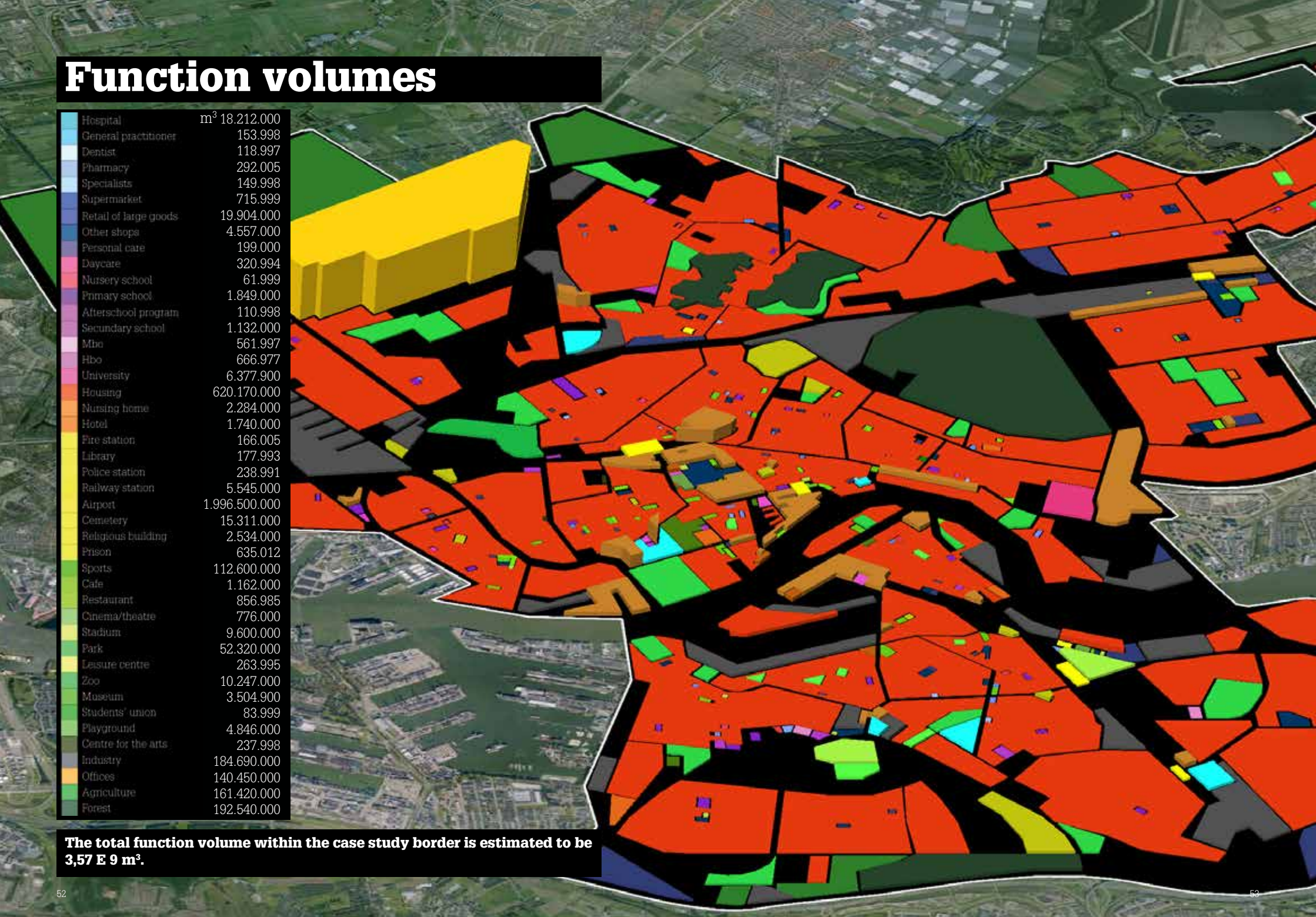
Function surfaces

	m²
Hospital	454.405
General practitioner	19.197
Dentist	14.895
Pharmacy	36.621
Specialists	18.718
Supermarket	71.662
Retail of large goods	995.178
Other shops	506.226
Personal care	24.761
Daycare	40.118
Nursery school	7.857
Primary school	205.652
Afterschool program	22.056
Secundary school	94.254
Mbo	35.160
Hbo	41.634
University	227.790
Housing	50.844.074
Nursing home	142.777
Hotel	51.552
Fire station	10.343
Library	22.284
Police station	14.935
Railway station	178.862
Airport	3.097.030
Cemetery	612.409
Religious building	63.355
Prison	31.764
Sports	4.515.250
Cafe	145.267
Restaurant	106.940
Cinema/theatre	38.801
Stadium	320.001
Park	2.491.495
Leisure centre	22.013
Zoo	341.557
Museum	160.664
Students' union	6.127
Playground	193.899
Centre for the arts	9.507
Industry	6.156.329
Offices	2.320.299
Agriculture	10.761.491
Forest	5.501.154



The total function surface within the case study border is estimated to be 9,10 E 7 m².

Function volumes



	m^3
Hospital	18.212.000
General practitioner	153.998
Dentist	118.997
Pharmacy	292.005
Specialists	149.998
Supermarket	715.999
Retail of large goods	19.904.000
Other shops	4.557.000
Personal care	199.000
Daycare	320.994
Nursery school	61.999
Primary school	1.849.000
Afterschool program	110.998
Secundary school	1.132.000
Mbo	561.997
Hbo	666.977
University	6.377.900
Housing	620.170.000
Nursing home	2.284.000
Hotel	1.740.000
Fire station	166.005
Library	177.993
Police station	238.991
Railway station	5.545.000
Airport	1.996.500.000
Cemetery	15.311.000
Religious building	2.534.000
Prison	635.012
Sports	112.600.000
Cafe	1.162.000
Restaurant	856.985
Cinema/theatre	776.000
Stadium	9.600.000
Park	52.320.000
Leisure centre	263.995
Zoo	10.247.000
Museum	3.504.900
Students' union	83.999
Playground	4.846.000
Centre for the arts	237.998
Industry	184.690.000
Offices	140.450.000
Agriculture	161.420.000
Forest	192.540.000

The total function volume within the case study border is estimated to be 3,57 E 9 m^3.

Function volumes

How is the height of the function volumes determined?

The height of each function depends on the type of function.
The height is the height ...

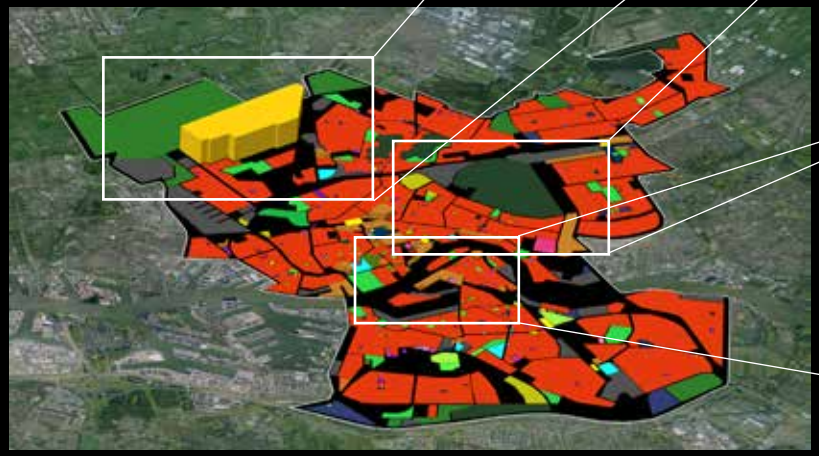
1. ... necessary to perform its function
Example: the airport. The height of the airport is the height necessary for planes to enter or exit the airport through the air. The height is based on the minimum height necessary for this action.

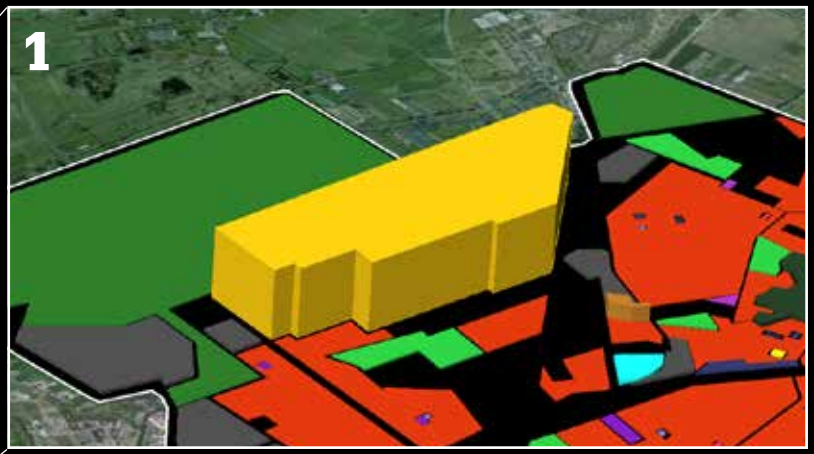
or

2. ... of objects within it
Example: forest. The height of the forest is based on the height of the trees. The height of the forest is based on the highest element (thus the heighest tree).

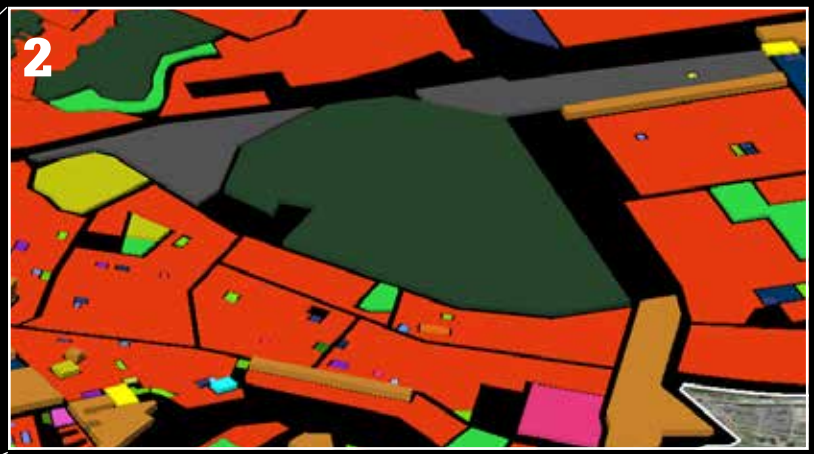
or

3. ... of the buildings within it.
Example: offices. The height of an office volume is based on the heighest office building within it.





Airport



Forest

Offices

Hospital	18.212.000	m³
General practitioner	153.998	
Dentist	118.997	
Pharmacy	292.005	
Specialists	149.998	
Supermarket	715.999	
Retail of large goods	19.904.000	
Other shops	4.557.000	
Personal care	199.000	
Daycare	320.994	
Nursery school	61.999	
Primary school	1.849.000	
Afterschool program	110.998	
Secundary school	1.132.000	
Mbo	561.997	
Hbo	666.977	
University	6.377.900	
Housing	620.170.000	
Nursing home	2.284.000	
Hotel	1.740.000	
Fire station	166.005	
Library	177.993	
Police station	238.991	
Railway station	5.545.000	
Airport	1.996.500.000	
Cemetery	15.311.000	
Religious building	2.534.000	
Prison	635.012	
Sports	112.600.000	
Cafe	1.162.000	
Restaurant	856.985	
Cinema/theatre	776.000	
Stadium	9.600.000	
Park	52.320.000	
Leisure centre	263.995	
Zoo	10.247.000	
Museum	3.504.900	
Students' union	83.999	
Playground	4.846.000	
Centre for the arts	237.998	
Industry	184.690.000	
Offices	140.450.000	
Agriculture	161.420.000	
Forest	192.540.000	

Functions and particles in the city (2013) in simplified shapes. Perspective view

Healthcare

18.926.998 m³

Shops

25.375.999 m³

Education

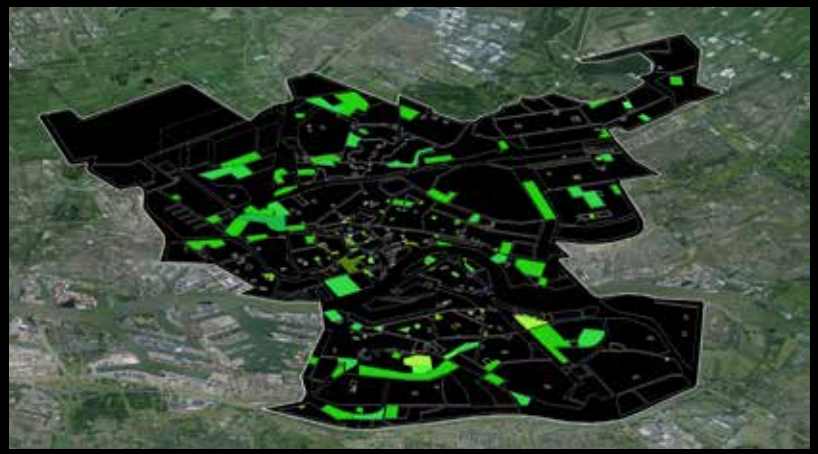
11.081.865 m³

Housing

624.194.000 m³

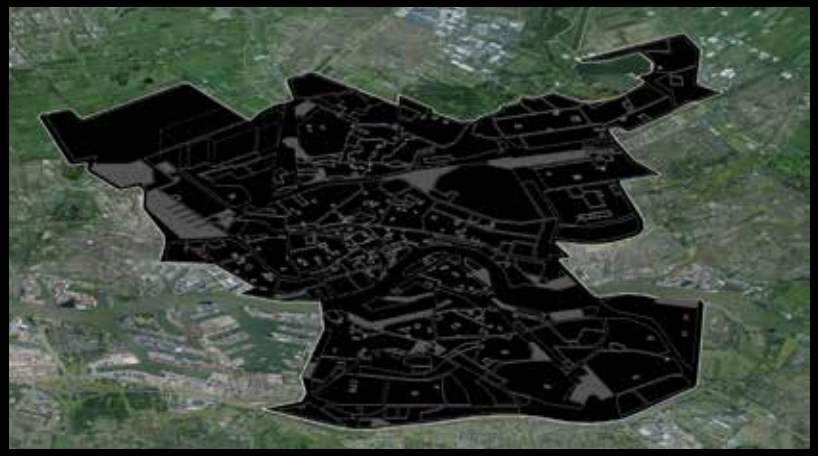
Other

2.021.108.001 m³



Leisure

195.498.877 m³



Industry

184.690.000 m³

Offices

140.450.000 m³

Agriculture

353.960.000 m³

Detail level of function volumes

The function volumes determined in the city of Rotterdam are not exactly the same as reality. Larger function volumes determined in the model, such as housing, could in reality still contain functions like shops and schools. At some points, the model distinguishes those different functions in different function volumes, at other points the model is simplified. Why is the function volume division not the same as reality? What was the reason that the model is simplified in some areas of Rotterdam, but detailed in other areas?

A quick search on the internet reveals that the city of Rotterdam contains about 560.000 homes [1], about 70 supermarkets [2], about 3800 other stores [3], about 163 primary schools [4], about 170 general practioners [5], etc. Why doesn't the model contain all those separate function volumes? The model is not as detailed as in reality for two main reasons.

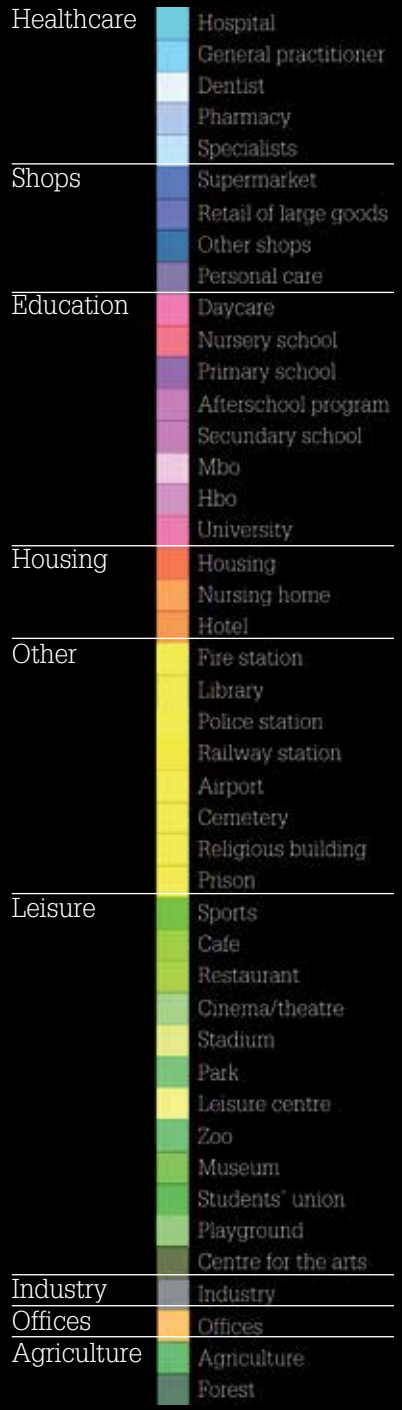
First of all, it is very timeconsuming to study the locations and volumes of all the different functions in the city of Rotterdam. Moreover, since this graduation project is a first test for creating a method to reduce travel time, a high detailing level might not even be necessary for more interesting results.

Secondly, the more detailed the model gets, the more complex the model with connections intensities between the function volumes becomes. That does not make the tools more difficult to understand, but it will have a bigger impact on computer capabilities to calculate results.

Apart from the above mentioned reasons to abstract the city to a certain extend, we can also argue a less detailed model based on chosen requirements for the city. Keeping smaller (more realistic) function volumes together in a larger volume will provide a sense of stability for the inhabitants.

But why then is the model detailed at some points and not everywhere? Why this detailing level? Why not more detailed and why not less detailed? Because city needs different functions, and daily routines and travel time results depend on them. Without differen types of functions, daily routines and city designs are not that interesting.

Even though the function volumes are not as detailed as in reality, I am aware of the fact that each simplified function volume actually consists of smaller function volumes. This fact becomes clear when zooming into the city and applying the tools on different scale levels.



Function detailing

In this project the city of Rotterdam was divided into volumes for 9 main functions: healthcare, shopping, education, housing, other, leisure, industry, offices and agriculture. Most of those functions are further subdivided into "specializations", leading to 45 different sub-functions.

Why were, in contrast to the other functions, offices and industry not further subdivided in subfunctions?

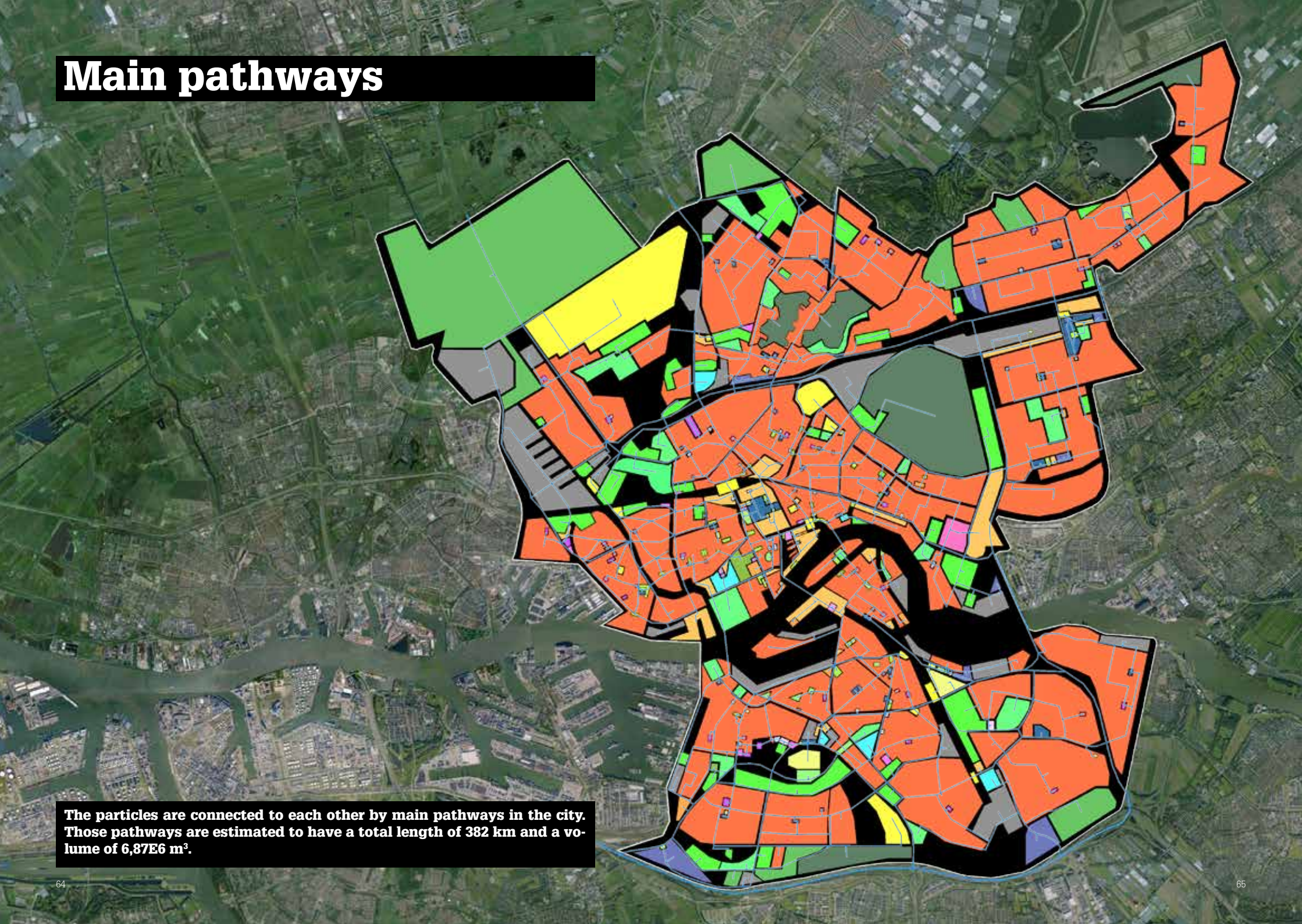
The reason is based on the daily routines of the inhabitants of the city: where do the people go to at what moment of the day? For this project it is interesting to know the differences between the functions (amount of people using a function and at what time -frame they use is). After all, based on those differences, one function could be more important than the other at certain times, and the city will adapt.

Therefore, for example, education is further subdivided into e.g. primary school and university. Generally, primary schools are used between around 08:00 and 16:00, while universities are used between 07:00 and 22:00. This difference is a reason for the city to adapt, and therefore necessary to determine.

When we look at offices and industry, we can further subdivide them into different types of offices and industry but still the amount of people using them (as in people/m^3) and the timeframes in which they are used are generally the same for all offices and the same for all industry. This lack of any (major) difference (at least any significant difference useful for the project) in sub-functions for offices and industry was the reason that sub-functions were left out for those two functions.

This is also the reason why it was not necessary to further subdivide the 45 sub-fuctions into for example soccer fields, tennis courts, gyms etc for the sub-function "sports".

Main pathways



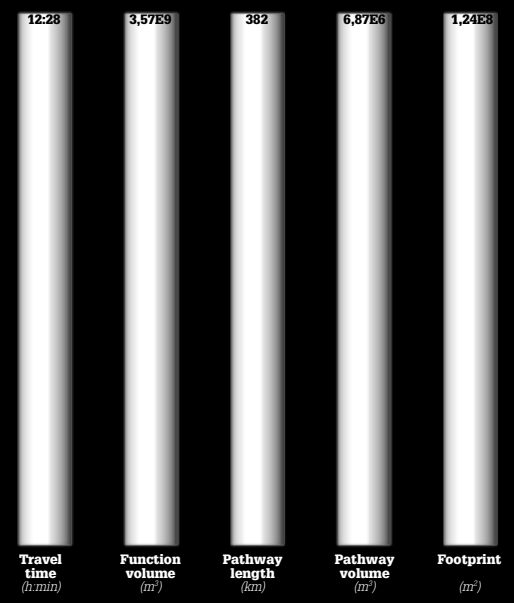
The particles are connected to each other by main pathways in the city. Those pathways are estimated to have a total length of 382 km and a volume of 6,87E6 m³.

Weekly passenger travel time

**Within this case study border,
Rotterdam citizens and visitors are estimated to spend 12 hours and 28 minutes* per week on travel**

within the city of Rotterdam.

**in case all travel is done:
* by bike
by car: 6 hours and 26 minutes
by public transport: 17 hours and 46 minutes
walking: 37 hours and 33 minutes**



Weekly passenger travel time

For each connection in the city, the travel time is collected from Google Maps. For each connection in the city, the travel time by car, by bicycle, by public transport and as a pedestrian is collected.

What are the precize start and end points of each connection? After all, many of the function volumes determined in the city cover large surfaces that in fact include multiple buildings and thus multiple entrances. For those volumes, such as housing volumes, an address in the center of the volume is chosen as the start and end point of an connection. For the volumes that in reality consist of just one building, the start/end point of the connection is the entrance closest to the other start/end point.

The total amount of travel time for the city of Rotterdam is calculated by these formulas:

Per connection, per week, for one type of vehicle:

Total travel time per connection (s)	=	Nr of people (#)*	X	Travel time per connection (S)**

Per week for one type of vehicle:

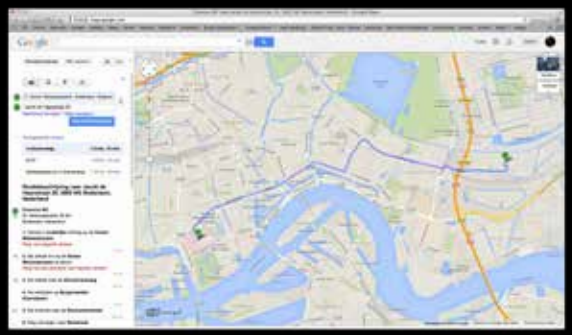
Total city's travel time (s)	=	$\sum$	Total travel time per connection (s)

* The number of people using that connection
** Data from Google.maps

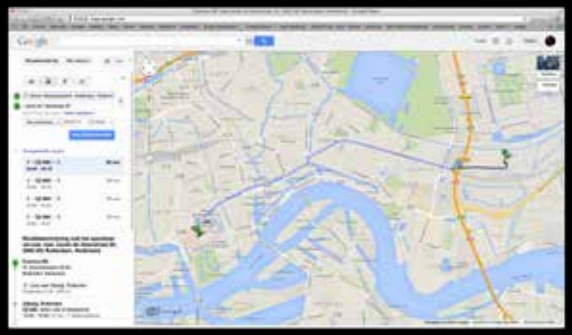
For each of the connections in the city, the travel time is calculated by inserting the end points of the connection into the "route planning" function of Google Maps.

For each of the connections Google Maps can calculate the travel time per:

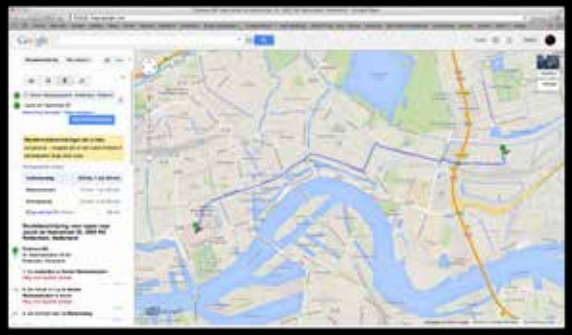
car



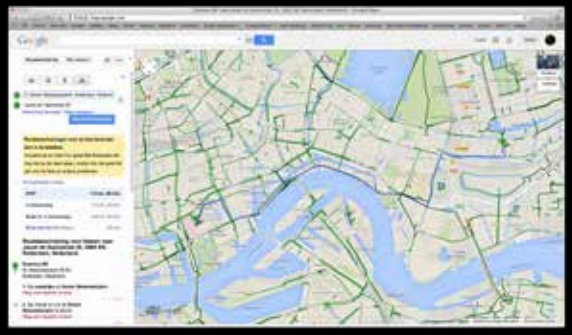
public transport



walking



bike



ABSTRACTION

Model abstraction

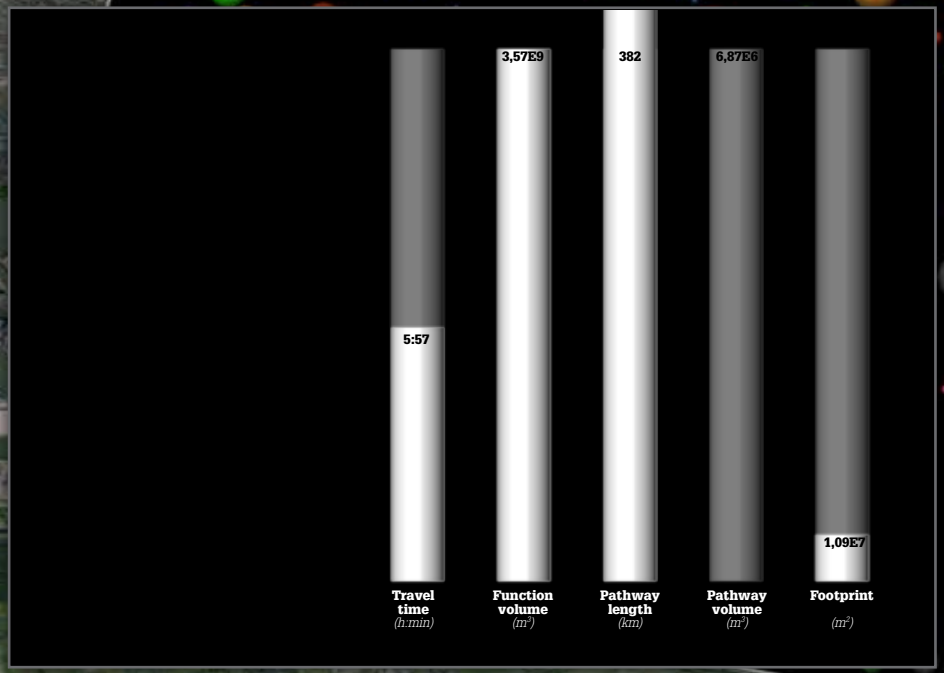
By abstracting the function volumes and pathways in the city the model is kept clearly understandable by only retaining the information which is relevant for testing the situation.

In the case of the function volumes, only the amount of cubic meters is important. Therefore the volume is represented as a sphere, losing the original dimensions and making all function volumes comparable in size.

In the case of the pathways, only the starting point and end point of the connection is important. Therefore each connection is represented as a direct line between those points. This makes each connection comparable in lenght.

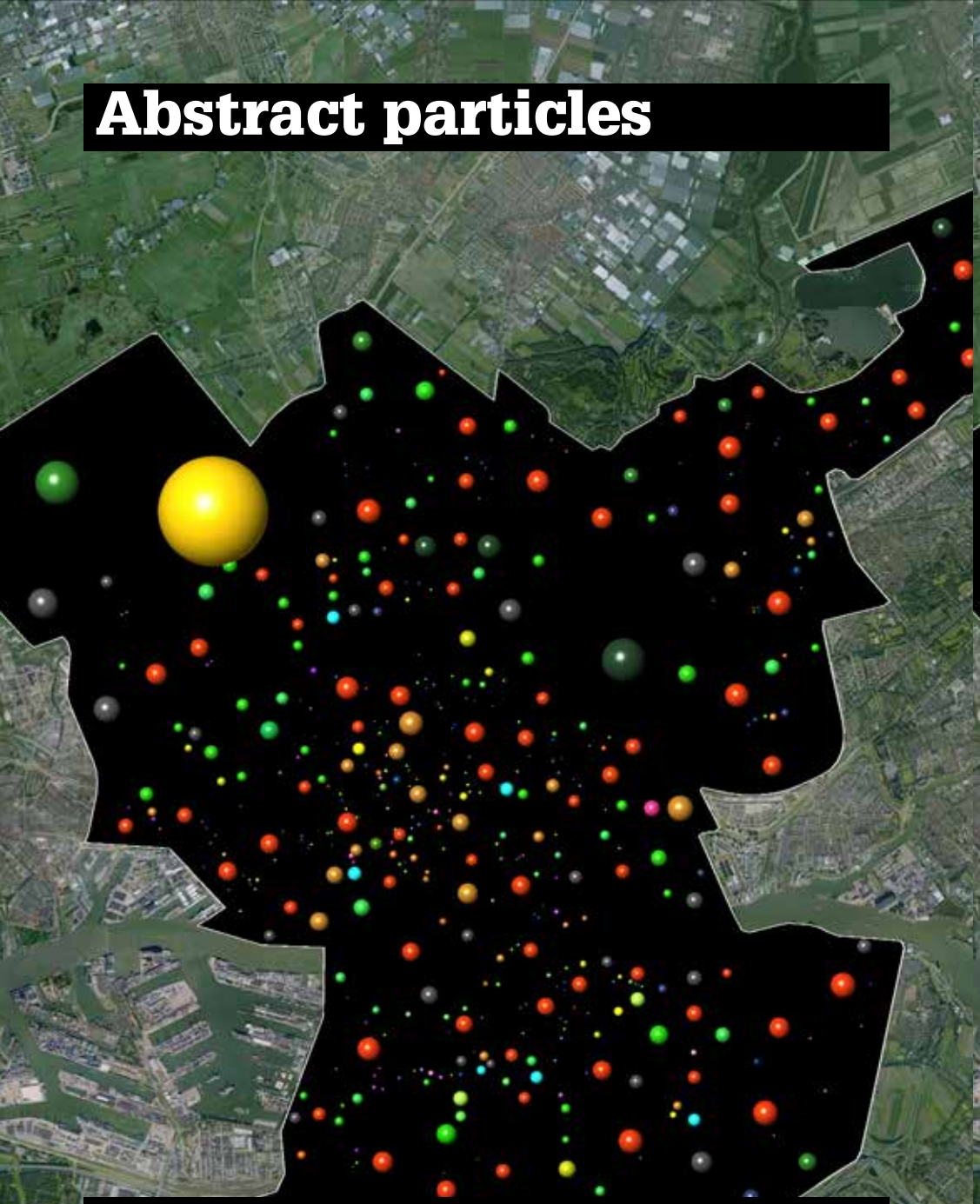
Abstract visualization of volumes and connections in the city will both help to clearly understand the situation and gives freedom to test different tools, and compare the results of the tools.

Abstract particles



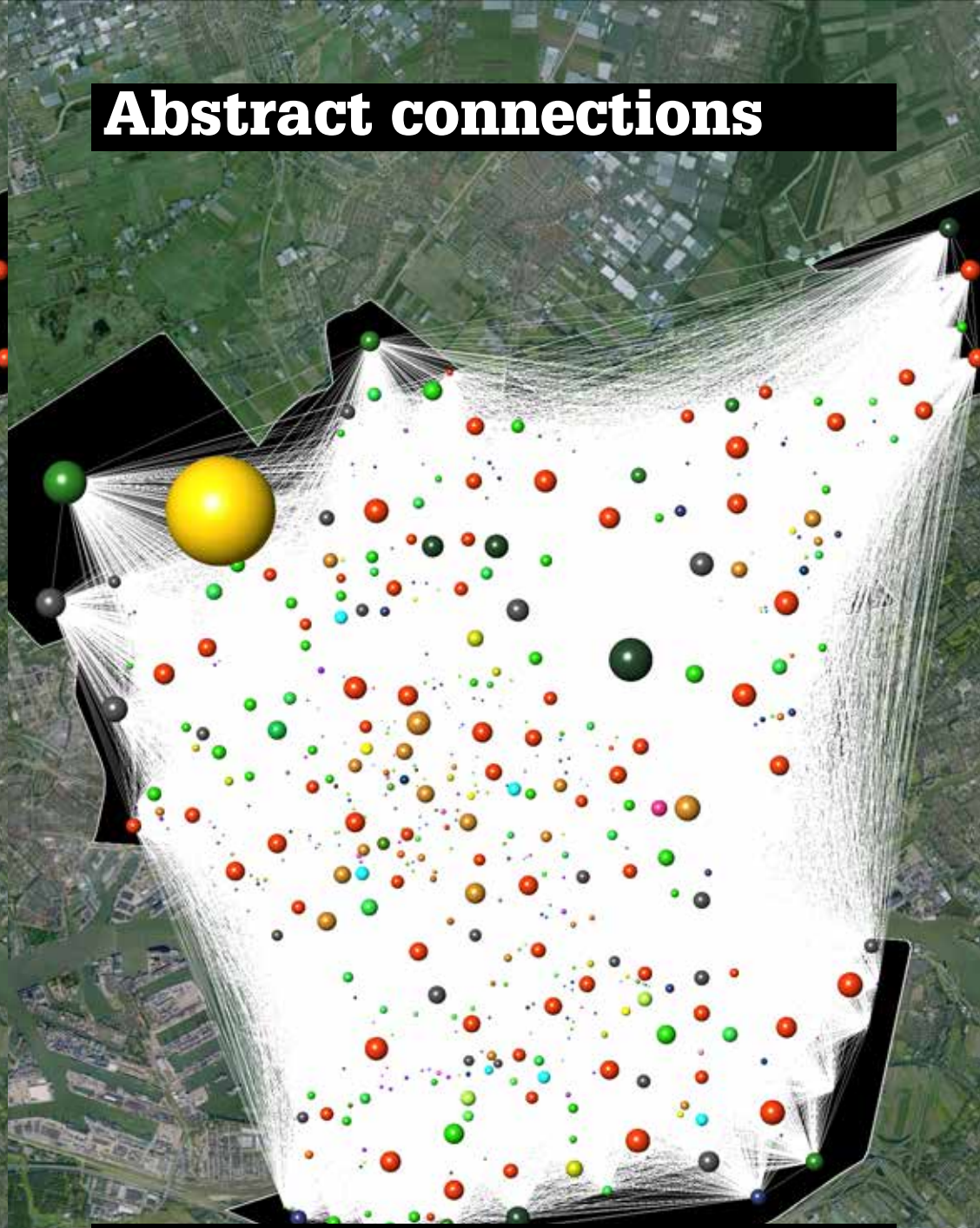
Abstract visualization of volumes and connections in the city will both help to clearly understand the situation and gives freedom to test different scenarios.

Abstract particles



Abstract visualization of volumes and connections in the city will both help to clearly understand the situation and gives freedom to test different scenarios.

Abstract connections



The abstract visualization of connections in the city. All 472 particles are interconnected, resulting in a total number of connections of 111.156.

TOOLS TO REDUCE TRAVEL TIME

The tools

When vehicle speed is constant, travel time depends on:

1. Pathway length
   The longer the pathway, the more travel time.

2. Pathway crossings
   Crossings lead to vehicles slowing down and waiting for other vehicles to pass, and thus an increase in travel time.

3. Transit time
   Especially when travelling by public transport travel time is increased by the time to move from one vehicle to another and the waiting time for the arrival and departure of the vehicle.

4. Pathway inclination
   Pathway inclination reduces the speed of vehicles moving upwards, and increases the speed of vehicles moving downwards. This thus effects the travel time.

5. Congestion
   When the pathway intensity is higher than the pathway capacity, this leads to congestion and traffic jams. Congestion leads to lower speeds and thus more travel time.

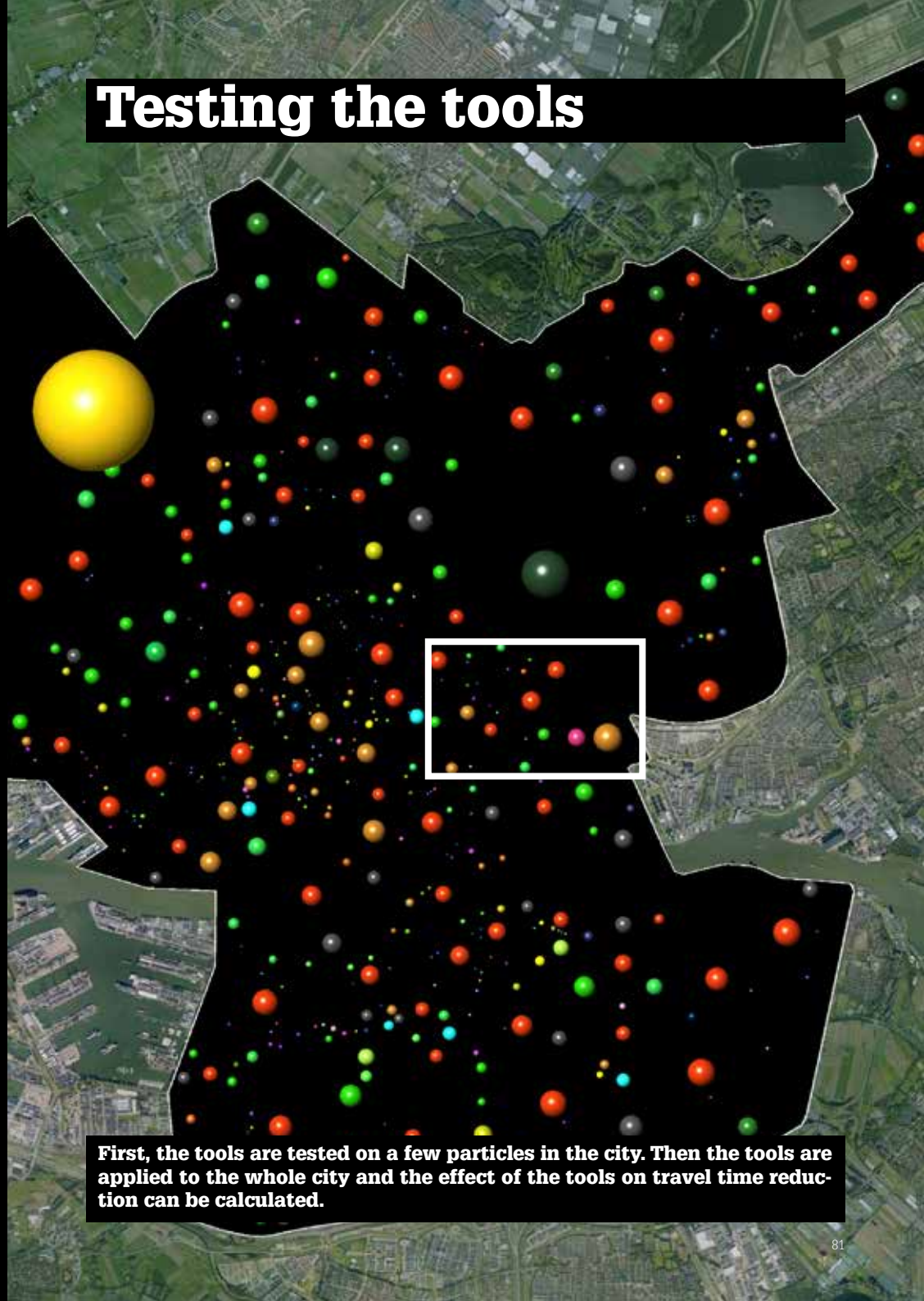
The City Accelerator project developed **5 TOOLS** to reduce travel time.

Tool 1, 2 and 3 all focus on the first factor that determines travel time. These tools reduce the size of the city and thus the pathway lengths within the city. Tool 4 and 5 also focus on the first factor by reducing the size of the city as much as possible, but also focus on the fifth factor. Factor 2, 3, and 4 could be dealt with in continuation of the City Accelerator project.

The tools are sets of rules that generate the city configuration or elements of the city based on data input.

Even though the case study is Rotterdam, the tools to reduce travel time are **GENERIC TOOLS** and could be applied to any city or to any scale level (building, neighbourhood, room, etc ...) This means the tools are suitable to reduce travel time in any city, or for example to reduce travel time within a building.

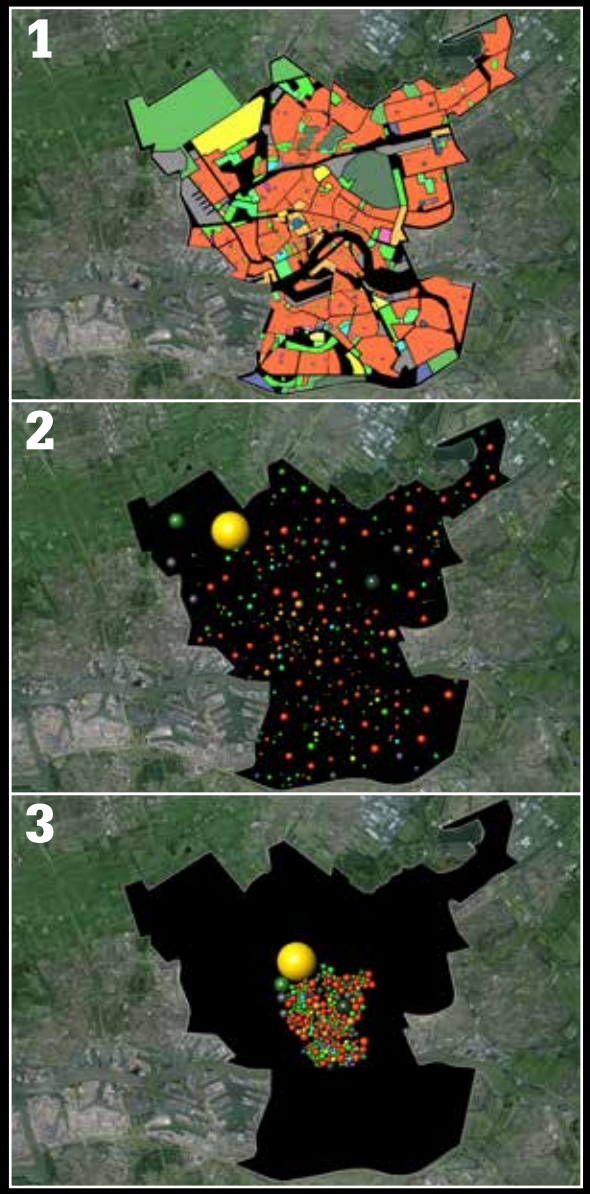
Testing the tools



First, the tools are tested on a few particles in the city. Then the tools are applied to the whole city and the effect of the tools on travel time reduction can be calculated.

TOOL 1
RESHAPE
PARTICLES

Tool decription



By reshaping the particles from their original shapes into spheres, the particles can lay closer together.

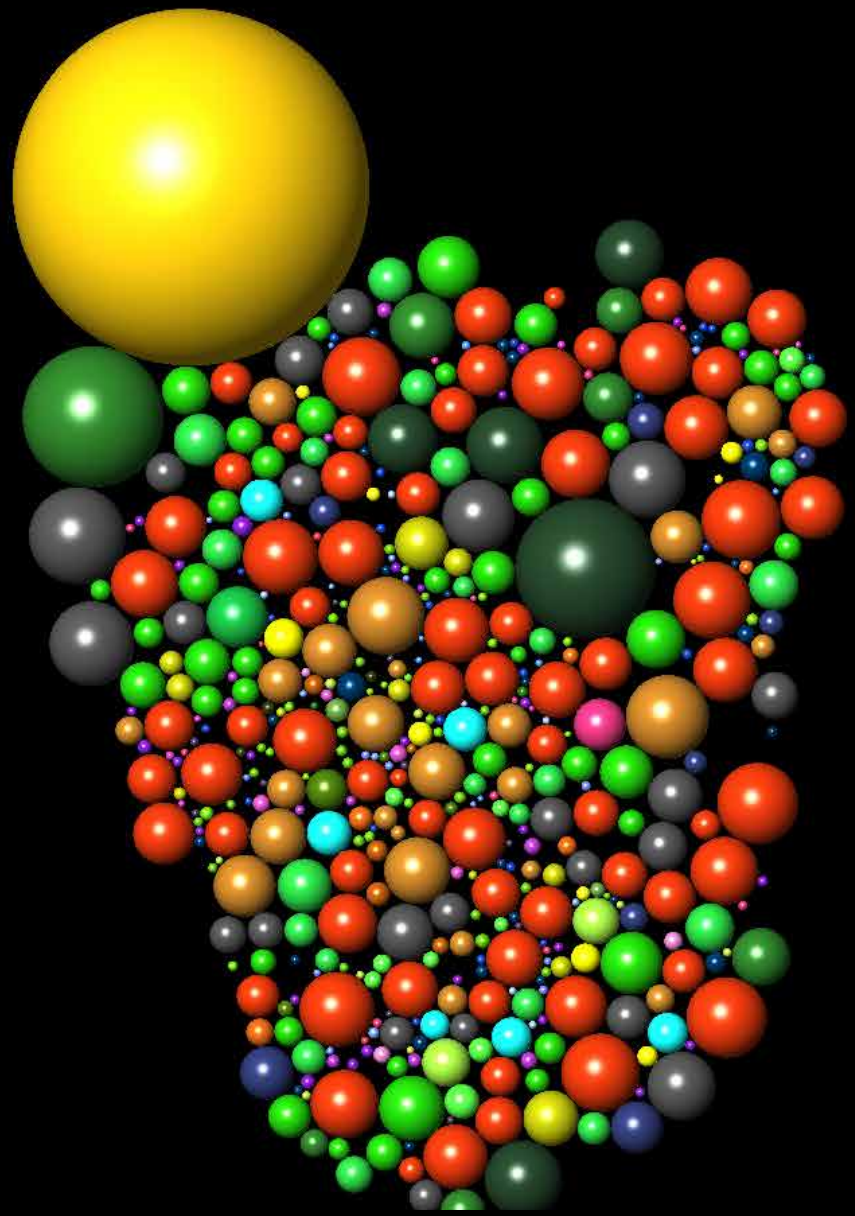
Tbe configuration of the particles remains the same as the configuration of the particles in current Rotterdam.

Tool decription

Rules

- **Each volume reshapes into a sphere with the same amount of volume**
- **Spheres cannot interpenetrate**
- **Spheres lay as close to each other as possible, while ...**
- **... the configuration of the spheres remains the same.**

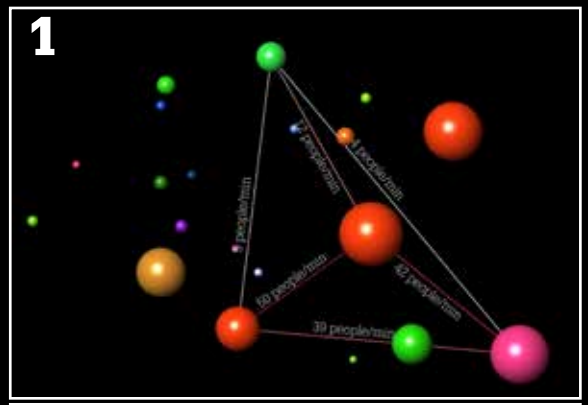
Particles closer together



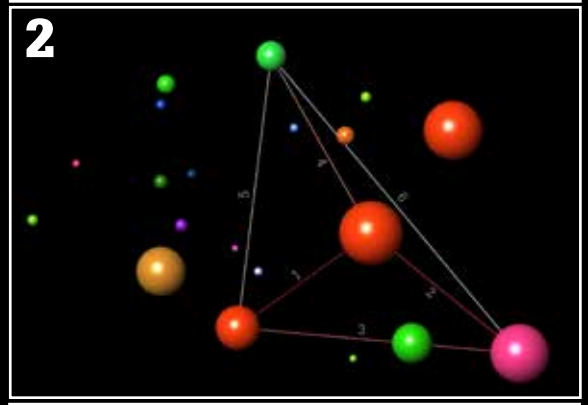
Because the volumes are reshaped into abstract spheres, the spheres can lay closer together, resulting in a reduction in travel time. The configuration of the particles remains the same as the case study baseline.

TOOL 2
CONFIGURATION

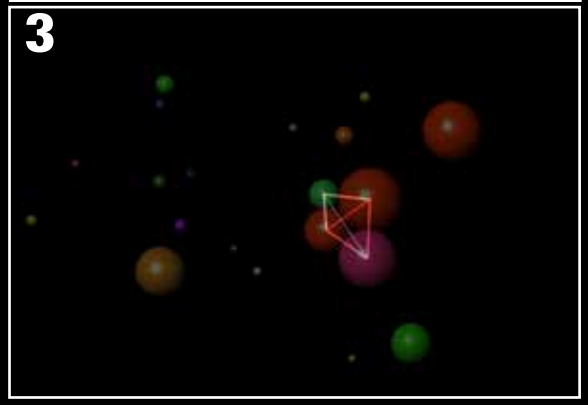
Tool decription



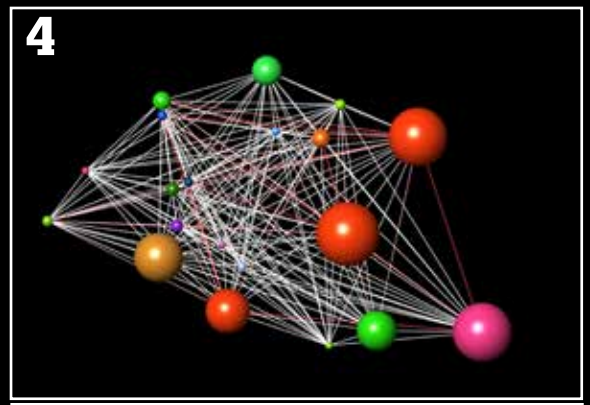
The particles in the city are connected to each other.
To explain the tool the first example has 4 interconnected particles. The length of each connection determines the travel time. The more people use that connection the higher the total cities travel time.
The connection intensity for each connection is expressed in nr of people per minute.



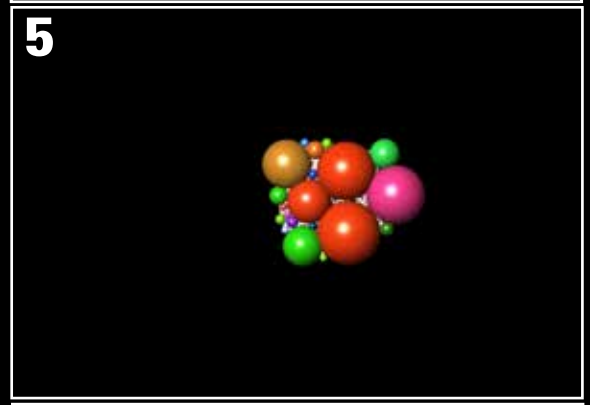
Based on the connection intensities, each connection is ranked in a hierarchy. The higher the amount of people per minute, the more important the connection.



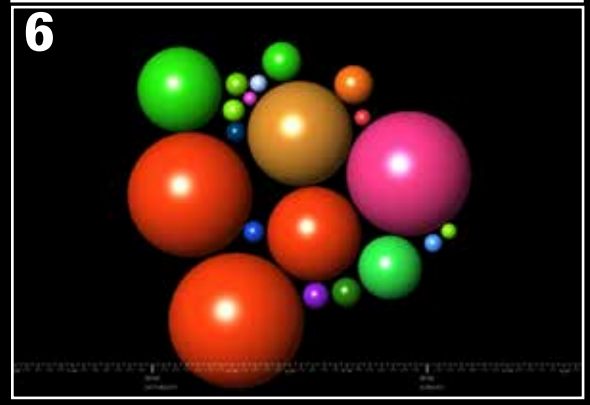
The hierarchy determines the configuration. The more important the connection, the closer the particles should be placed together. This image shows that connections with higher intensities are as short as possible.
In this example, the only connection that is not as short is possible is the connection with the lowest intensity.



This method can be applied to as many particles as necessary.



Based on the connection intensities and therefore their hierarchy, this example will be configured like this.



Since the connection intensities can change every half hour, the configuration of the city can change as well.
This gives us an adaptable city.

Tool decription

Rules:

- **Spheres cannot interpenetrate**
- **Spheres lay as close to each other as possible, while ...**
- **... spheres that have a connection with a higher connection intensity are positioned closer to each other than spheres that have a lower connection intensity.**

Formulas

Per person

$$\text{Travel time per pathway (s)} = \frac{\text{Pathway length (m)}}{\text{Speed (m/s)}}$$

Per pathway

$$\text{Total travel time per pathway (s)} = \text{Nr of people (\#)} \times \text{Travel time per pathway (S)}$$

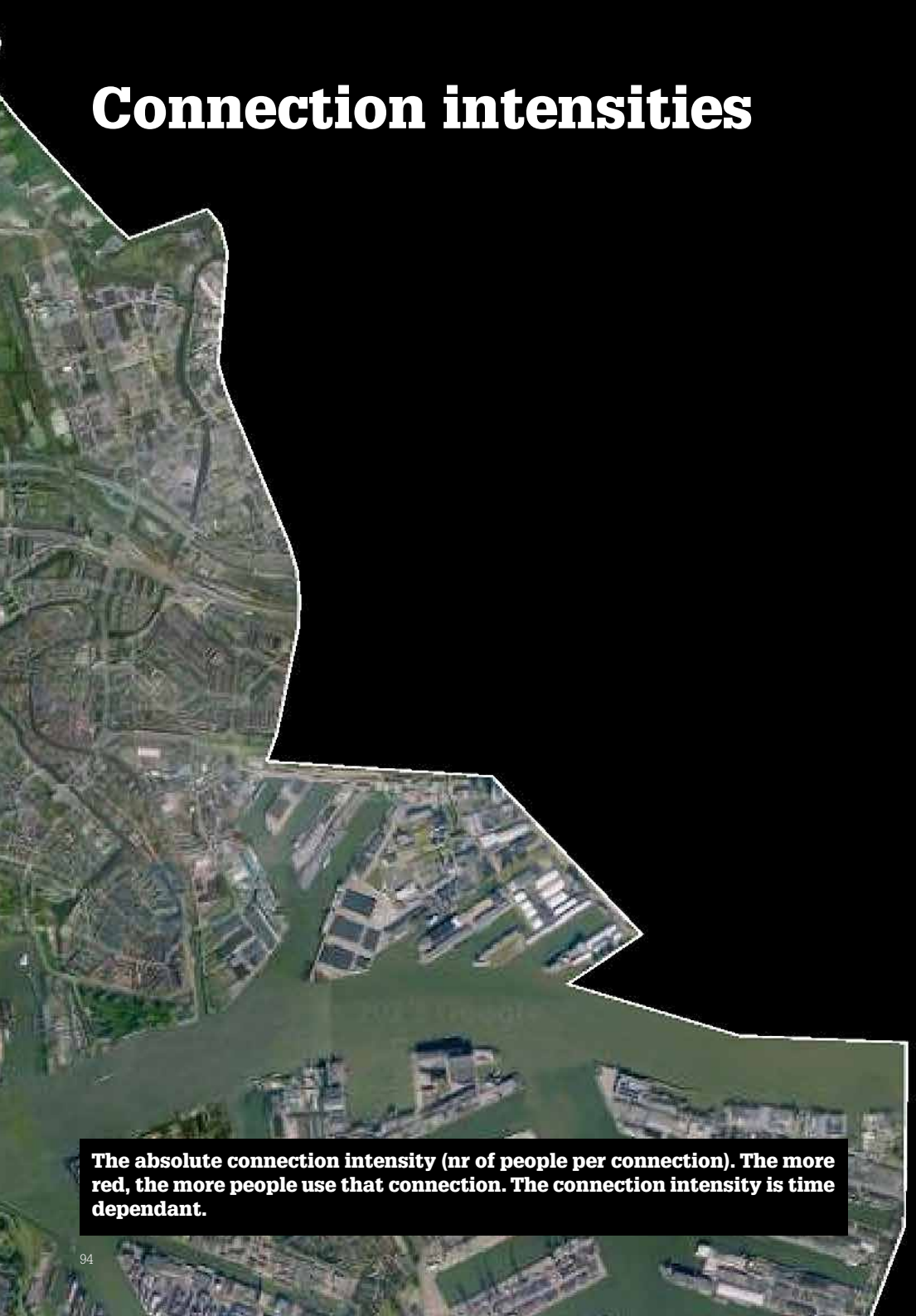
Whole city

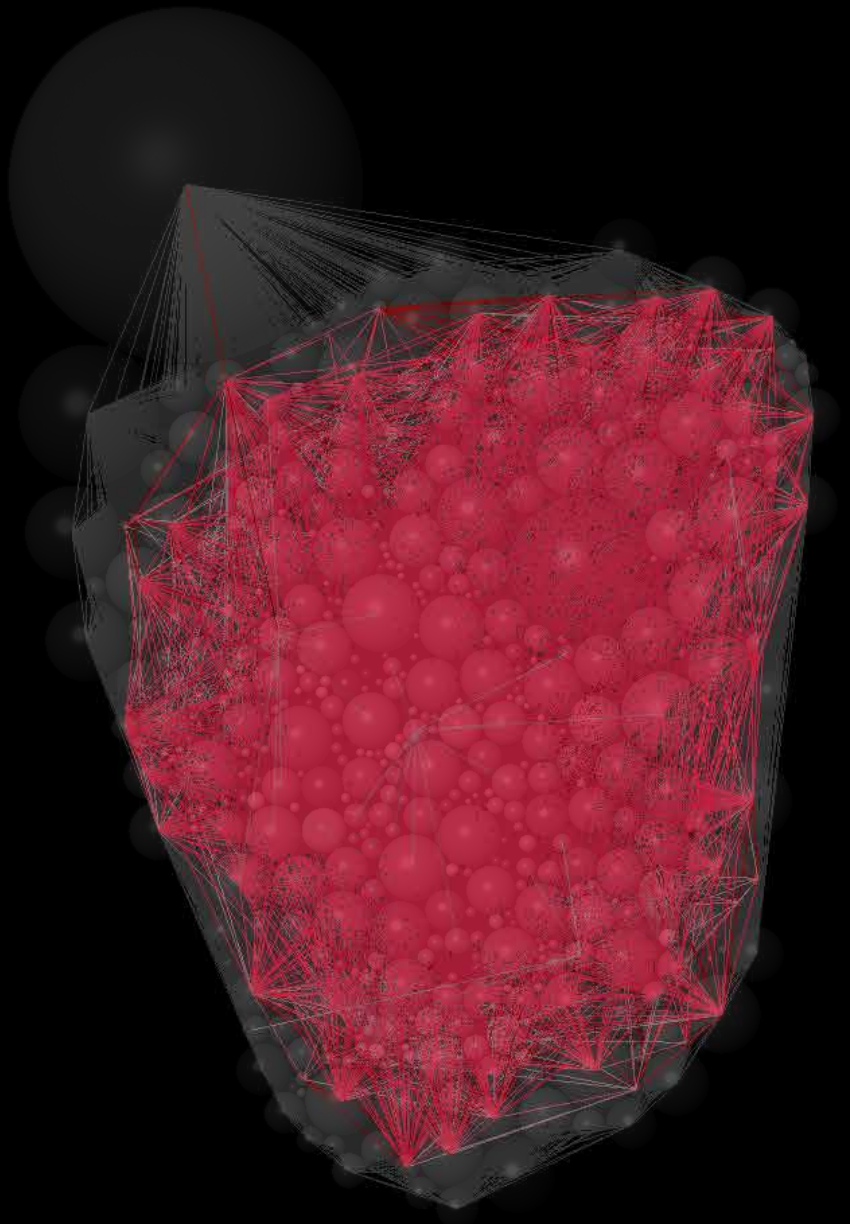
$$\text{SUM Total travel time per pathway (s)}$$

The formulas proof the importance of including the connection intensity and the hierarchy into de rules to configure the city.

When the amount of people using the pathway is higher the travel time per pathway should be lower to keep the total travel time per pathway as low as possible. We can lower the travel time per pathway by reducing the pathway length.

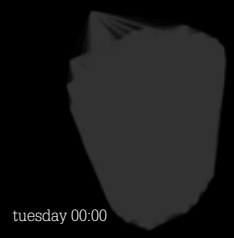
Connection intensities





The absolute connection intensity (nr of people per connection). The more red, the more people use that connection. The connection intensity is time dependant.

TUESDAY 08:00


tuesday 00:00


saturday 00:00


sunday 00:00


tuesday 00:30

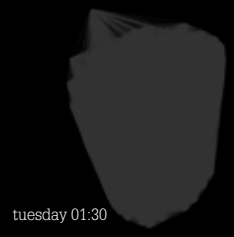

saturday 00:30


sunday 00:30


tuesday 01:00

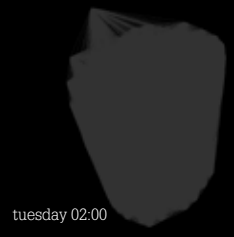

saturday 01:00


sunday 01:00


tuesday 01:30

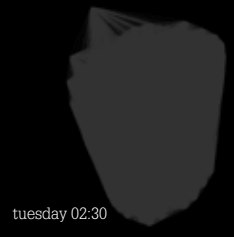

saturday 01:30

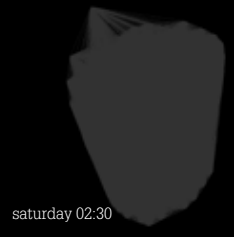

sunday 01:30


tuesday 02:00

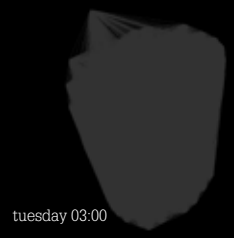

saturday 02:00


sunday 02:00


tuesday 02:30

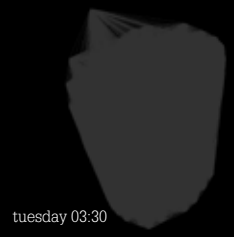

saturday 02:30


sunday 02:30


tuesday 03:00

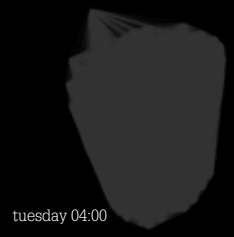

saturday 03:00


sunday 03:00


tuesday 03:30

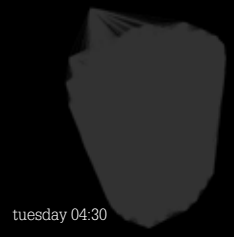

saturday 03:30


sunday 03:30


tuesday 04:00


saturday 04:00


sunday 04:00


tuesday 04:30

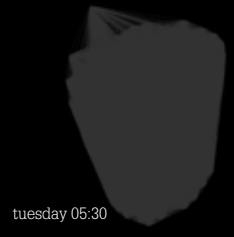

saturday 04:30


sunday 04:30


tuesday 05:00

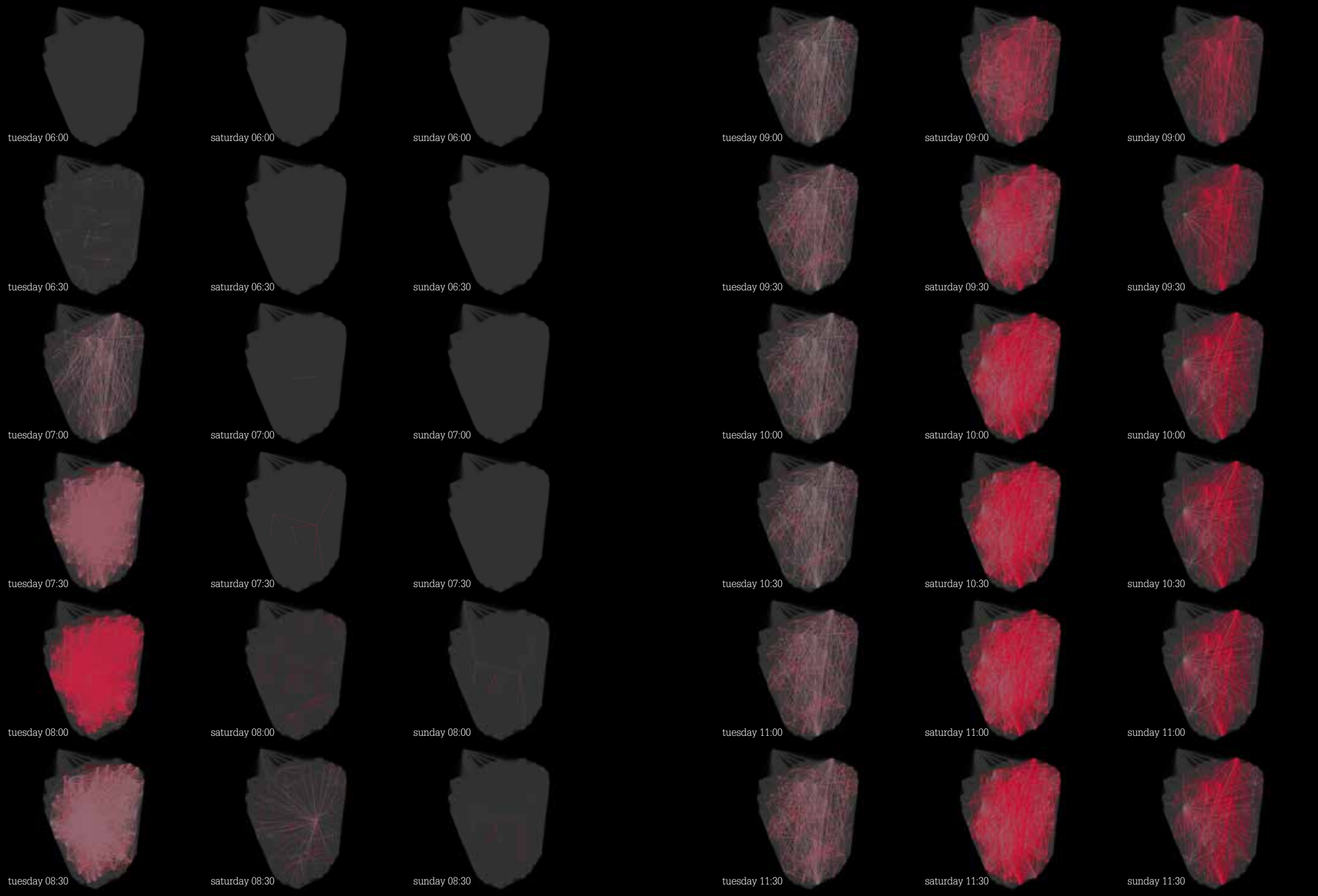

saturday 05:00

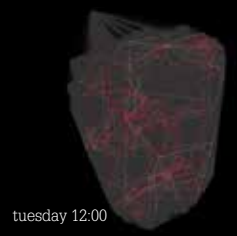

sunday 05:00

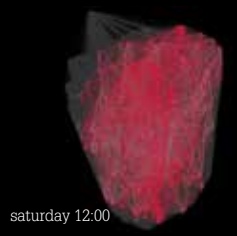

tuesday 05:30


saturday 05:30


sunday 05:30

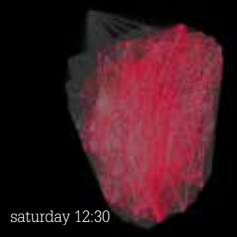

tuesday 06:00
saturday 06:00
sunday 06:00
tuesday 09:00
saturday 09:00
sunday 09:00
tuesday 06:30
saturday 06:30
sunday 06:30
tuesday 09:30
saturday 09:30
sunday 09:30
tuesday 07:00
saturday 07:00
sunday 07:00
tuesday 10:00
saturday 10:00
sunday 10:00
tuesday 07:30
saturday 07:30
sunday 07:30
tuesday 10:30
saturday 10:30
sunday 10:30
tuesday 08:00
saturday 08:00
sunday 08:00
tuesday 11:00
saturday 11:00
sunday 11:00
tuesday 08:30
saturday 08:30
sunday 08:30
tuesday 11:30
saturday 11:30
sunday 11:30


tuesday 12:00


saturday 12:00

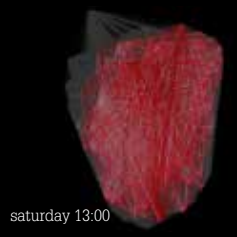

sunday 12:00

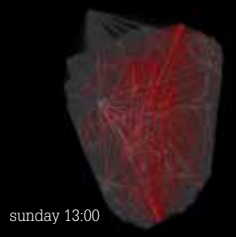

tuesday 12:30

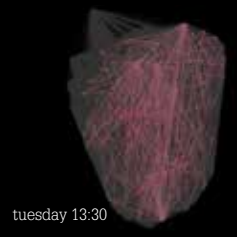

saturday 12:30


sunday 12:30


tuesday 13:00


saturday 13:00


sunday 13:00


tuesday 13:30

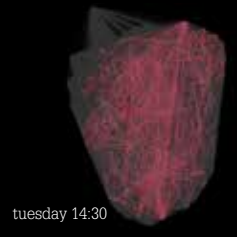

saturday 13:30


sunday 13:30


tuesday 14:00


saturday 14:00


sunday 14:00

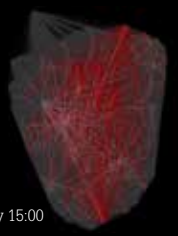

tuesday 14:30


saturday 14:30


sunday 14:30

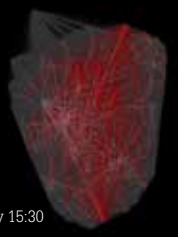

tuesday 15:00


saturday 15:00


sunday 15:00


tuesday 15:30


saturday 15:30


sunday 15:30

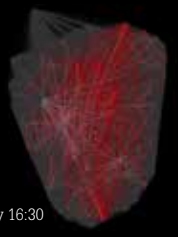

tuesday 16:00


saturday 16:00


sunday 16:00

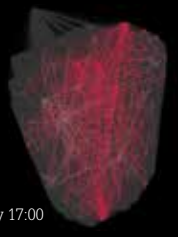

tuesday 16:30


saturday 16:30


sunday 16:30

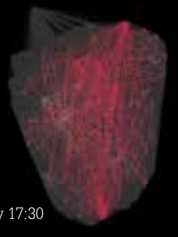

tuesday 17:00

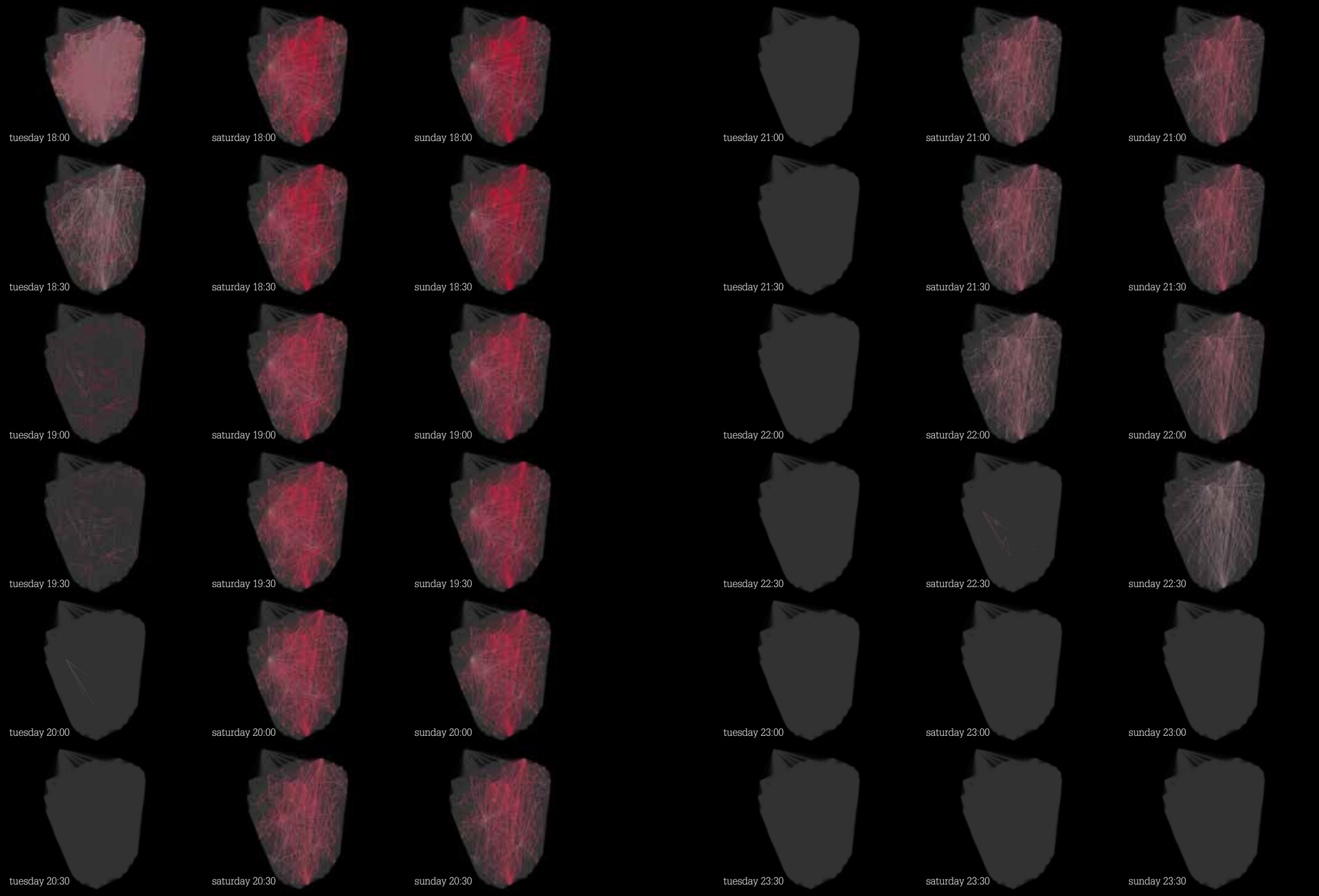

saturday 17:00


sunday 17:00

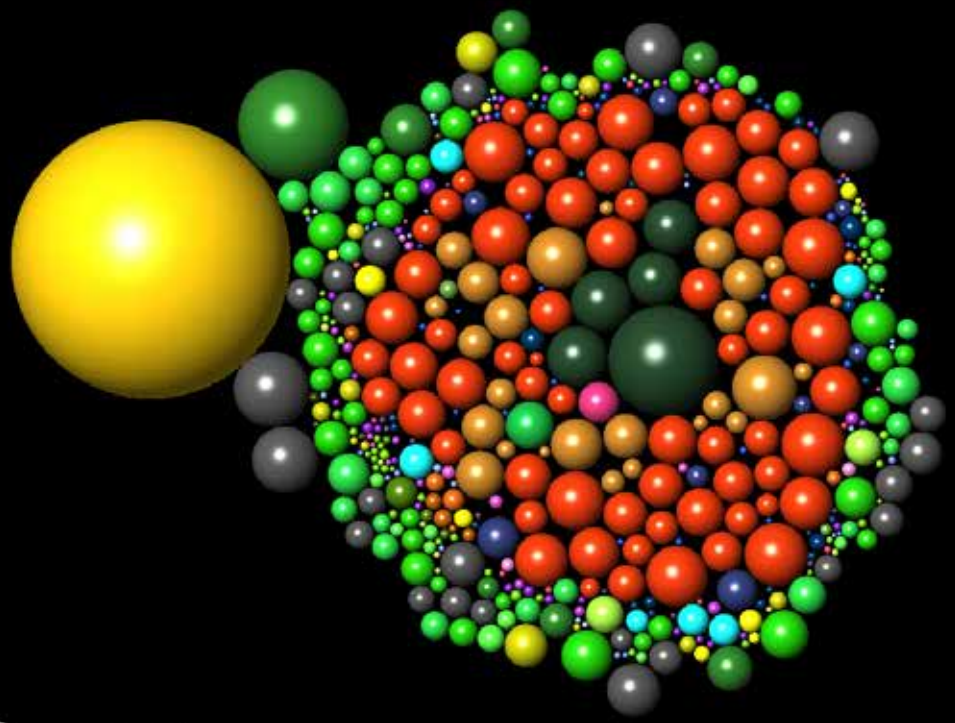

tuesday 17:30


saturday 17:30


sunday 17:30

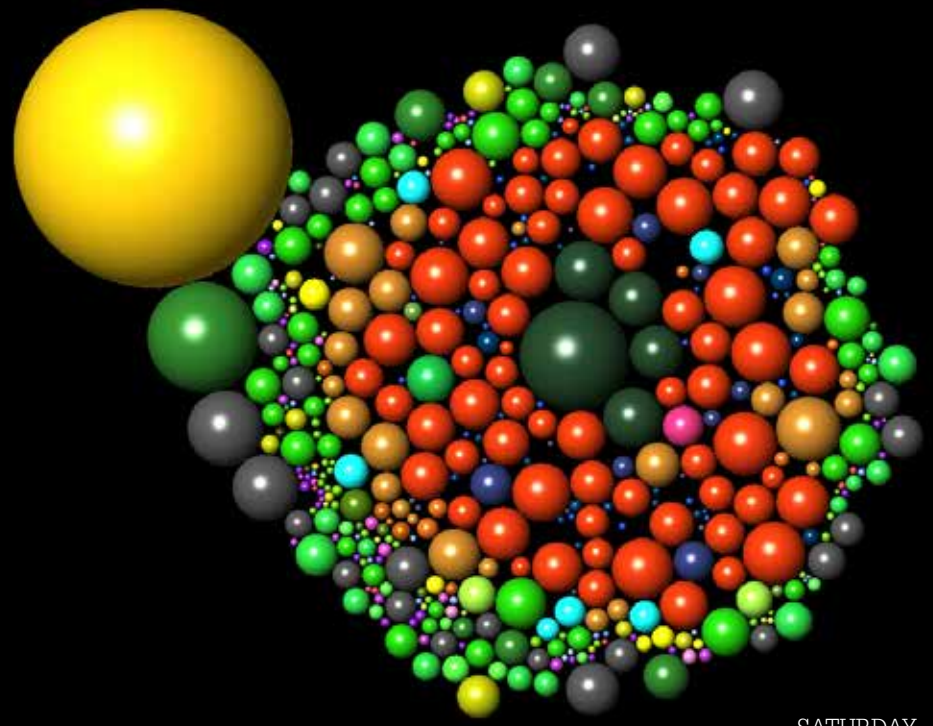

tuesday 18:00
saturday 18:00
sunday 18:00
tuesday 18:30
saturday 18:30
sunday 18:30
tuesday 19:00
saturday 19:00
sunday 19:00
tuesday 19:30
saturday 19:30
sunday 19:30
tuesday 20:00
saturday 20:00
sunday 20:00
tuesday 20:30
saturday 20:30
sunday 20:30
tuesday 21:00
saturday 21:00
sunday 21:00
tuesday 21:30
saturday 21:30
sunday 21:30
tuesday 22:00
saturday 22:00
sunday 22:00
tuesday 22:30
saturday 22:30
sunday 22:30
tuesday 23:00
saturday 23:00
sunday 23:00
tuesday 23:30
saturday 23:30
sunday 23:30

Fixed city configuration

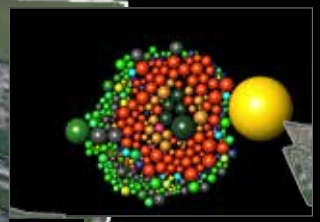


The fixed configuration of the city is based on the total connection intensity per week. The configuration of the city does not change.

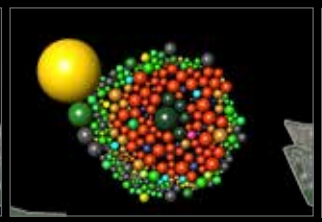
Daily city configuration



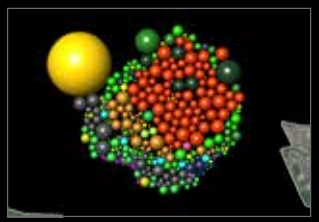
SATURDAY



Tuesday



Saturday



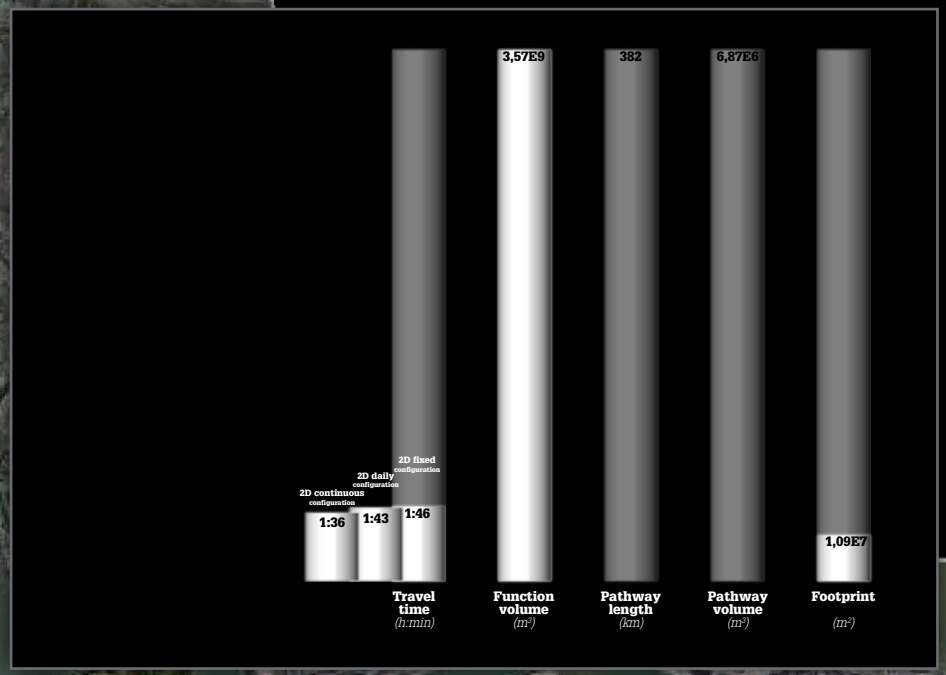
Sunday

The daily configuration of the city is based on the total connection intensity for each day. The configuration of the city changes only at night. There are three city configurations: one for a weekday, one for saturday and one for sunday.

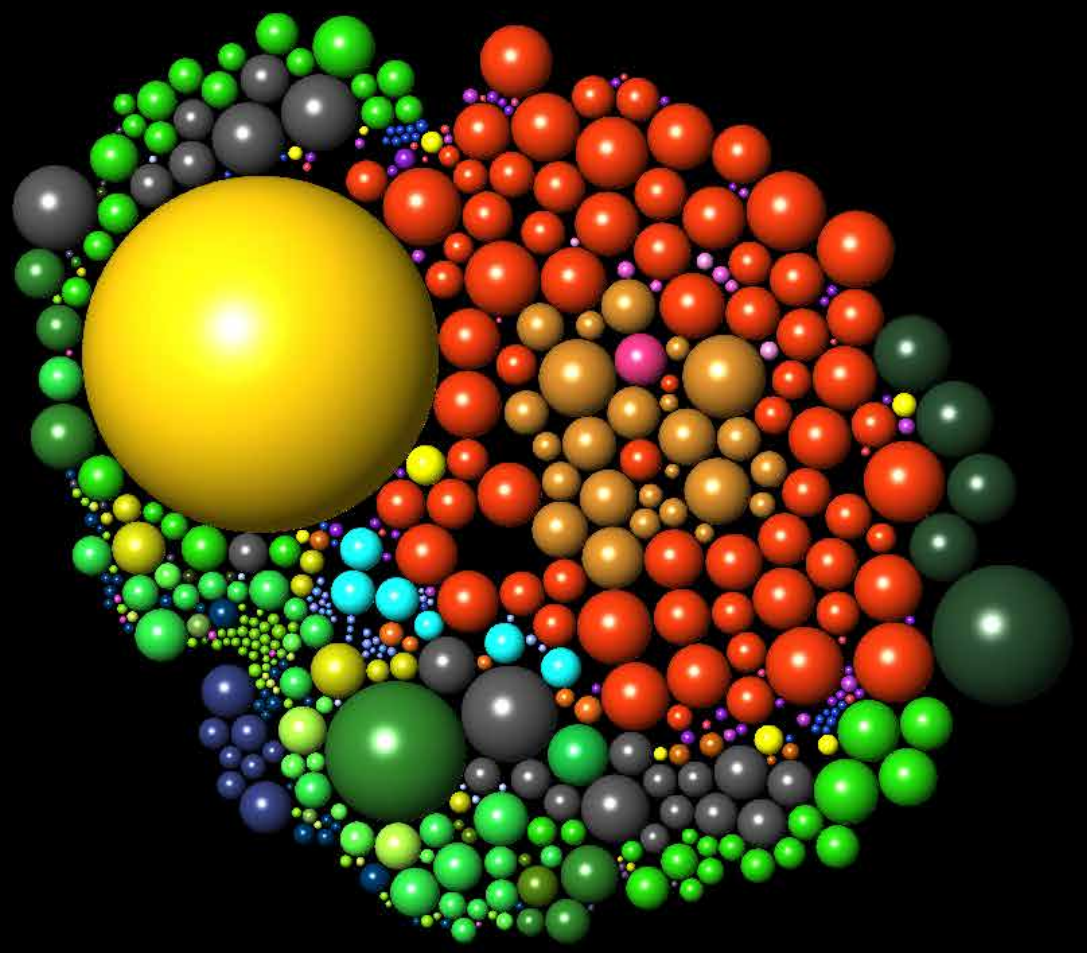
Just by adapting the city daily, we can already see differences in city configurations.

On tuesdays the program is mixed, with housing, education and office particles laying in between each other. On saturdays the education program is moved outwards. Offices are also less important and therefore moved towards the side. On sundays the particles are the least mixed.

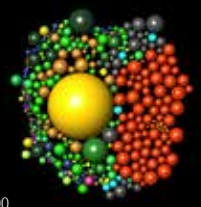
Continuous city configuration

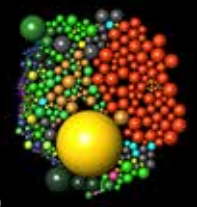


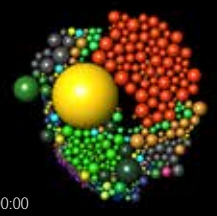
The continuous configuration of the city is based on the connection intensity for every 30 minutes of the week. The configuration of the city changes constantly.

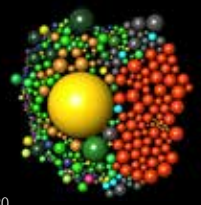


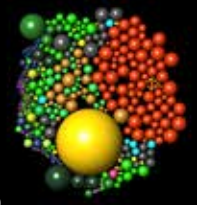
TUESDAY 08:00

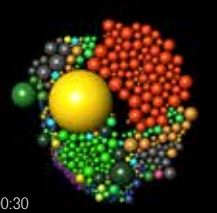

tuesday 00:00

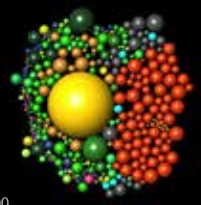

saturday 00:00

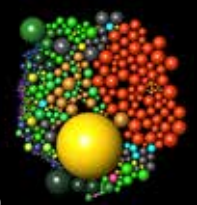

sunday 00:00

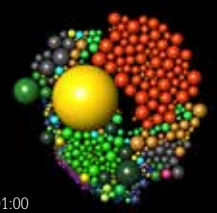

tuesday 00:30

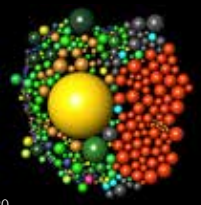

saturday 00:30

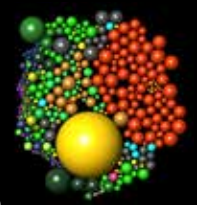

sunday 00:30

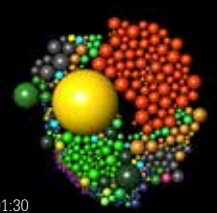

tuesday 01:00

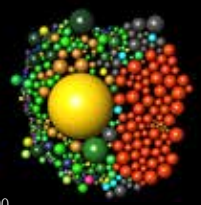

saturday 01:00

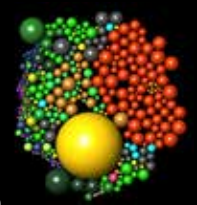

sunday 01:00

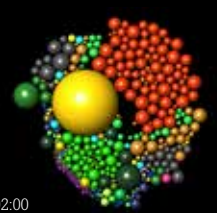

tuesday 01:30

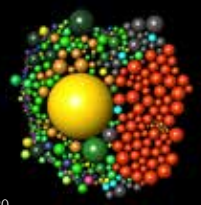

saturday 01:30

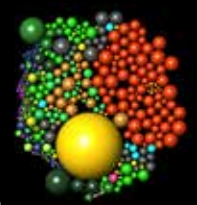

sunday 01:30

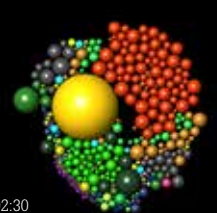

tuesday 02:00

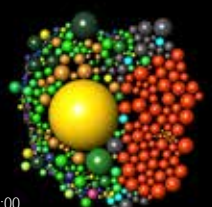

saturday 02:00

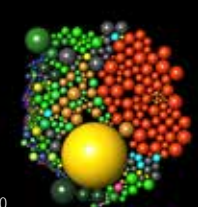

sunday 02:00

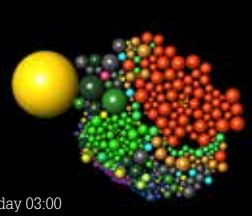

tuesday 02:30

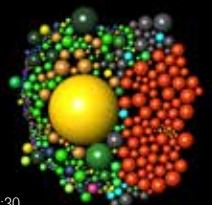

saturday 02:30

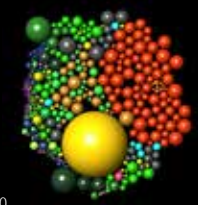

sunday 02:30

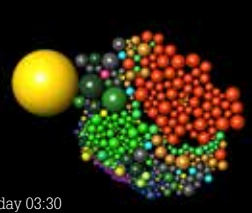

tuesday 03:00

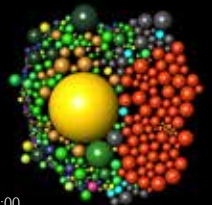

saturday 03:00

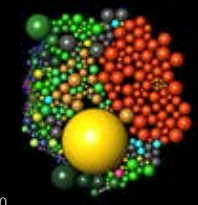

sunday 03:00

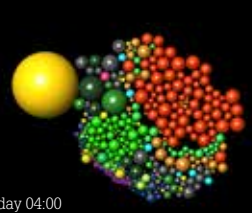

tuesday 03:30

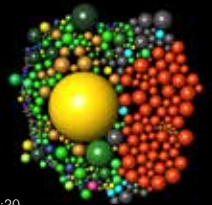

saturday 03:30

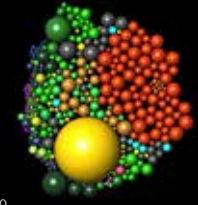

sunday 03:30

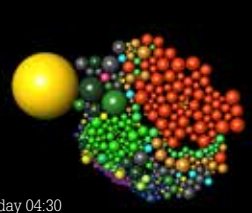

tuesday 04:00

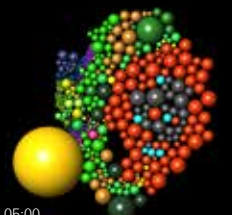

saturday 04:00

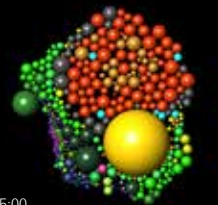

sunday 04:00

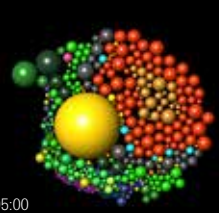

tuesday 04:30

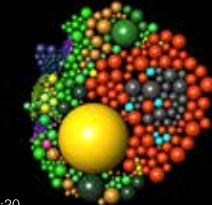

saturday 04:30

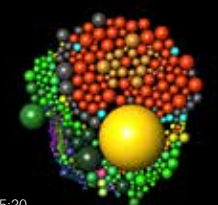

sunday 04:30

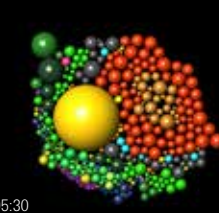

tuesday 05:00

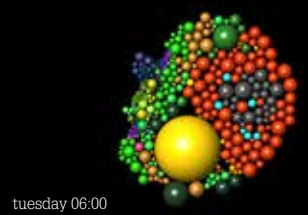

saturday 05:00

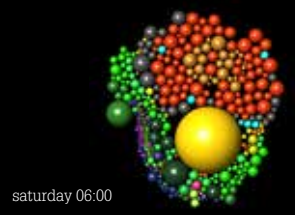

sunday 05:00

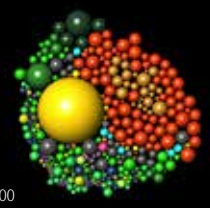

tuesday 05:30

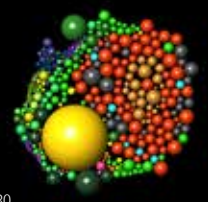

saturday 05:30

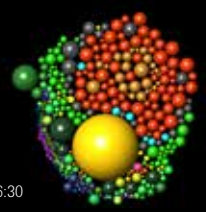

sunday 05:30

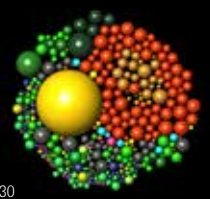

tuesday 06:00

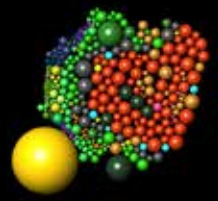

saturday 06:00

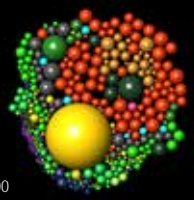

sunday 06:00

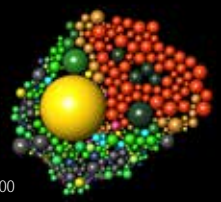

tuesday 06:30


saturday 06:30

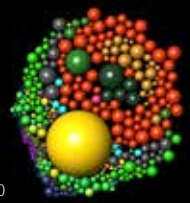

sunday 06:30

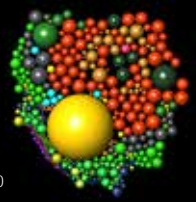

tuesday 07:00

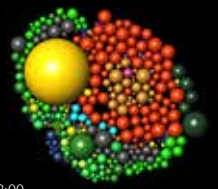

saturday 07:00

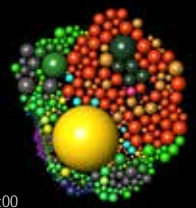

sunday 07:00

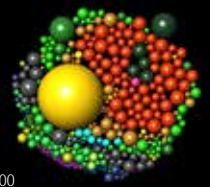

tuesday 07:30

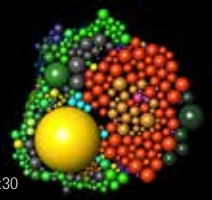

saturday 07:30

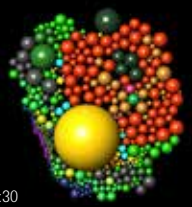

sunday 07:30

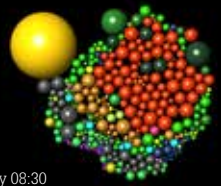

tuesday 08:00

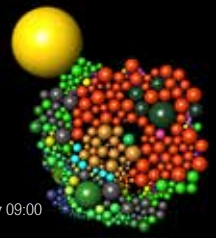

saturday 08:00

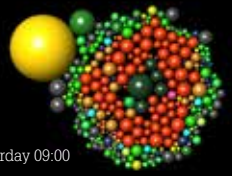

sunday 08:00

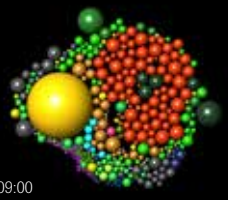

tuesday 08:30

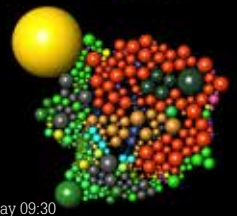

saturday 08:30

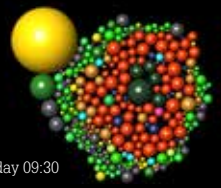

sunday 08:30

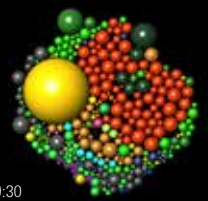

tuesday 09:00

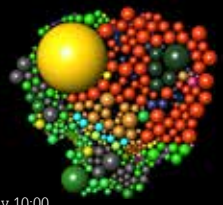

saturday 09:00

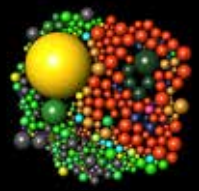

sunday 09:00

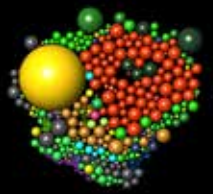

tuesday 09:30

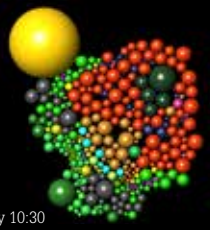

saturday 09:30

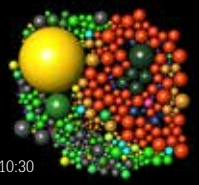

sunday 09:30

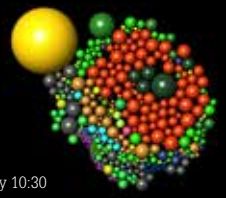

tuesday 10:00

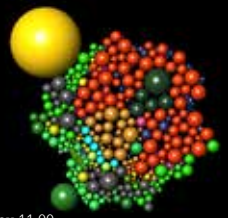

saturday 10:00

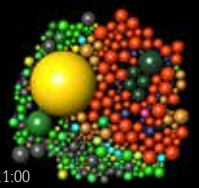

sunday 10:00

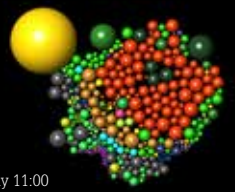

tuesday 10:30


saturday 10:30

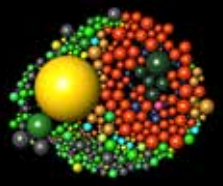

sunday 10:30

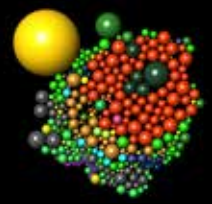

tuesday 11:00

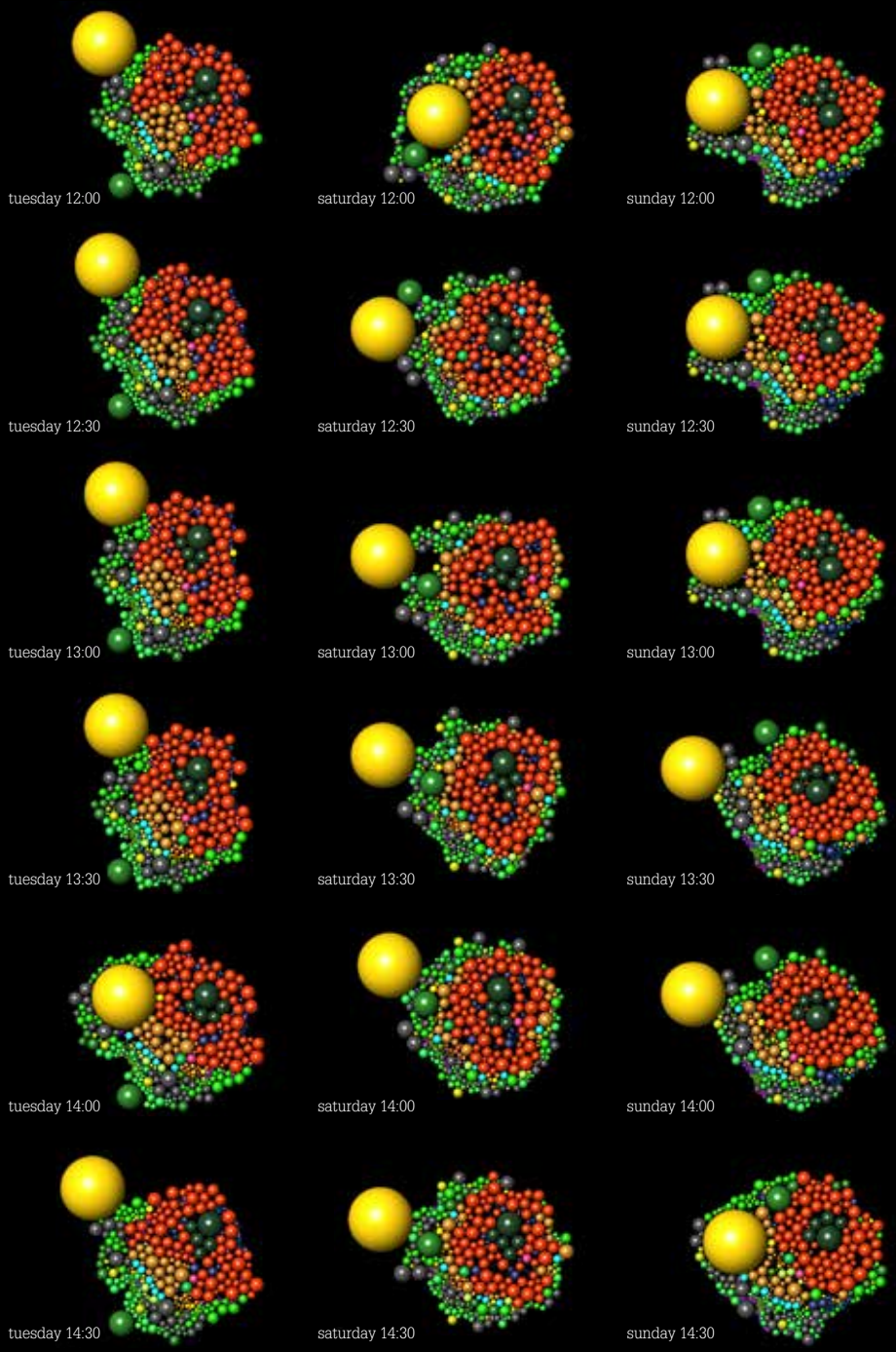

saturday 11:00

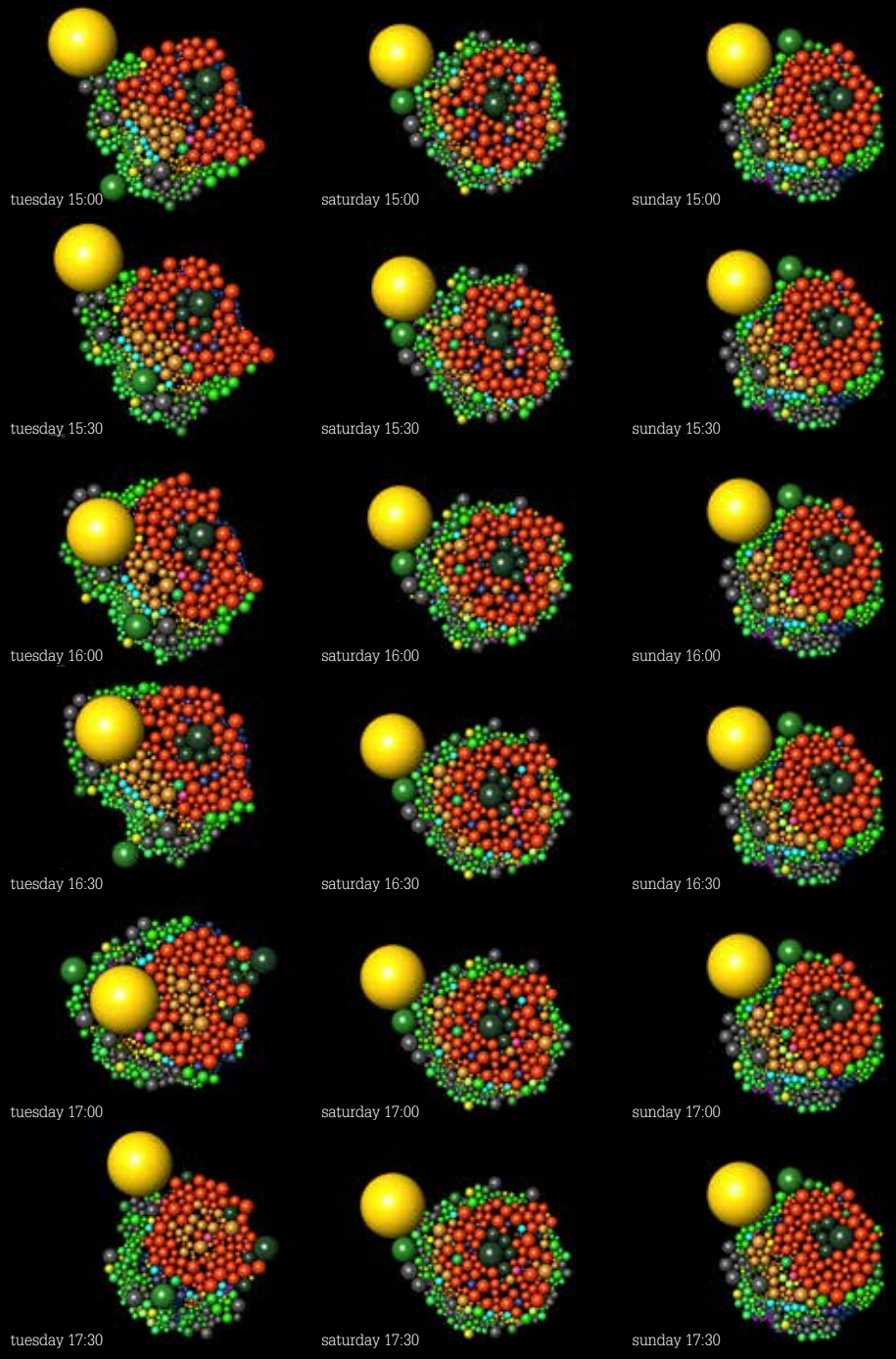

sunday 11:00

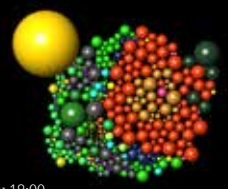

tuesday 11:30

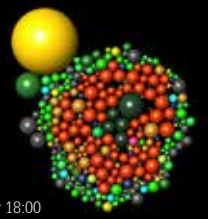

saturday 11:30

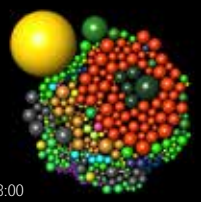

sunday 11:30

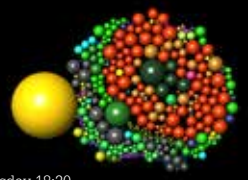

tuesday 12:00
saturday 12:00
sunday 12:00
tuesday 12:30
saturday 12:30
sunday 12:30
tuesday 13:00
saturday 13:00
sunday 13:00
tuesday 13:30
saturday 13:30
sunday 13:30
tuesday 14:00
saturday 14:00
sunday 14:00
tuesday 14:30
saturday 14:30
sunday 14:30

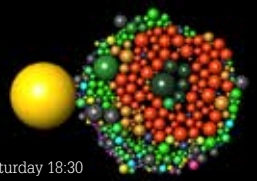

tuesday 15:00
saturday 15:00
sunday 15:00
tuesday 15:30
saturday 15:30
sunday 15:30
tuesday 16:00
saturday 16:00
sunday 16:00
tuesday 16:30
saturday 16:30
sunday 16:30
tuesday 17:00
saturday 17:00
sunday 17:00
tuesday 17:30
saturday 17:30
sunday 17:30

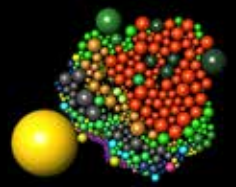

tuesday 18:00

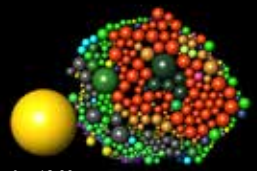

saturday 18:00

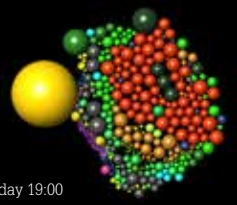

sunday 18:00

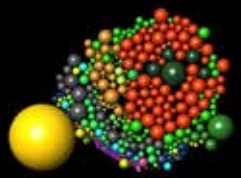

tuesday 18:30

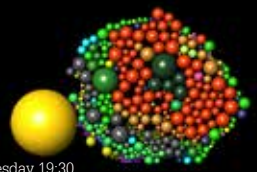

saturday 18:30

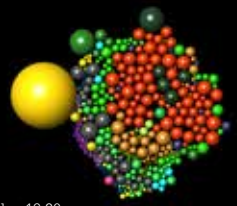

sunday 18:30

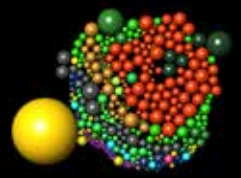

tuesday 19:00

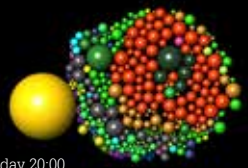

saturday 19:00

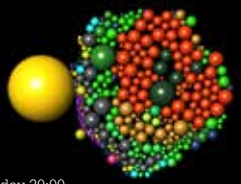

sunday 19:00

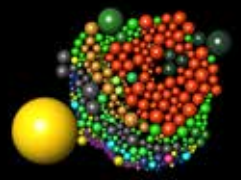

tuesday 19:30

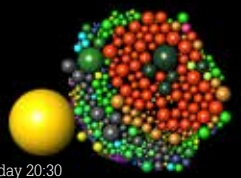

saturday 19:30

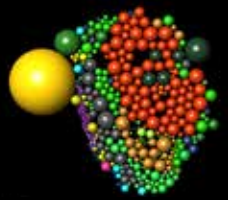

sunday 19:30

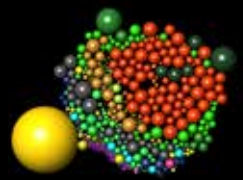

tuesday 20:00

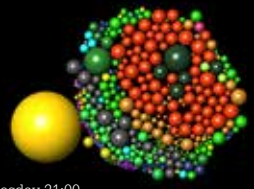

saturday 20:00

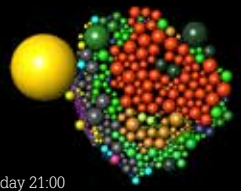

sunday 20:00

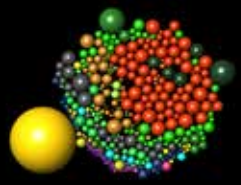

tuesday 20:30

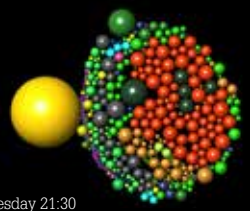

saturday 20:30

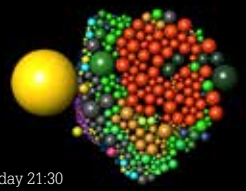

sunday 20:30

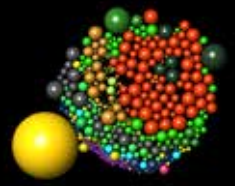

tuesday 21:00

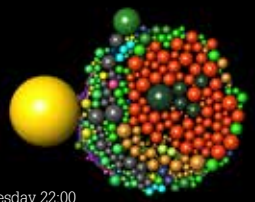

saturday 21:00

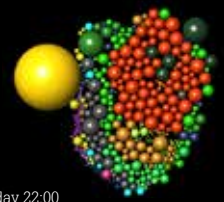

sunday 21:00

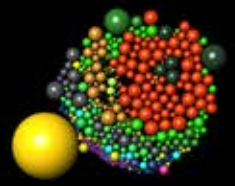

tuesday 21:30

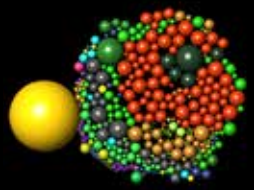

saturday 21:30

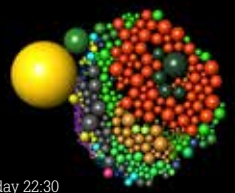

sunday 21:30

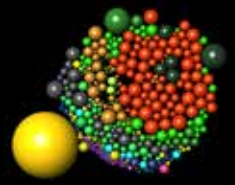

tuesday 22:00

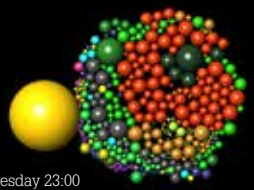

saturday 22:00

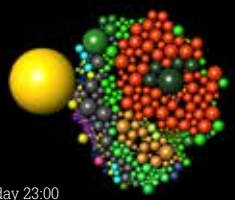

sunday 22:00

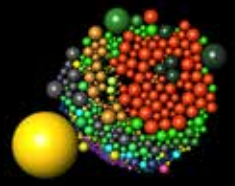

tuesday 22:30

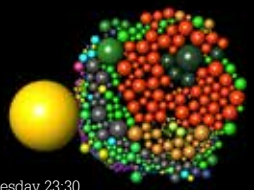

saturday 22:30

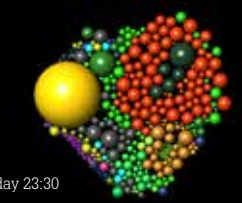

sunday 22:30

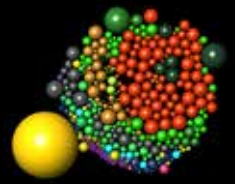

tuesday 23:00


saturday 23:00

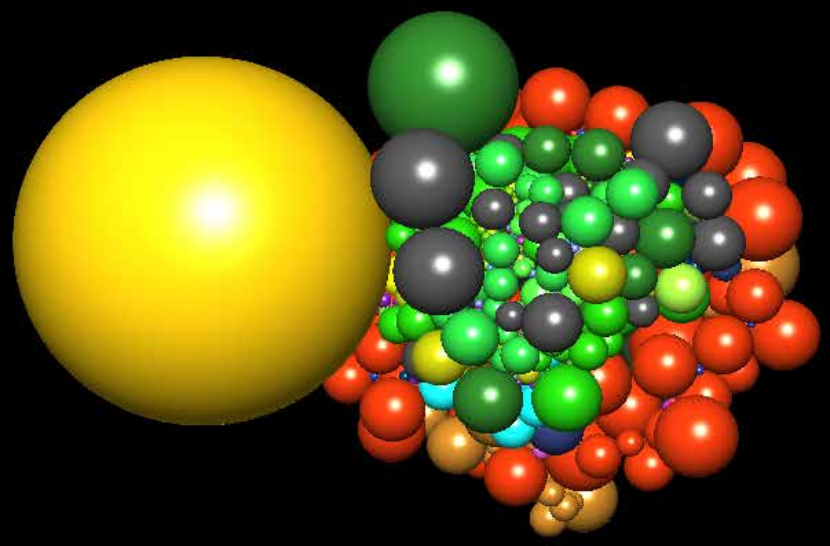

sunday 23:00


tuesday 23:30


saturday 23:30

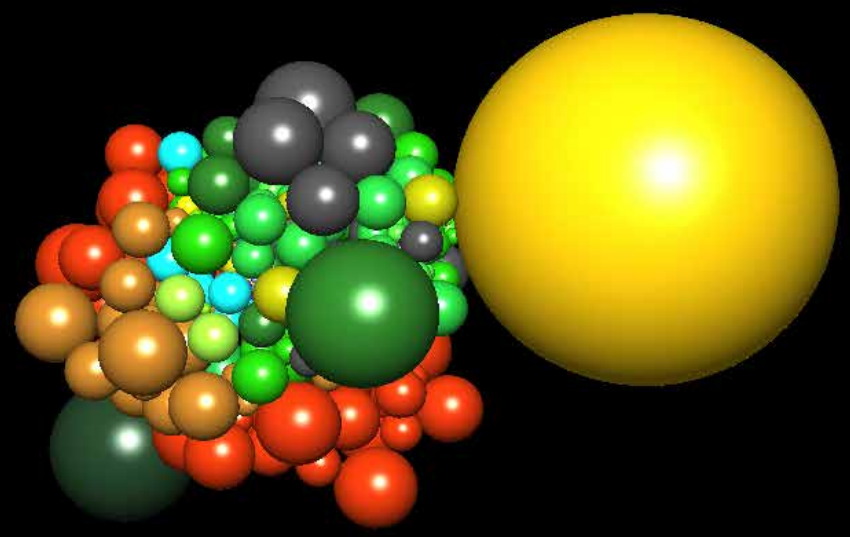

sunday 23:30

Fixed city configuration 3D

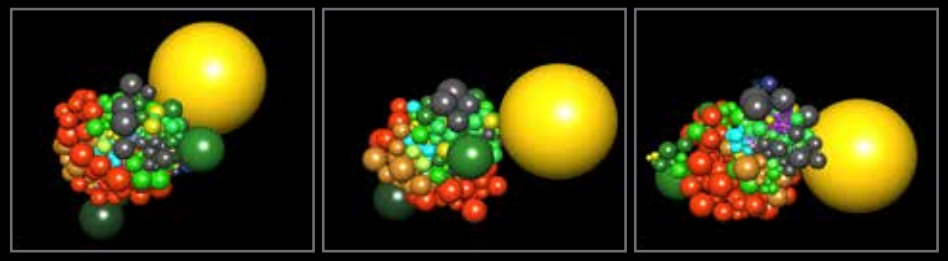


The fixed configuration of the city is based on the total connection intensity per week. The configuration of the city does not change.

Daily city configuration 3D



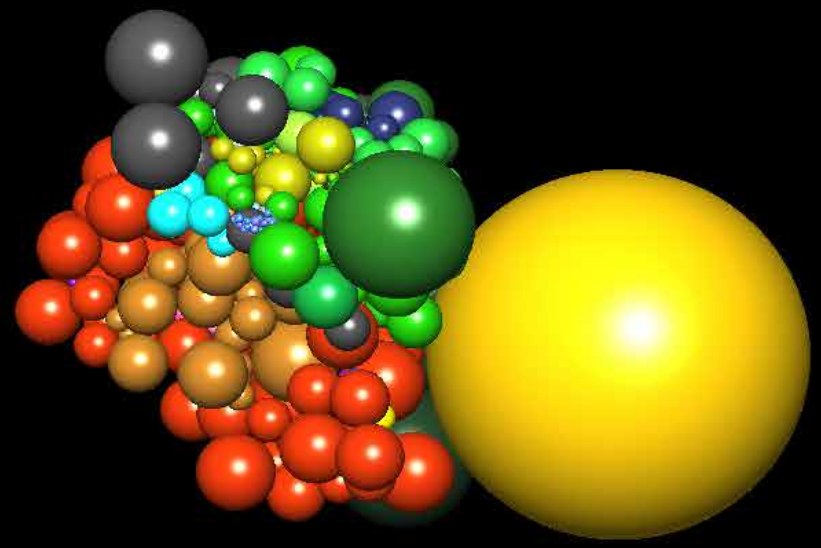
SATURDAY



Tuesday Saturday Sunday

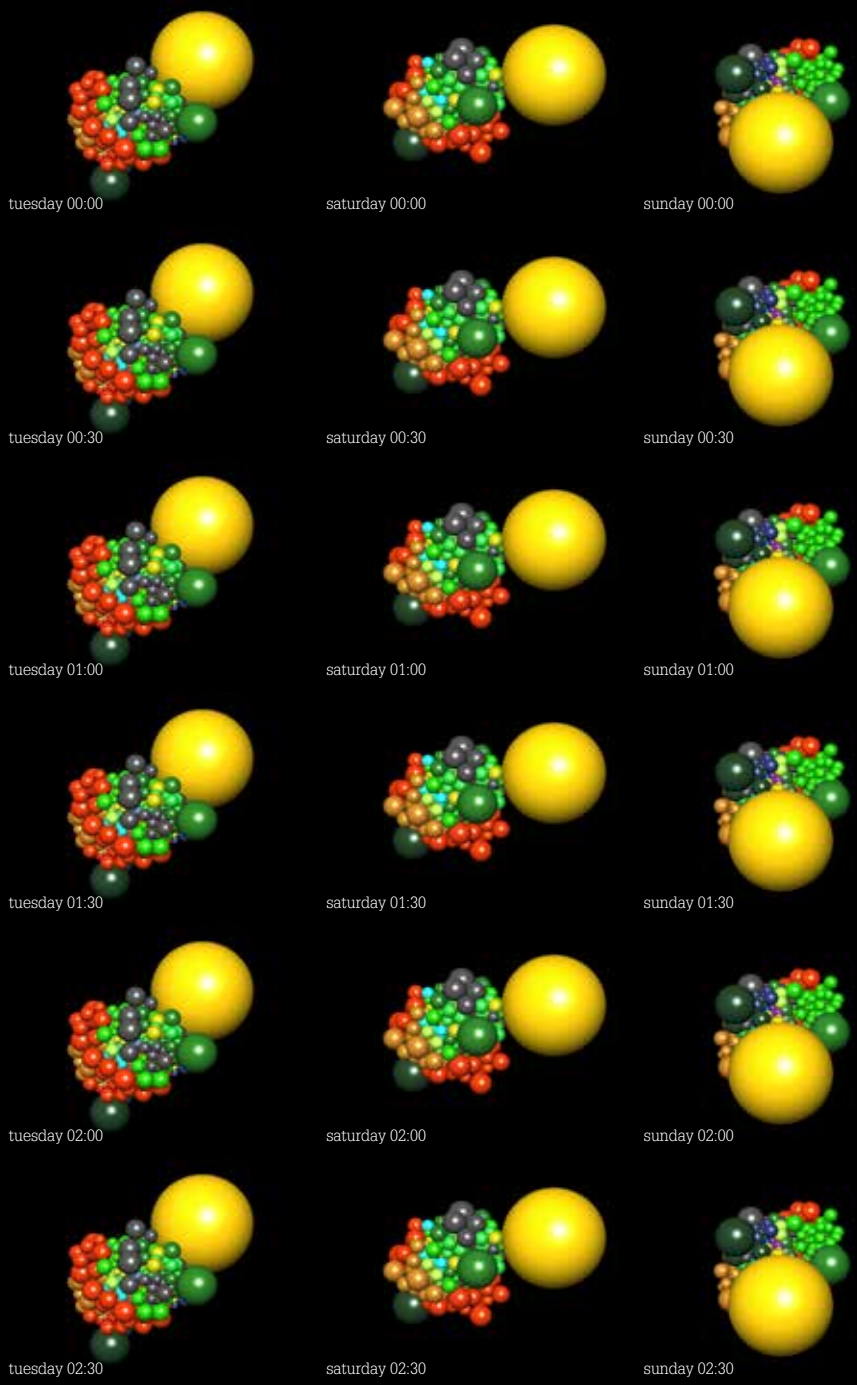
The daily configuration of the city is based on the total connection intensity for each day. The configuration of the city changes only at night. There are three city configurations: one for a weekday, one for saturday and one for sunday.

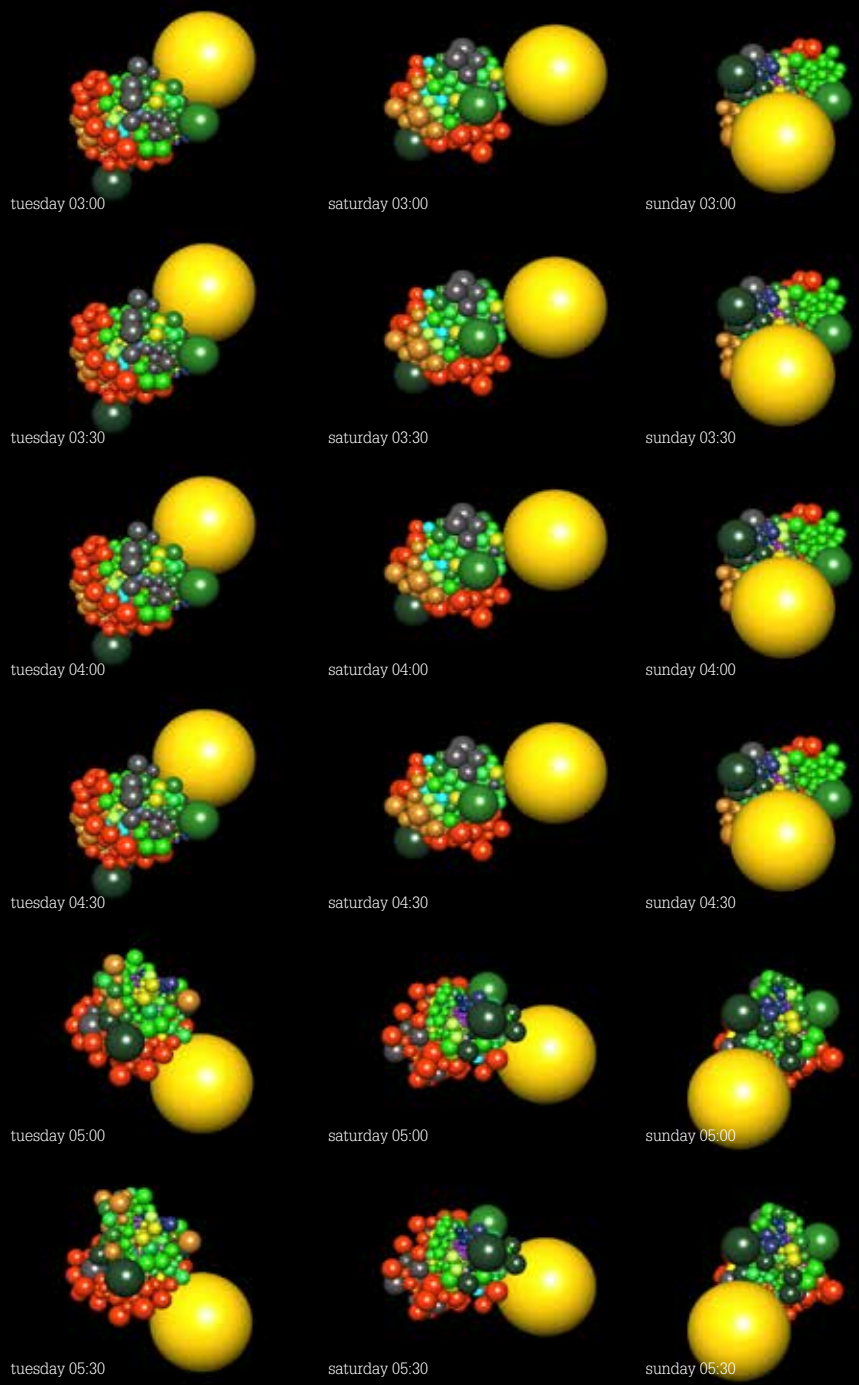
Continuous city configuration 3D

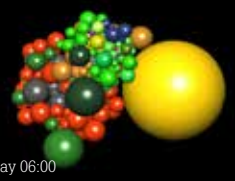


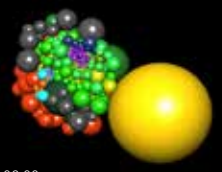
TUESDAY 08:00

The continuous configuration of the city is based on the connection intensity for every 30 minutes of the week. The configuration of the city changes constantly.

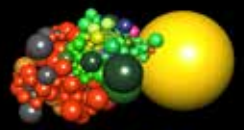

tuesday 00:00
saturday 00:00
sunday 00:00
tuesday 00:30
saturday 00:30
sunday 00:30
tuesday 01:00
saturday 01:00
sunday 01:00
tuesday 01:30
saturday 01:30
sunday 01:30
tuesday 02:00
saturday 02:00
sunday 02:00
tuesday 02:30
saturday 02:30
sunday 02:30

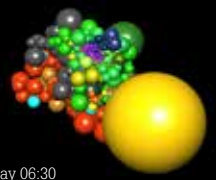

tuesday 03:00
saturday 03:00
sunday 03:00
tuesday 03:30
saturday 03:30
sunday 03:30
tuesday 04:00
saturday 04:00
sunday 04:00
tuesday 04:30
saturday 04:30
sunday 04:30
tuesday 05:00
saturday 05:00
sunday 05:00
tuesday 05:30
saturday 05:30
sunday 05:30


tuesday 06:00


saturday 06:00

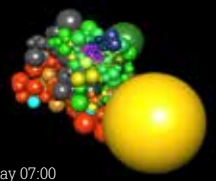

sunday 06:00

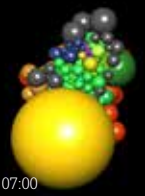

tuesday 06:30


saturday 06:30


sunday 06:30

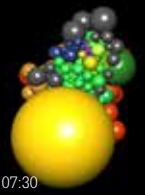

tuesday 07:00

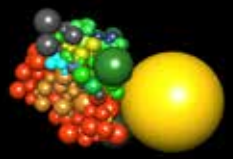

saturday 07:00


sunday 07:00


tuesday 07:30

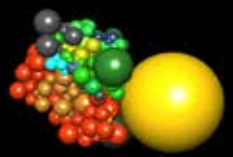

saturday 07:30


sunday 07:30


tuesday 08:00


saturday 08:00


sunday 08:00

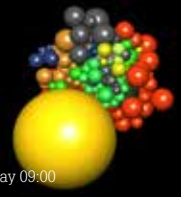

tuesday 08:30


saturday 08:30

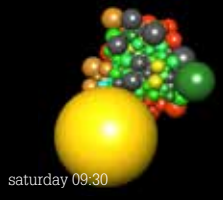

sunday 08:30

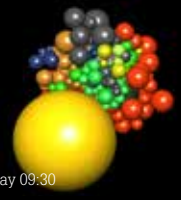

tuesday 09:00

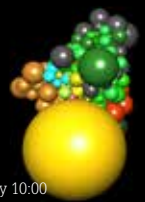

saturday 09:00


sunday 09:00

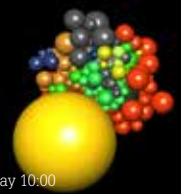

tuesday 09:30

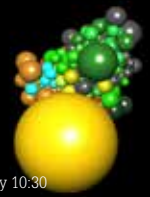

saturday 09:30


sunday 09:30

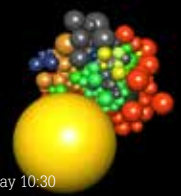

tuesday 10:00

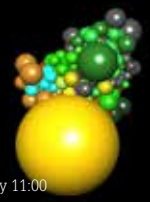

saturday 10:00

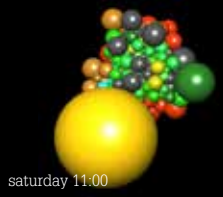

sunday 10:00

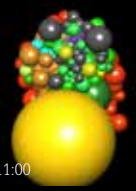

tuesday 10:30

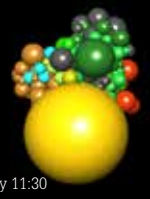

saturday 10:30

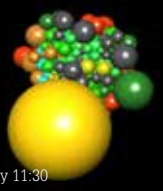

sunday 10:30

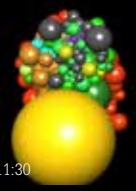

tuesday 11:00

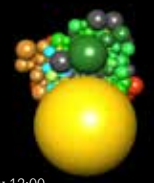

saturday 11:00


sunday 11:00

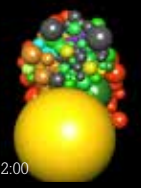

tuesday 11:30


saturday 11:30

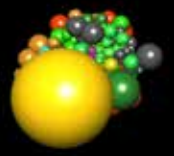

sunday 11:30

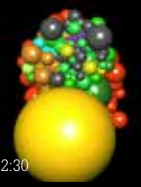

tuesday 12:00

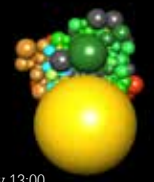

saturday 12:00

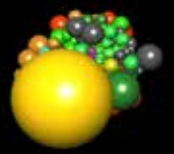

sunday 12:00

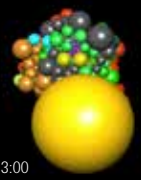

tuesday 12:30

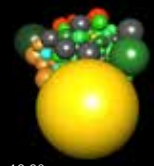

saturday 12:30

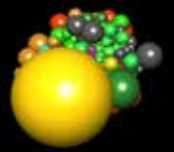

sunday 12:30

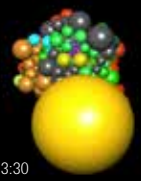

tuesday 13:00


saturday 13:00

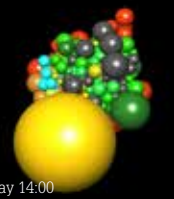

sunday 13:00

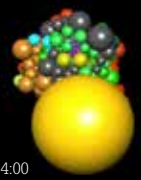

tuesday 13:30

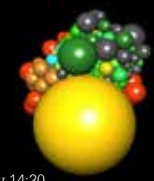

saturday 13:30

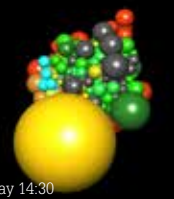

sunday 13:30

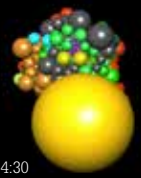

tuesday 14:00

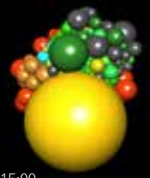

saturday 14:00

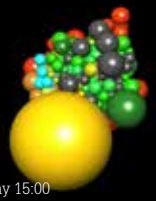

sunday 14:00

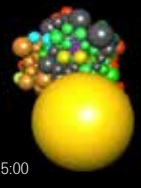

tuesday 14:30

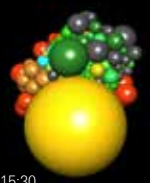

saturday 14:30

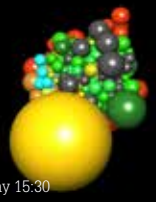

sunday 14:30

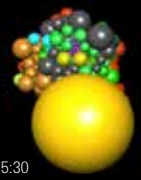

tuesday 15:00

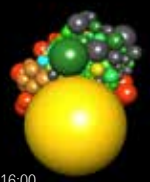

saturday 15:00


sunday 15:00

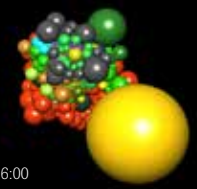

tuesday 15:30


saturday 15:30


sunday 15:30

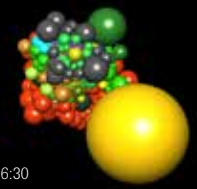

tuesday 16:00


saturday 16:00


sunday 16:00

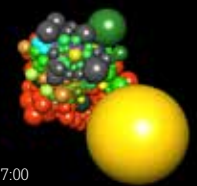

tuesday 16:30

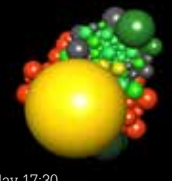

saturday 16:30


sunday 16:30

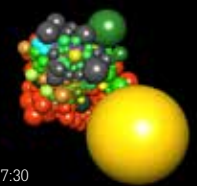

tuesday 17:00


saturday 17:00

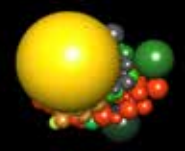

sunday 17:00

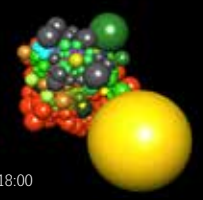

tuesday 17:30

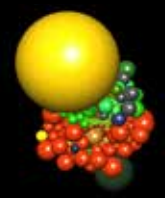

saturday 17:30

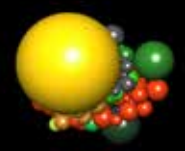

sunday 17:30


tuesday 18:00

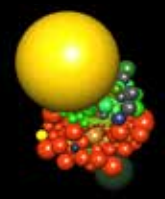

saturday 18:00

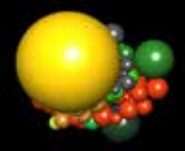

sunday 18:00

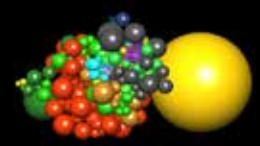

tuesday 18:30

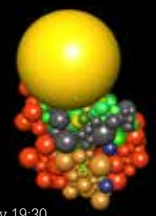

saturday 18:30

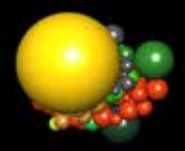

sunday 18:30

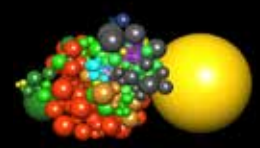

tuesday 19:00

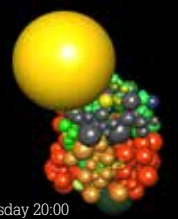

saturday 19:00

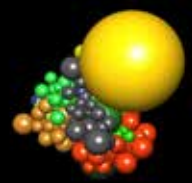

sunday 19:00

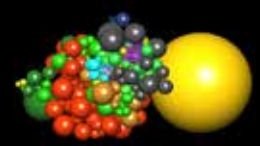

tuesday 19:30

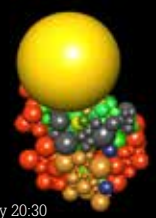

saturday 19:30

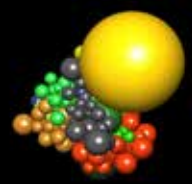

sunday 19:30

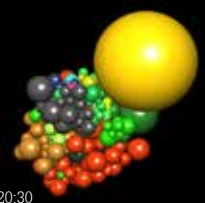

tuesday 20:00

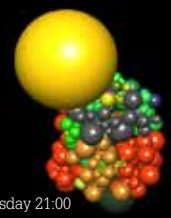

saturday 20:00

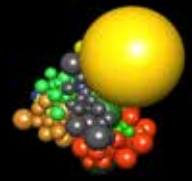

sunday 20:00

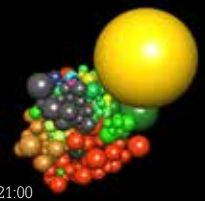

tuesday 20:30

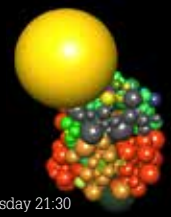

saturday 20:30

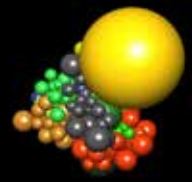

sunday 20:30

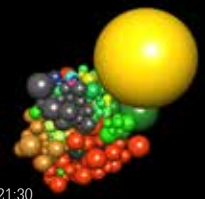

tuesday 21:00

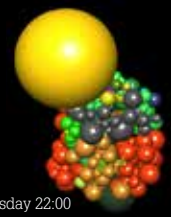

saturday 21:00

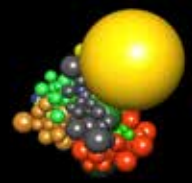

sunday 21:00


tuesday 21:30

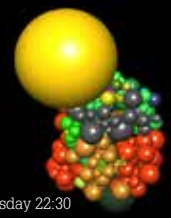

saturday 21:30

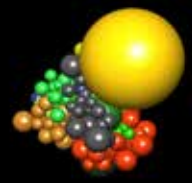

sunday 21:30


tuesday 22:00

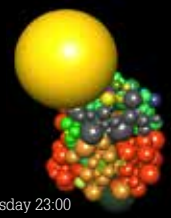

saturday 22:00

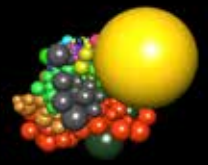

sunday 22:00


tuesday 22:30

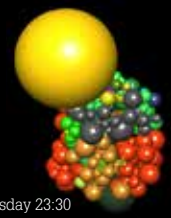

saturday 22:30


sunday 22:30


tuesday 23:00


saturday 23:00

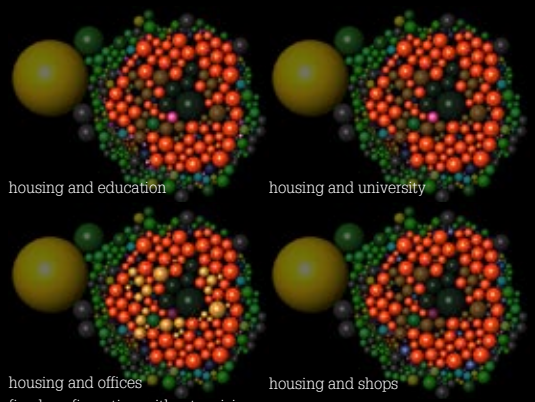

sunday 23:00


tuesday 23:30


saturday 23:30


sunday 23:30

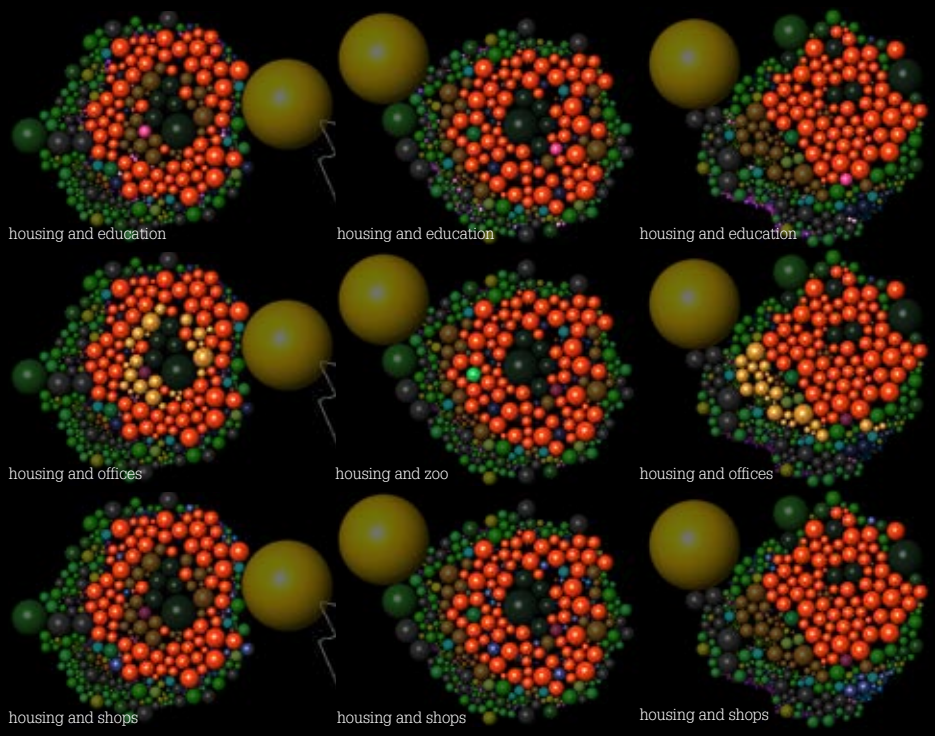
Analysis results



housing and education
housing and university
housing and offices
housing and shops
fixed configuration without resizing

If we create a city configuration in which all particles are fixed an do not move, the configuration is based on total connection intensities during the week.
We then see that shops, offices, education, the university and housing lay close together.

housing

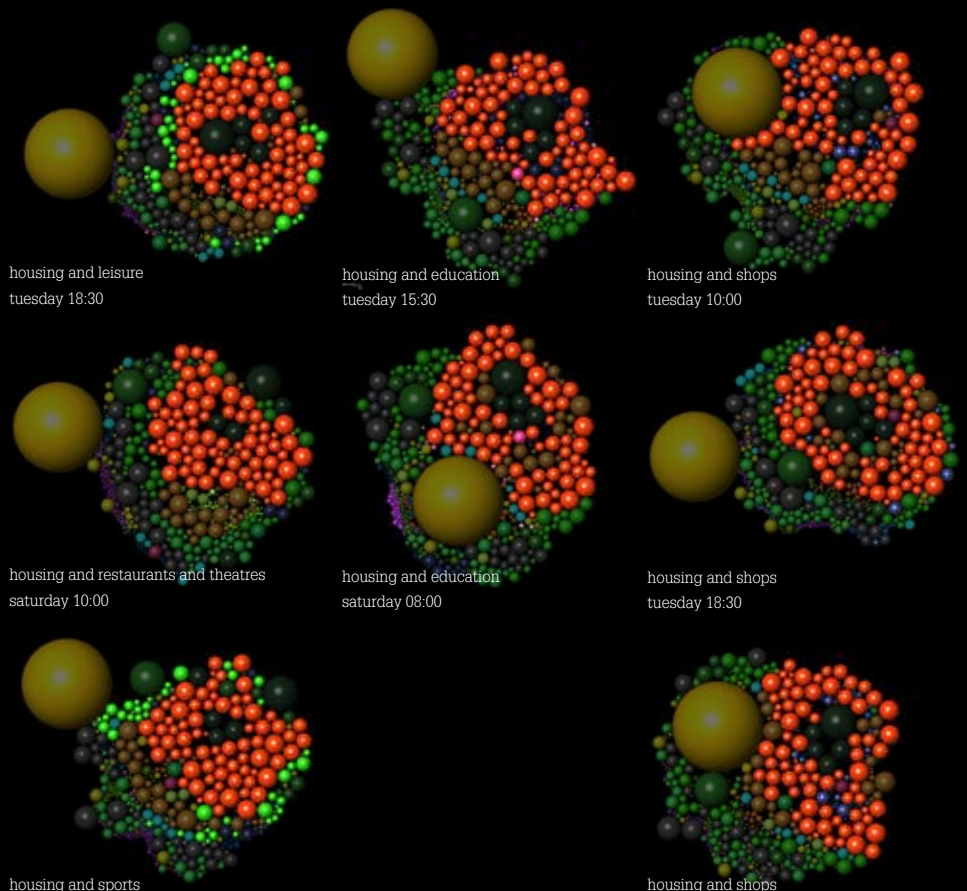


housing and education
housing and education
housing and education
housing and offices
housing and zoo
housing and offices
housing and shops
housing and shops
housing and shops

weekday
daily configuration without resizing

saturday

sunday



housing and leisure
tuesday 18:30

housing and education
tuesday 15:30

housing and shops
tuesday 10:00

housing and restaurants and theatres
saturday 10:00

housing and education
saturday 08:00

housing and shops
tuesday 18:30

housing and sports
sunday 11:00

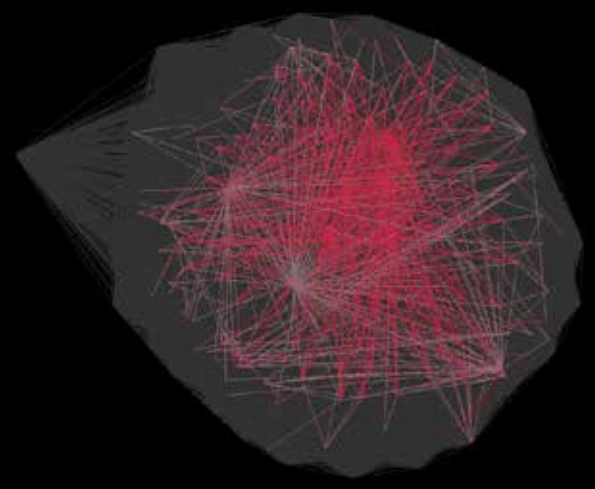
housing and shops
saturday 10:00

continuous configuration without resizing

In case the configuration of the city changes daily we can see differences in the configurations. While on a weekday, housing, offices and education lay closer together on a Saturday they lay further apart and especially housing and shops lay closer together

When the configuration of the city continuously changes it adapts to travel demands at that time. You see for example that at tuesday and saturday 10:00 housing and shops lay close to each other, but they lay further apart at tuesday 18:30 since shops are closed at that time.

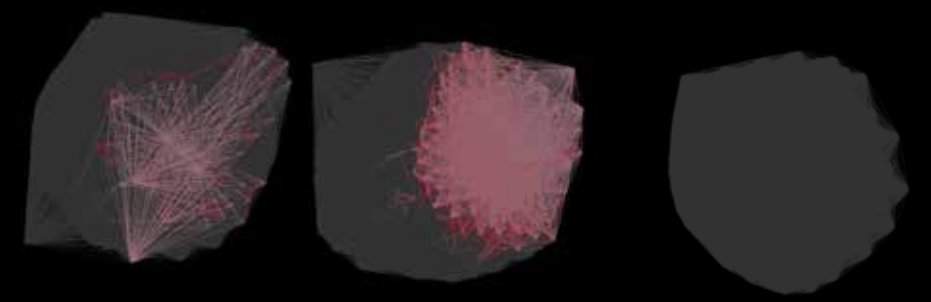
Analysis results



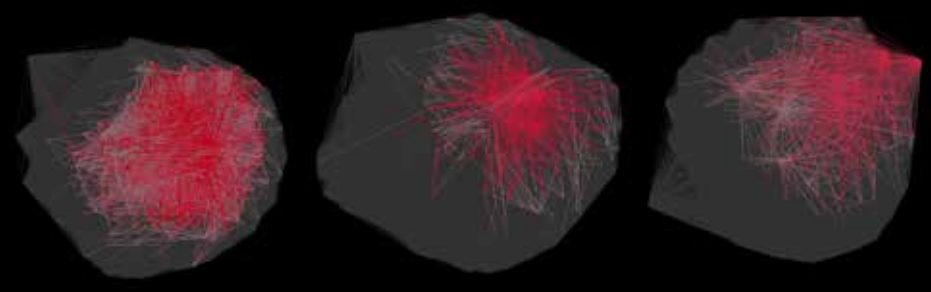
fixed configuration with resizing particles
sunday 20:00

In the fixed city configuration, we see that the particles with higher connection intensties between them lay closer together: generally, the connections higher intensities are shorther than the ones with lower intensities. The ones with the lowest intensities (grey lines) are situated on the edge of the city. The highes travel activity is thus centered in the city.

tuesday 07:00 saturday 04:00 sunday 20:00
daily configuration with resizing particles



tuesday 07:00 tuesday 18:00 saturday 04:00

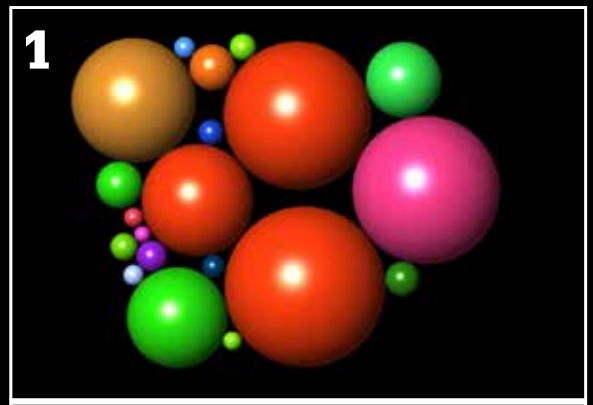


saturday 16:00 sunday 12:00 sunday 20:00
continuous configuration with resizing particles

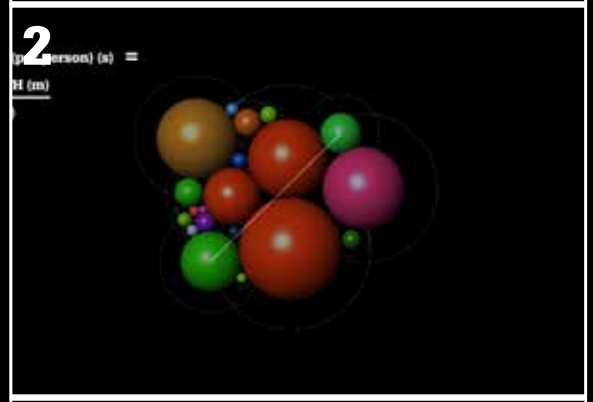
In a continuously configuring city, the particles which have a higher connection intensty are generally near each other. Therefore the used particles are clustered most of the time. This clustering does not necessarily have to be in the center of the city.

TOOL 3
RESIZING
PARTICLES

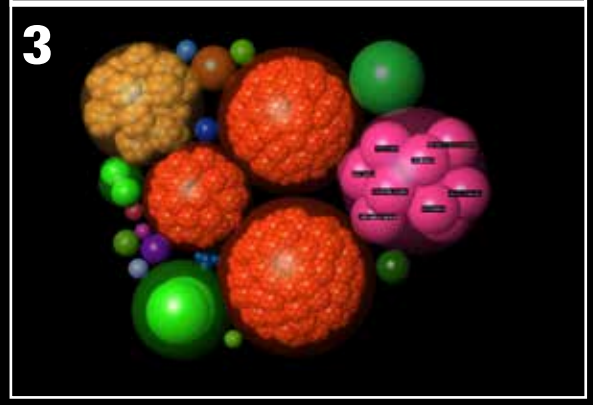
Tool decription



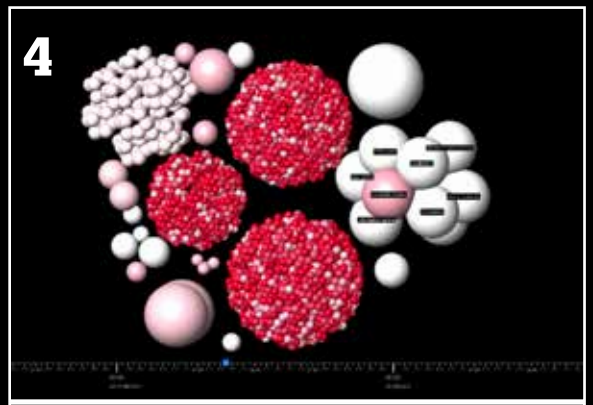
What impact could the size of the particles have on speed in the city?



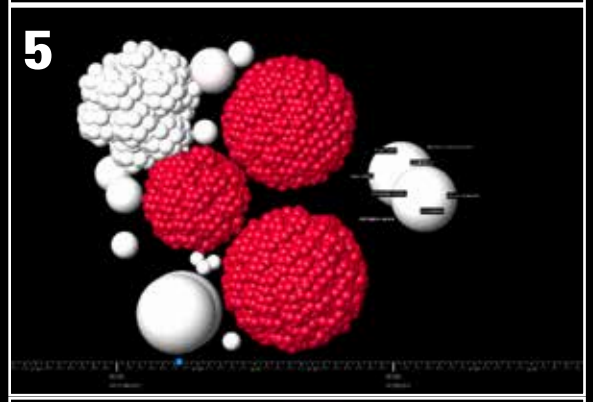
Travel time depends on the pathway length, and when particles reduce in size the pathways become shorter.



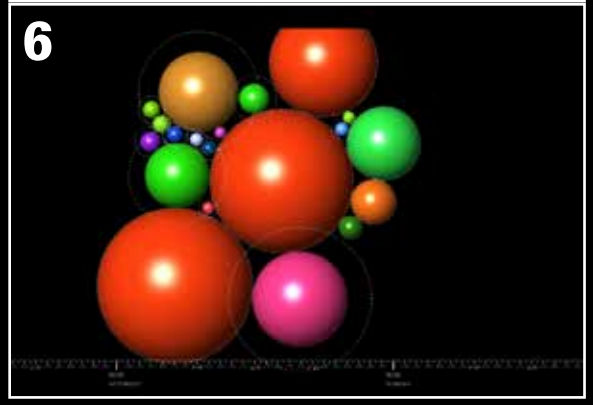
As we know the particles actually consist of smaller particles.



The redness indicates the number of people (% of maximum capacity) using each particle.



The volume of each particle consists of open space and space for building construction and storage of furniture and items. On average every particle consists of 30% construction/storage space and 70% open space.
What happens to travel time if the particles can resize to their necessary volume of 30% when they are not used?

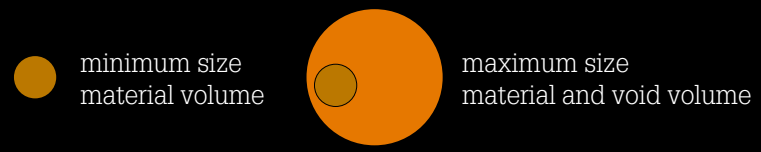


We can combine the resizing of the particles with moving the particles according to hierarchy (tool 2).

Tool decription

Rules:

- **The spheres remain in the same configuration when they are resizing, but will stay as close to each other as possible.**
- **The minimum size of the sphere is based on the total volume of material, such as construction and furniture. The maximum size of the sphere is the volume determined in current Rotterdam and includes void spaces.**



- **When the particle intensity is zero, the particle reduces to it's minimum size. When the particle intensity is higher than zero, the particle grows to it's maximum size.**

Formulas

Per person

$$\text{Travel time per pathway (s)} = \frac{\text{Pathway length (m)}}{\text{Speed (m/s)}}$$

Per particle

$$\text{Particle volume (m}^3\text{)} = \text{Void volume (m3)} + \text{Solid volume (m}^3\text{)}$$

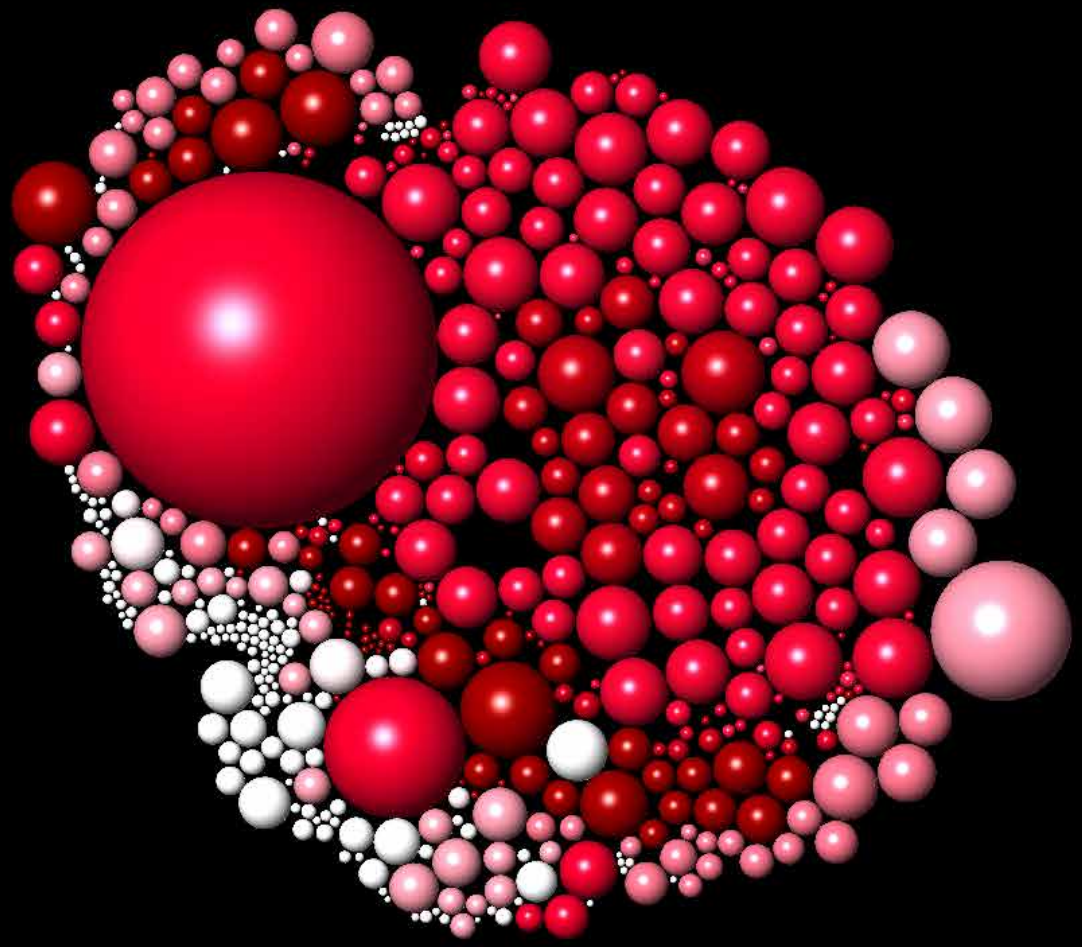
The first formula already proofs that by reducing the size of the particles, the pathway length becomes smaller and thus the travel time per pathway becomes smaller.

Void volume consists of open space which is used for view, circulation and to perform activities. Solid volume is tangible objects such as the construction and materials in the building, furniture etc..

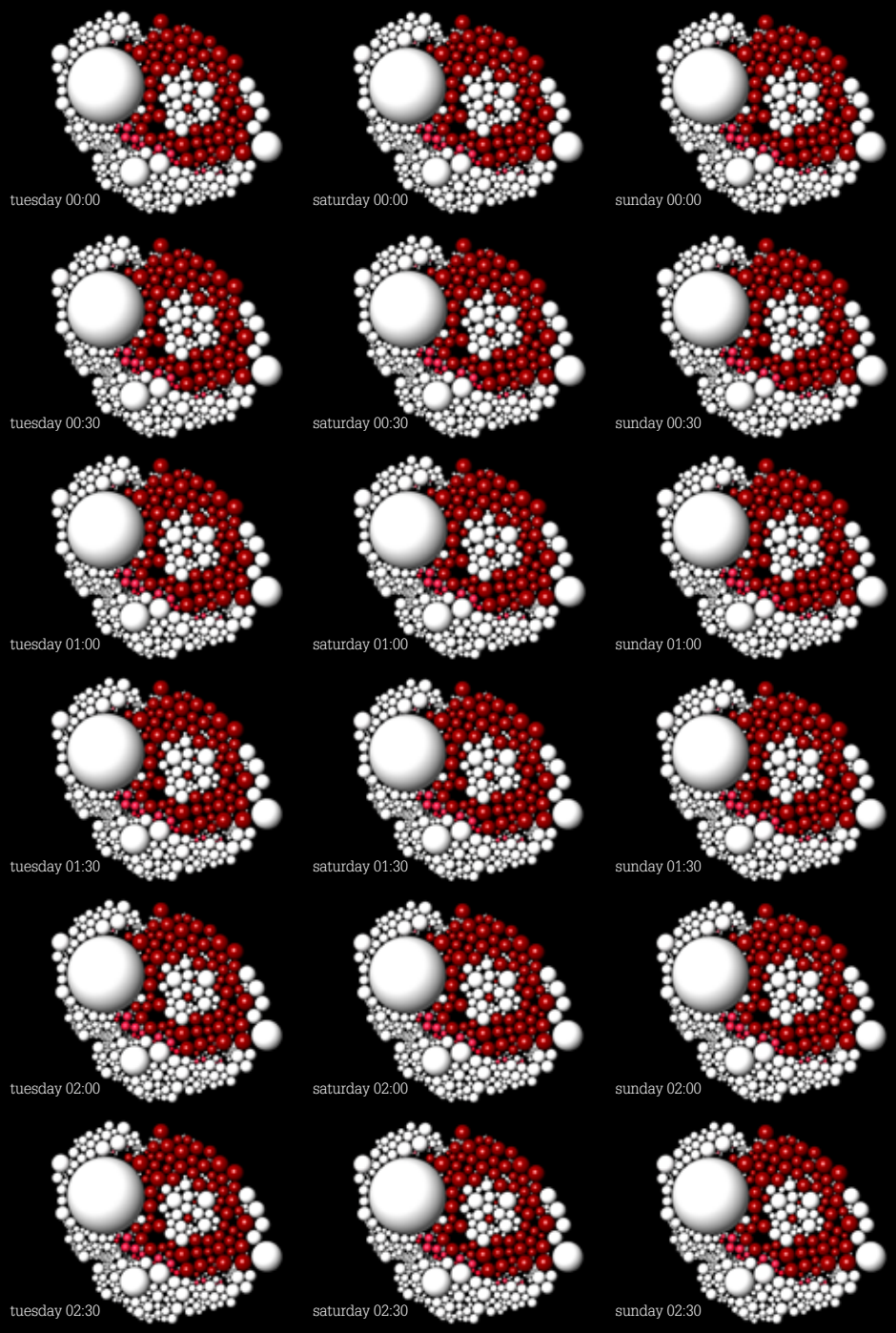
The solid volume cannot be reduced in size. The void volume however, could disappear. Therefore to reduce the particle volume, we should reduce the amount of void volume.

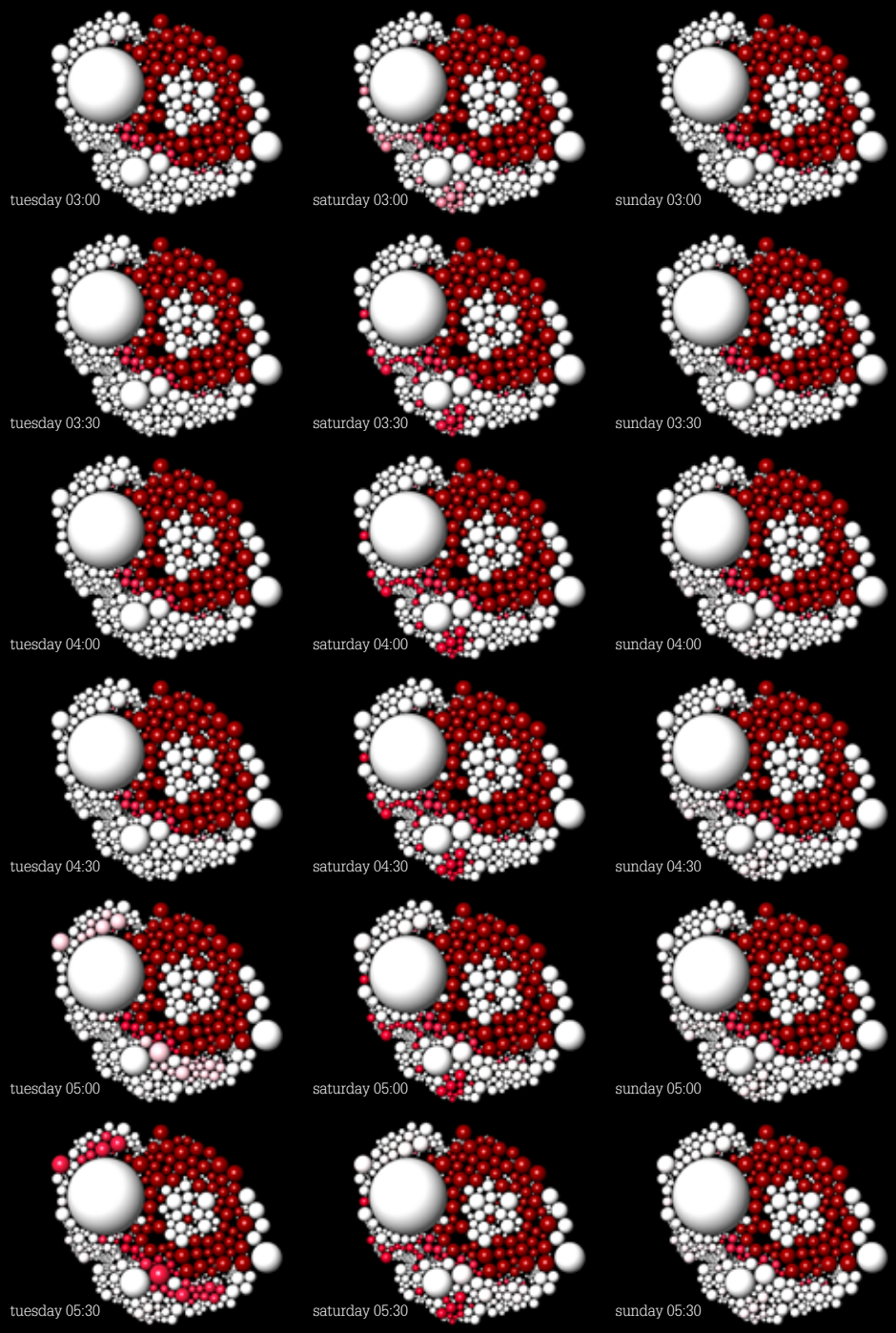
Particle occupancy

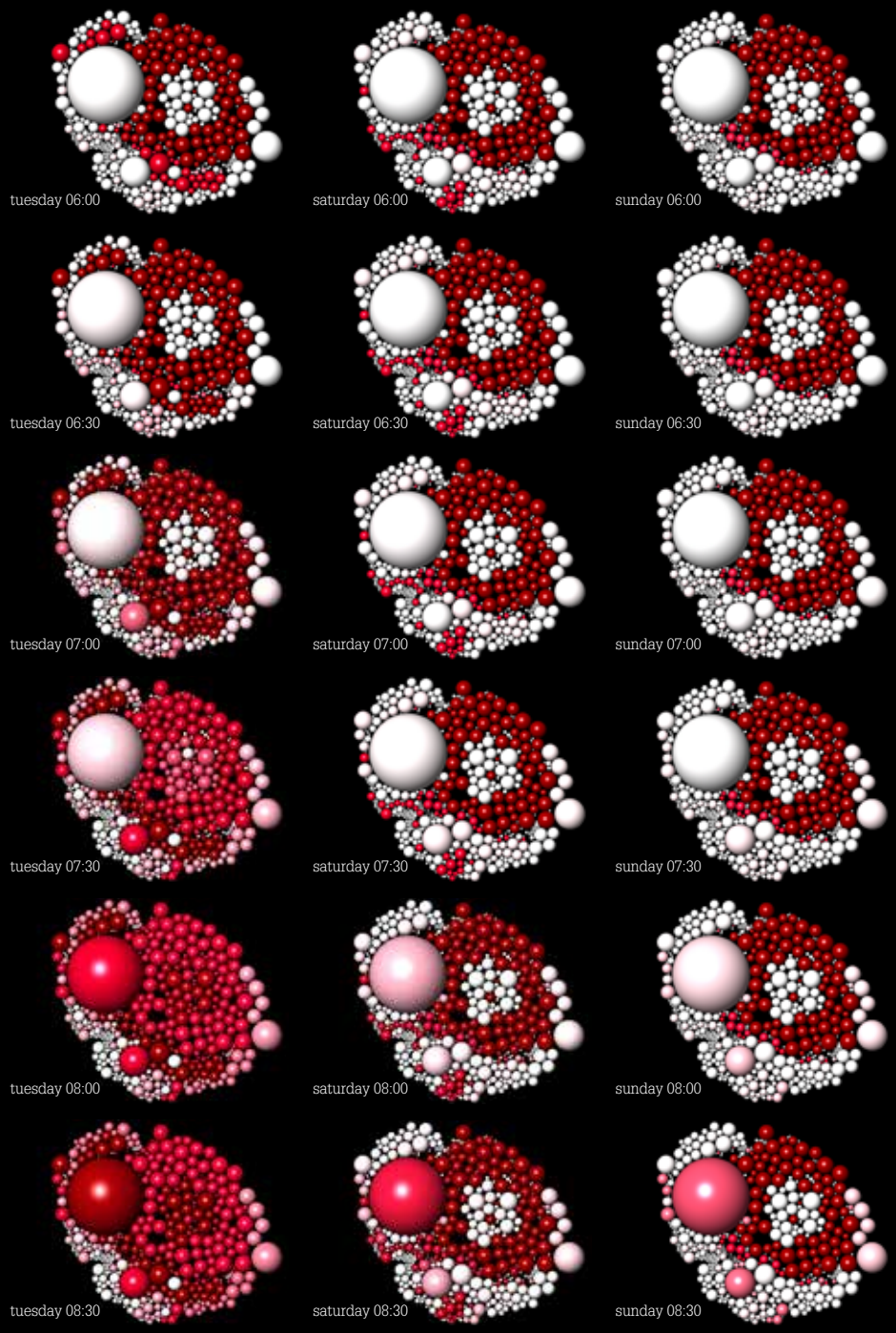
The particle occupancy in terms of percentage (% of maximum particle capacity). The more red, the more the particle reaches it's maximum capacity. The particle occupancy is time dependant.

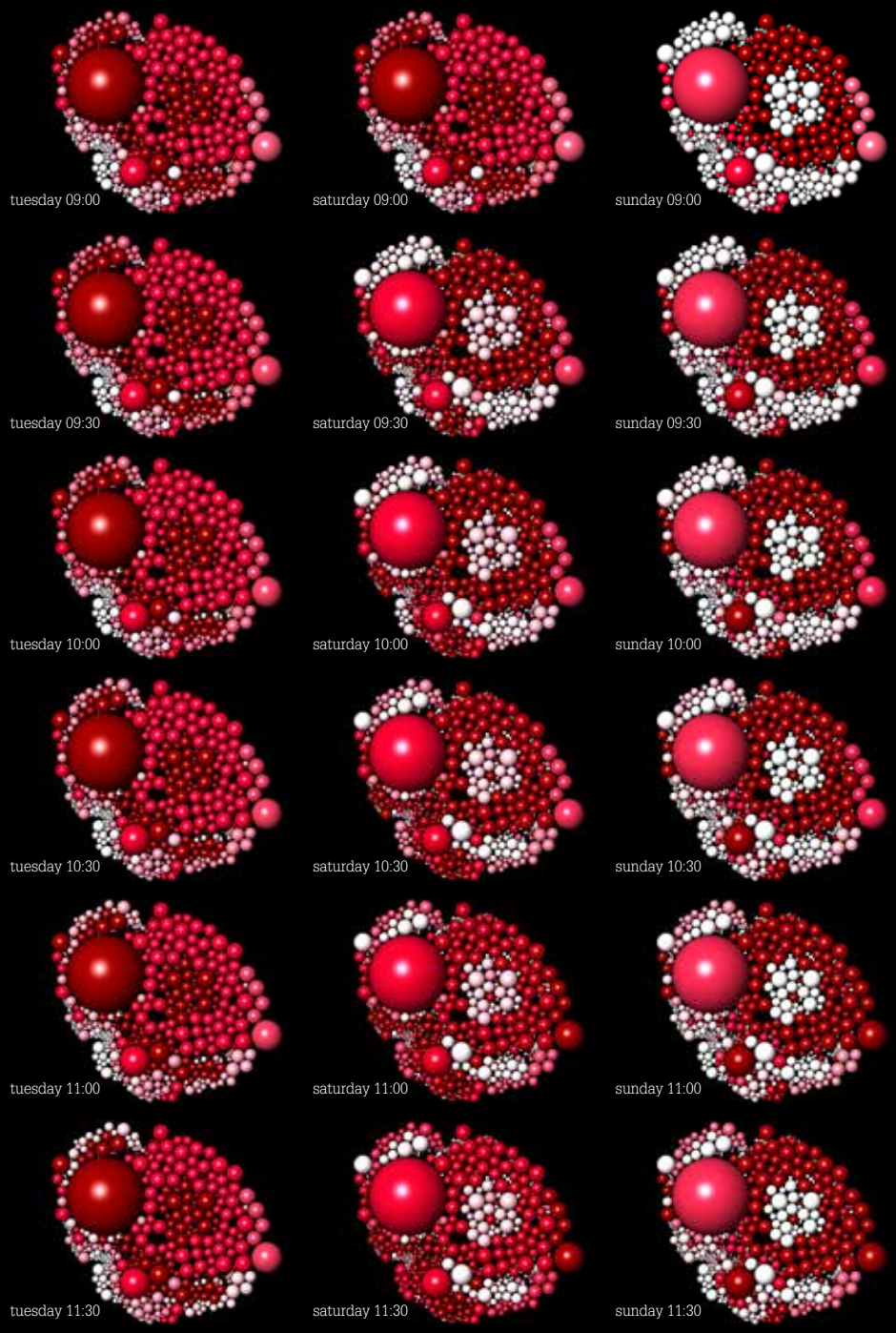


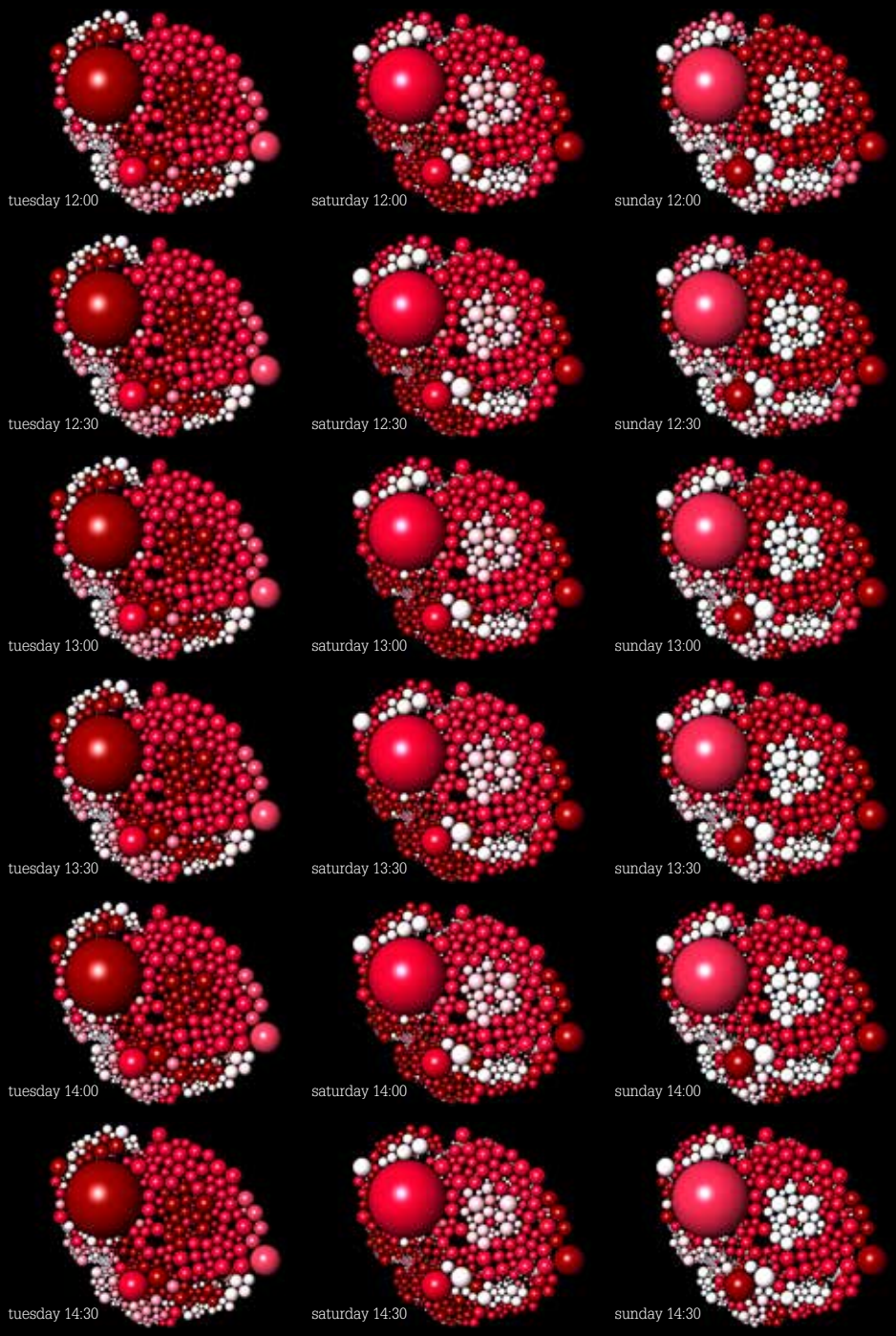
occupancy: TUESDAY 08:00
configuration: TUESDAY 08:00

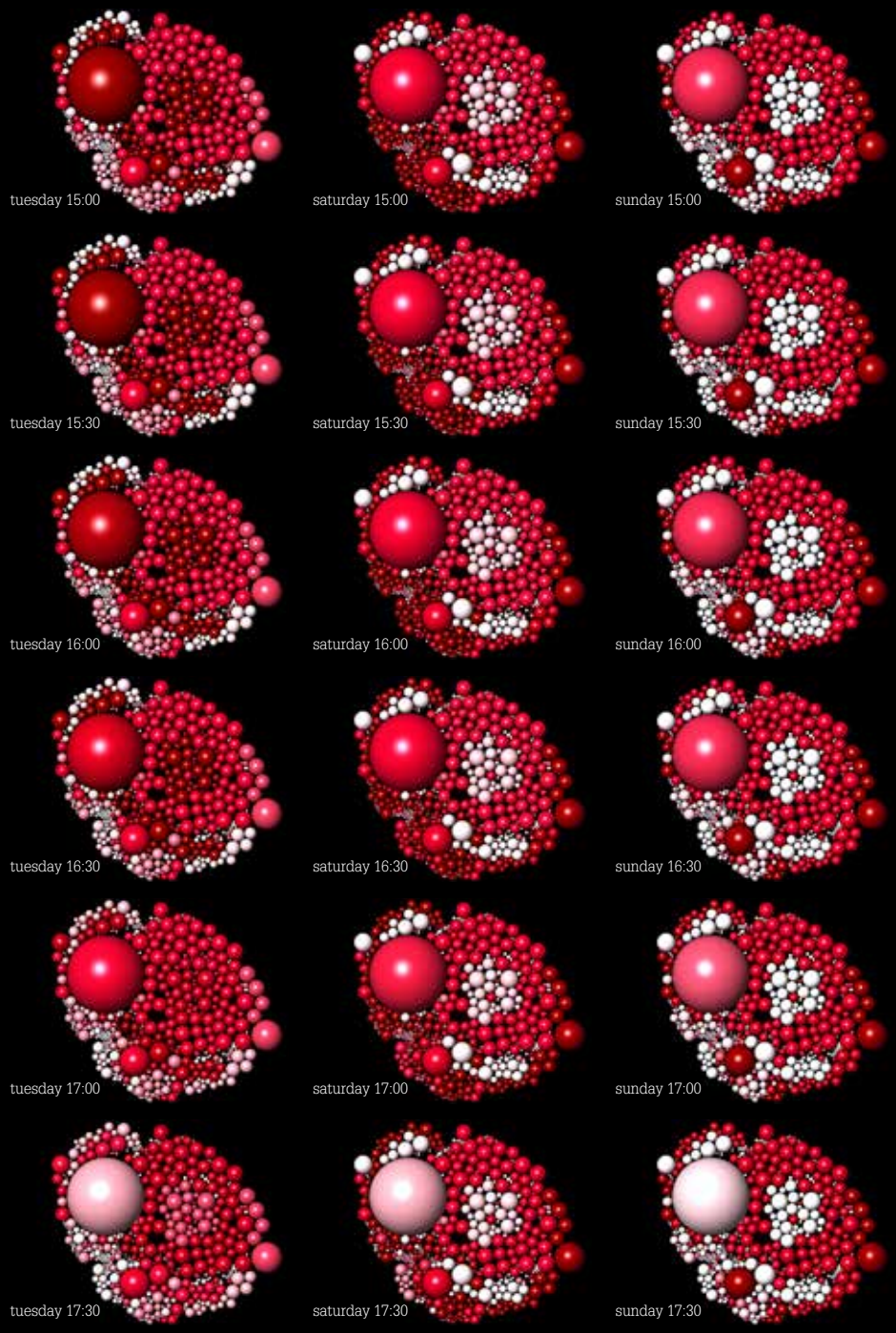

tuesday 00:00
saturday 00:00
sunday 00:00
tuesday 00:30
saturday 00:30
sunday 00:30
tuesday 01:00
saturday 01:00
sunday 01:00
tuesday 01:30
saturday 01:30
sunday 01:30
tuesday 02:00
saturday 02:00
sunday 02:00
tuesday 02:30
saturday 02:30
sunday 02:30

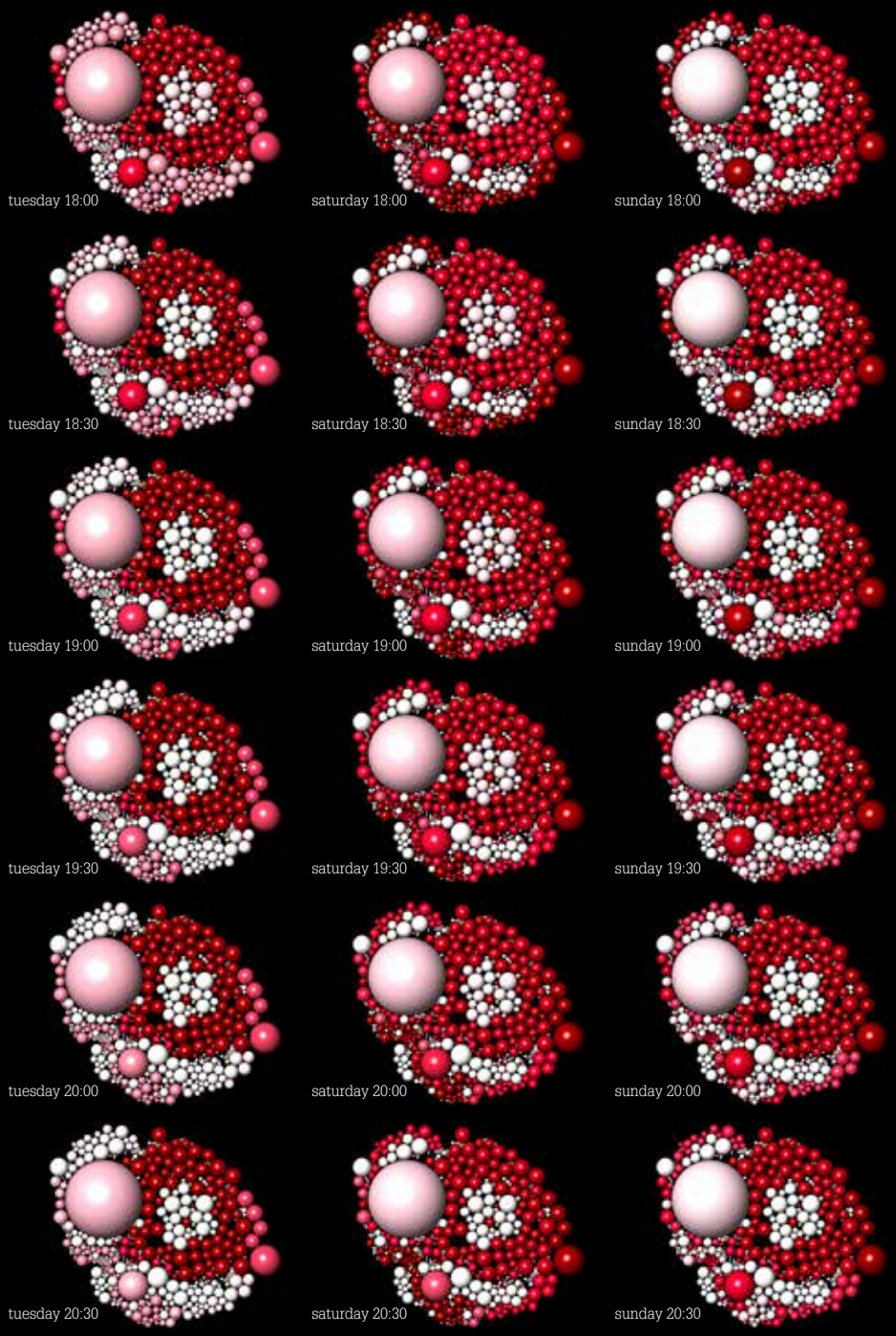

tuesday 03:00
saturday 03:00
sunday 03:00
tuesday 03:30
saturday 03:30
sunday 03:30
tuesday 04:00
saturday 04:00
sunday 04:00
tuesday 04:30
saturday 04:30
sunday 04:30
tuesday 05:00
saturday 05:00
sunday 05:00
tuesday 05:30
saturday 05:30
sunday 05:30

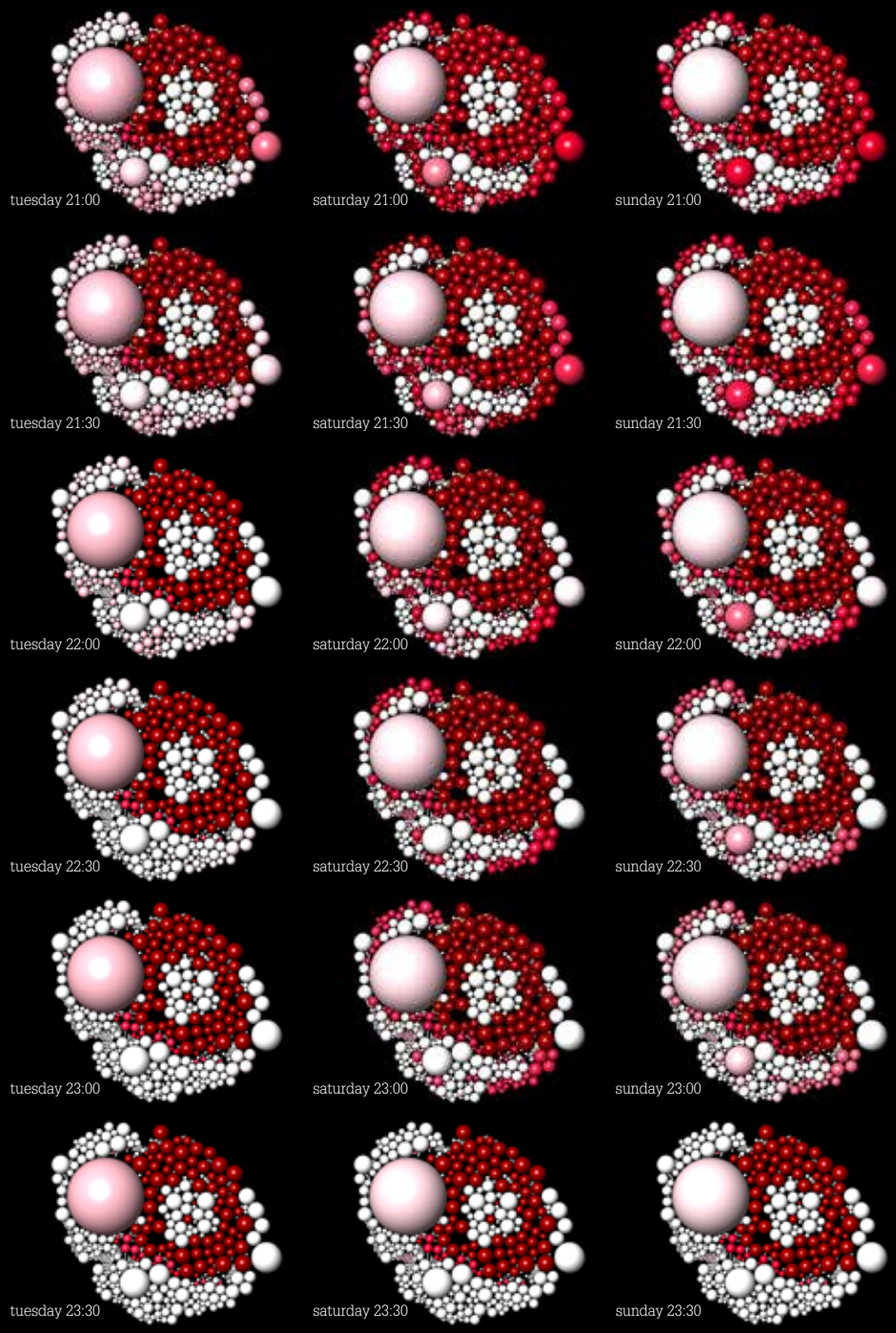

tuesday 06:00
saturday 06:00
sunday 06:00
tuesday 06:30
saturday 06:30
sunday 06:30
tuesday 07:00
saturday 07:00
sunday 07:00
tuesday 07:30
saturday 07:30
sunday 07:30
tuesday 08:00
saturday 08:00
sunday 08:00
tuesday 08:30
saturday 08:30
sunday 08:30


tuesday 09:00
saturday 09:00
sunday 09:00
tuesday 09:30
saturday 09:30
sunday 09:30
tuesday 10:00
saturday 10:00
sunday 10:00
tuesday 10:30
saturday 10:30
sunday 10:30
tuesday 11:00
saturday 11:00
sunday 11:00
tuesday 11:30
saturday 11:30
sunday 11:30

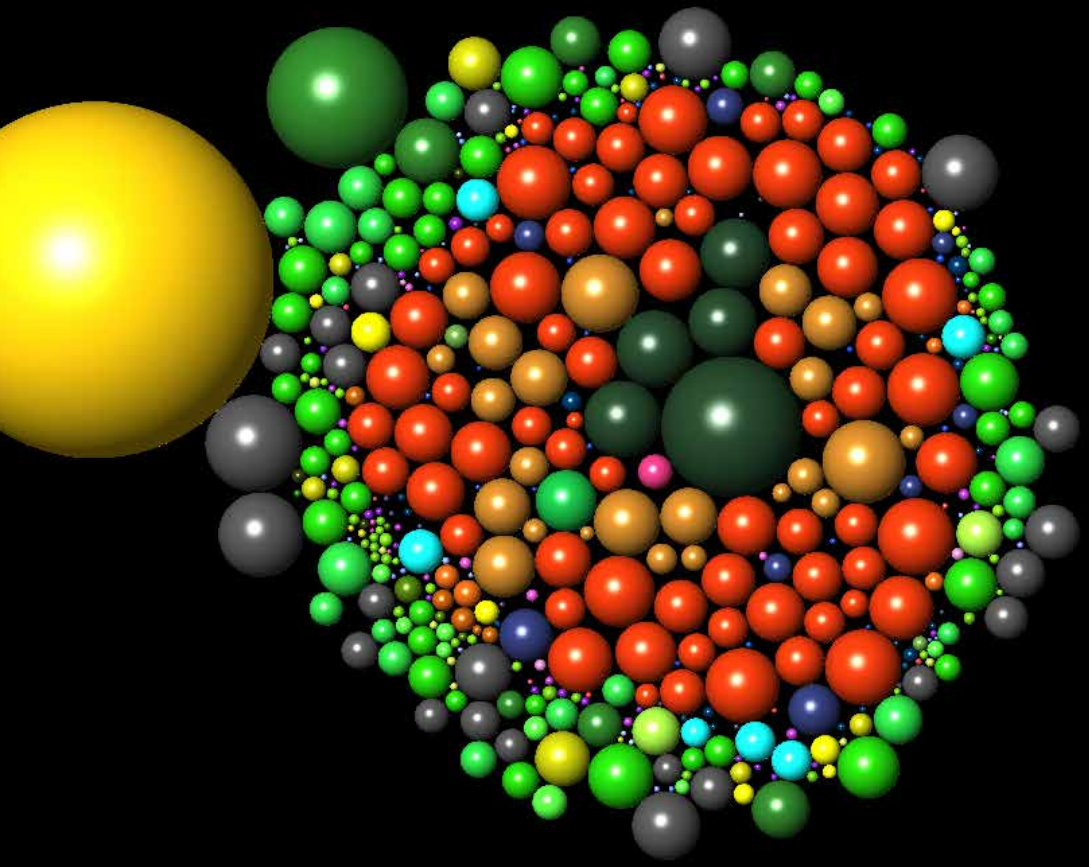

tuesday 12:00
saturday 12:00
sunday 12:00
tuesday 12:30
saturday 12:30
sunday 12:30
tuesday 13:00
saturday 13:00
sunday 13:00
tuesday 13:30
saturday 13:30
sunday 13:30
tuesday 14:00
saturday 14:00
sunday 14:00
tuesday 14:30
saturday 14:30
sunday 14:30


tuesday 15:00
saturday 15:00
sunday 15:00
tuesday 15:30
saturday 15:30
sunday 15:30
tuesday 16:00
saturday 16:00
sunday 16:00
tuesday 16:30
saturday 16:30
sunday 16:30
tuesday 17:00
saturday 17:00
sunday 17:00
tuesday 17:30
saturday 17:30
sunday 17:30


tuesday 18:00
saturday 18:00
sunday 18:00
tuesday 18:30
saturday 18:30
sunday 18:30
tuesday 19:00
saturday 19:00
sunday 19:00
tuesday 19:30
saturday 19:30
sunday 19:30
tuesday 20:00
saturday 20:00
sunday 20:00
tuesday 20:30
saturday 20:30
sunday 20:30


tuesday 21:00
saturday 21:00
sunday 21:00
tuesday 21:30
saturday 21:30
sunday 21:30
tuesday 22:00
saturday 22:00
sunday 22:00
tuesday 22:30
saturday 22:30
sunday 22:30
tuesday 23:00
saturday 23:00
sunday 23:00
tuesday 23:30
saturday 23:30
sunday 23:30

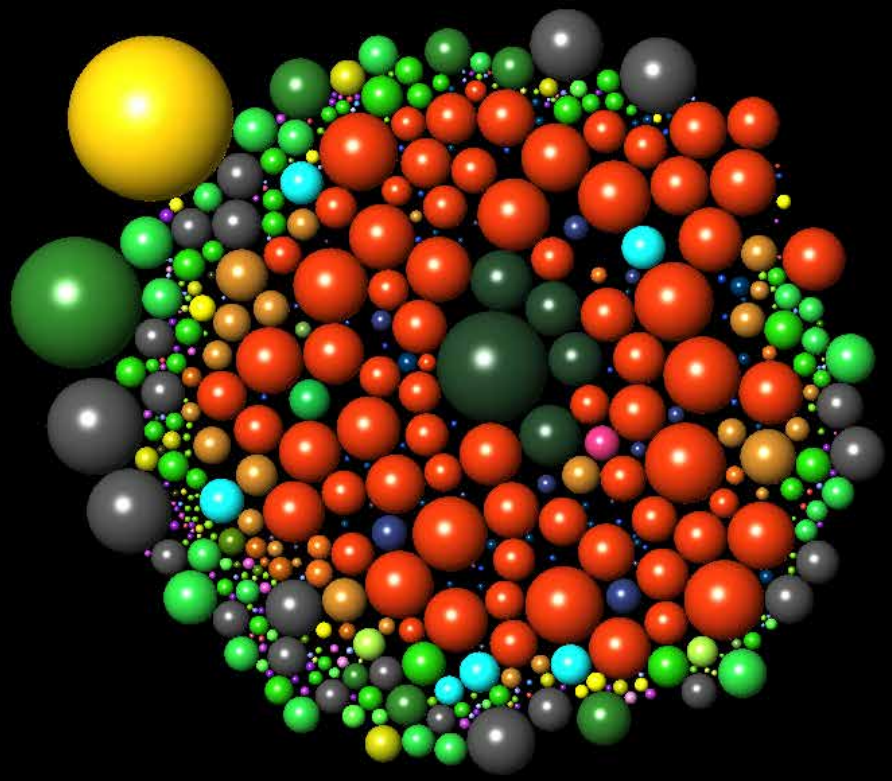
Fixed city configuration



SUNDAY 20:00

The configuration of the city remains the same. Only the size of the particles changes.

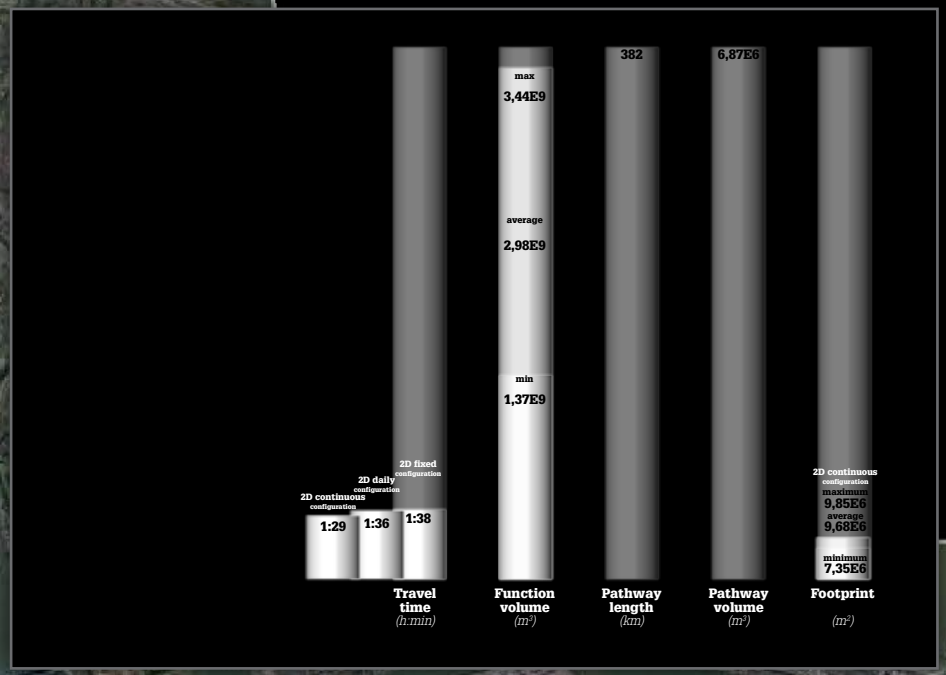
Daily city configuration



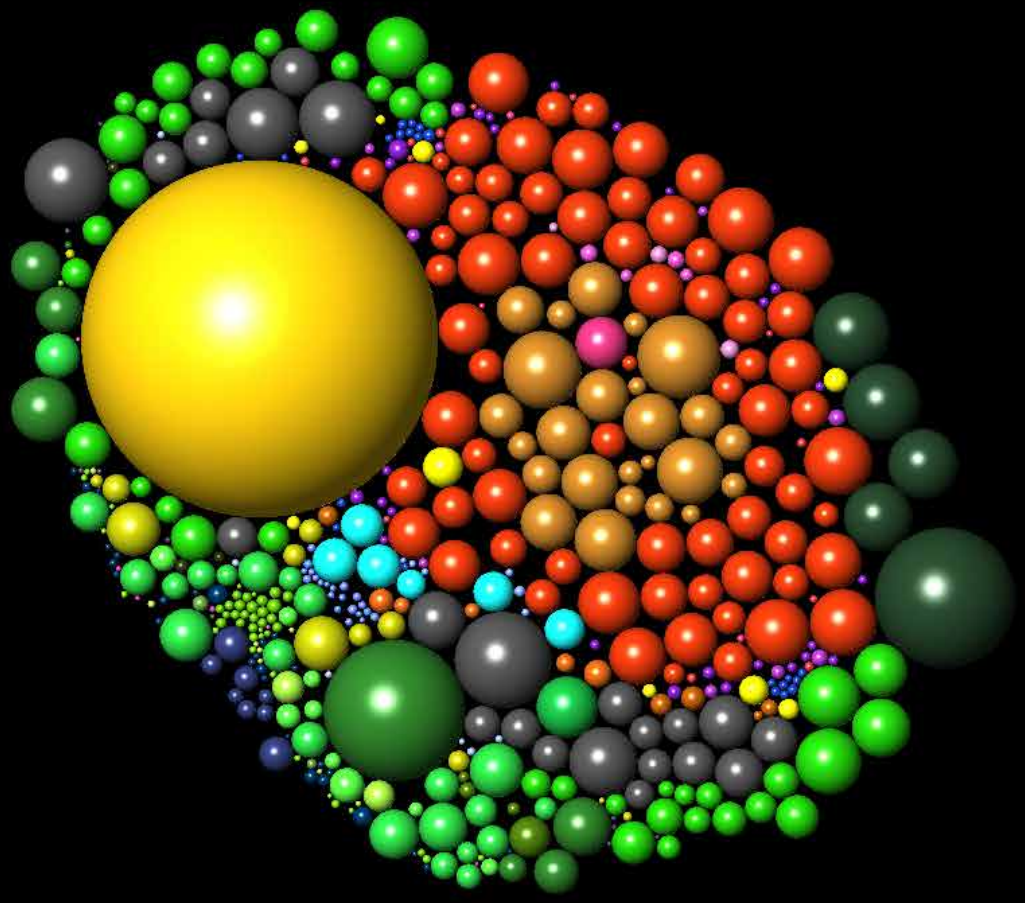
SATURDAY 04:00

The configuration of the city changes only at night. There are still three city configurations: one for a weekday, one for saturday and one for sunday. During the day, only the size of the particles changes.

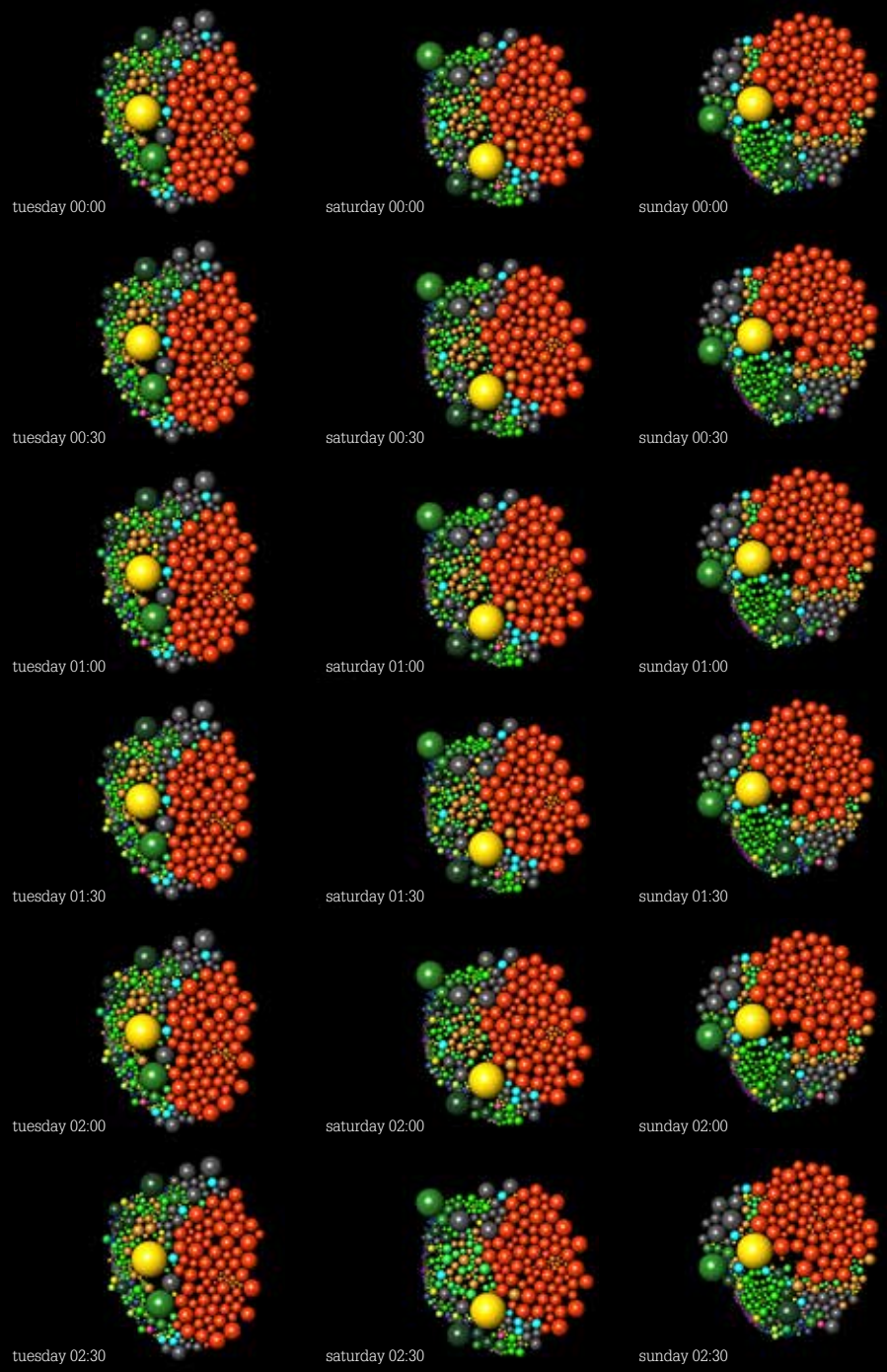
Continuous city configuration

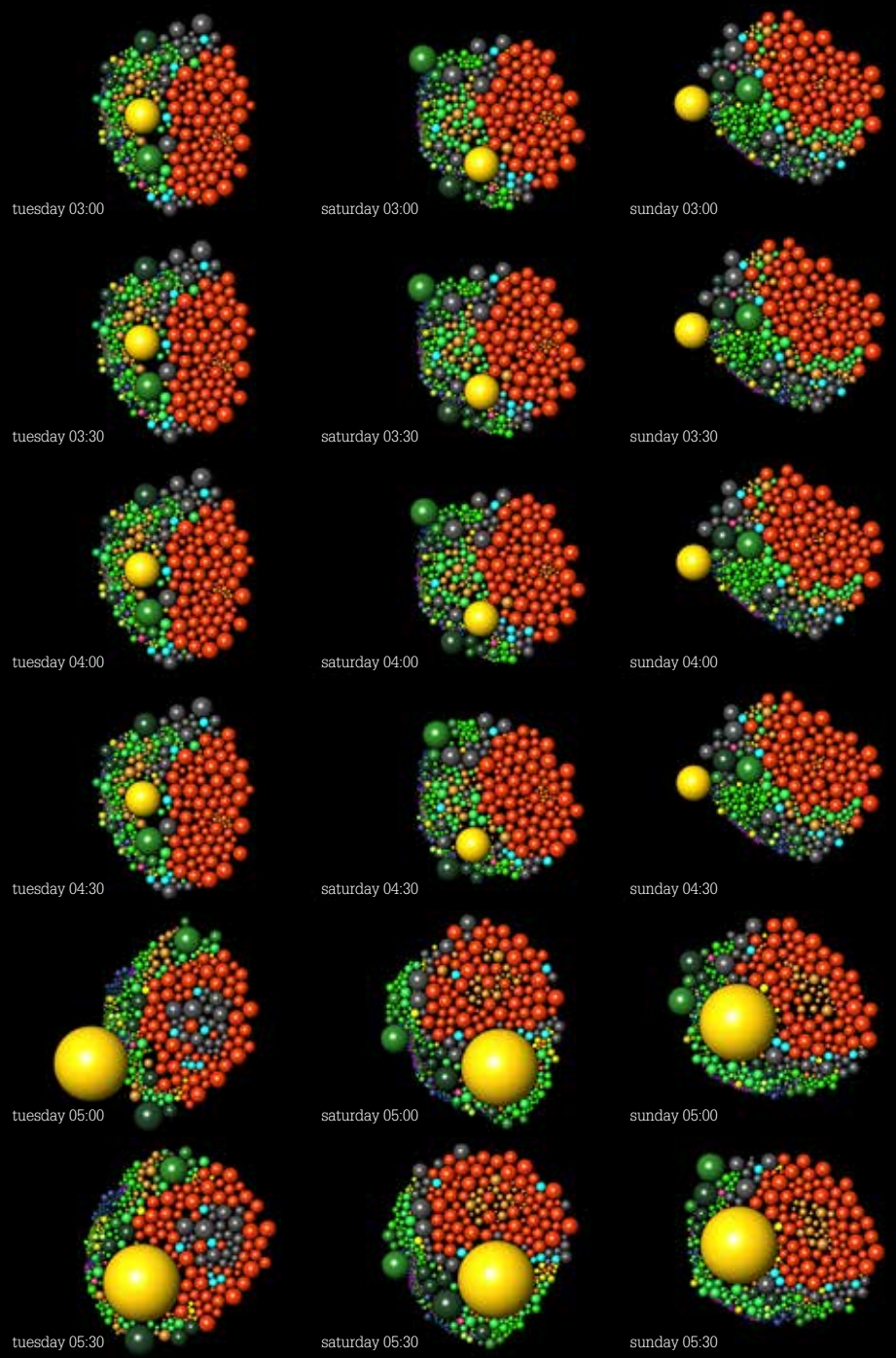


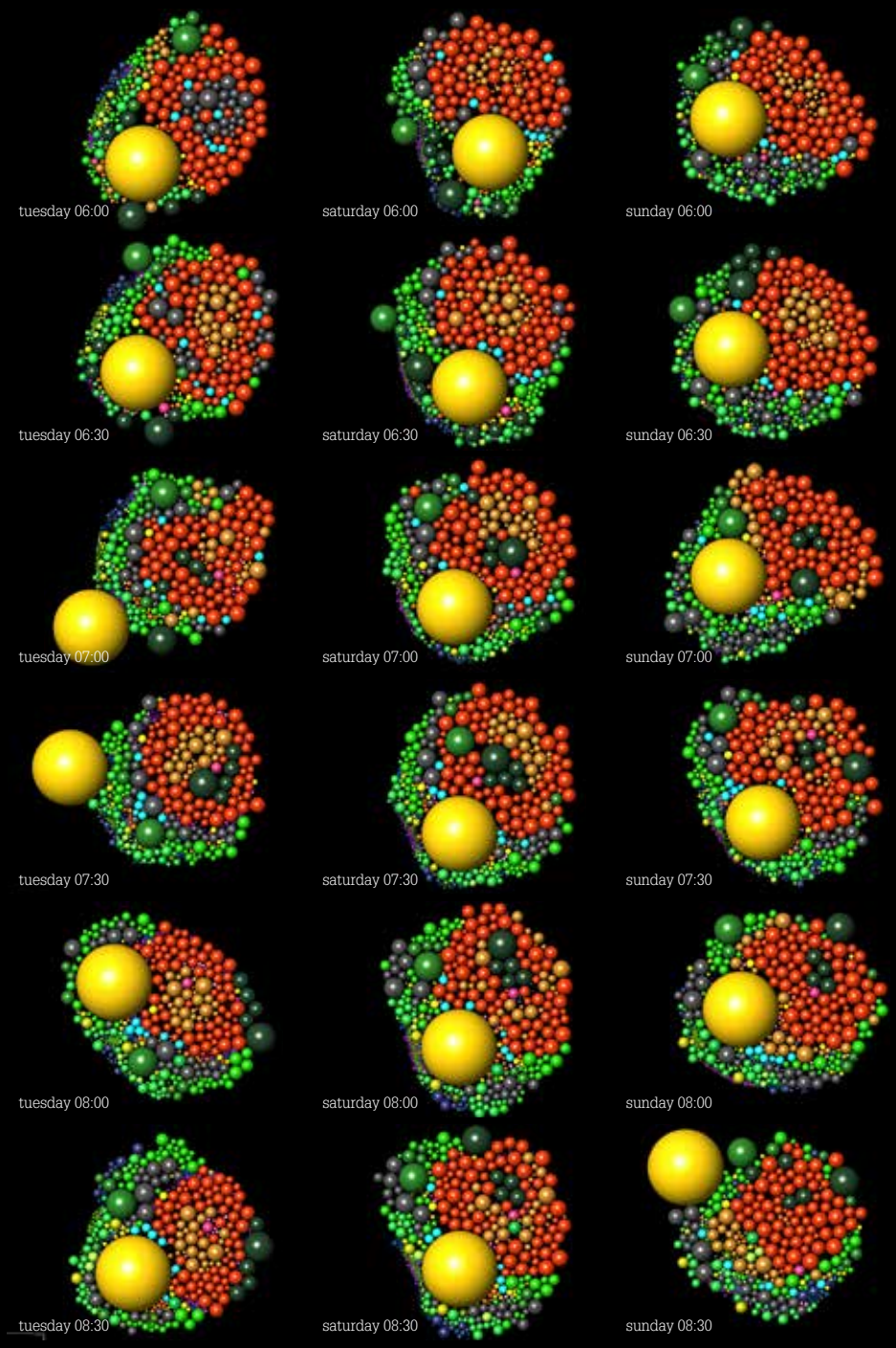
Both the configuration of the city and the sizes of the particles could continuously change.

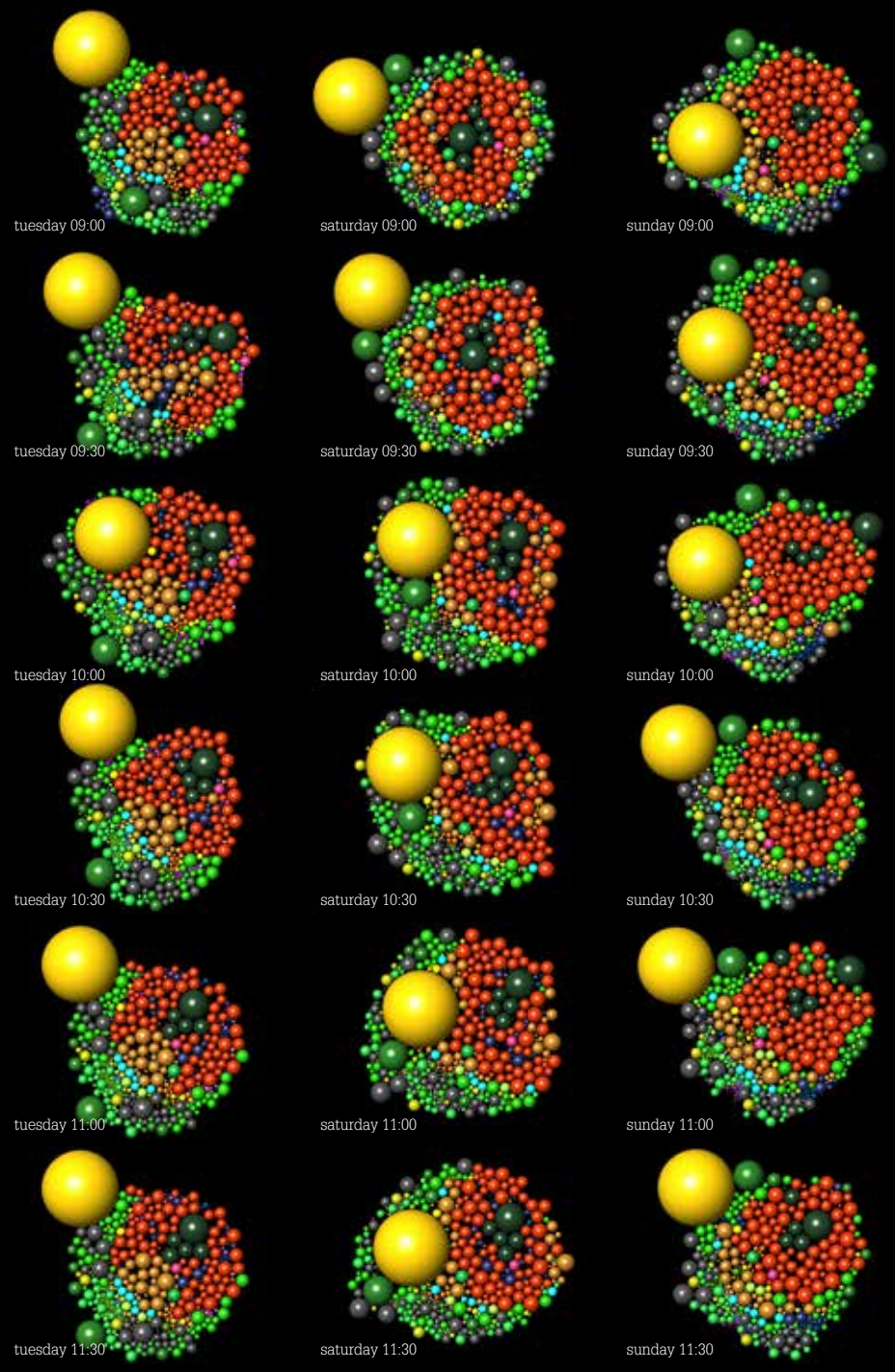


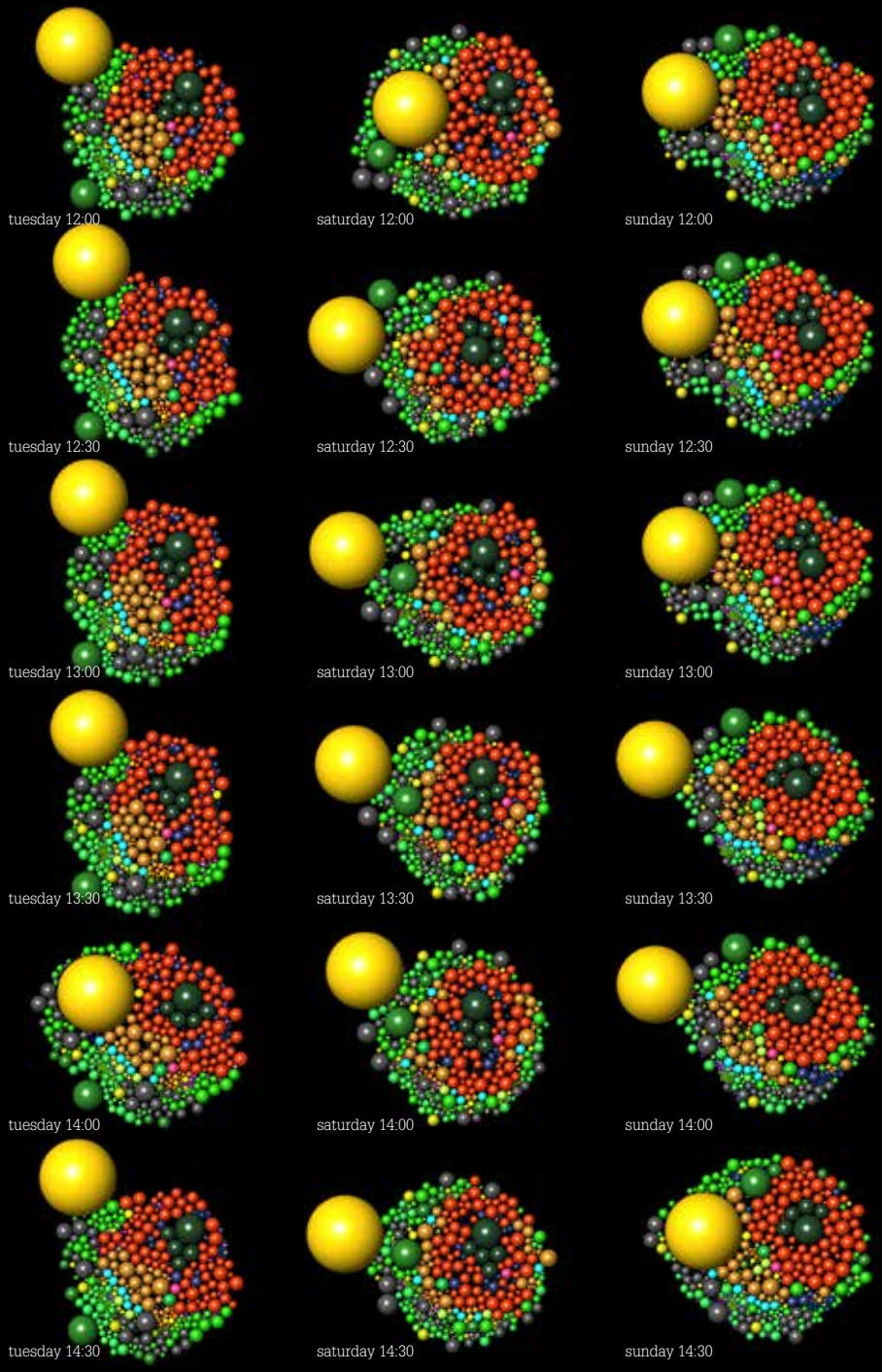
TUESDAY 08:00

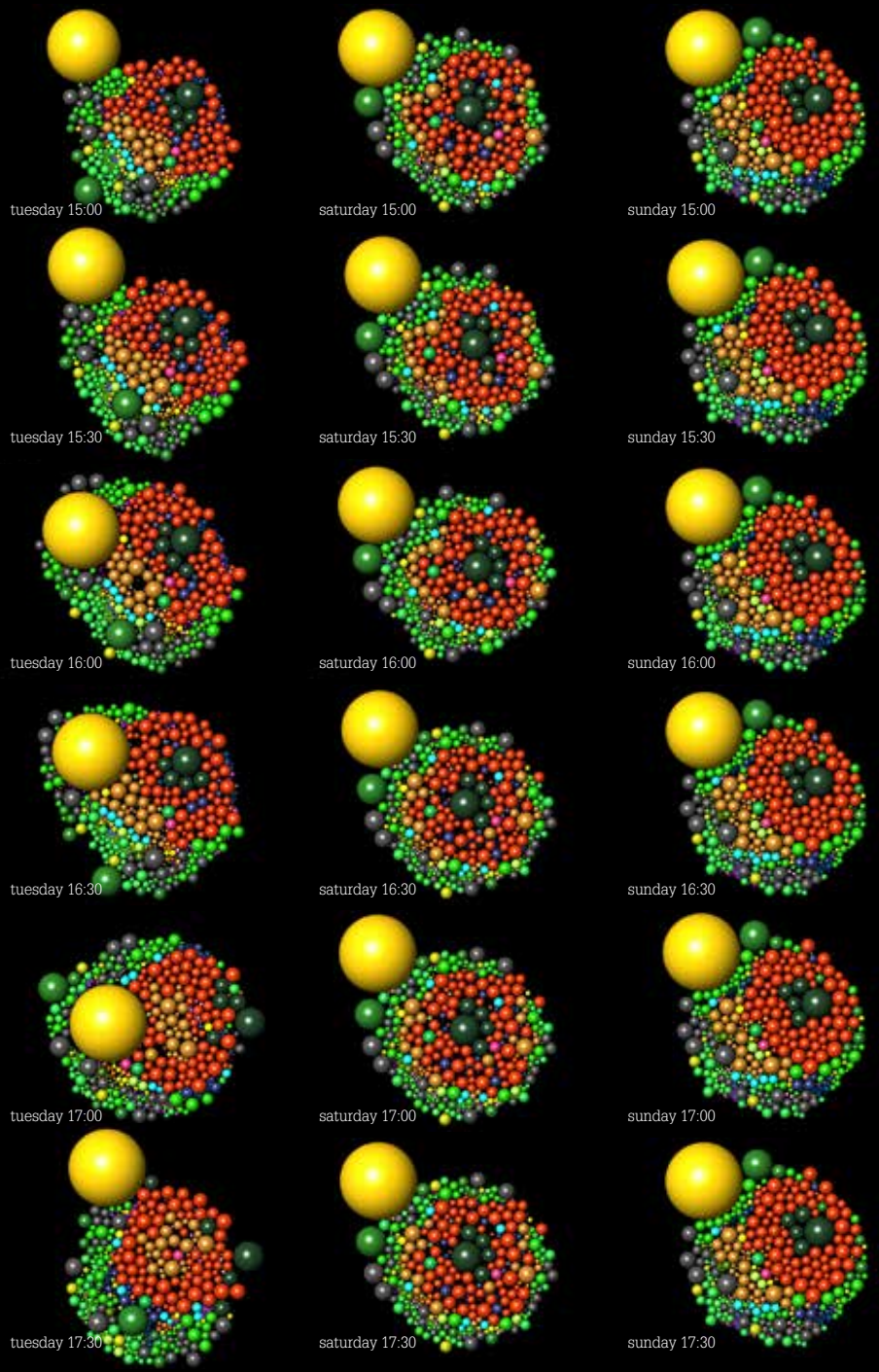

tuesday 00:00
saturday 00:00
sunday 00:00
tuesday 00:30
saturday 00:30
sunday 00:30
tuesday 01:00
saturday 01:00
sunday 01:00
tuesday 01:30
saturday 01:30
sunday 01:30
tuesday 02:00
saturday 02:00
sunday 02:00
tuesday 02:30
saturday 02:30
sunday 02:30

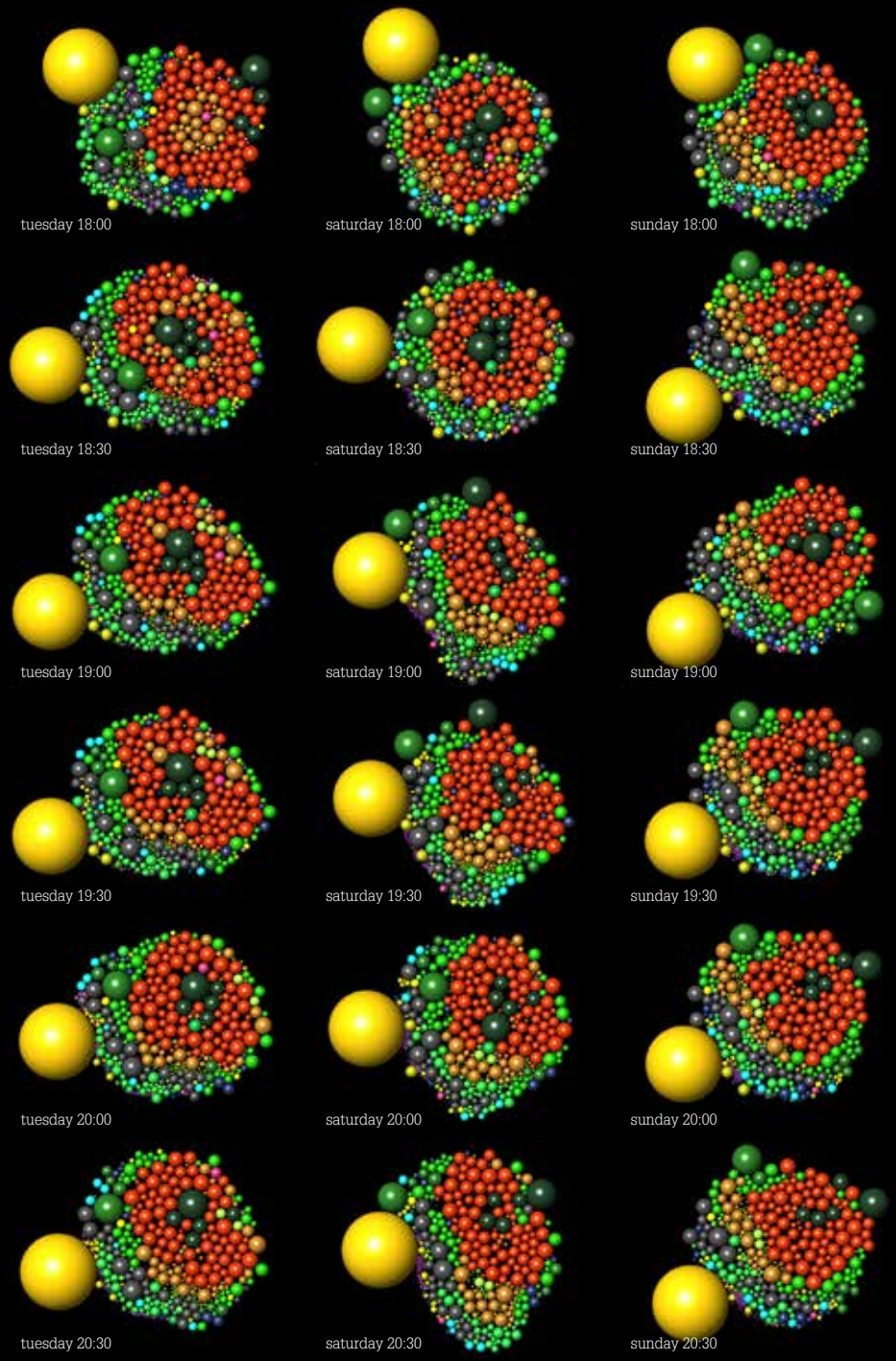

tuesday 03:00
saturday 03:00
sunday 03:00
tuesday 03:30
saturday 03:30
sunday 03:30
tuesday 04:00
saturday 04:00
sunday 04:00
tuesday 04:30
saturday 04:30
sunday 04:30
tuesday 05:00
saturday 05:00
sunday 05:00
tuesday 05:30
saturday 05:30
sunday 05:30

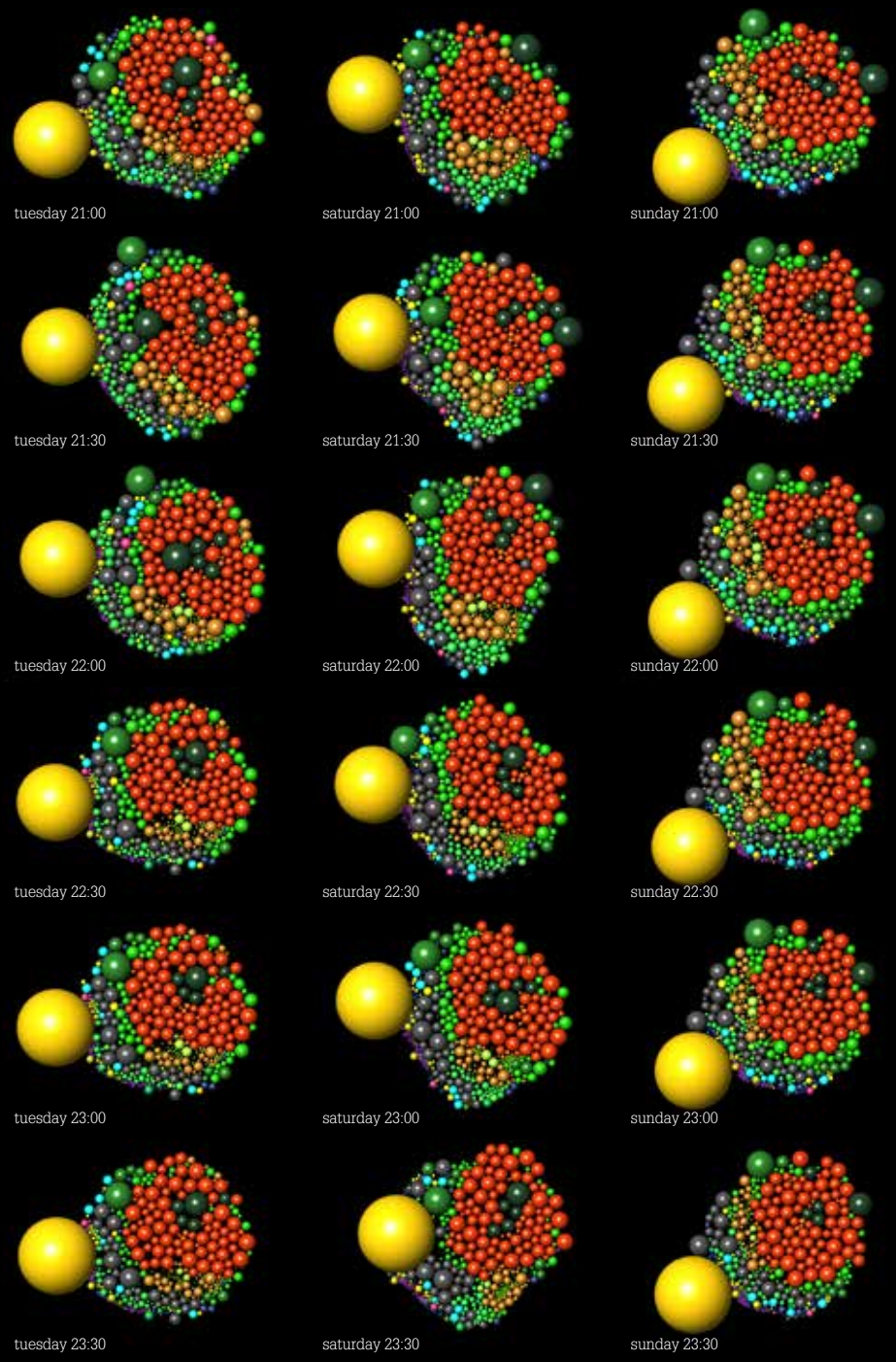

tuesday 06:00
saturday 06:00
sunday 06:00
tuesday 06:30
saturday 06:30
sunday 06:30
tuesday 07:00
saturday 07:00
sunday 07:00
tuesday 07:30
saturday 07:30
sunday 07:30
tuesday 08:00
saturday 08:00
sunday 08:00
tuesday 08:30
saturday 08:30
sunday 08:30


tuesday 09:00
saturday 09:00
sunday 09:00
tuesday 09:30
saturday 09:30
sunday 09:30
tuesday 10:00
saturday 10:00
sunday 10:00
tuesday 10:30
saturday 10:30
sunday 10:30
tuesday 11:00
saturday 11:00
sunday 11:00
tuesday 11:30
saturday 11:30
sunday 11:30

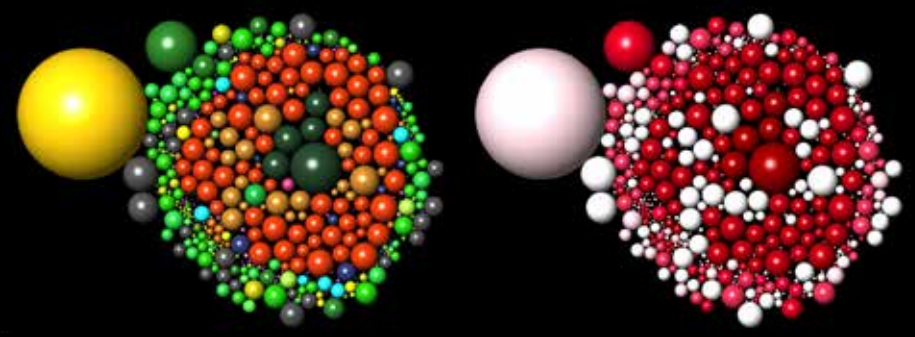

tuesday 12:00
saturday 12:00
sunday 12:00
tuesday 12:30
saturday 12:30
sunday 12:30
tuesday 13:00
saturday 13:00
sunday 13:00
tuesday 13:30
saturday 13:30
sunday 13:30
tuesday 14:00
saturday 14:00
sunday 14:00
tuesday 14:30
saturday 14:30
sunday 14:30


tuesday 15:00
saturday 15:00
sunday 15:00
tuesday 15:30
saturday 15:30
sunday 15:30
tuesday 16:00
saturday 16:00
sunday 16:00
tuesday 16:30
saturday 16:30
sunday 16:30
tuesday 17:00
saturday 17:00
sunday 17:00
tuesday 17:30
saturday 17:30
sunday 17:30

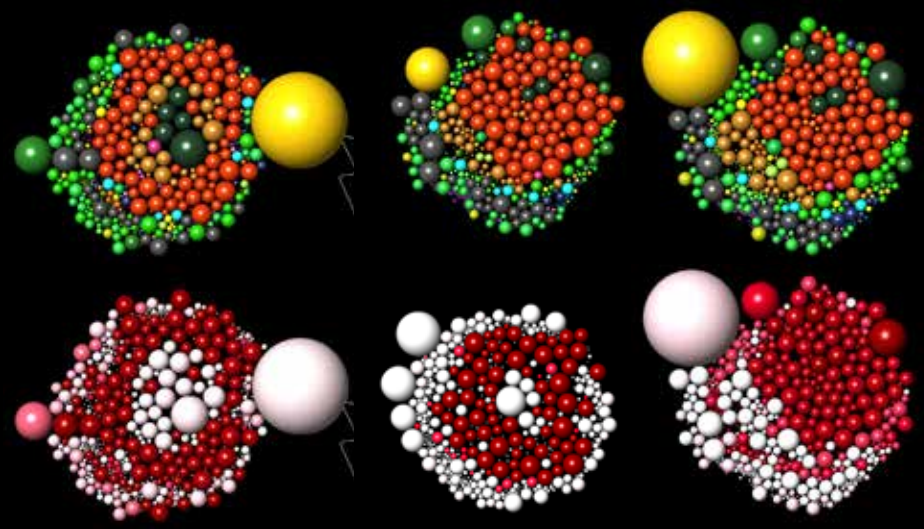

tuesday 18:00
saturday 18:00
sunday 18:00
tuesday 18:30
saturday 18:30
sunday 18:30
tuesday 19:00
saturday 19:00
sunday 19:00
tuesday 19:30
saturday 19:30
sunday 19:30
tuesday 20:00
saturday 20:00
sunday 20:00
tuesday 20:30
saturday 20:30
sunday 20:30


tuesday 21:00
saturday 21:00
sunday 21:00
tuesday 21:30
saturday 21:30
sunday 21:30
tuesday 22:00
saturday 22:00
sunday 22:00
tuesday 22:30
saturday 22:30
sunday 22:30
tuesday 23:00
saturday 23:00
sunday 23:00
tuesday 23:30
saturday 23:30
sunday 23:30

Analysis results

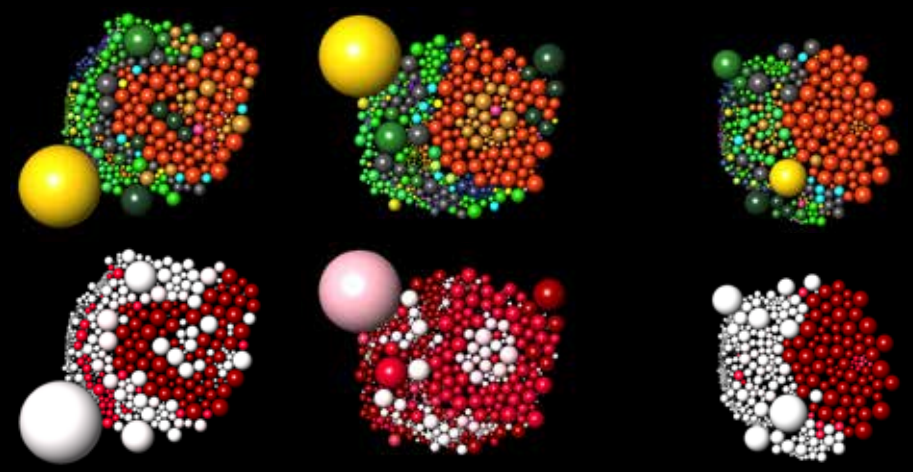


fixed configuration with resizing particles
sunday 20:00

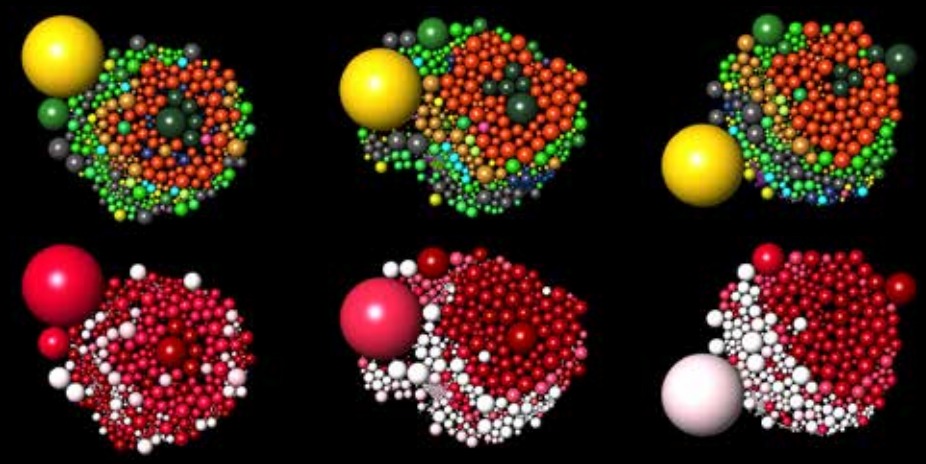


tuesday 07:00 saturday 04:00 sunday 20:00
daily configuration with resizing particles

Since the particles in the city do not reconfigure (fixed configuration) or only configure once a day (daily configuration), the used particles could be spread out over the city.



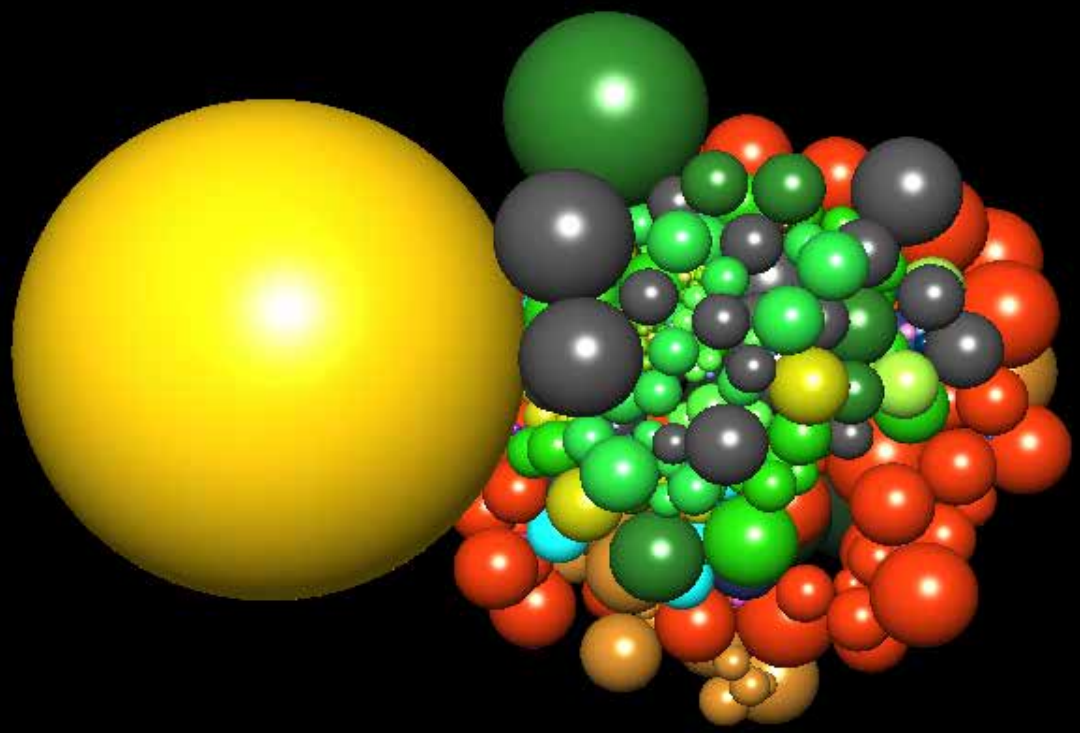
tuesday 07:00 tuesday 18:00 saturday 04:00



saturday 16:00 sunday 12:00 sunday 20:00
continuous configuration with resizing particles

In a continuously configuring city, the particles which are used are generally near each other. Therefore the used particles are clustered most of the time.

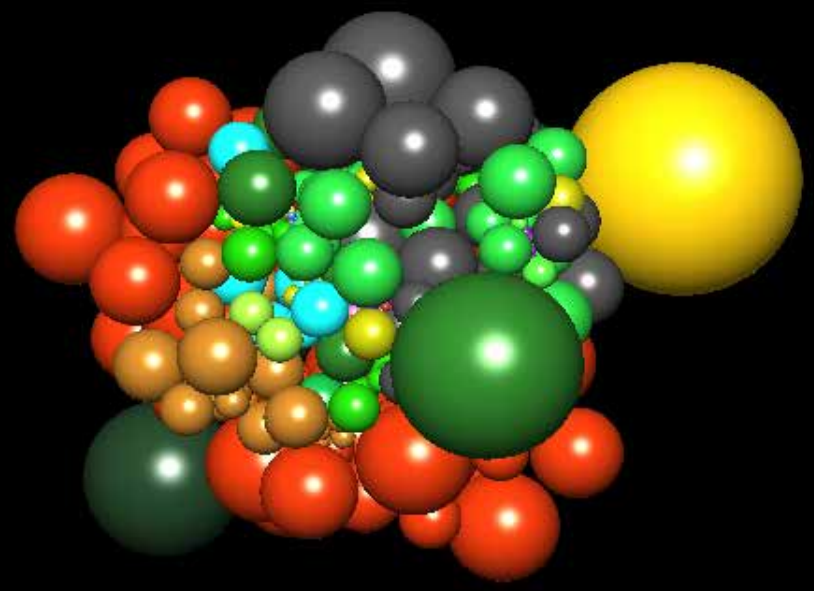
Fixed city configuration 3D



SUNDAY 20:00

The configuration of the city remains the same. Only the size of the particles changes.

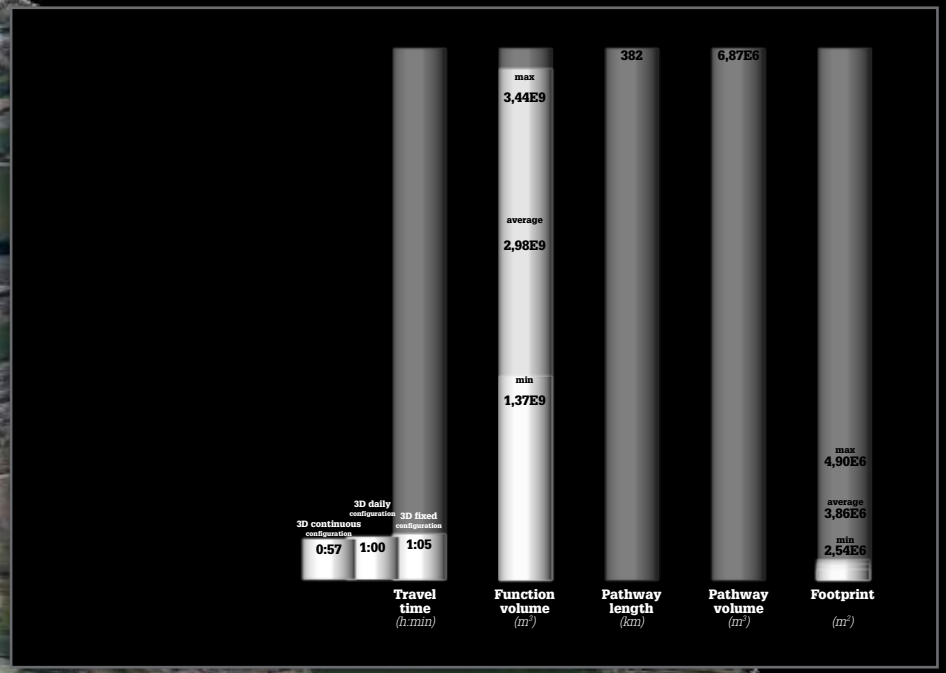
Daily city configuration 3D

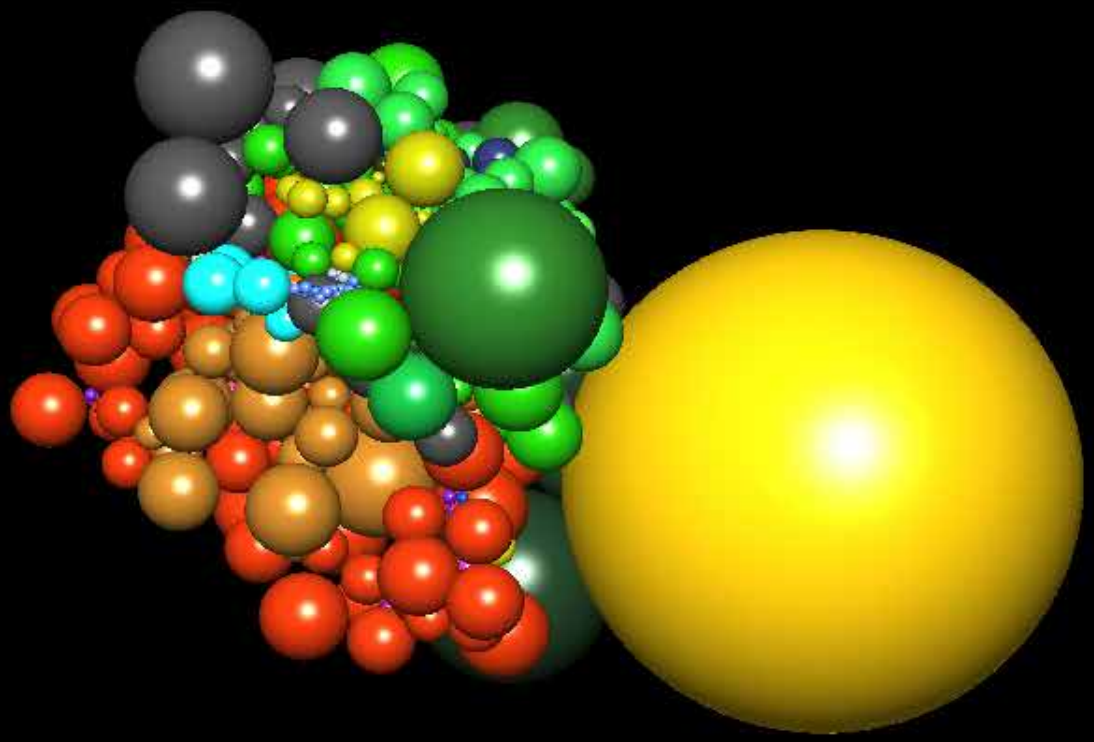


SATURDAY 04:00

The configuration of the city changes only at night. There are still three city configurations: one for a weekday, one for saturday and one for sunday. During the day, only the size of the particles changes.

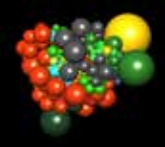
Continuous city configuration 3D

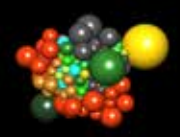


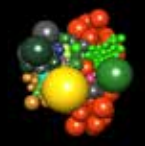


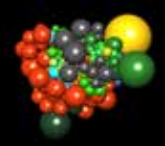
TUESDAY 08:00

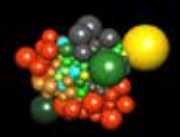
Both the configuration of the city and the sizes of the particles could continuously change.

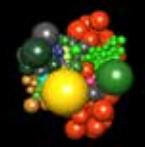

tuesday 00:00

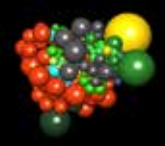

saturday 00:00

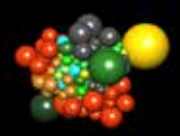

sunday 00:00

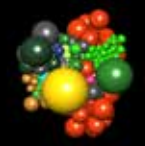

tuesday 00:30

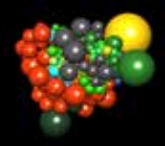

saturday 00:30

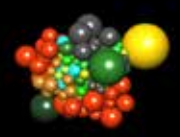

sunday 00:30

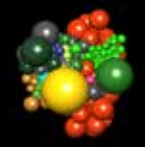

tuesday 01:00

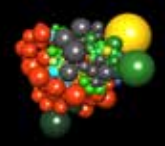

saturday 01:00

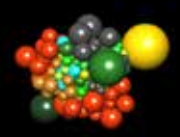

sunday 01:00

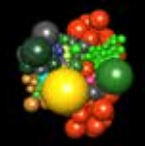

tuesday 01:30

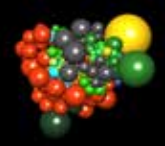

saturday 01:30

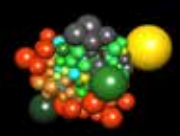

sunday 01:30

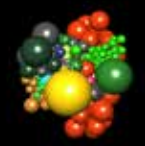

tuesday 02:00

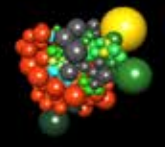

saturday 02:00

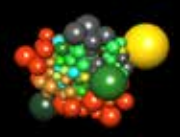

sunday 02:00

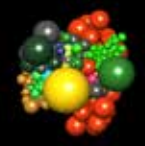

tuesday 02:30


saturday 02:30

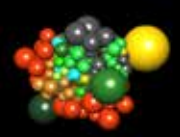

sunday 02:30

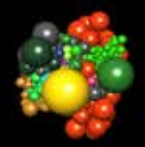

tuesday 03:00

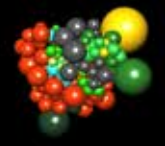

saturday 03:00

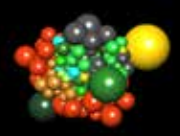

sunday 03:00

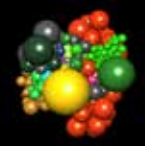

tuesday 03:30

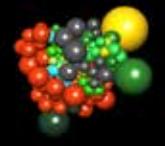

saturday 03:30

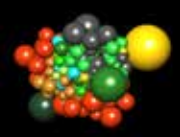

sunday 03:30

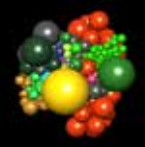

tuesday 04:00

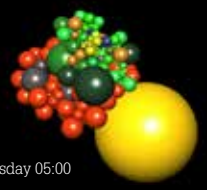

saturday 04:00

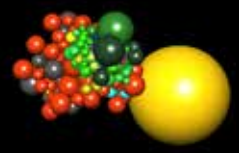

sunday 04:00


tuesday 04:30


saturday 04:30

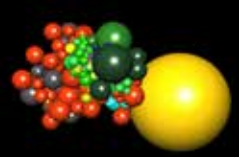

sunday 04:30


tuesday 05:00

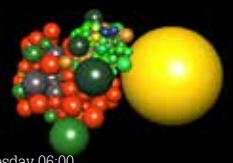

saturday 05:00

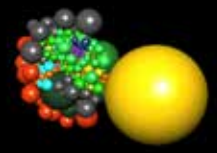

sunday 05:00


tuesday 05:30

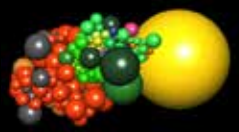

saturday 05:30

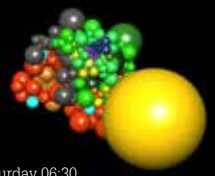

sunday 05:30


tuesday 06:00


saturday 06:00

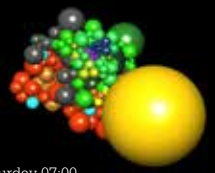

sunday 06:00


tuesday 06:30

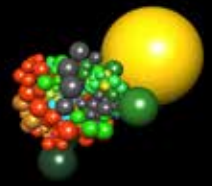

saturday 06:30


sunday 06:30


tuesday 07:00

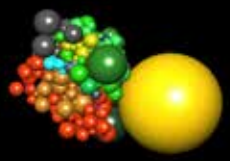

saturday 07:00


sunday 07:00

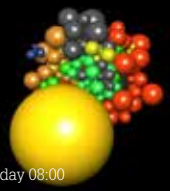

tuesday 07:30

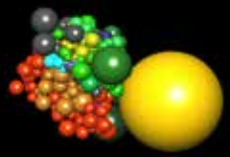

saturday 07:30


sunday 07:30


tuesday 08:00

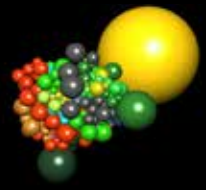

saturday 08:00


sunday 08:00


tuesday 08:30


saturday 08:30


sunday 08:30


tuesday 09:00

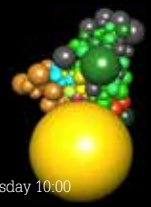

saturday 09:00


sunday 09:00

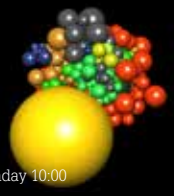

tuesday 09:30

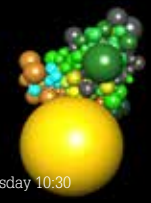

saturday 09:30


sunday 09:30


tuesday 10:00

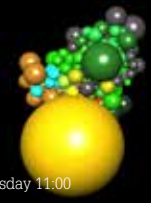

saturday 10:00


sunday 10:00


tuesday 10:30


saturday 10:30


sunday 10:30

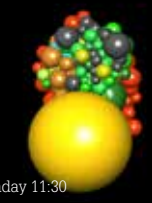

tuesday 11:00


saturday 11:00


sunday 11:00


tuesday 11:30


saturday 11:30

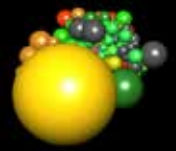

sunday 11:30


tuesday 12:00

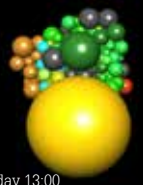

saturday 12:00

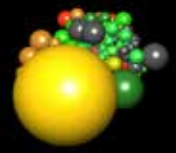

sunday 12:00

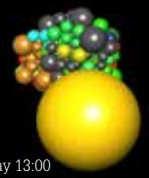

tuesday 12:30

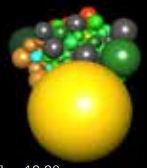

saturday 12:30

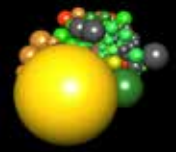

sunday 12:30

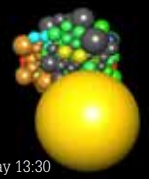

tuesday 13:00

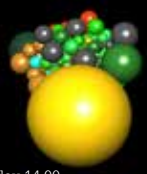

saturday 13:00

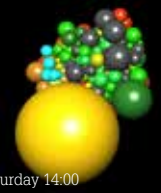

sunday 13:00

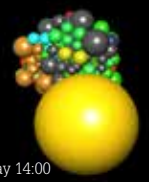

tuesday 13:30

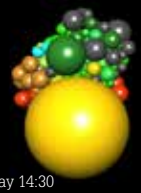

saturday 13:30

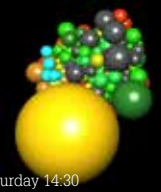

sunday 13:30

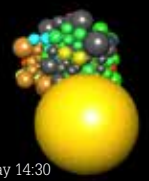

tuesday 14:00


saturday 14:00


sunday 14:00

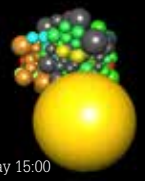

tuesday 14:30


saturday 14:30


sunday 14:30

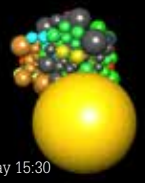

tuesday 15:00


saturday 15:00


sunday 15:00


tuesday 15:30


saturday 15:30


sunday 15:30

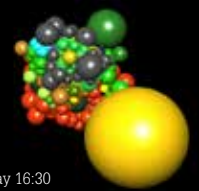

tuesday 16:00


saturday 16:00

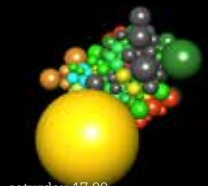

sunday 16:00

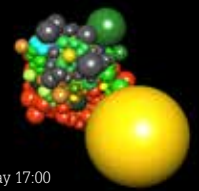

tuesday 16:30

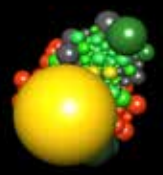

saturday 16:30


sunday 16:30

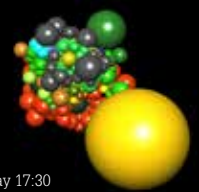

tuesday 17:00

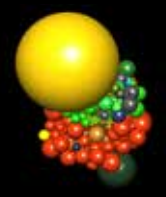

saturday 17:00

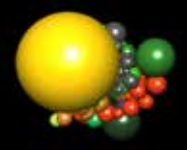

sunday 17:00

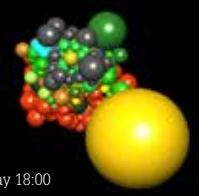

tuesday 17:30

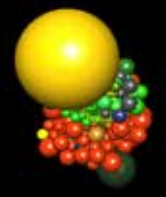

saturday 17:30


sunday 17:30

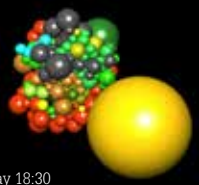

tuesday 18:00

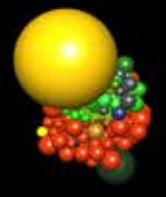

saturday 18:00

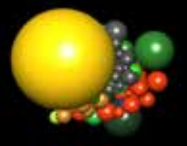

sunday 18:00

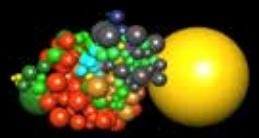

tuesday 18:30

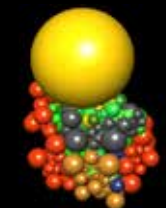

saturday 18:30


sunday 18:30

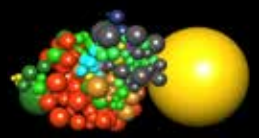

tuesday 19:00

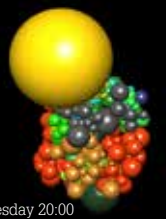

saturday 19:00

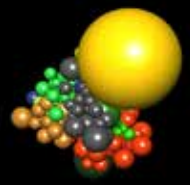

sunday 19:00

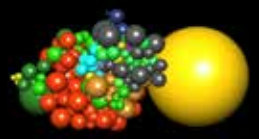

tuesday 19:30

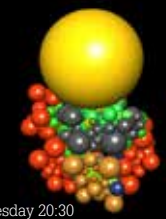

saturday 19:30

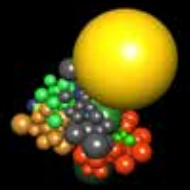

sunday 19:30

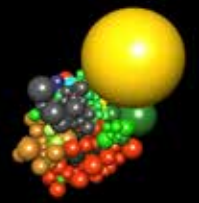

tuesday 20:00

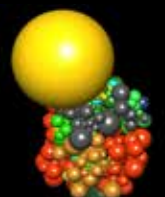

saturday 20:00

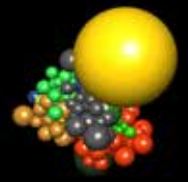

sunday 20:00

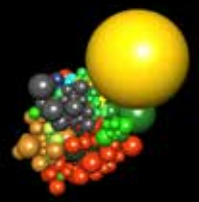

tuesday 20:30

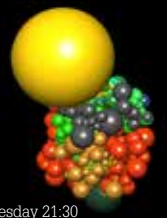

saturday 20:30

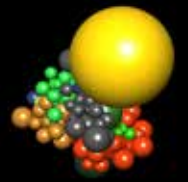

sunday 20:30


tuesday 21:00

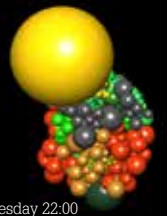

saturday 21:00

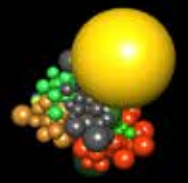

sunday 21:00

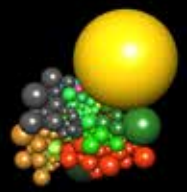

tuesday 21:30

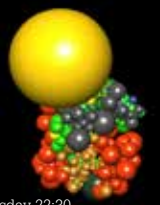

saturday 21:30

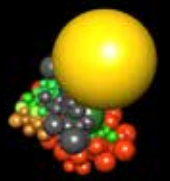

sunday 21:30


tuesday 22:00

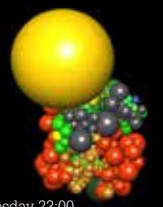

saturday 22:00

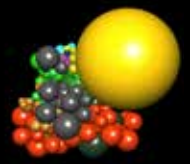

sunday 22:00


tuesday 22:30

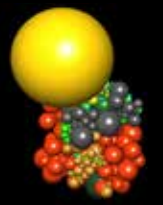

saturday 22:30

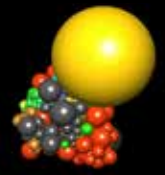

sunday 22:30


tuesday 23:00


saturday 23:00


sunday 23:00

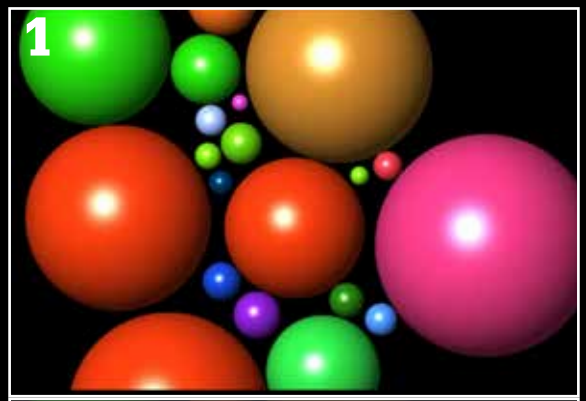

tuesday 23:30


saturday 23:30

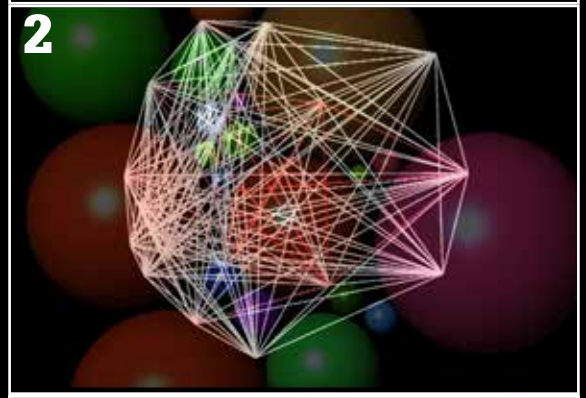

sunday 23:30

TOOL 4 PATHWAY VOLUME

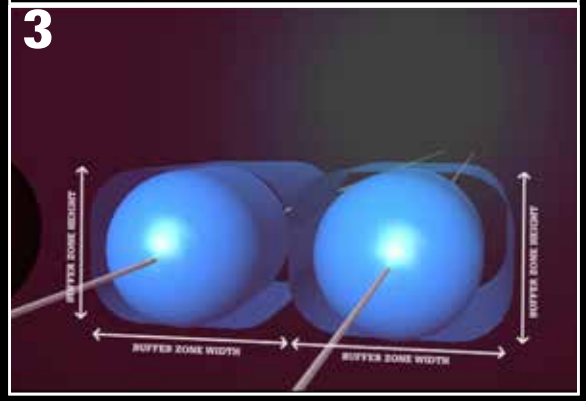
Tool decription



How do we determine the volume of the pathways?

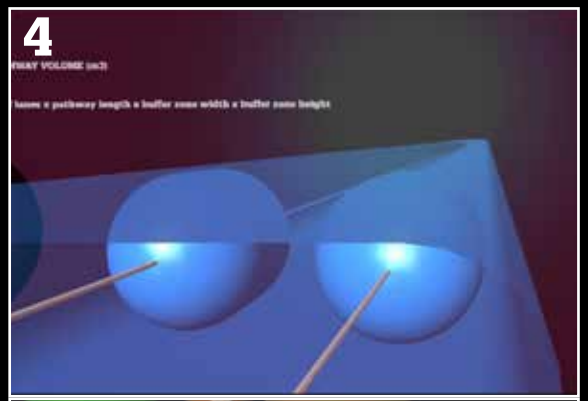


As we know the connections between the particles have different intensities (people/min).

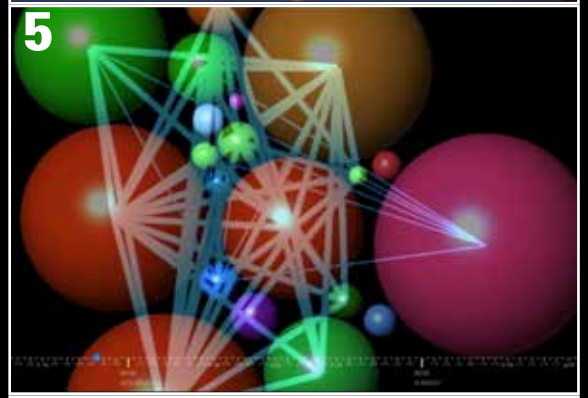


To see what determines the volume of a pathway we look at one connection.

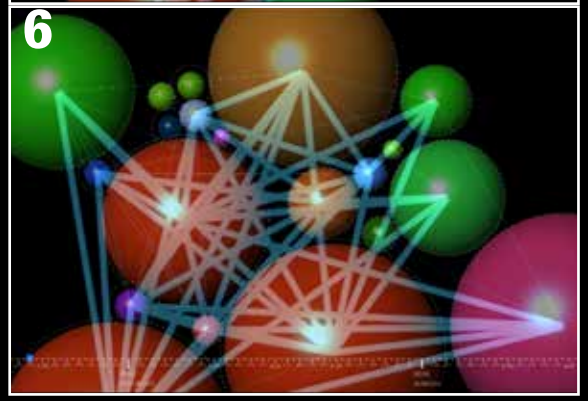
Each vehicle has a buffer zone in which no other vehicle can place itself in for safety reasons. If a pathway is that busy that buffer zones are interpenetrating, that pathway should consist of more lanes.



Based on the buffer zones of the vehicles and the number of lanes per pathway, this is the volume necessary for the pathways. This means that at some times of the day, some pathways are not necessary



Then this is what it would look like when pathways appear and disappear when they are necessary or not. Again, you can see that when a pathway is not used, it does not have a volume.



And this is what it would look like if we apply the pathway volumes to the model we already had with moving and resizing particles.

Tool decription

Rules:

- **Pathways are a direct (straight) connection between the centers of the spheres.**

- **Pathway volumes and dimensions are based on connection intensities, maximum pathway capacity, speed of the vehicle, vehicle capacity, and vehicle buffer zone dimensions. (see formulas)**
  Since the connection intensities change continuously, the number of lanes and thus the pathway volume could also change. And thus, when the connection intensity is zero, the pathway volume is zero.

Formulas

Per pathway

$$\text{Connection intensity (veh/s)} = \frac{\text{Connection intensity (people/s)}}{\text{Vehicle capacity (people/veh)}}$$

$$\text{Pathway intensity (veh/m)} = \frac{\text{Connection intensity (veh/s)}}{\text{Speed (m/s)}}$$

$$\text{Pathway capacity (veh/m)} = \frac{\text{1 vehicle}}{\text{Buffer zone length (m)}}$$

$$\text{Nr of lanes (\#)} = \frac{\text{Pathway intensity (veh/m)}}{\text{Pathway capacity (veh/m)}}$$

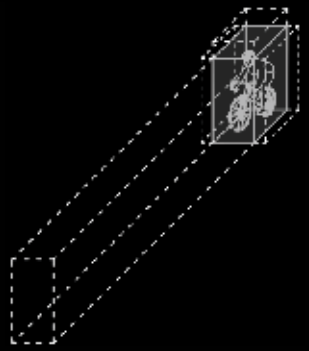
$$\text{Pathway volume (m}^3\text{)} = \text{Buffer zone width (m)} \times \text{Buffer zone length (m)} \times \text{Pathway height (m)} \times \text{Nr of lanes (\#)}$$

The formulas are based on vehicle properties. These properties have been researched and collected by the 4 Minute City studios of The Why Factory.

Vehicle

Bike

Buffer zone



Buffer zone

length:	1,8 m
width:	0,6 m
height:	1,8 m
length with buffer:	12,0 m
width with buffer:	1,0 m
height with buffer:	2,1 m

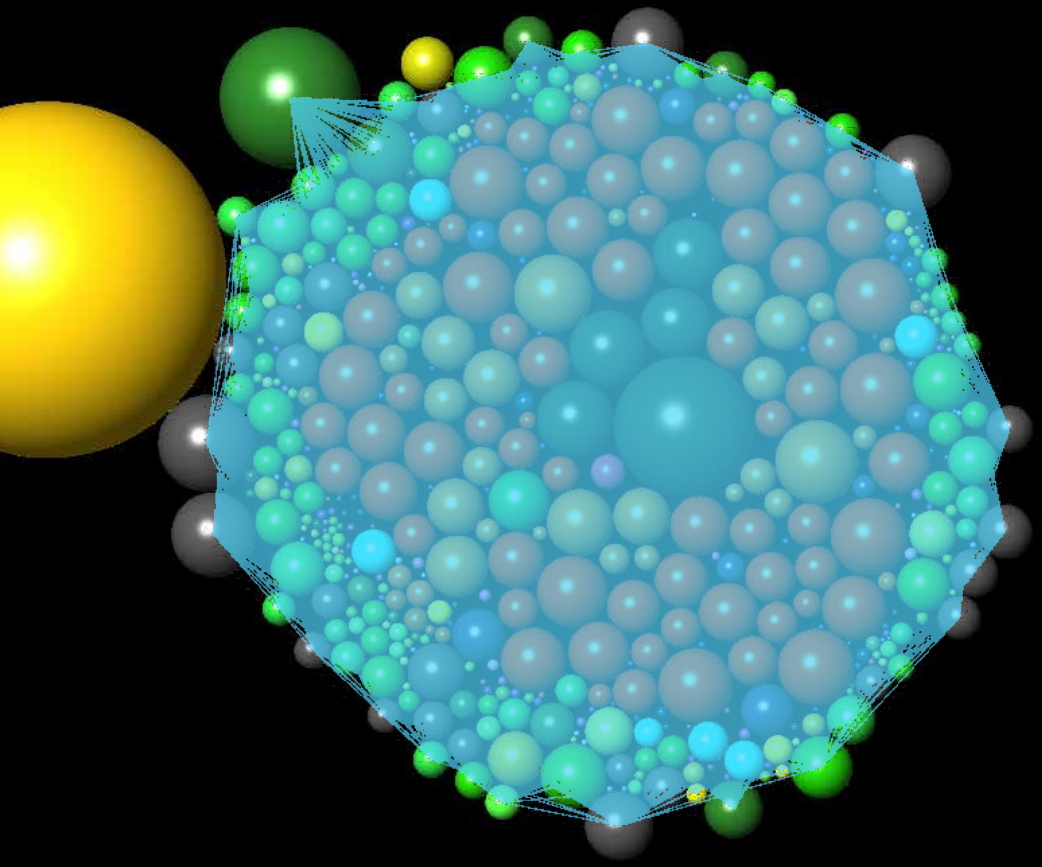
Speed

16 km/h
5 m/s

Capacity

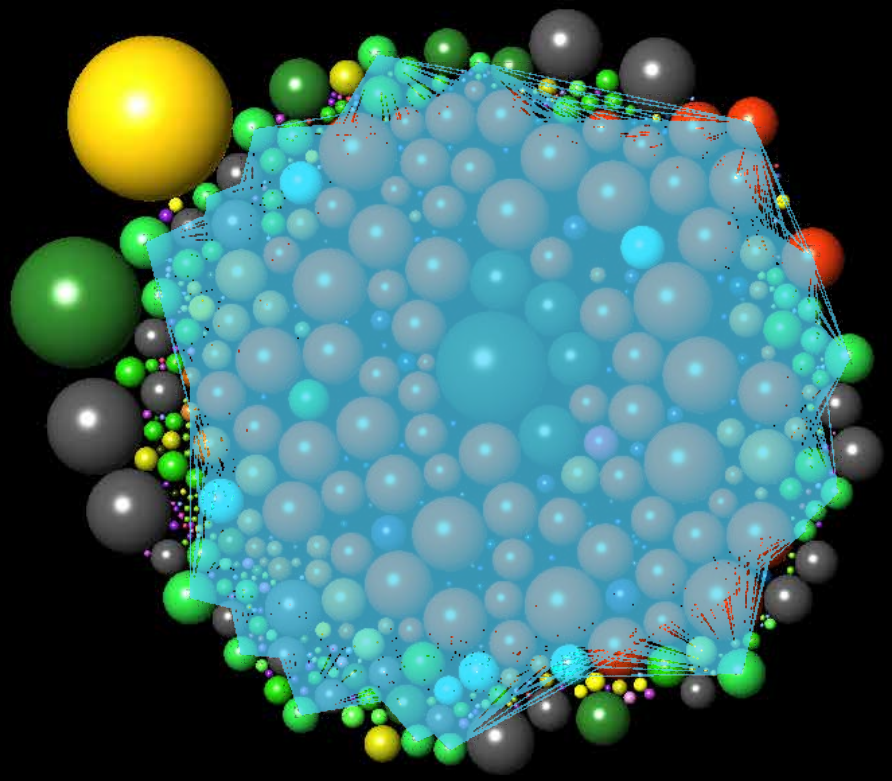
2 persons

Fixed city configuration



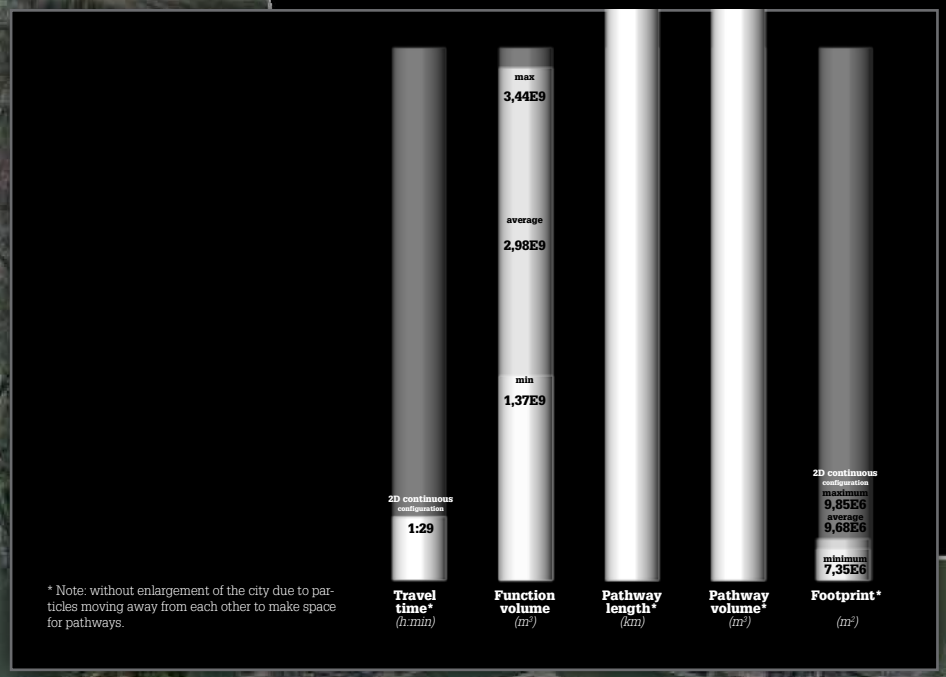
SUNDAY 20:00

Daily city configuration



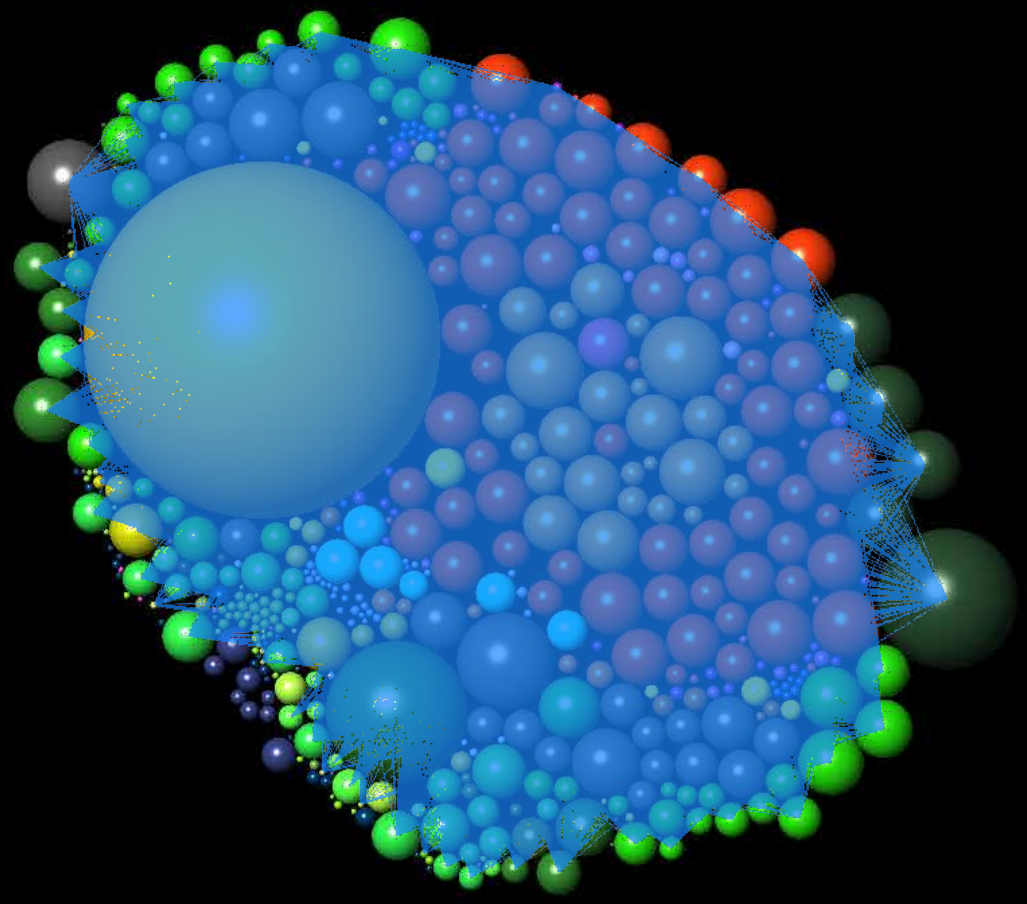
SATURDAY 04:00

Continuous city configuration



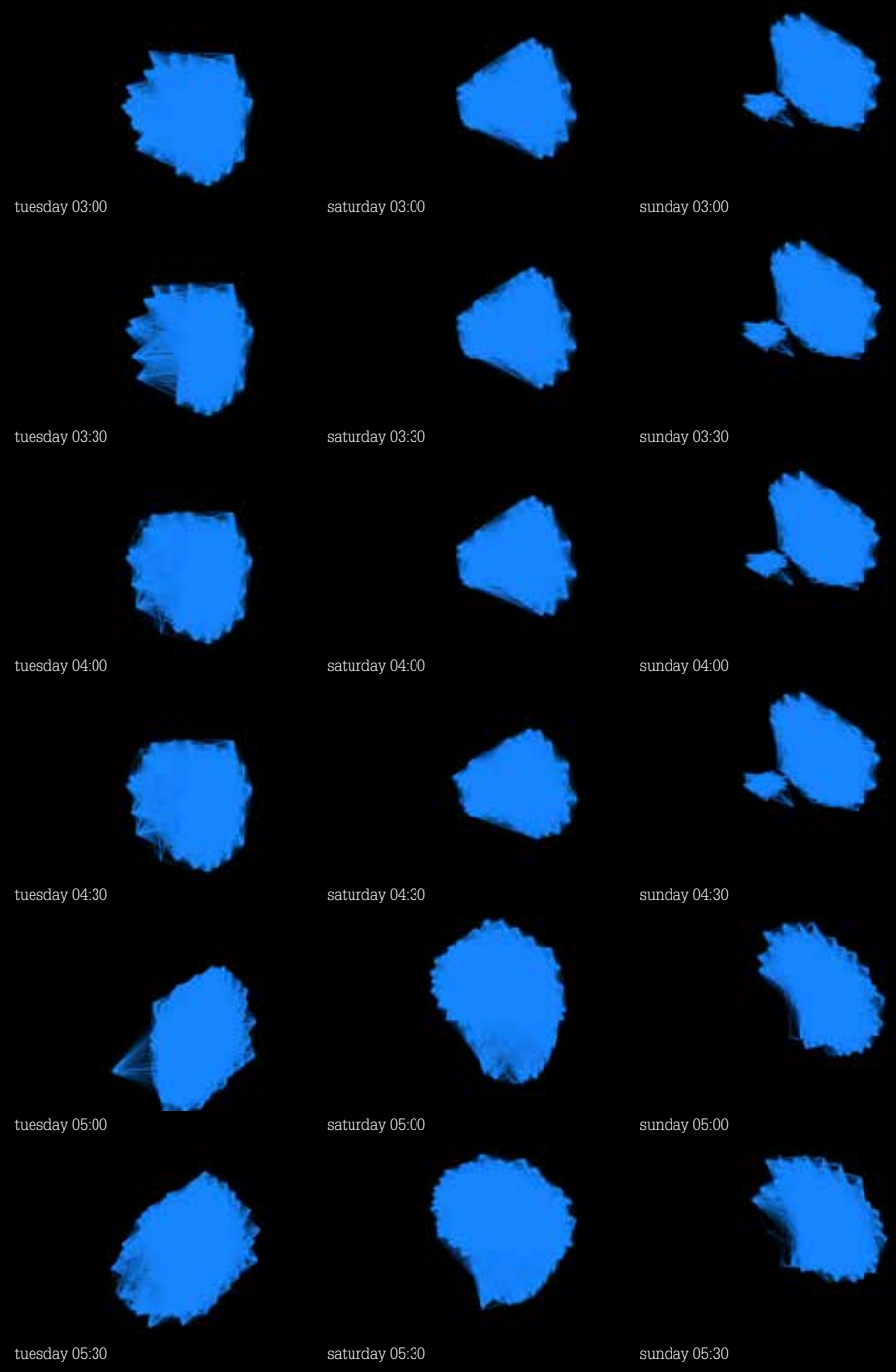
* Note: without enlargement of the city due to particles moving away from each other to make space for pathways.

Both the configuration of the city (and thus the location of the pathways) and the sizes of the particles and pathways could continuously change.



TUESDAY 08:00


tuesday 00:00
saturday 00:00
sunday 00:00
tuesday 00:30
saturday 00:30
sunday 00:30
tuesday 01:00
saturday 01:00
sunday 01:00
tuesday 01:30
saturday 01:30
sunday 01:30
tuesday 02:00
saturday 02:00
sunday 02:00
tuesday 02:30
saturday 02:30
sunday 02:30


tuesday 03:00
saturday 03:00
sunday 03:00
tuesday 03:30
saturday 03:30
sunday 03:30
tuesday 04:00
saturday 04:00
sunday 04:00
tuesday 04:30
saturday 04:30
sunday 04:30
tuesday 05:00
saturday 05:00
sunday 05:00
tuesday 05:30
saturday 05:30
sunday 05:30


tuesday 06:00


saturday 06:00


sunday 06:00


tuesday 06:30


saturday 06:30


sunday 06:30


tuesday 07:00


saturday 07:00


sunday 07:00


tuesday 07:30


saturday 07:30


sunday 07:30


tuesday 08:00


saturday 08:00


sunday 08:00


tuesday 08:30


saturday 08:30


sunday 08:30


tuesday 09:00


saturday 09:00


sunday 09:00


tuesday 09:30


saturday 09:30


sunday 09:30


tuesday 10:00


saturday 10:00


sunday 10:00

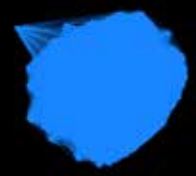

tuesday 10:30


saturday 10:30


sunday 10:30


tuesday 11:00


saturday 11:00


sunday 11:00


tuesday 11:30


saturday 11:30


sunday 11:30


tuesday 12:00


saturday 12:00


sunday 12:00


tuesday 12:30


saturday 12:30


sunday 12:30

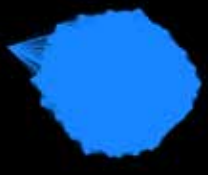

tuesday 13:00


saturday 13:00


sunday 13:00

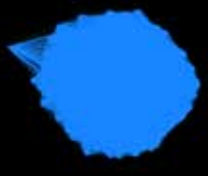

tuesday 13:30


saturday 13:30


sunday 13:30


tuesday 14:00


saturday 14:00


sunday 14:00


tuesday 14:30


saturday 14:30


sunday 14:30


tuesday 15:00


saturday 15:00

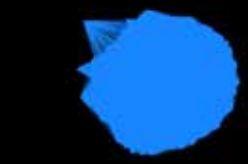

sunday 15:00


tuesday 15:30


saturday 15:30


sunday 15:30


tuesday 16:00


saturday 16:00


sunday 16:00


tuesday 16:30


saturday 16:30

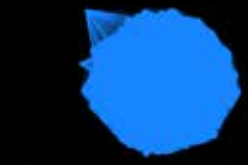

sunday 16:30


tuesday 17:00

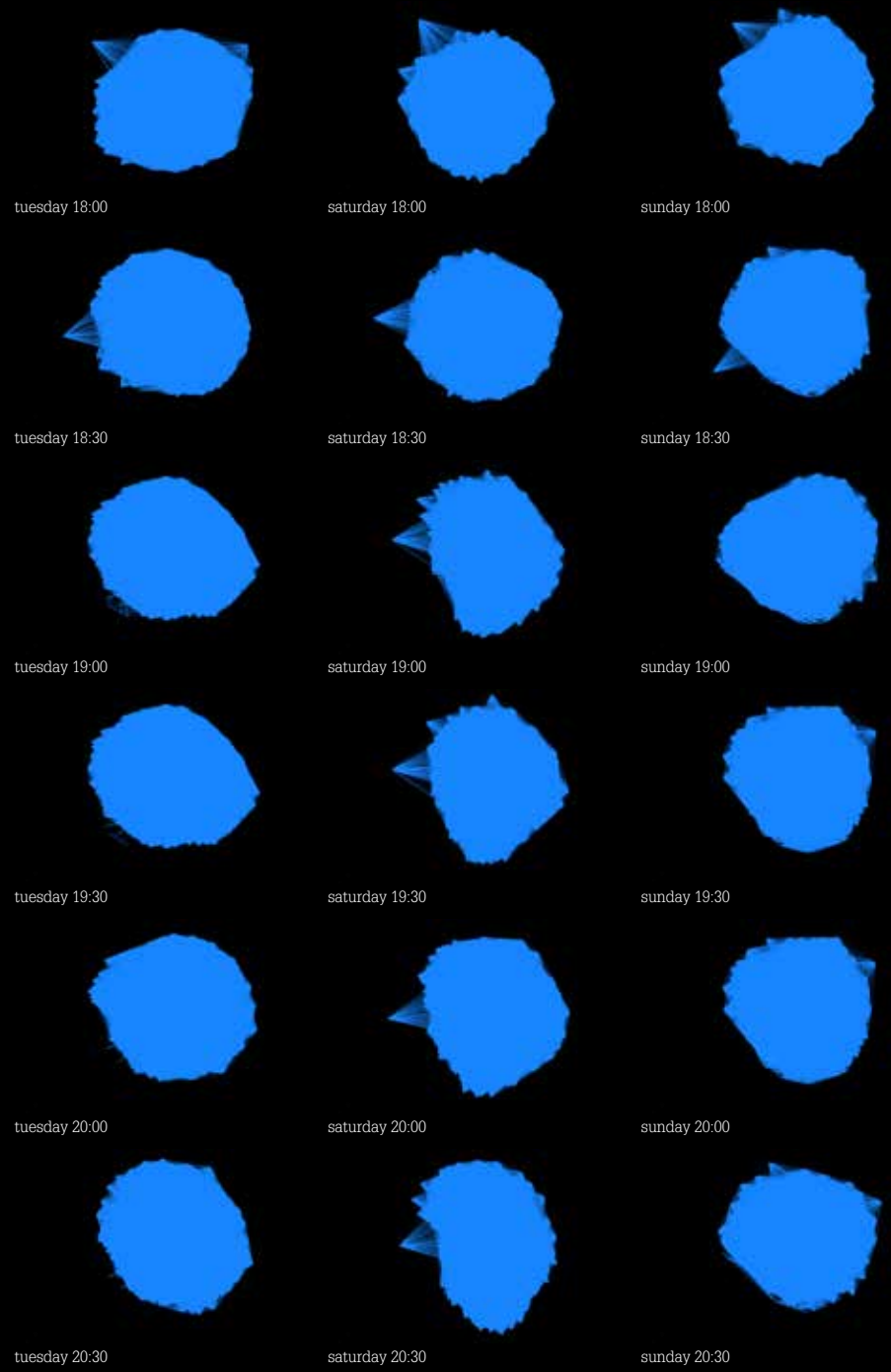

saturday 17:00

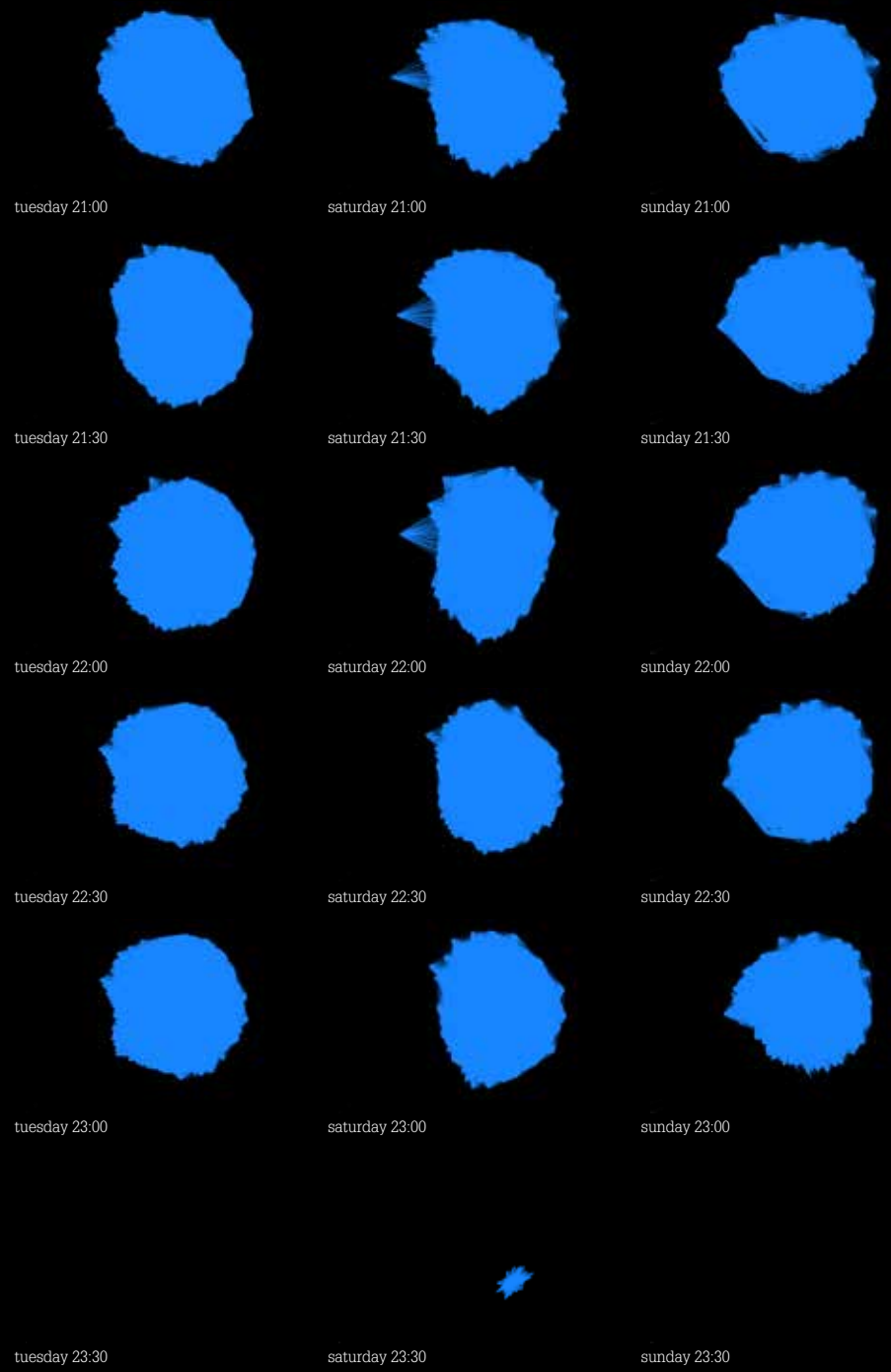

sunday 17:00


tuesday 17:30


saturday 17:30

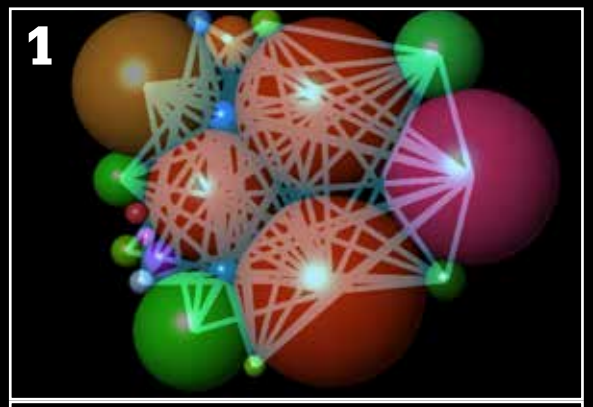

sunday 17:30


tuesday 18:00
saturday 18:00
sunday 18:00
tuesday 18:30
saturday 18:30
sunday 18:30
tuesday 19:00
saturday 19:00
sunday 19:00
tuesday 19:30
saturday 19:30
sunday 19:30
tuesday 20:00
saturday 20:00
sunday 20:00
tuesday 20:30
saturday 20:30
sunday 20:30

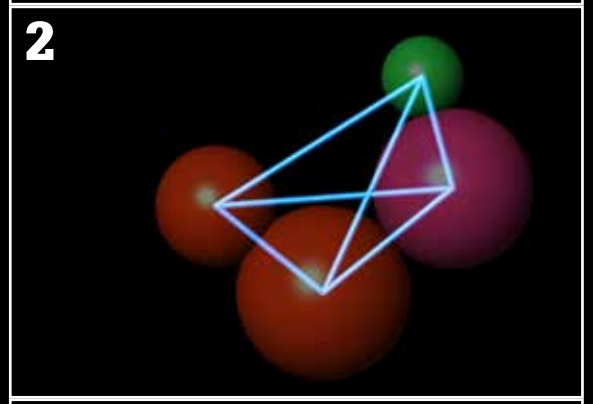

tuesday 21:00
saturday 21:00
sunday 21:00
tuesday 21:30
saturday 21:30
sunday 21:30
tuesday 22:00
saturday 22:00
sunday 22:00
tuesday 22:30
saturday 22:30
sunday 22:30
tuesday 23:00
saturday 23:00
sunday 23:00
tuesday 23:30
saturday 23:30
sunday 23:30

TOOL 5 PATHWAY MERGING

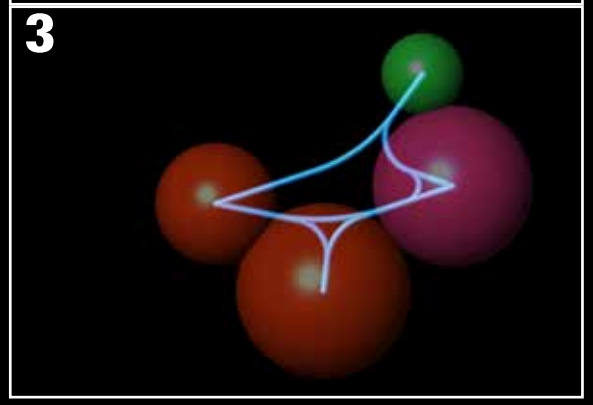
Tool decription



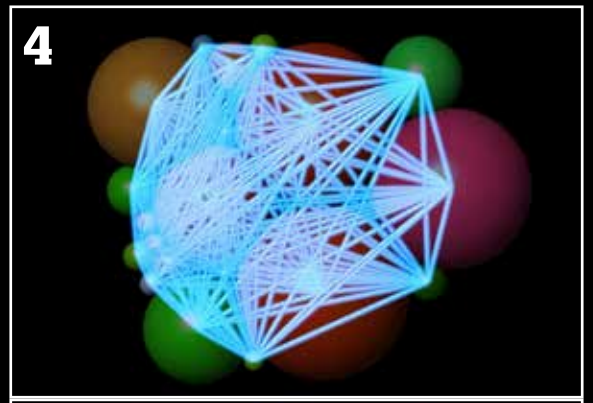
The starting situation is the end result of the previous pathway volume tool.
What happens if we merge-pathways?



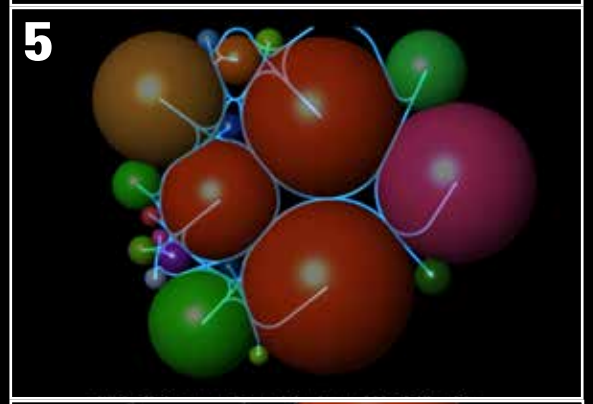
Again, to be able to comprehend the situation we start with just four particles.



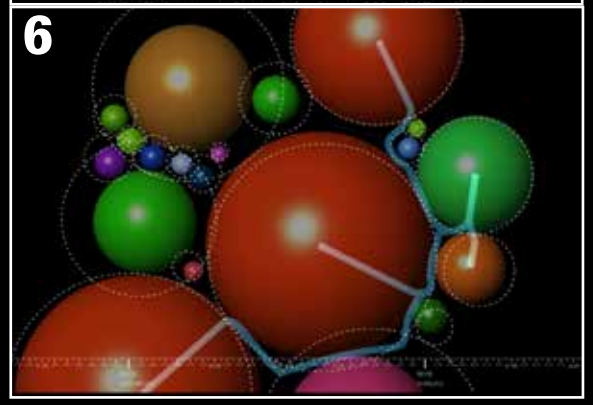
Then this is what happens when all the connections between particles are merged.



Then this is what happens when all connections between the twenty example particles are merged.



At first sight you can already see the amount of pathway volume is less.



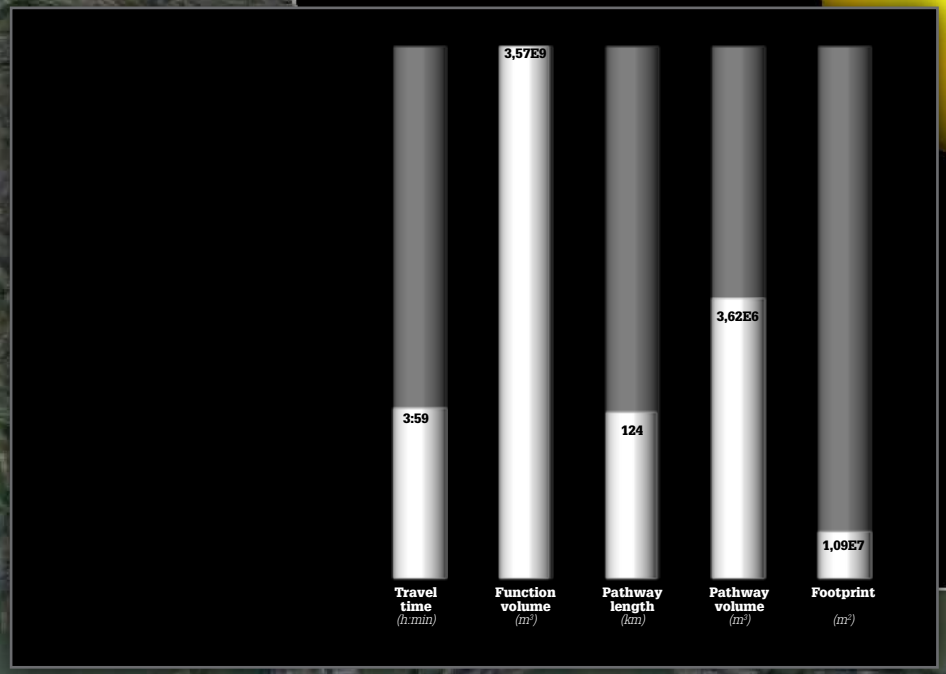
If we combine that with the model of moving and resizing particles it would look like this.
The result of the pathway volume tool is used here: the pathways get a volume when they are needed and disappear when they are not used.

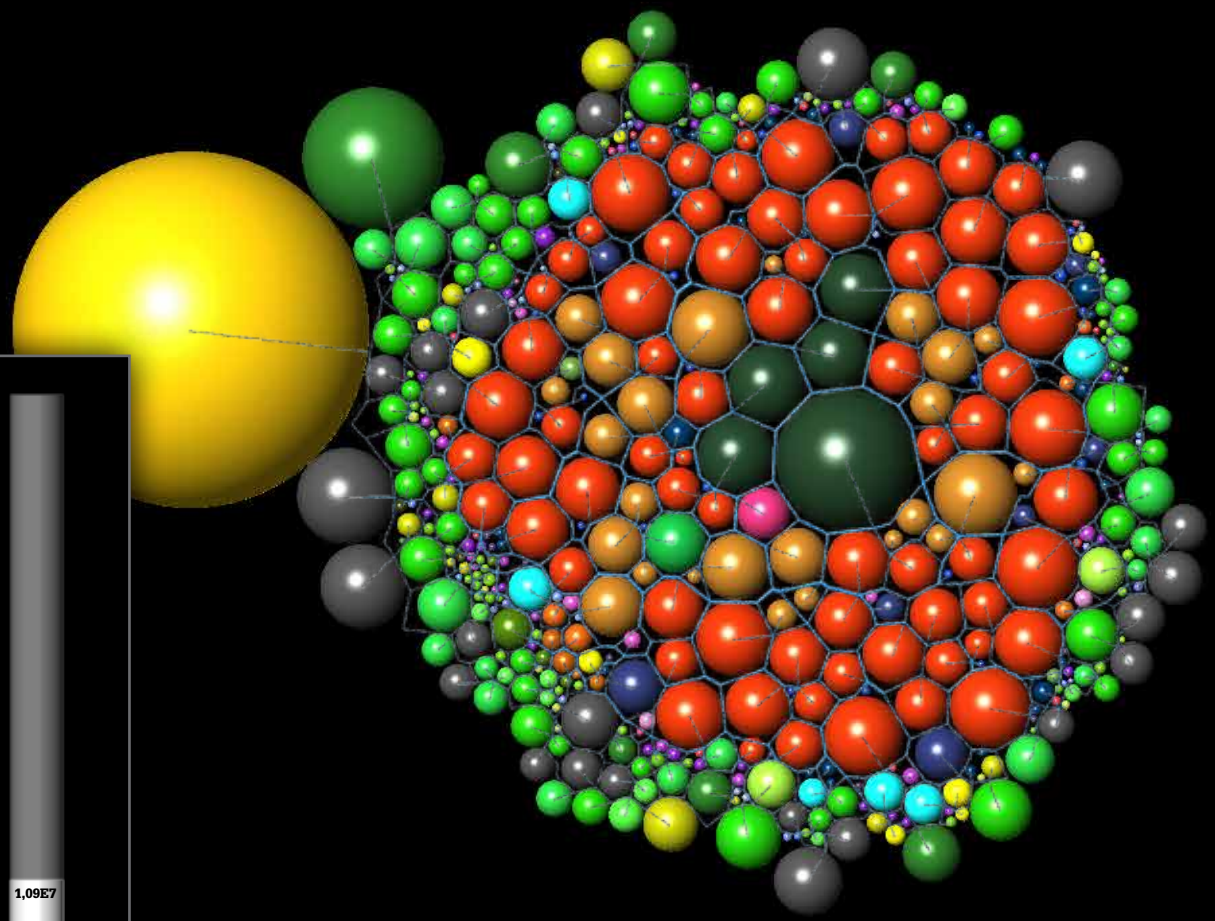
Tool decription

Rules:

- **Each connection will find its shortest route inbetween the particles.**
- **For each segment of the pathways the pathway volume is calculated based on the intensity, maximum pathway capacity, speed of the vehicle, vehicle capacity, and vehicle buffer zone dimensions.**

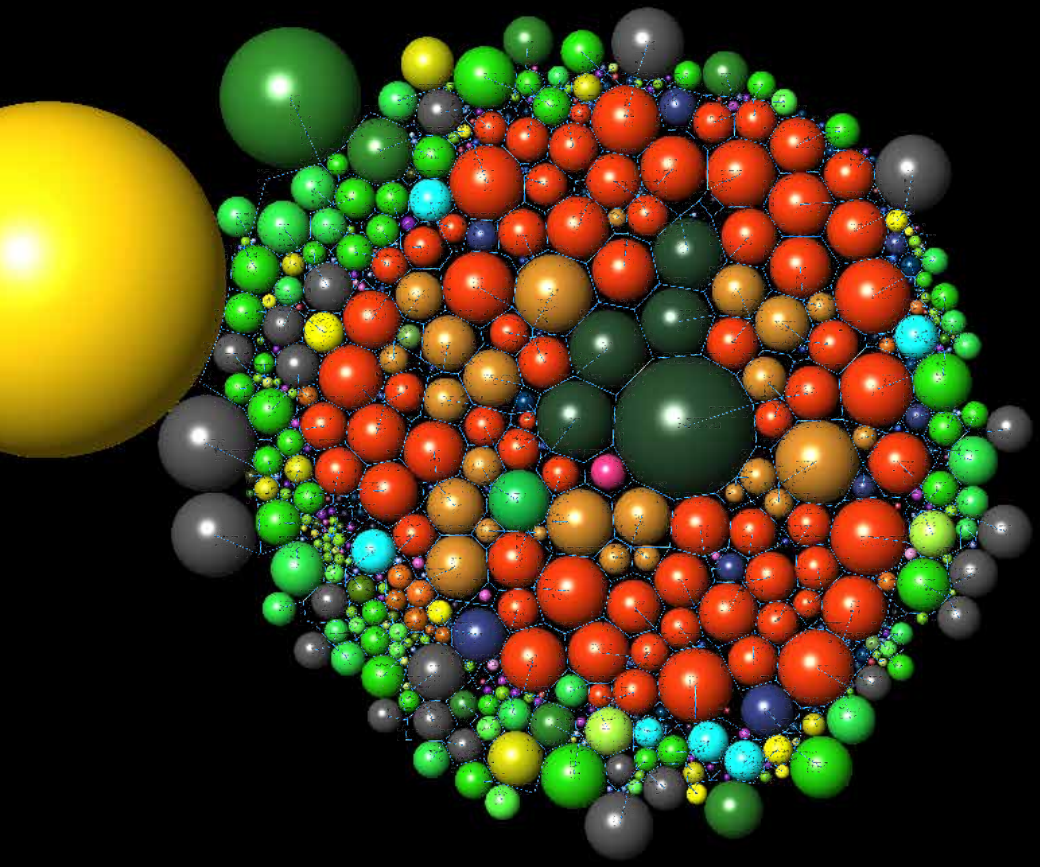
Fixed city configuration without resizing particles





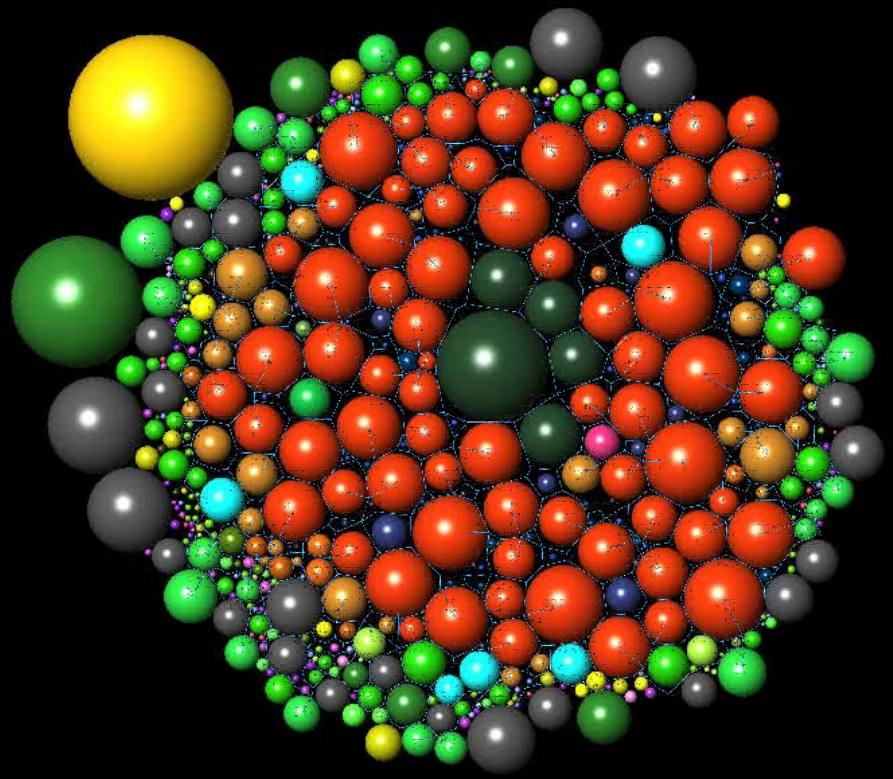
The configuration is fixed and volumes do not resize. Pathways do not resize because it won't result in a smaller city since particles are fixed. Pathway widths are based on the maximum pathway intensity for that pathway during the week.

Fixed city configuration with resizing particles



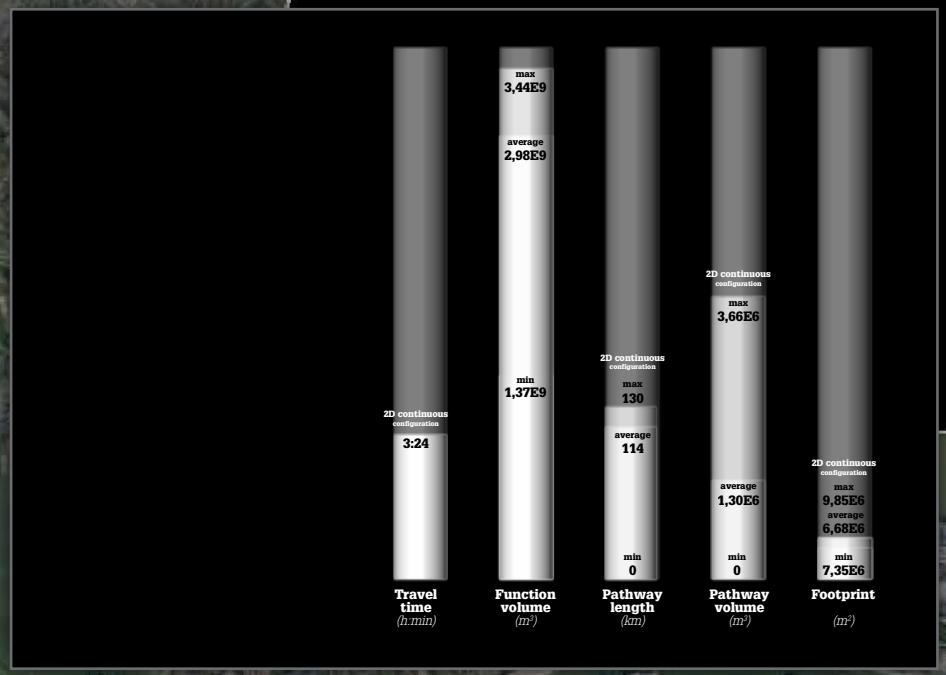
SUNDAY 20:00

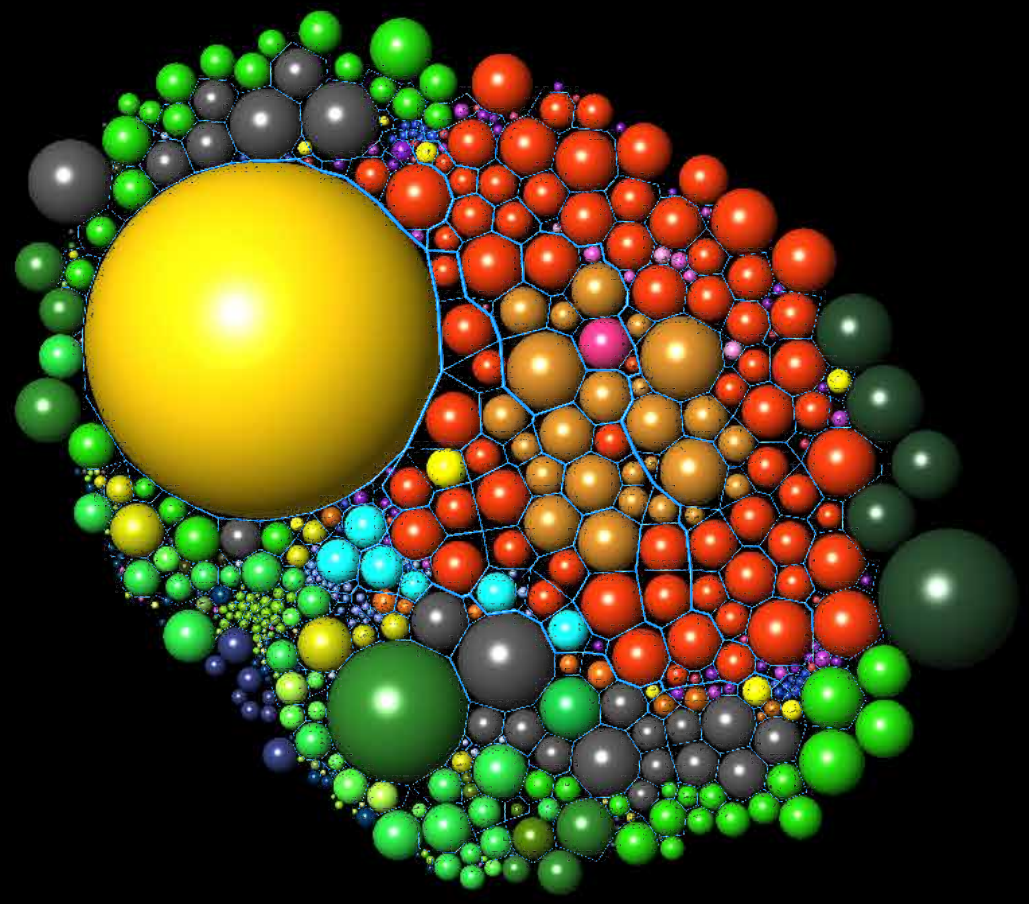
Daily city configuration with resizing particles



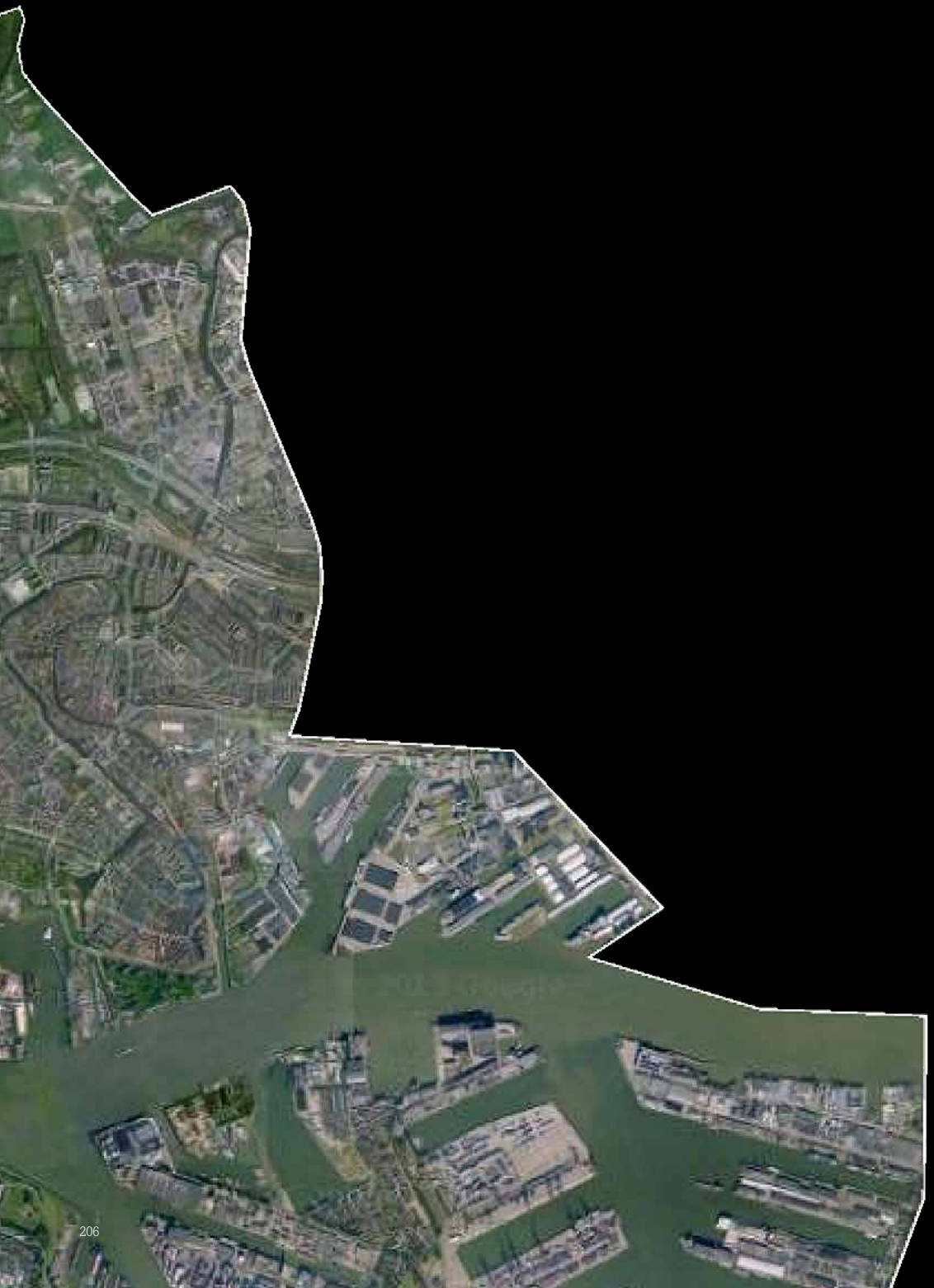
SATURDAY 04:00

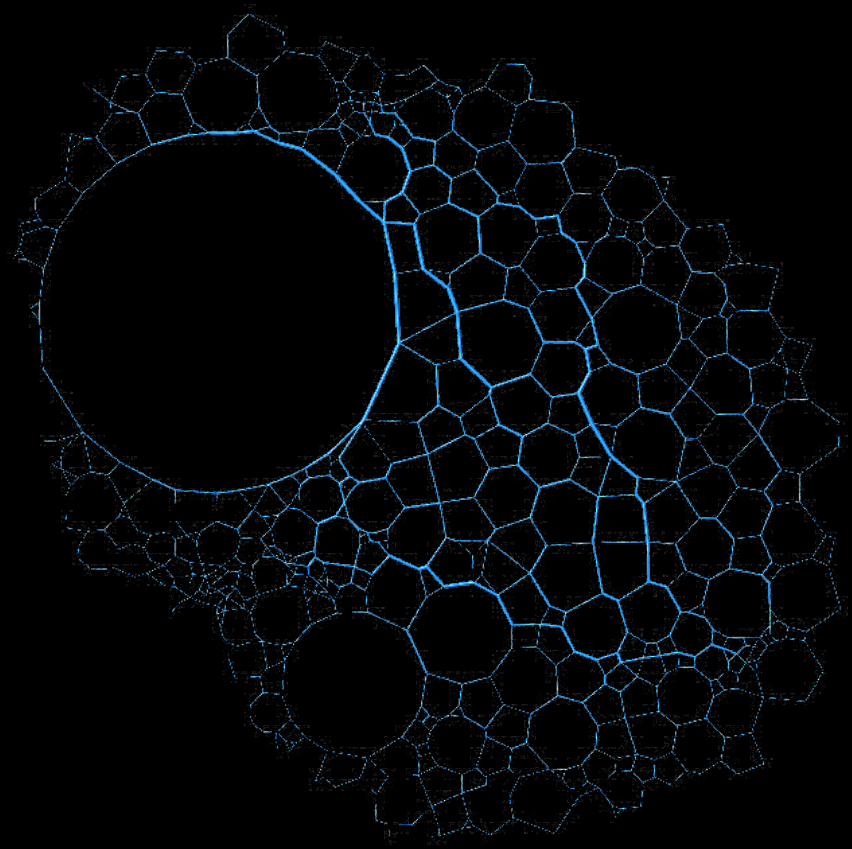
Continuous city configuration with resizing particles





TUESDAY 08:00





TUESDAY 08:00

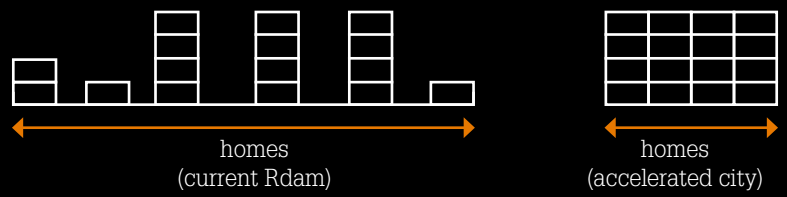
AWAY FROM ABSTRACTION

Demands

- **For a city with a 2D configuration, particles should be kept as narrow as possible (see tool 0, tt reduction by shape). As a result, pathways will be as short as possible.**

Current implication of this demand in this project:

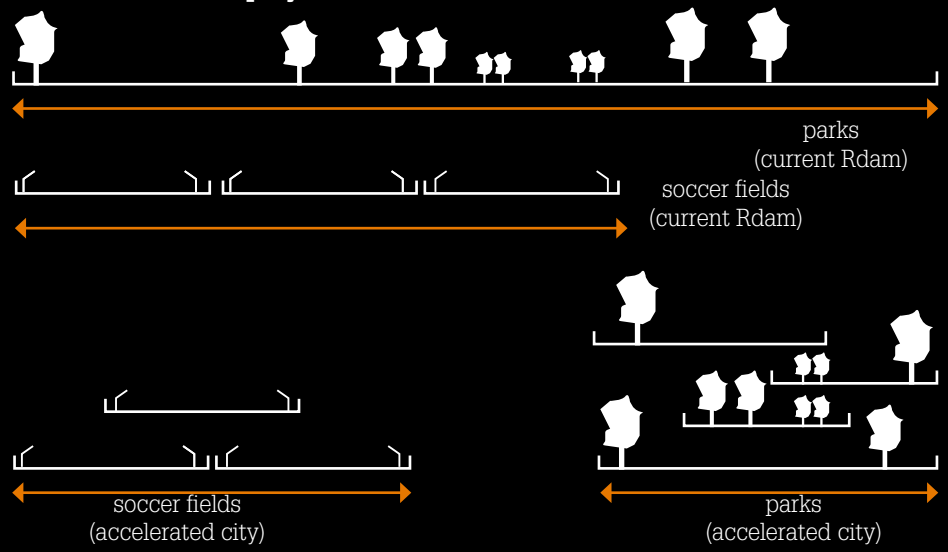
Only blocks with homes and shops are kept as narrow as possible, in other words, with a larger height dan in current Rotterdam.



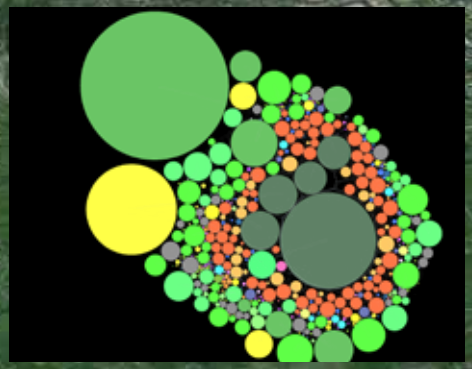
Future possiblities for the project:

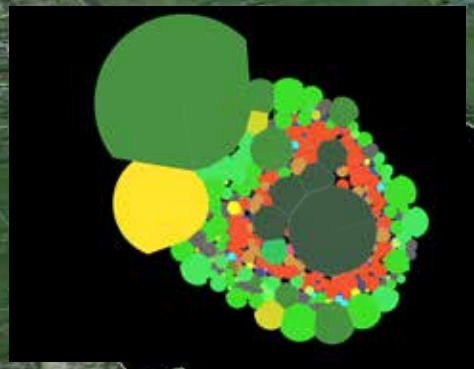
Also other functions such as sports, parks, forest and agriculture could have a larger height by stacking layers on top of each other. This will result in a travel time reduction compared to the 2D configured cities in this project.

NB: stacking these other functions is already applied in the 3D configured cities in this project.

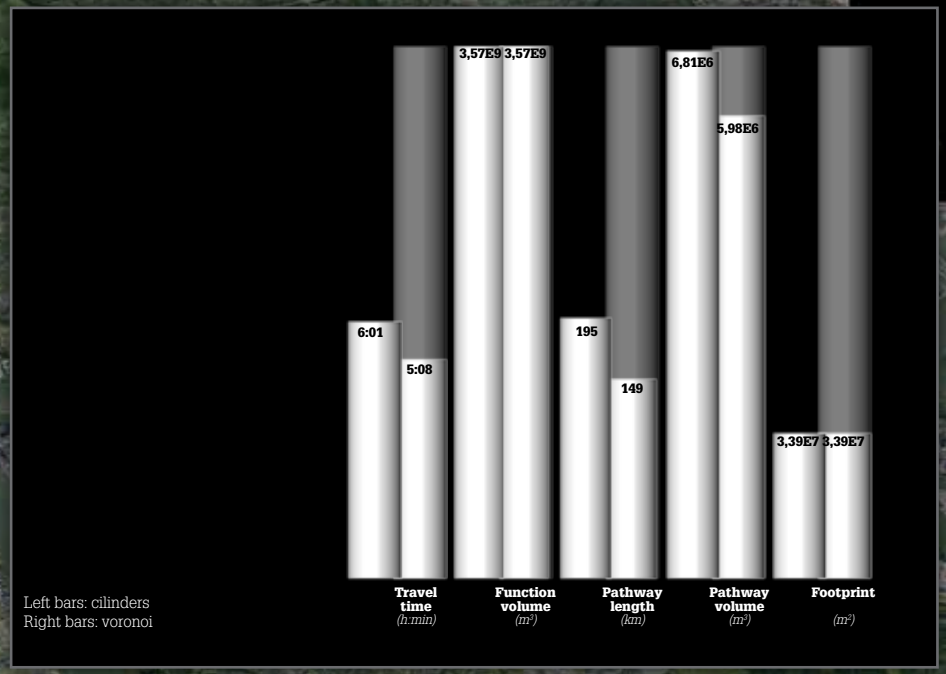


Fixed 2D city configuration without resizing

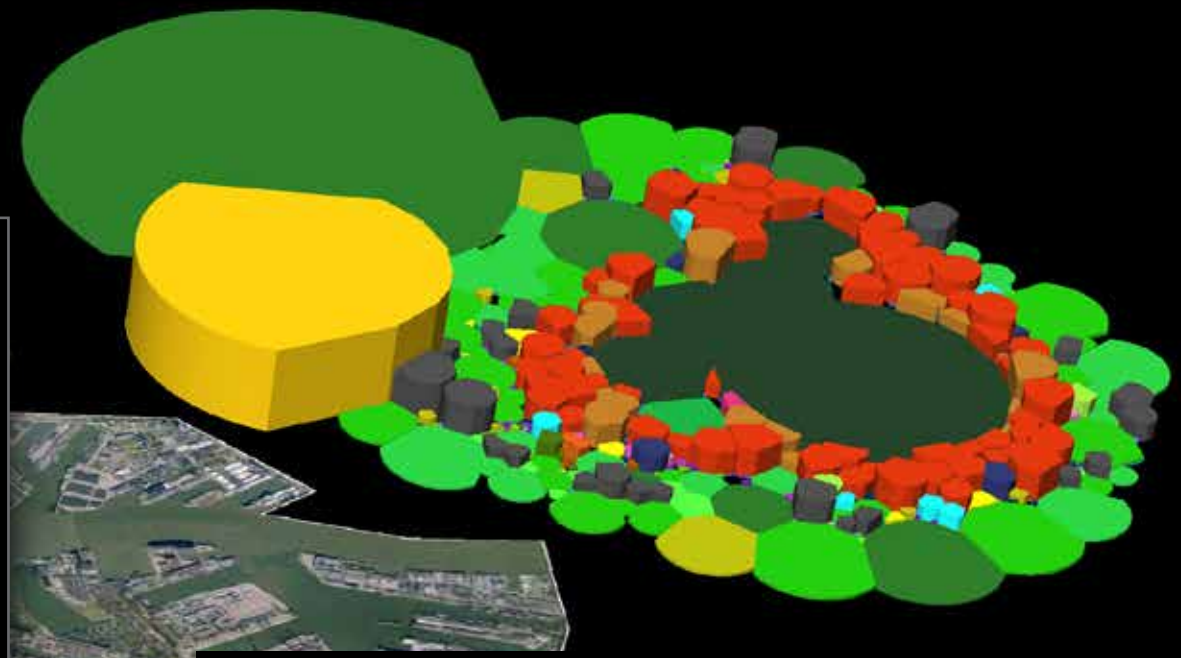


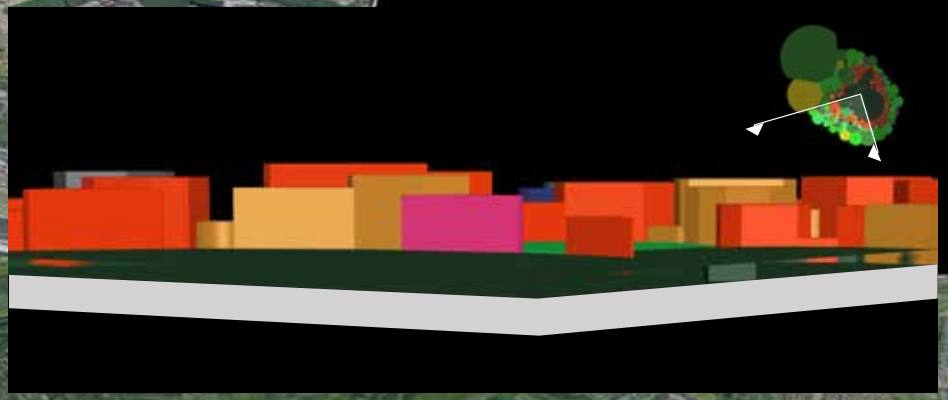


Spheres vs voronoi: the city becomes smaller when the volumes turn from spheres into voronoi shapes.

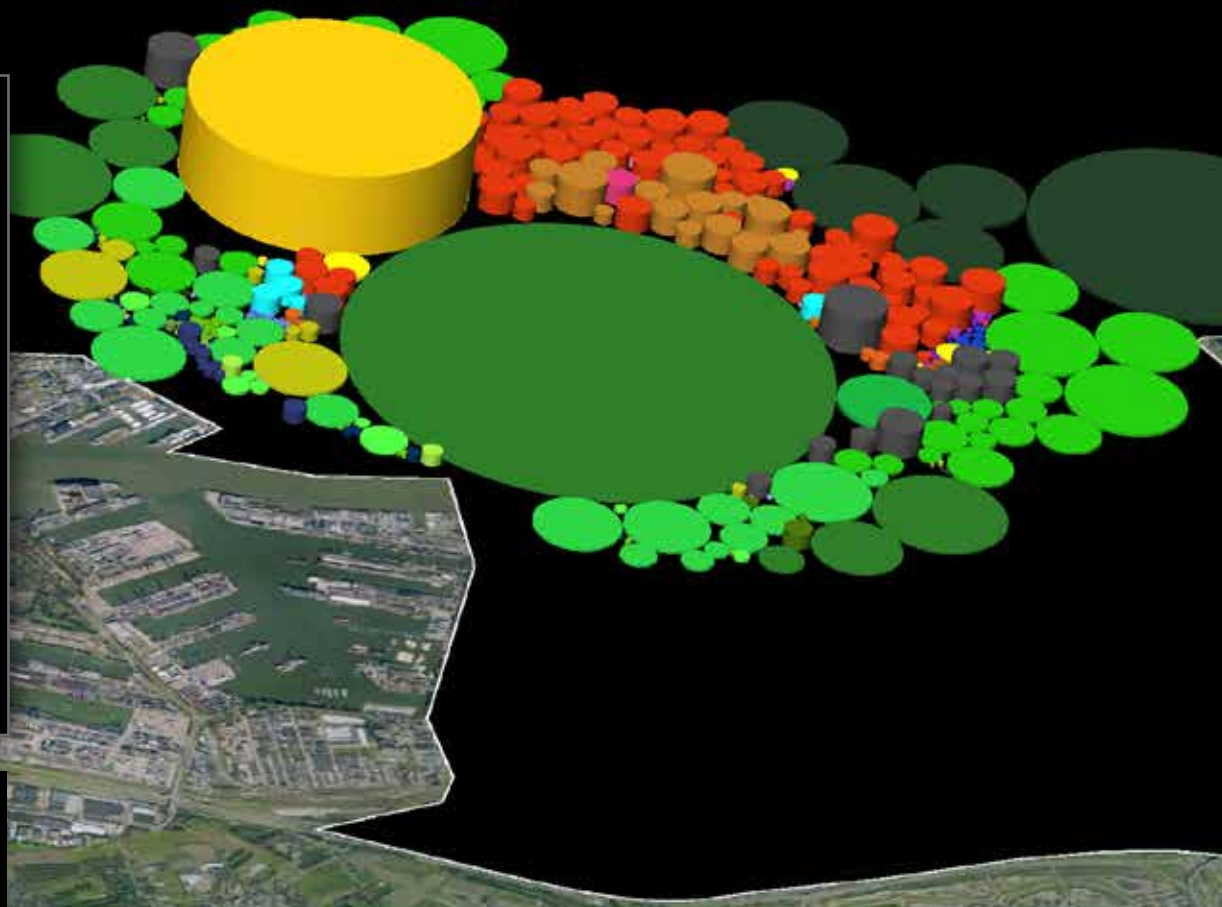


The configuration is fixed and volumes do not resize. Therefore the shape of the city never changes. This means the volumes can be packed together, closing the gaps between them by turning into voronoi shapes. By closing the gaps, the city becomes smaller and therefore faster.



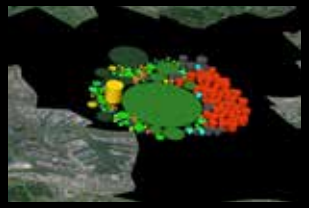


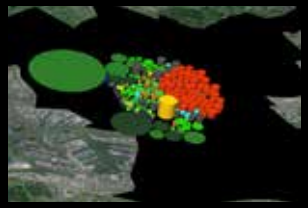
Continuous 2D city configuration

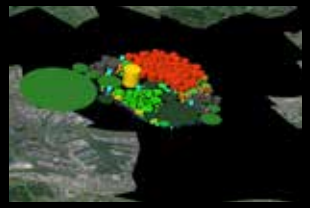


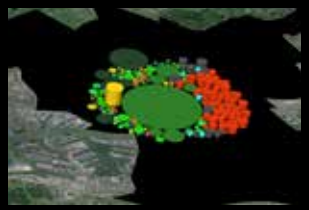
The configuration of the city continuously changes and functions grow and shrink in size. Therefore the shape of the city always changes. The functions should therefore have a floorplan with a shape that enables the particles to move beside each other: a shape with little sharp corners. The most optimum is the circle. With particles needing a necessary height, each particle has the shape of a cilinder.

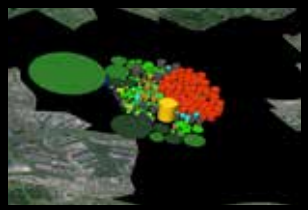
TUESDAY 08:00

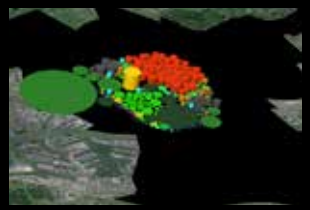

tuesday 00:00

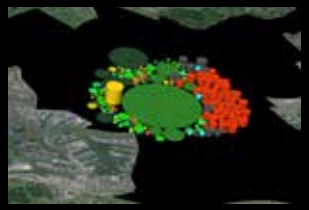

saturday 00:00

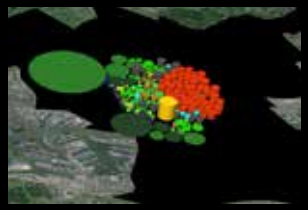

sunday 00:00

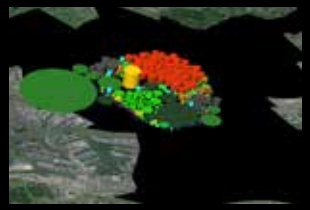

tuesday 00:30


saturday 00:30

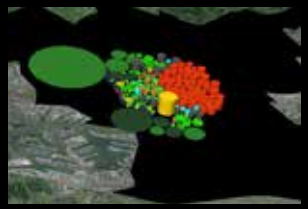

sunday 00:30

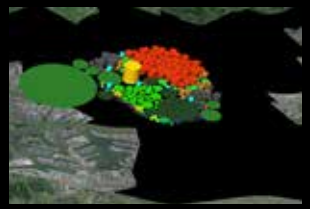

tuesday 01:00

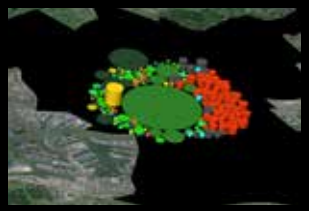

saturday 01:00

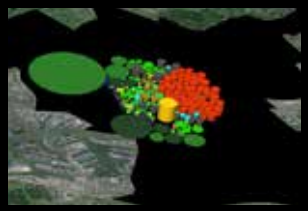

sunday 01:00

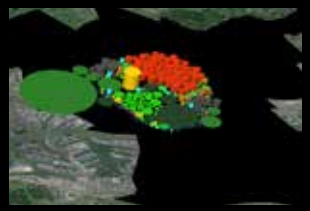

tuesday 01:30

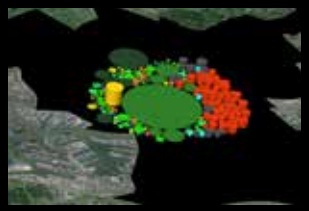

saturday 01:30

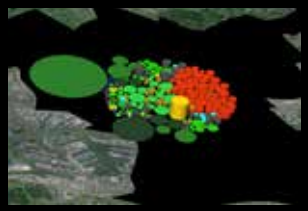

sunday 01:30


tuesday 02:00

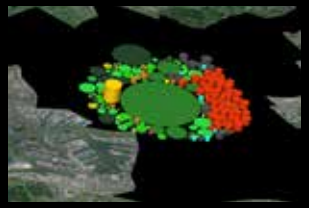

saturday 02:00

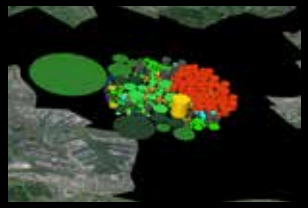

sunday 02:00


tuesday 02:30

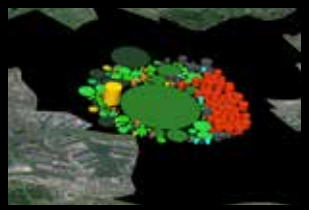

saturday 02:30

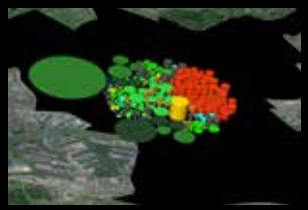

sunday 02:30


tuesday 03:00

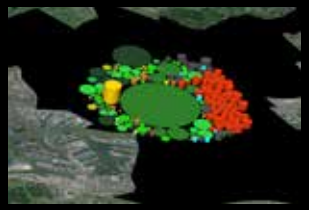

saturday 03:00

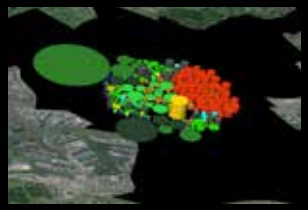

sunday 03:00


tuesday 03:30

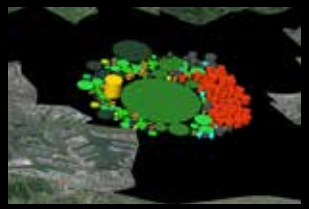

saturday 03:30

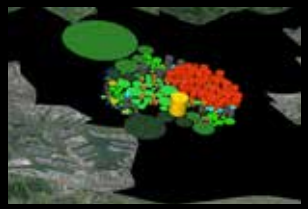

sunday 03:30


tuesday 04:00

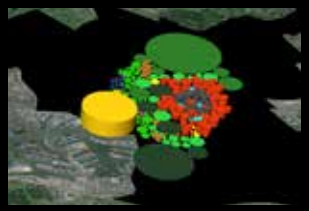

saturday 04:00

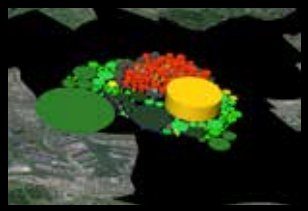

sunday 04:00

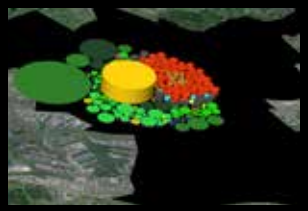

tuesday 04:30

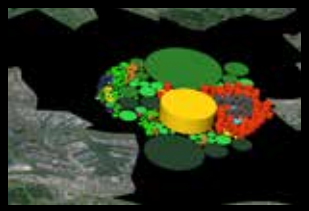

saturday 04:30

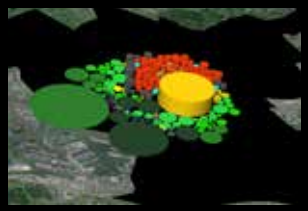

sunday 04:30

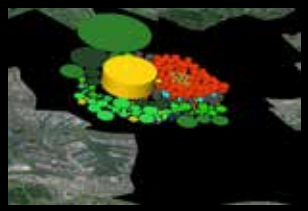

tuesday 05:00

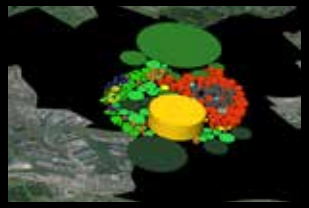

saturday 05:00

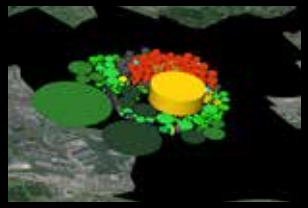

sunday 05:00

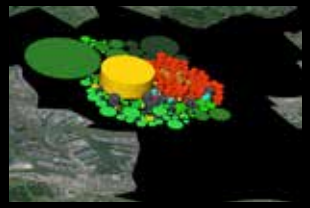

tuesday 05:30

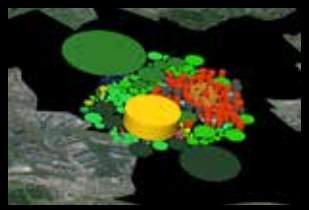

saturday 05:30

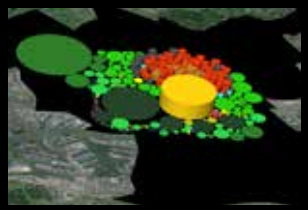

sunday 05:30

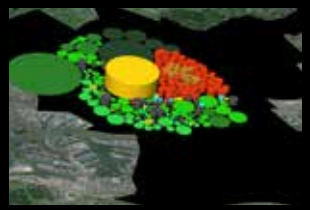

tuesday 06:00

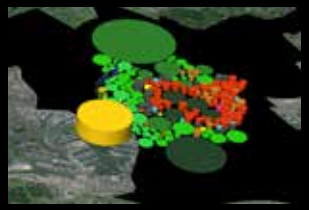

saturday 06:00

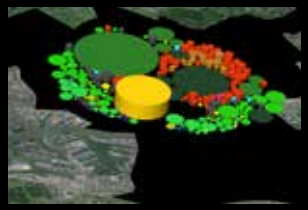

sunday 06:00

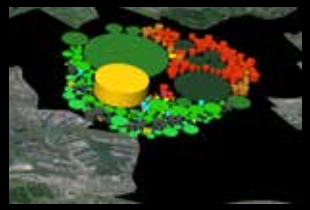

tuesday 06:30

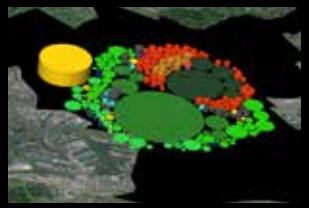

saturday 06:30

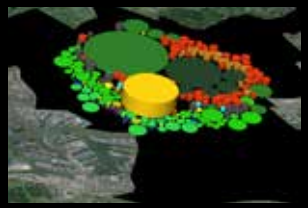

sunday 06:30

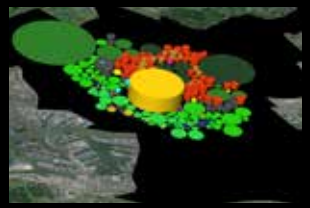

tuesday 07:00

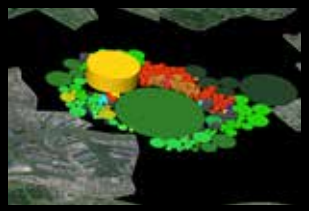

saturday 07:00

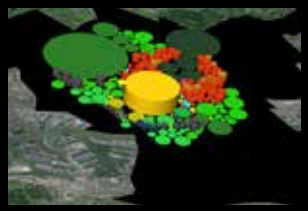

sunday 07:00

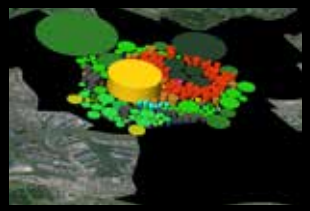

tuesday 07:30

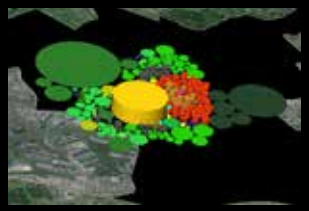

saturday 07:30

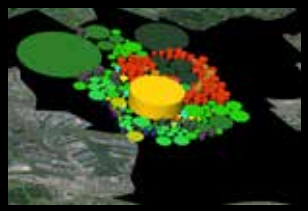

sunday 07:30

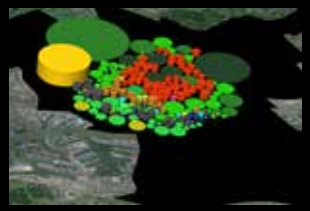

tuesday 08:00

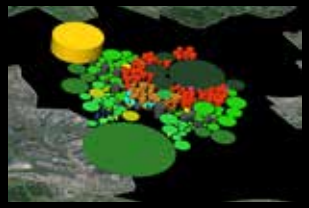

saturday 08:00

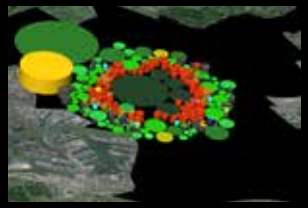

sunday 08:00

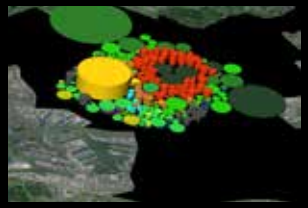

tuesday 08:30

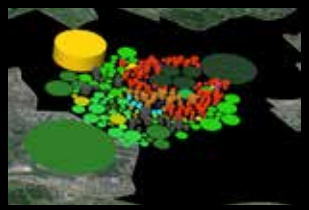

saturday 08:30

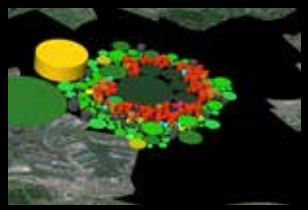

sunday 08:30

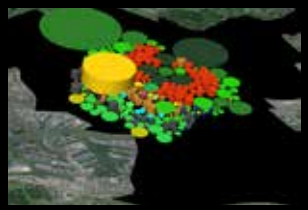

tuesday 09:00

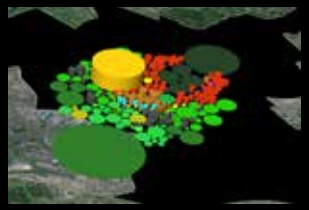

saturday 09:00

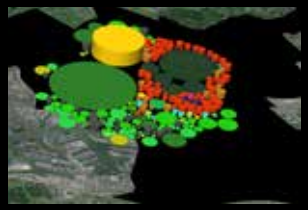

sunday 09:00

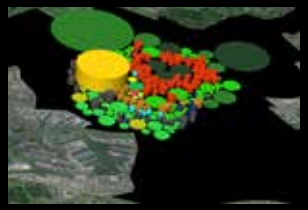

tuesday 09:30

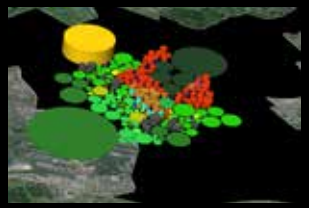

saturday 09:30

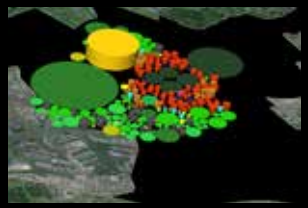

sunday 09:30


tuesday 10:00

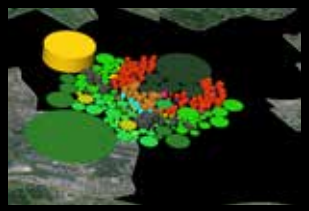

saturday 10:00

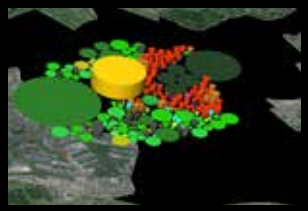

sunday 10:00

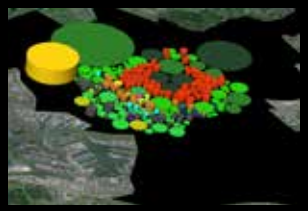

tuesday 10:30

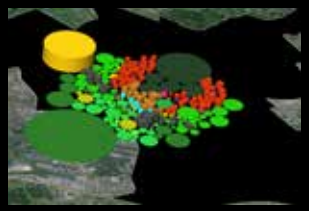

saturday 10:30

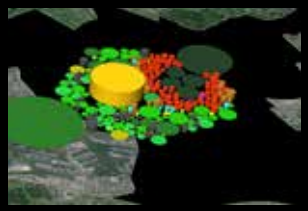

sunday 10:30

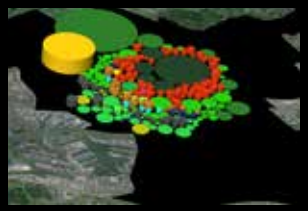

tuesday 11:00

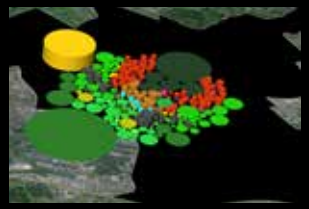

saturday 11:00

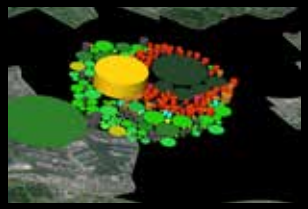

sunday 11:00

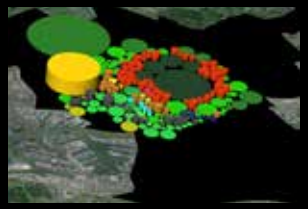

tuesday 11:30

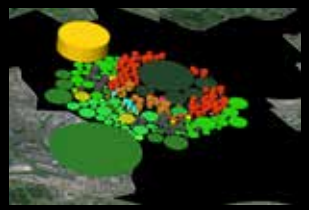

saturday 11:30

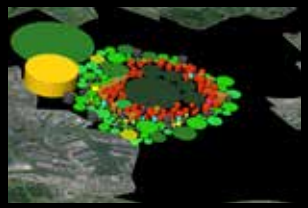

sunday 11:30

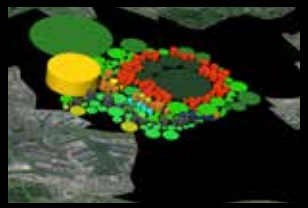

tuesday 12:00

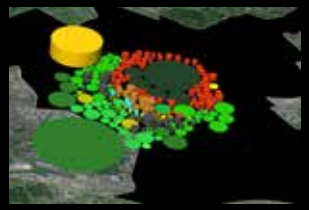

saturday 12:00

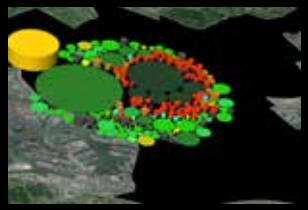

sunday 12:00

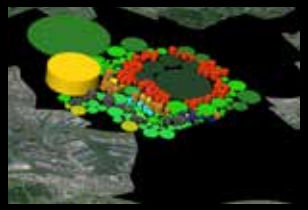

tuesday 12:30

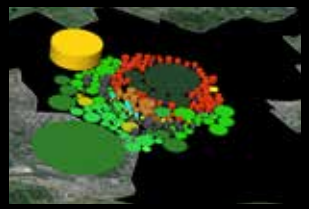

saturday 12:30

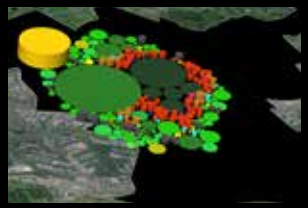

sunday 12:30

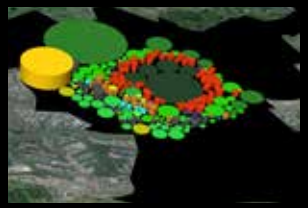

tuesday 13:00

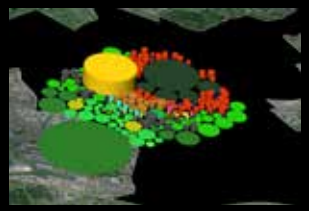

saturday 13:00

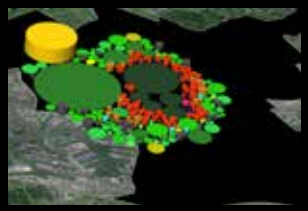

sunday 13:00

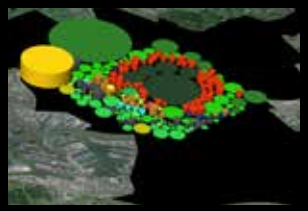

tuesday 13:30

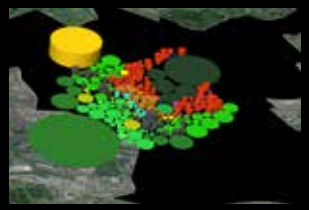

saturday 13:30

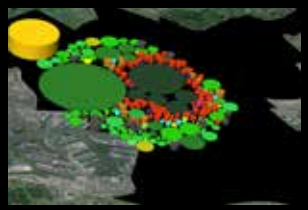

sunday 13:30

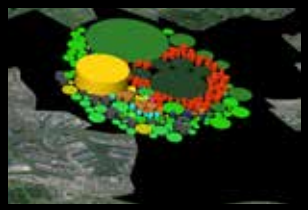

tuesday 14:00

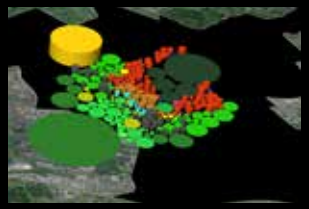

saturday 14:00

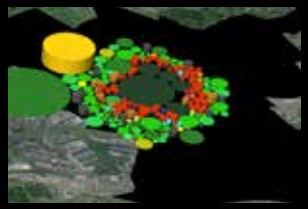

sunday 14:00

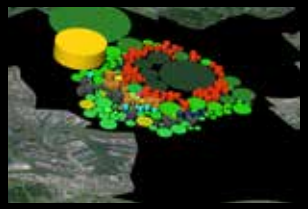

tuesday 14:30

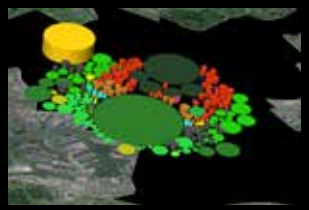

saturday 14:30

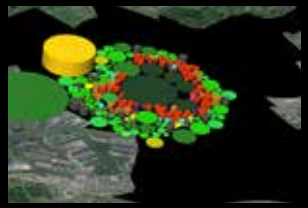

sunday 14:30

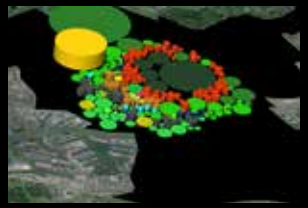

tuesday 15:00

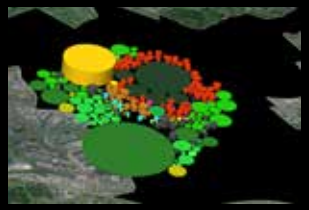

saturday 15:00

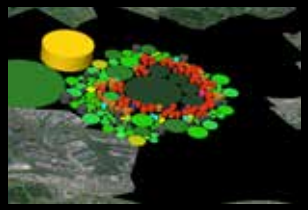

sunday 15:00

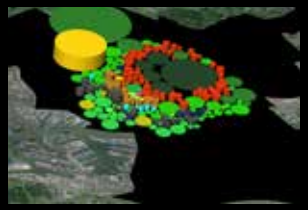

tuesday 15:30

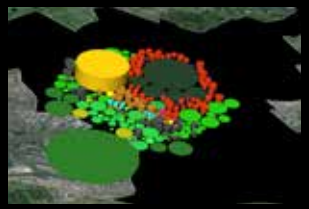

saturday 15:30

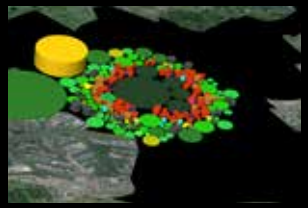

sunday 15:30

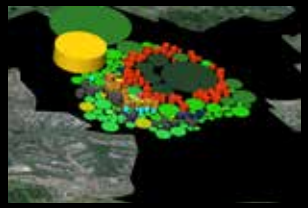

tuesday 16:00

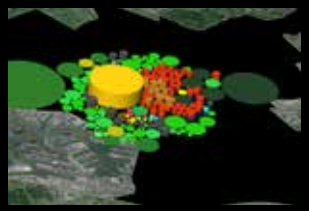

saturday 16:00

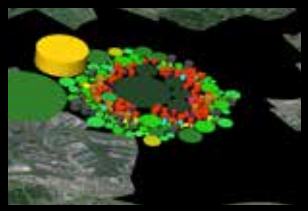

sunday 16:00

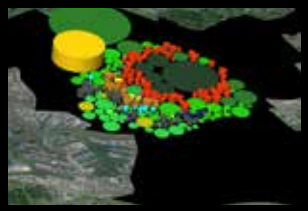

tuesday 16:30

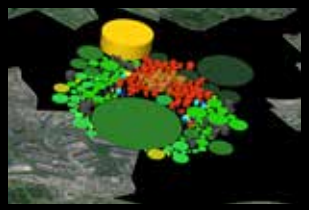

saturday 16:30

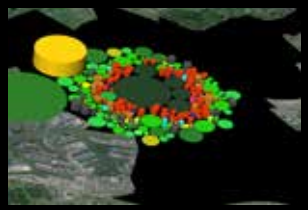

sunday 16:30

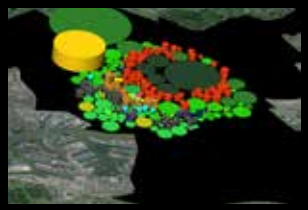

tuesday 17:00

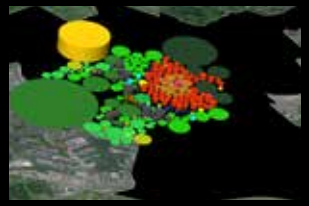

saturday 17:00

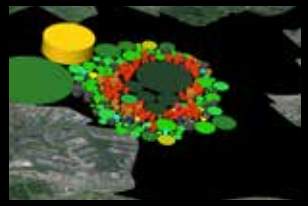

sunday 17:00

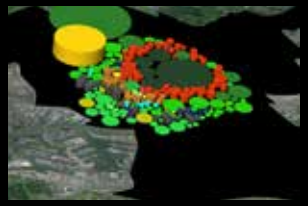

tuesday 17:30

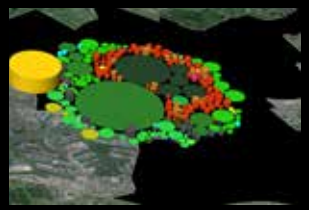

saturday 17:30

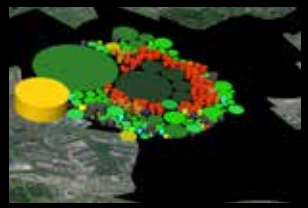

sunday 17:30

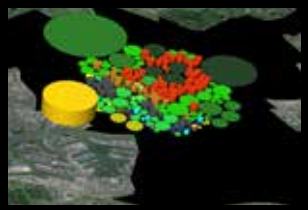

tuesday 18:00

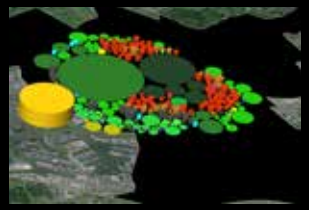

saturday 18:00

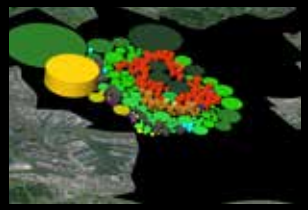

sunday 18:00

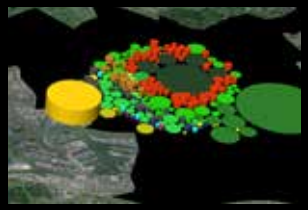

tuesday 18:30

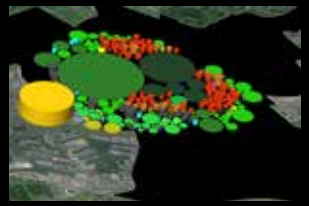

saturday 18:30

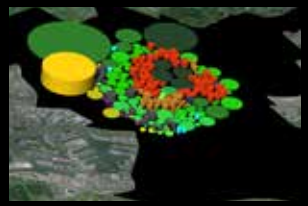

sunday 18:30

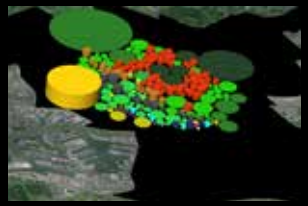

tuesday 19:00

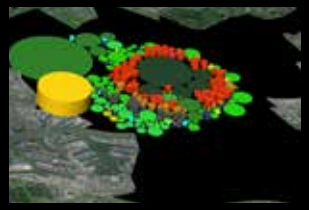

saturday 19:00

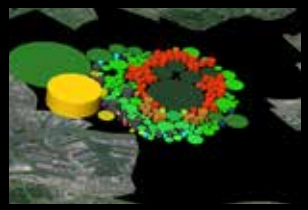

sunday 19:00

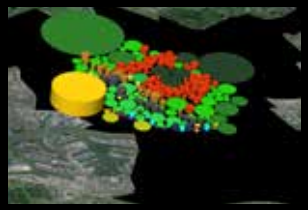

tuesday 19:30

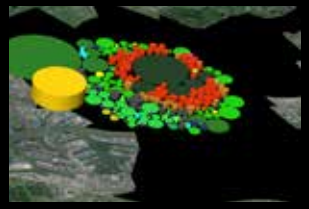

saturday 19:30

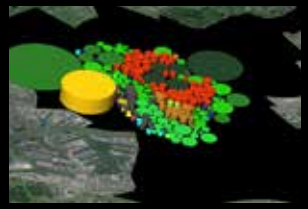

sunday 19:30

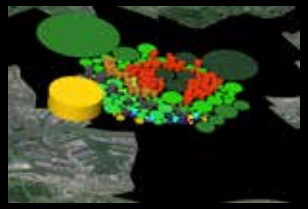

tuesday 20:00

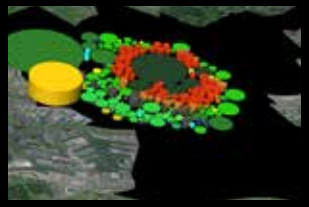

saturday 20:00

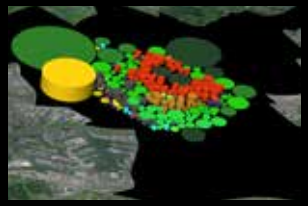

sunday 20:00

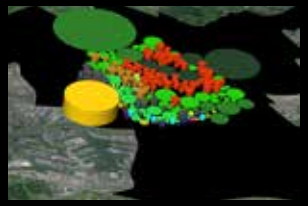

tuesday 20:30

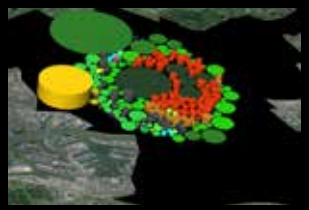

saturday 20:30

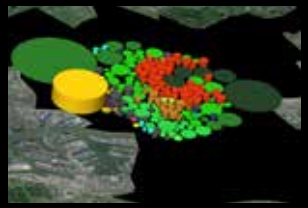

sunday 20:30

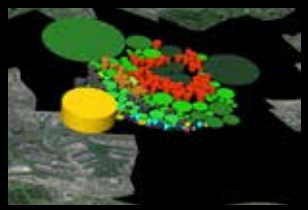

tuesday 21:00

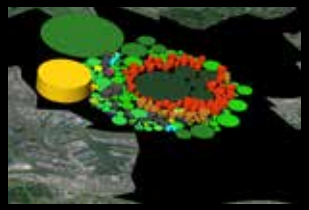

saturday 21:00

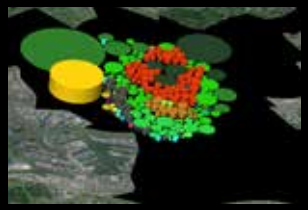

sunday 21:00

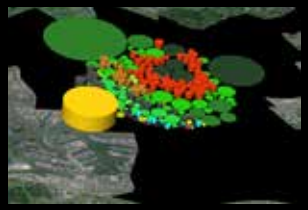

tuesday 21:30

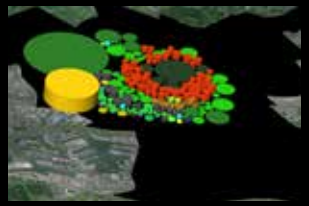

saturday 21:30

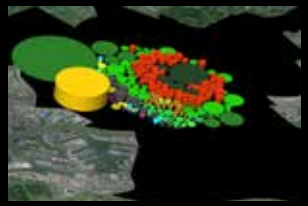

sunday 21:30

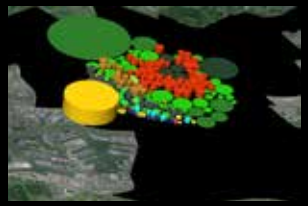

tuesday 22:00

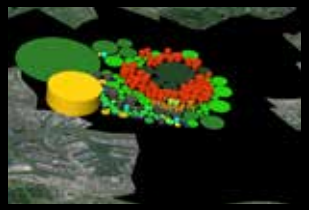

saturday 22:00

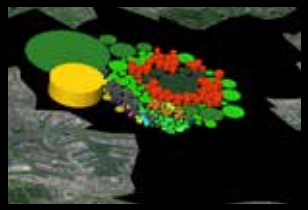

sunday 22:00

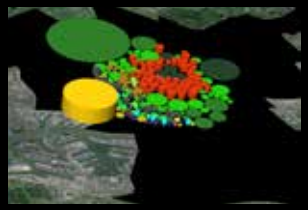

tuesday 22:30

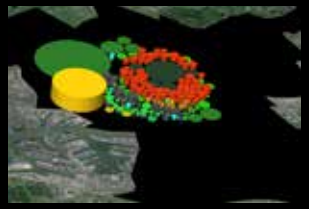

saturday 22:30

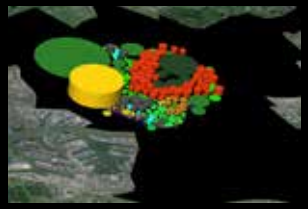

sunday 22:30

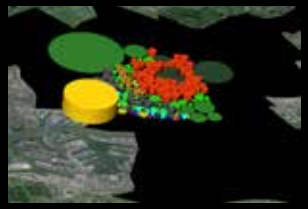

tuesday 23:00


saturday 23:00

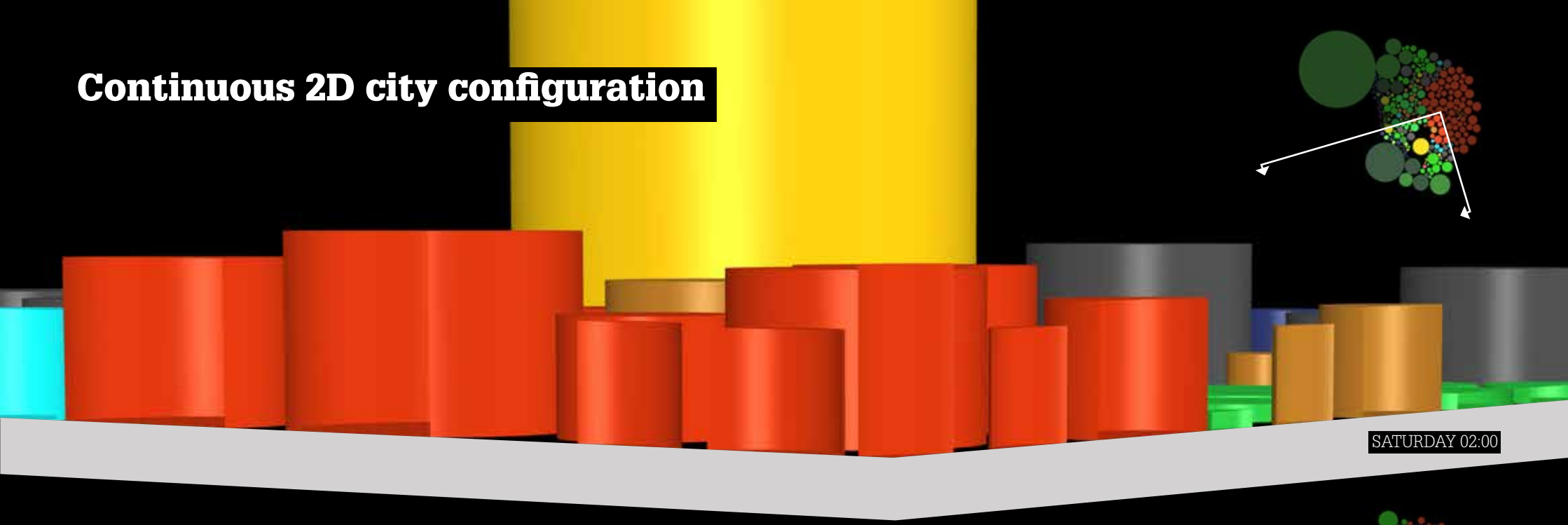

sunday 23:00

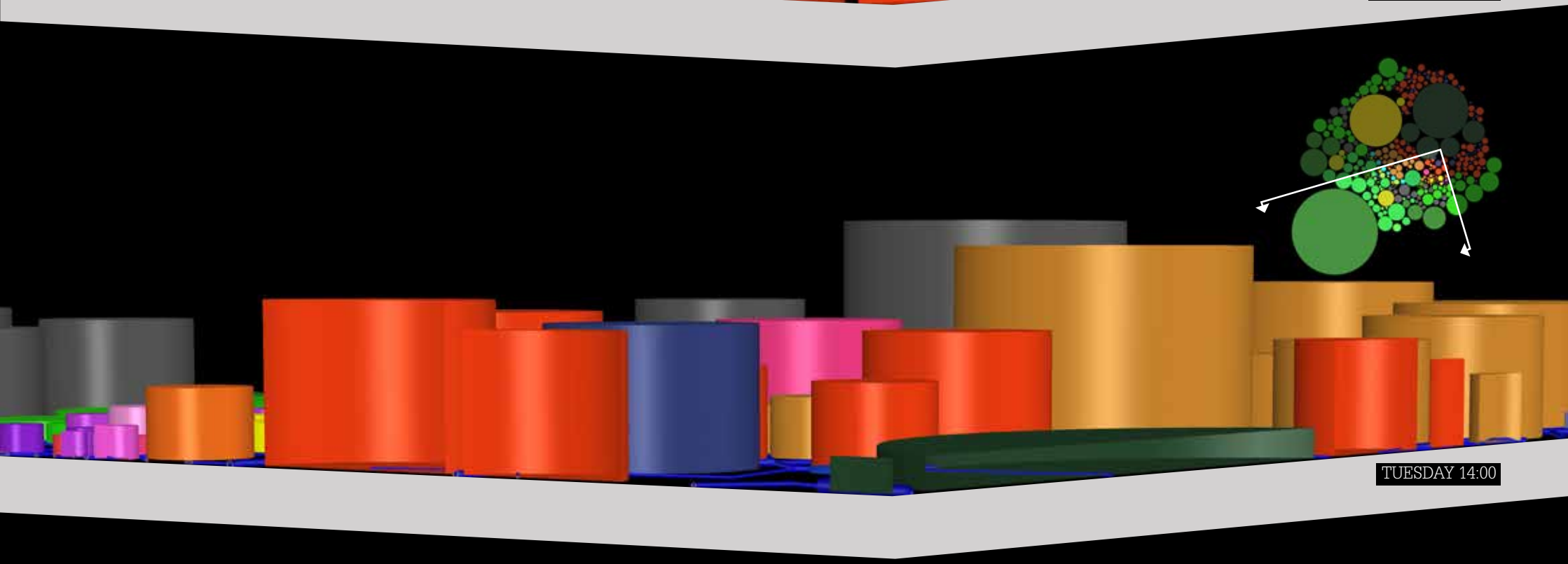

tuesday 23:30


saturday 23:30

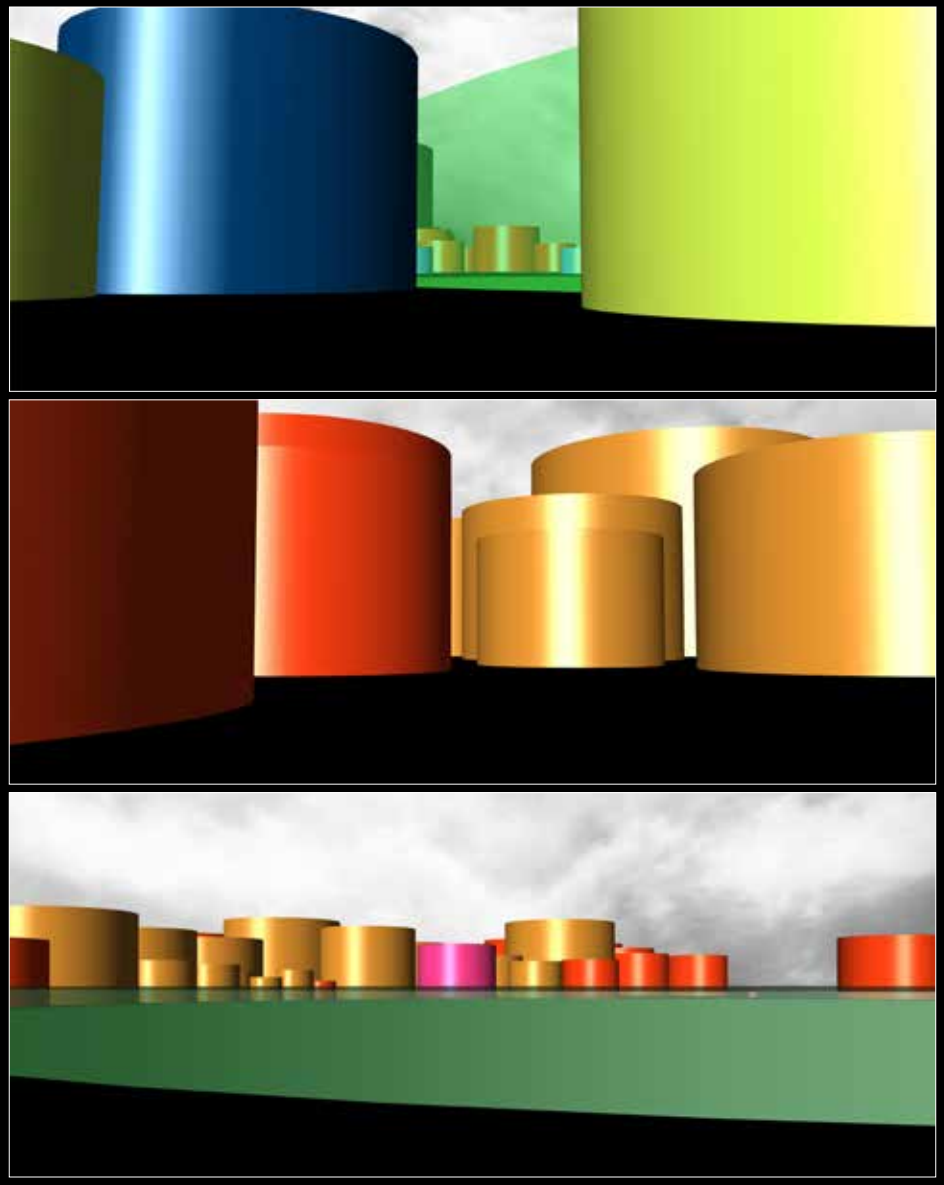

sunday 23:30

Continuous 2D city configuration



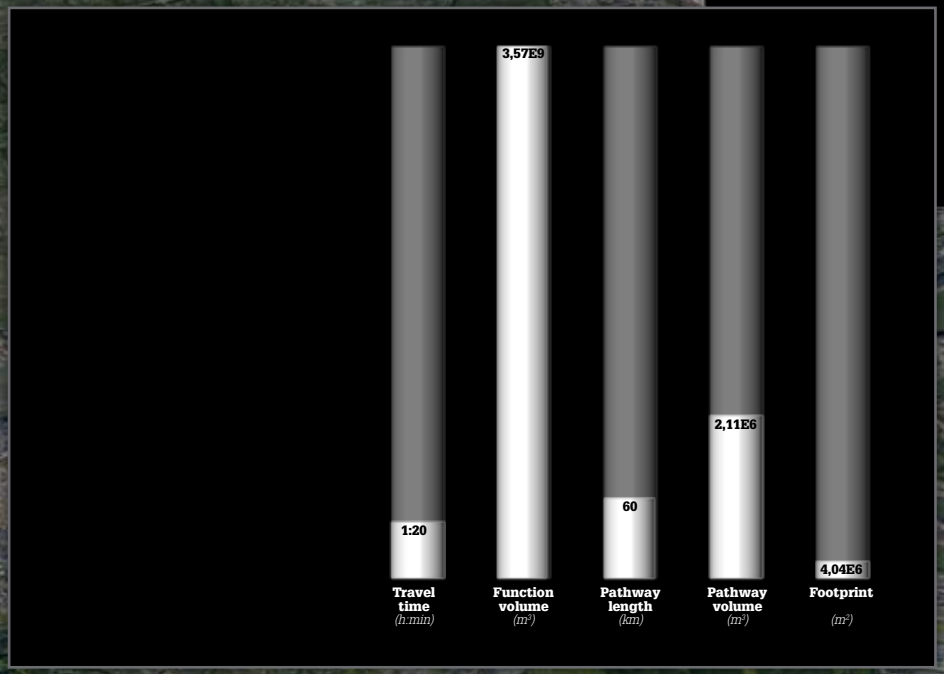


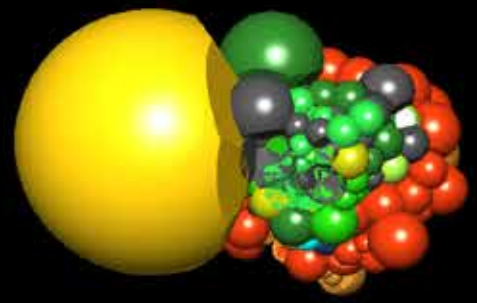
Continuous 2D city configuration



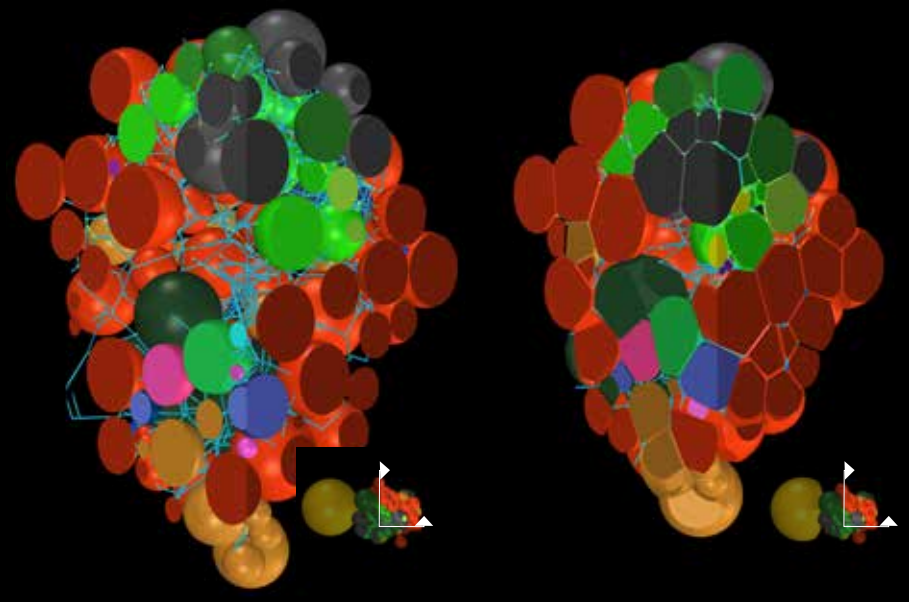
Eye level perspectives of the city.
The semi-transparant volumes are functions such as forests and parks that, because they mainly consist of plants and trees have a semi-transparant character.

Fixed 3D city configuration without resizing

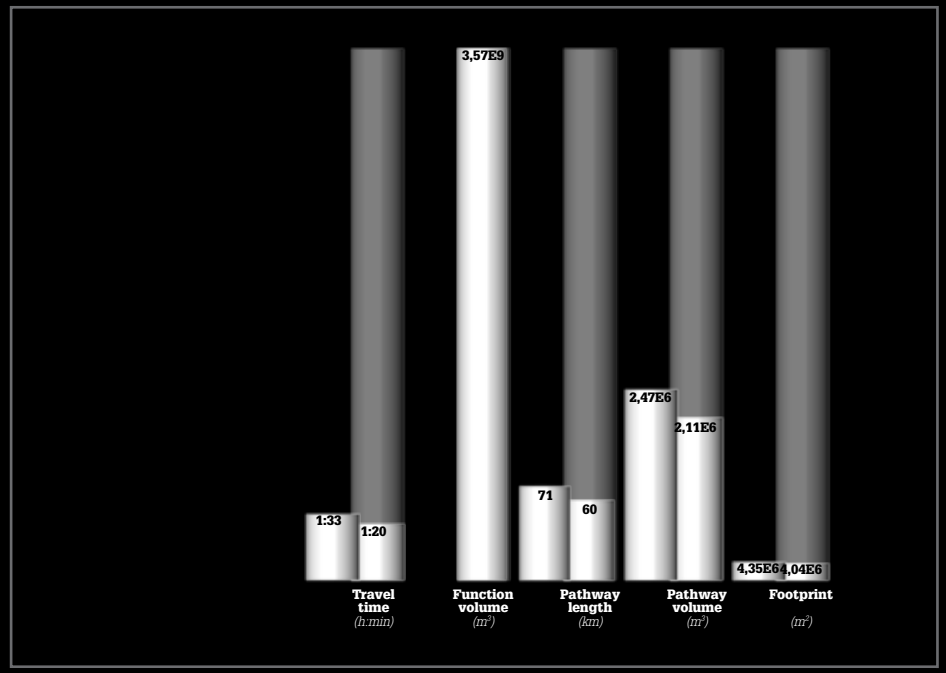




The configuration is fixed and volumes do not resize. Therefore the shape of the city never changes. This means the volumes can be packed together, closing the gaps between them by turning into voronoi shapes. By closing the gaps, the city becomes smaller and therefore faster.

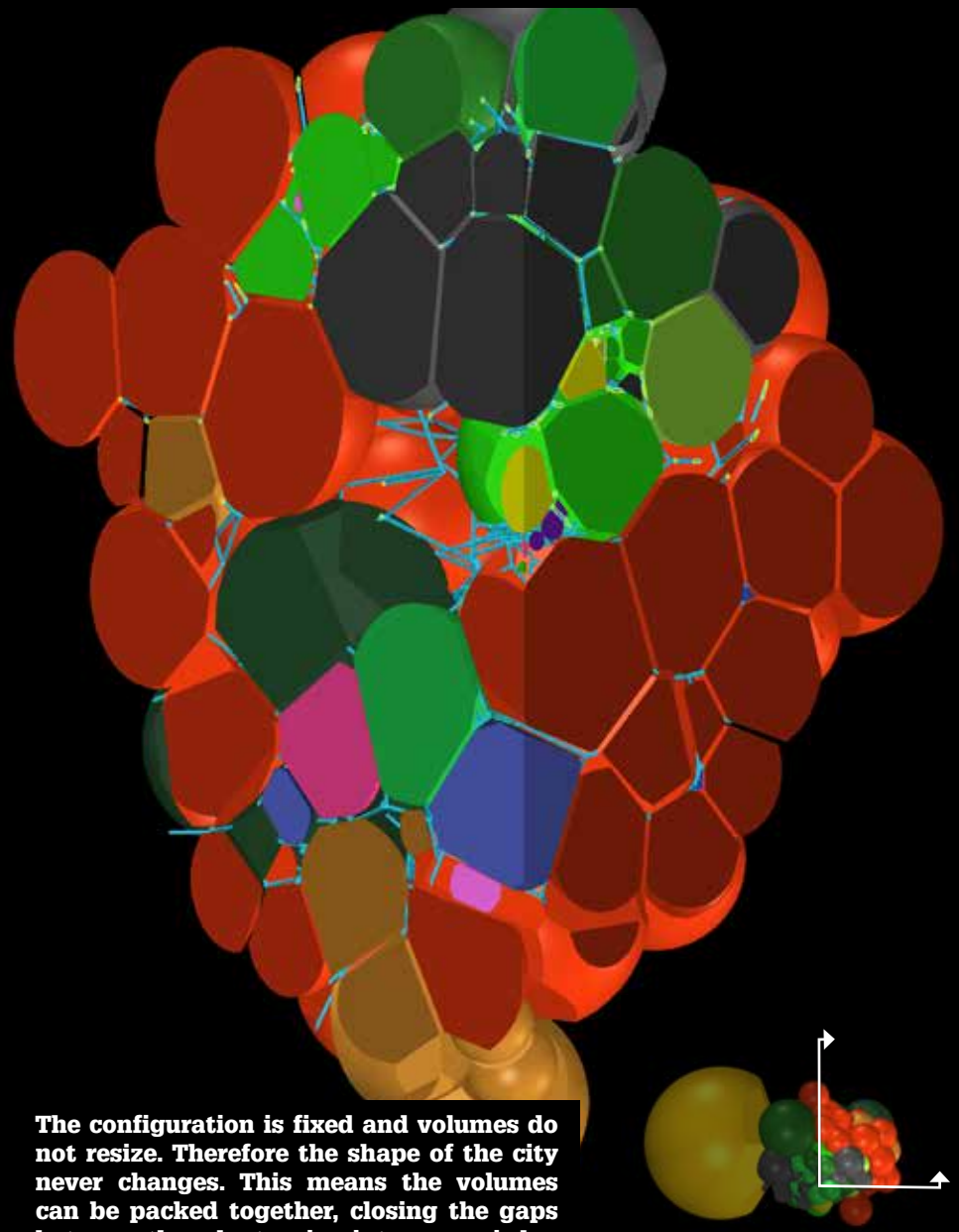


Spheres vs voronoi: the city becomes smaller when the volumes turn from spheres into voronoi shapes.



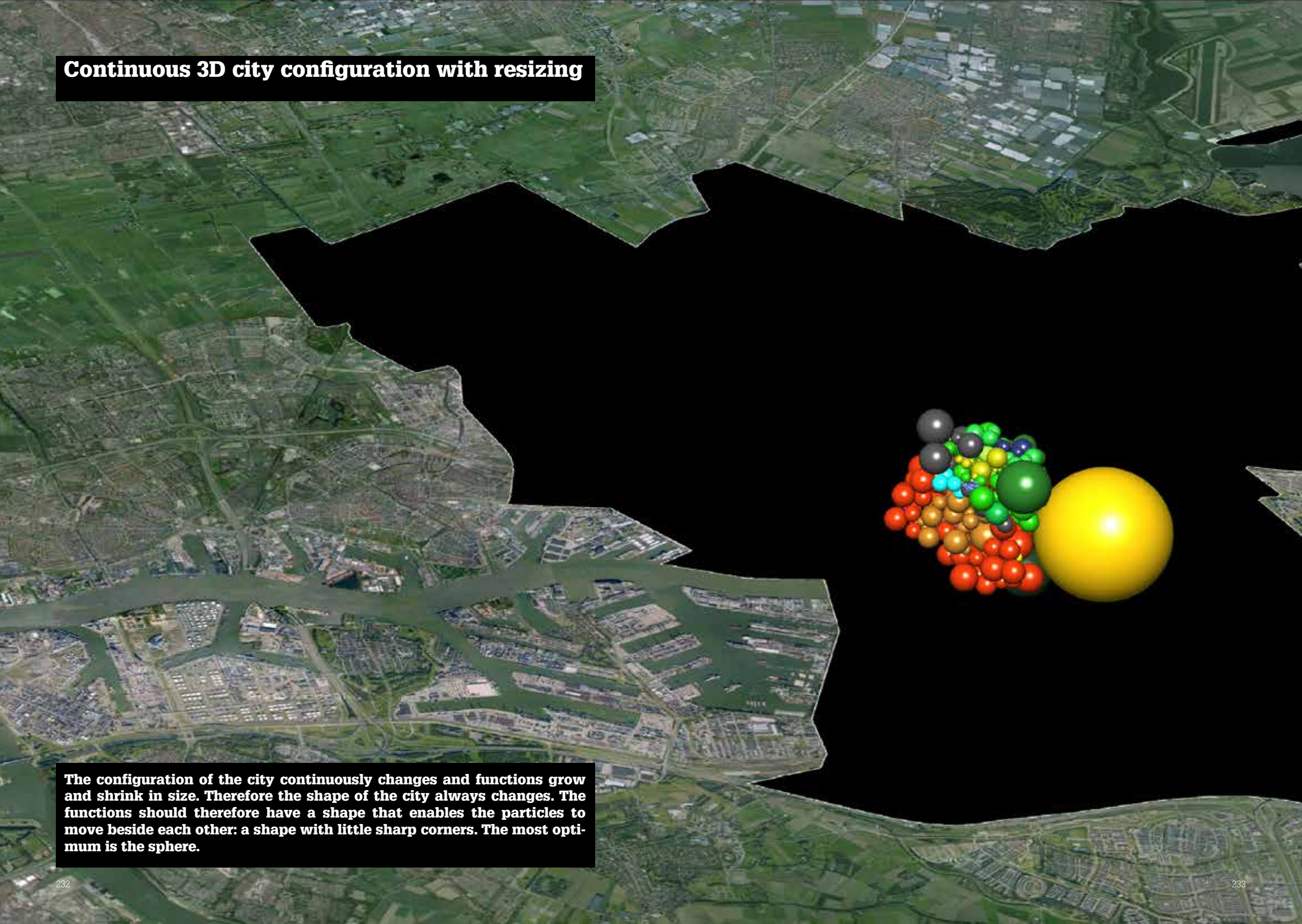
Left bars: Spheres
Right bars: Voronoi

Fixed 3D city configuration without resizing



The configuration is fixed and volumes do not resize. Therefore the shape of the city never changes. This means the volumes can be packed together, closing the gaps between them by turning into voronoi shapes. By closing the gaps, the city becomes smaller and therefore faster.

Continuous 3D city configuration with resizing



The configuration of the city continuously changes and functions grow and shrink in size. Therefore the shape of the city always changes. The functions should therefore have a shape that enables the particles to move beside each other: a shape with little sharp corners. The most optimum is the sphere.

CONCLUSION
TOOL IMPACT

Weekly passenger travel time

When all tools are applied to the city of Rotterdam, Rotterdam citizens and visitors are estimated to spend 6 hours and 6 minutes* per week on travel within the city of Rotterdam. (Current Rotterdam: 12 hours and 28 minutes*)

Based on the shape and location of functions and pathways, the border of the city of Rotterdam changes as well.

in case all travel is done:
*** by bike in a continuous 2D configuration**

City values: before and after

Current Rotterdam

After application of all five tools: Continuously configuring 2D city with resizing particles and merged pathways.

Research questions

What if the city could reduce travel time?

1.
How can the city reduce travel time as much as possible?

By applying the five tools to the city:

Tool 1: **Reshaping the particles could lead to a travel time reduction of 66%**
Tool 2: **Configuring the city based on connection intensities reduces travel time with 12% to 50%.**
Tool 3: **Resizing the particles reduces travel time slightly with 7%.**
Tool 4: **Direct pathways for a shorter travel time.**
To calculate the travel time impact more research is needed.
Tool 5: **Limiting space for pathways by merging them.**
To calculate the travel time impact more research is needed.
There are possibilities to adapt the rules of the tools to research if travel time could be reduced even more.

2.
How much can the city reduce travel time?
How much of the 3,9 years will we be able to spend on other things than travel?

Applying all tools on the city of Rotterdam will result in a travel time reduction of 51%.
This saves us:
6 hours and 22 minutes a week,
more than 14 days a year,
2,2 years in a lifetime.

3.
What would the city and life in the city look like then?

Travel time in life time

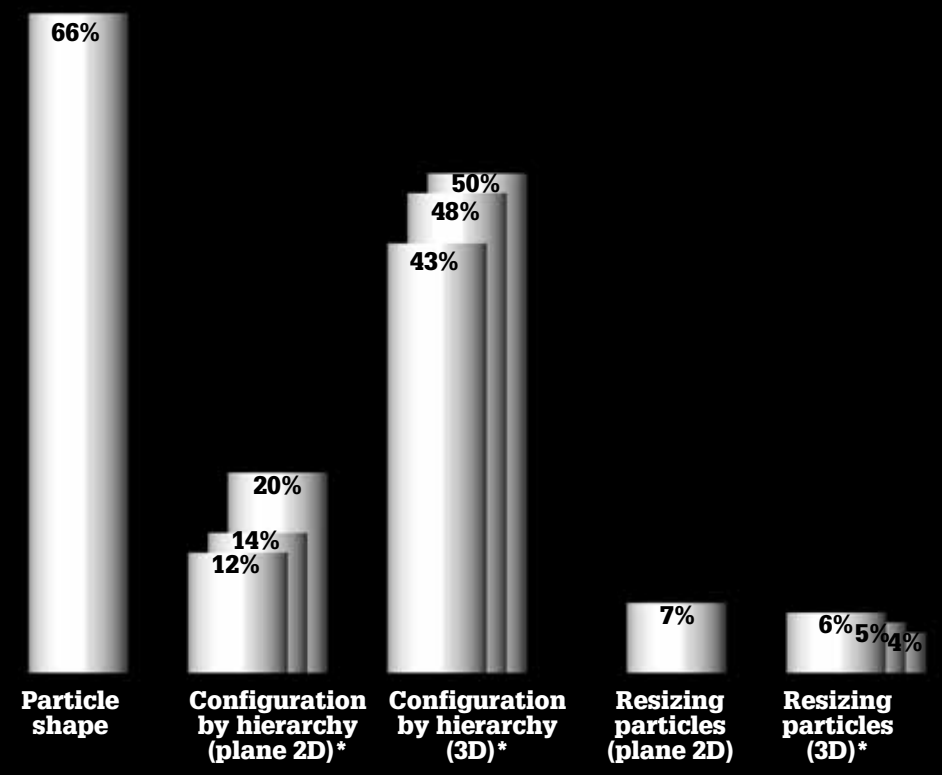
If we eliminate all travel time during our lives, we gain 3,9 years in our lives to spend on other activities.

*based on a life expectancy of 77,3 years (Dutch average) *Source:CBS*
*based on an average travel time per day of 73 minutes
Source:De mobiele stad, van den Boomen, Venhoeven, 2012
* based on 8 hours of sleep each night

Total years in our lives we are awake

Travel time reduction (%)

Which tool has the biggest impact on travel time reduction?
The graphs show the impact of the tool when only that tool would be applied to the city.



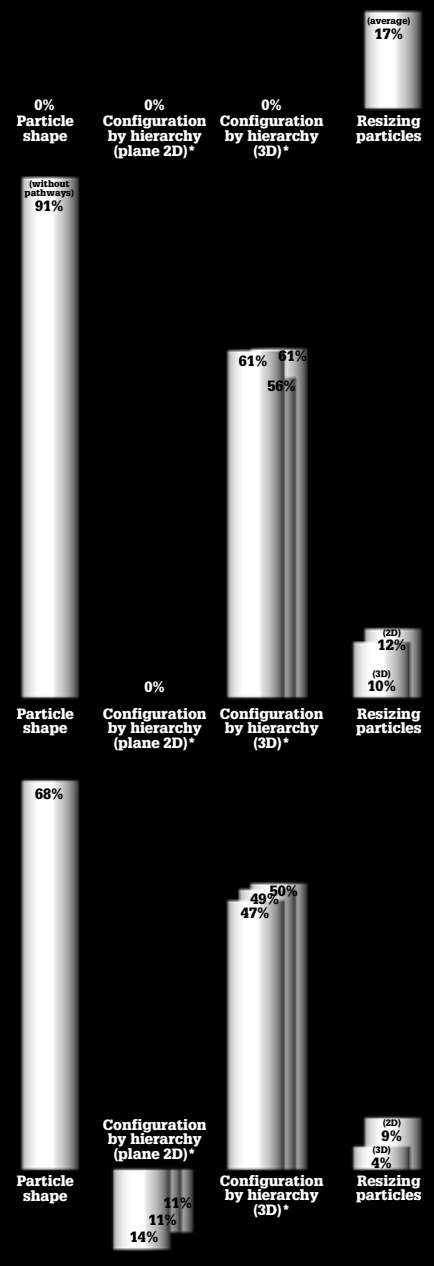
Front bar: fixed configuration
Middle bar: daily configuration
Back bar: continuous configuration

Other city impacts

Function volume reduction (%)
Which tool has the biggest impact on function volume in the city?

Footprint reduction (%)
Which tool has the biggest impact on the city's footprint?

Pathway length/volume reduction/ increase (%)
Which tool has the biggest impact on pathway length and pathway volume in the city?



* compared to abstract spheres in original size.

PART 3

CASE STUDY NEIGHBOURHOOD

CASE STUDY HOUSING DISTRICT

Case study border

One housing district is the same as one housing volume in the case study Rotterdam.

Function surfaces

This housing district consists of 10 neighbourhoods.

Neighbourhoods after tool application

After application of the tools on each neighbourhood, this is what each neighbourhood looks like. The cases study neighbourhood explains how this shape was generated.

CASE STUDY NEIGHBOURHOOD

Case study housing district

Case study neighbourhood

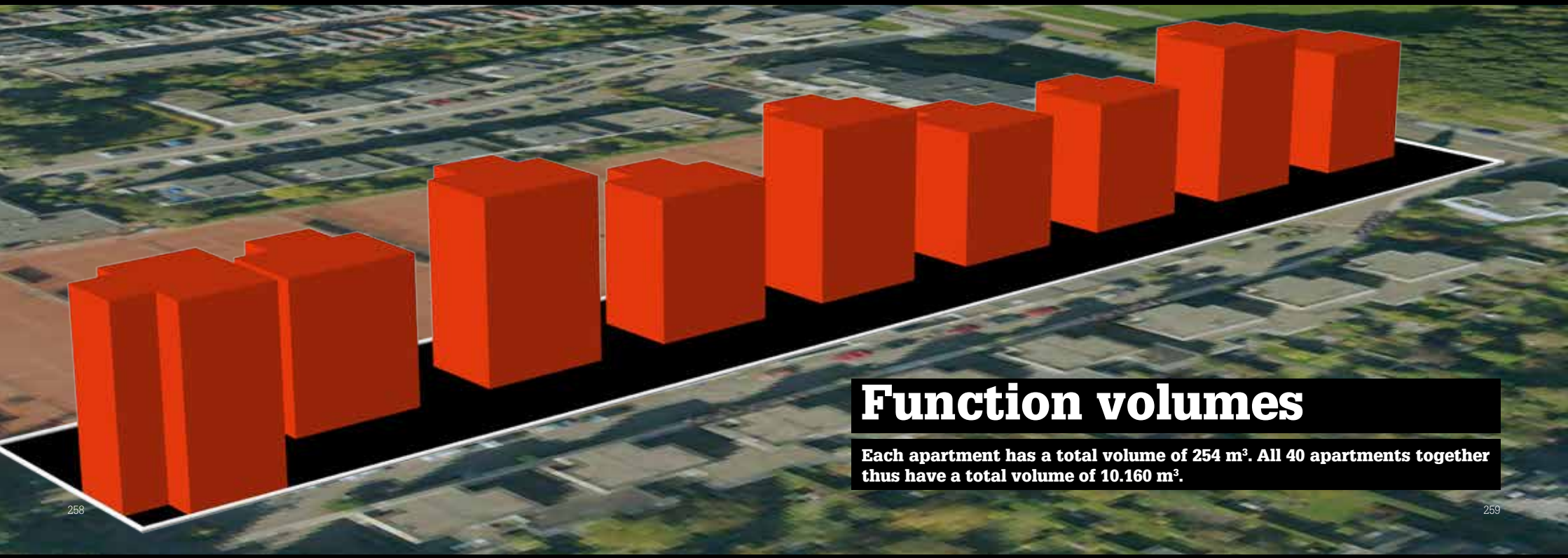
40 apartments within the case study border

Weekly travel time

Function surfaces

Main pathways

Door to door connections between the apartments



Function volumes

Each apartment has a total volume of 254 m³. All 40 apartments together thus have a total volume of 10.160 m³.

ABSTRACTION

Abstract particles

By abstracting the apartment volumes into spheres, the total volume of each apartment and thus the total volume of the case study remains the same: 10.160 m^3.

Abstract connections

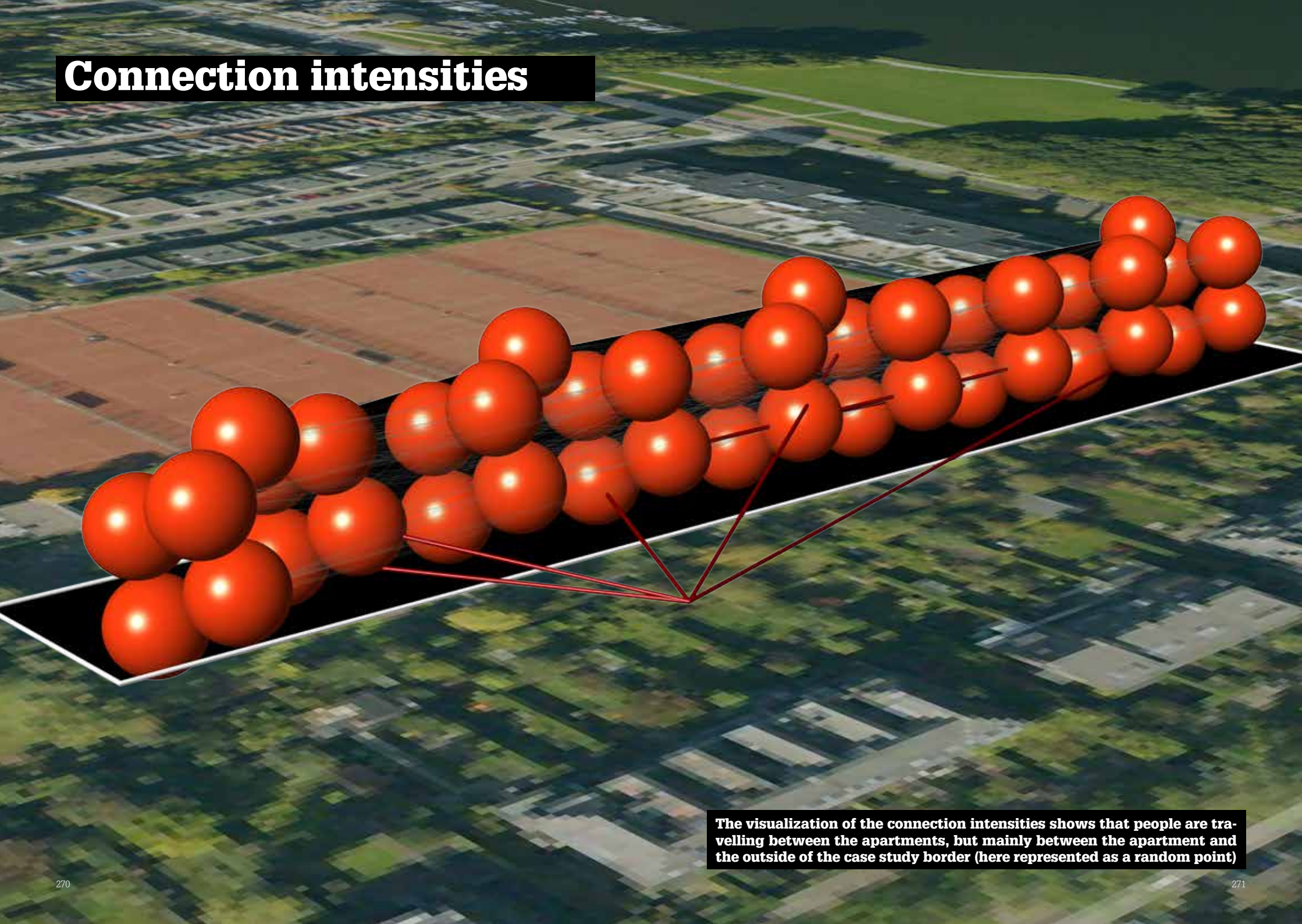
TOOL 1
RESHAPE
PARTICLES

Particles further away

In contrast with the case study Rotterdam, abstract volumes will lay further away from each other when the volumes are reshaped into abstract spheres

TOOL 2
CONFIGURATION

Connection intensities



The visualization of the connection intensities shows that people are travelling between the apartments, but mainly between the apartment and the outside of the case study border (here represented as a random point)

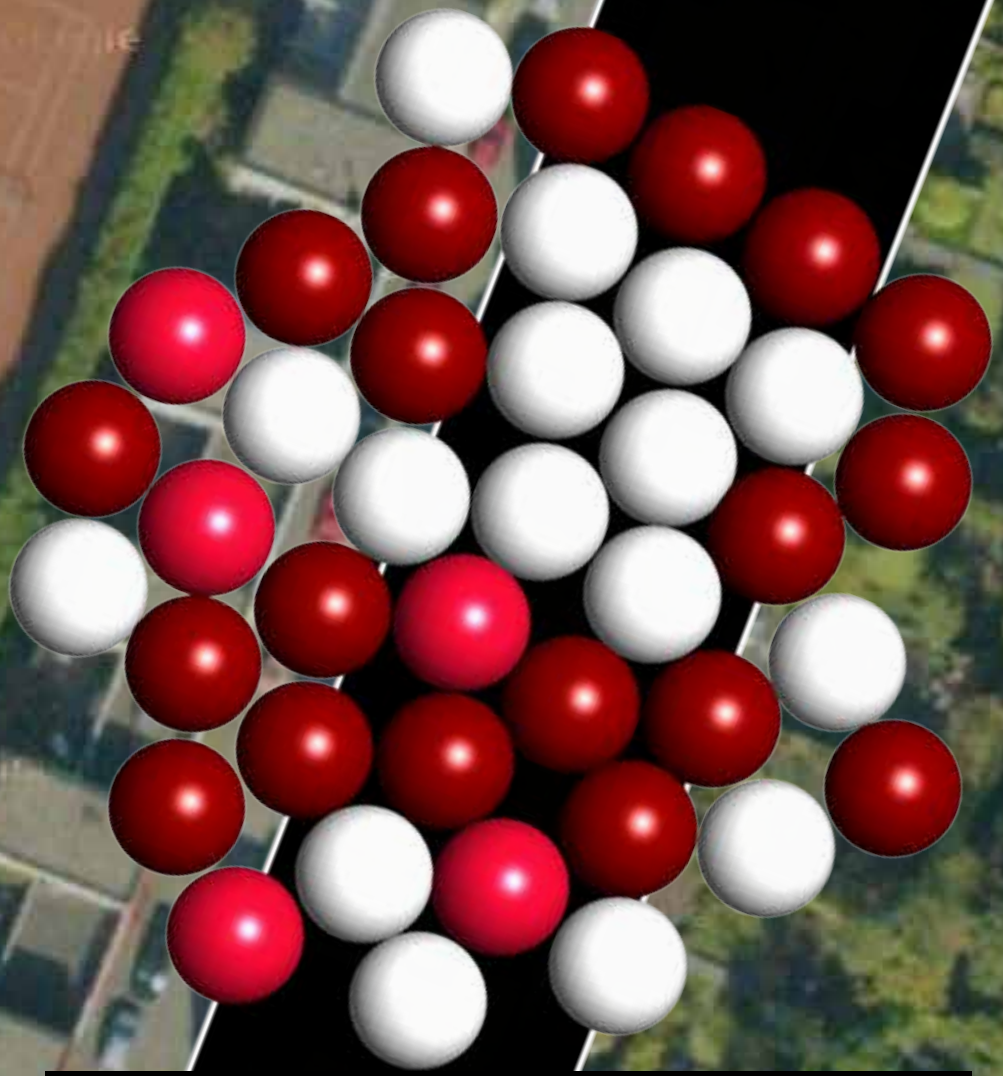
Continuous configuration

Based on connection intensities, homed could continuously change their position. Homes that have people travelling between them will lay as close together as possible. Homes with people entering or leaving their home after/for travel outside the case study border will lay as close to the (here abstract) exit point.

TUESDAY 14:00

TOOL 3
RESIZING
PARTICLES

Particle intensities



The particle occupancy in terms of percentage (% of maximum particle capacity). The more red, the more the particle reaches it's maximum capacity. The particle occupancy is time dependant.

TUESDAY 14:00

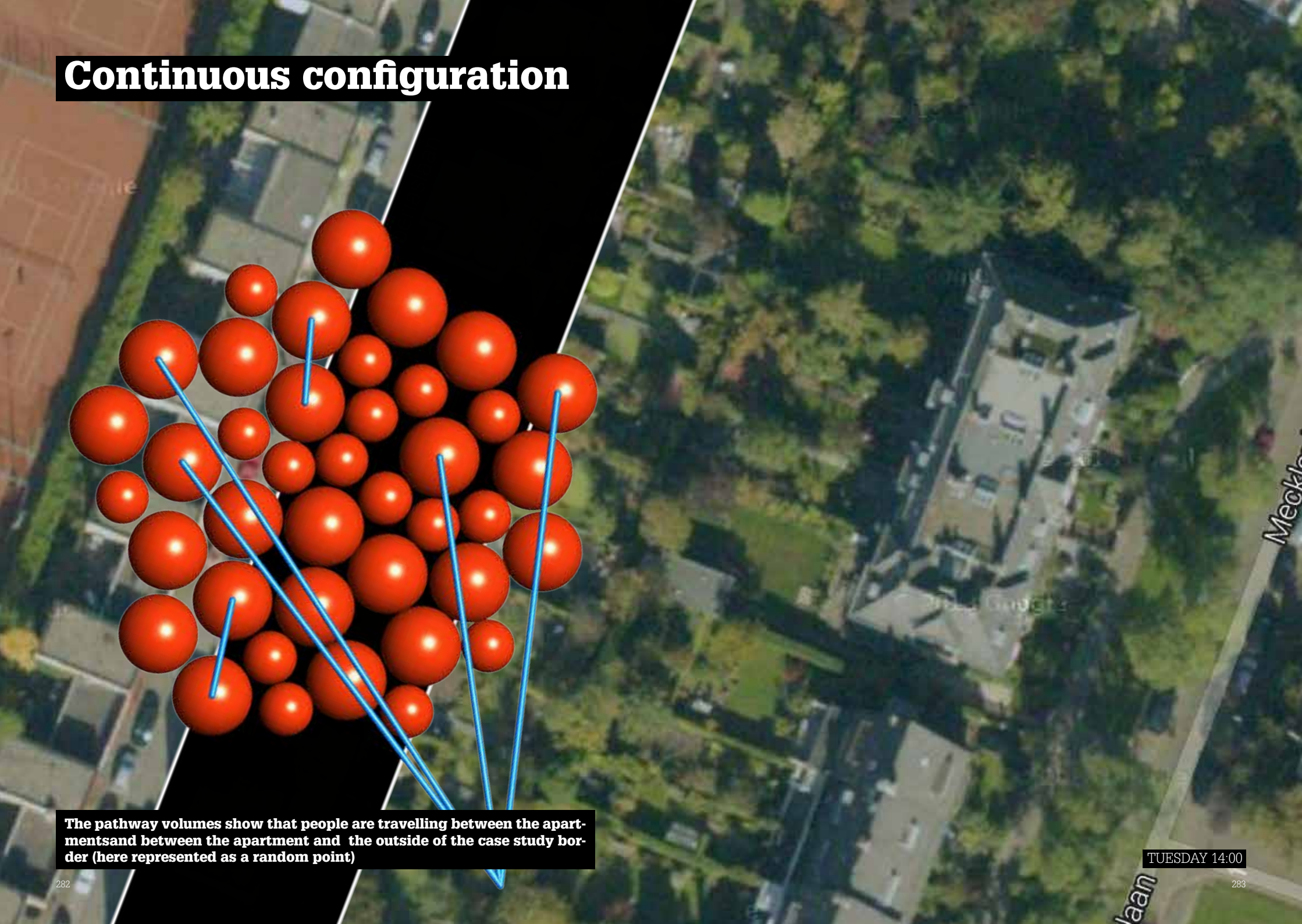
Continuous configuration

When an apartment is not in use, it reduces its size. Therefore at different times of the day apartments could have different sizes.

TUESDAY 14:00

TOOL 4 PATHWAY VOLUME

Continuous configuration



The pathway volumes show that people are travelling between the apartmentsand between the apartment and the outside of the case study border (here represented as a random point)

TUESDAY 14:00

TOOL 5 PATHWAY MERGING

Continuous configuration

Merged pathways run inbetween the particles.

TUESDAY 14:00

AWAY FROM ABSTRACTION

Continuous configuration

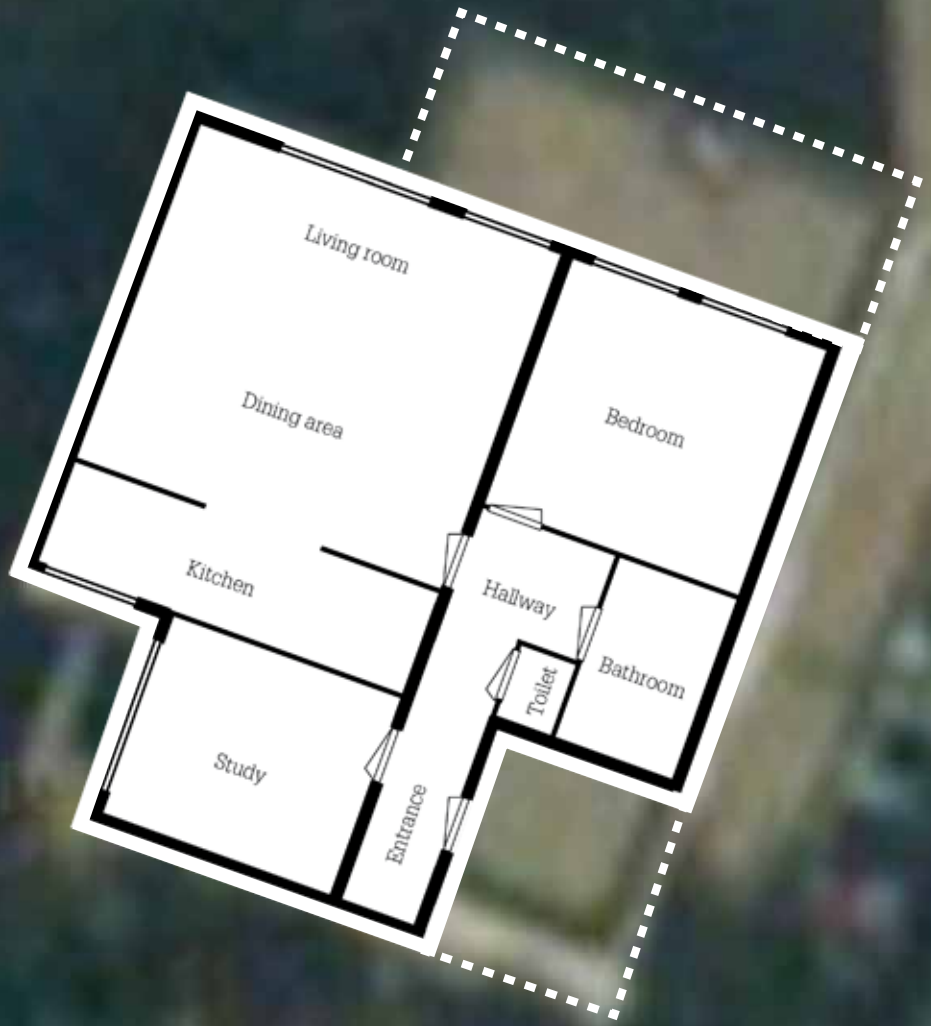
Each apartment has a certain shape. The case study apartment will explain how the shape of one apartment came into being.

PART 4

CASE STUDY APARTMENT

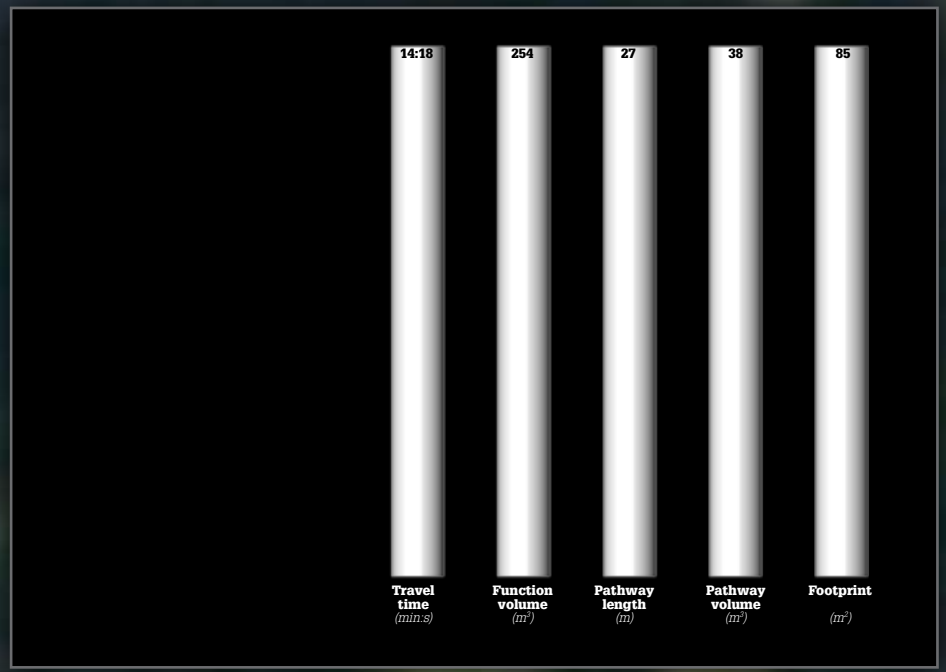
CASE STUDY BASELINE

Case study apartment



Apartment for 2 people within the continuous white border. The dotted border includes the flat's entrance, staircases and corridors for residents to reach their home.

Weekly travel time

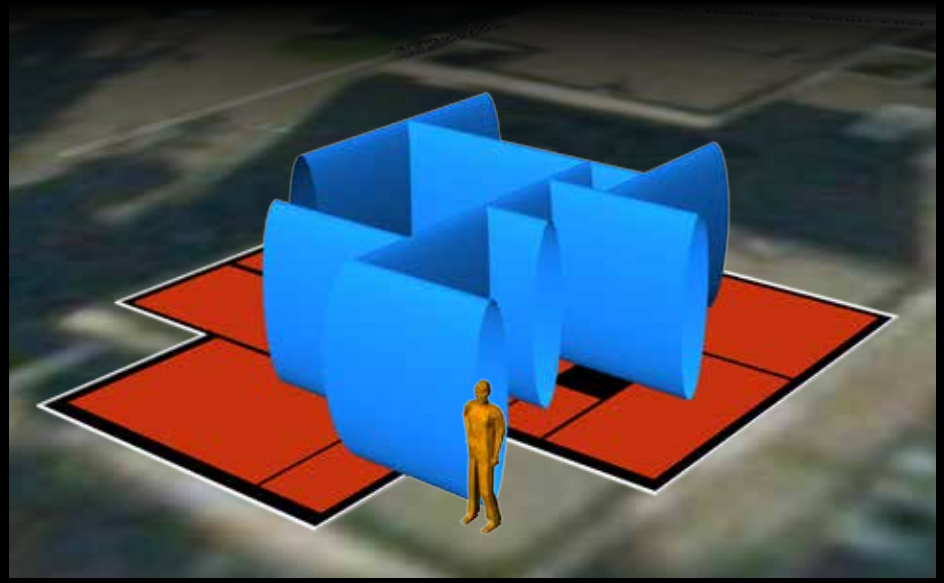


Within this two person apartment, residents are estimated to spend 14 minutes and 18 seconds* per week on travelling from room to room within the home.

*** in case all travel is done by walking from one room to another.**

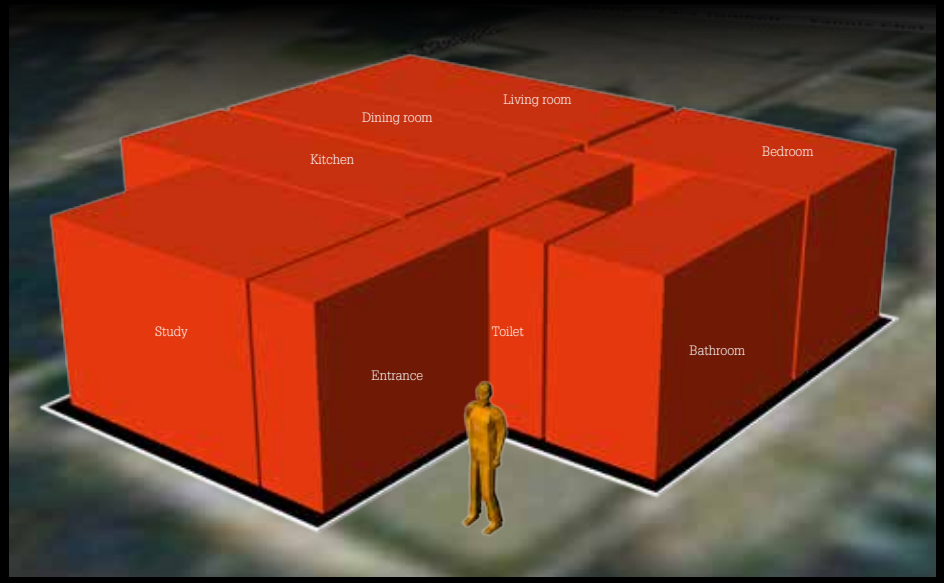
Function surfaces

Apartment for 2 people with a total floor surface of 85 m².



Main pathways

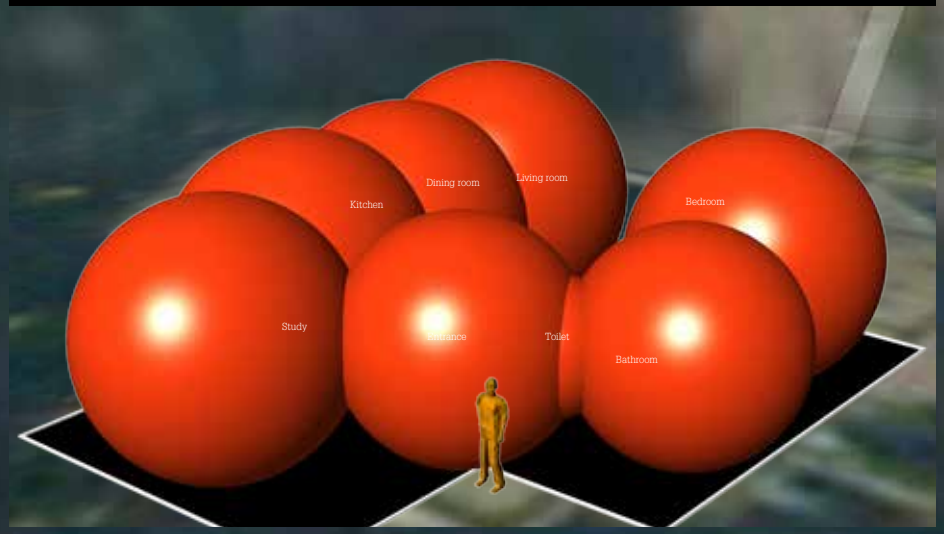
Function volumes



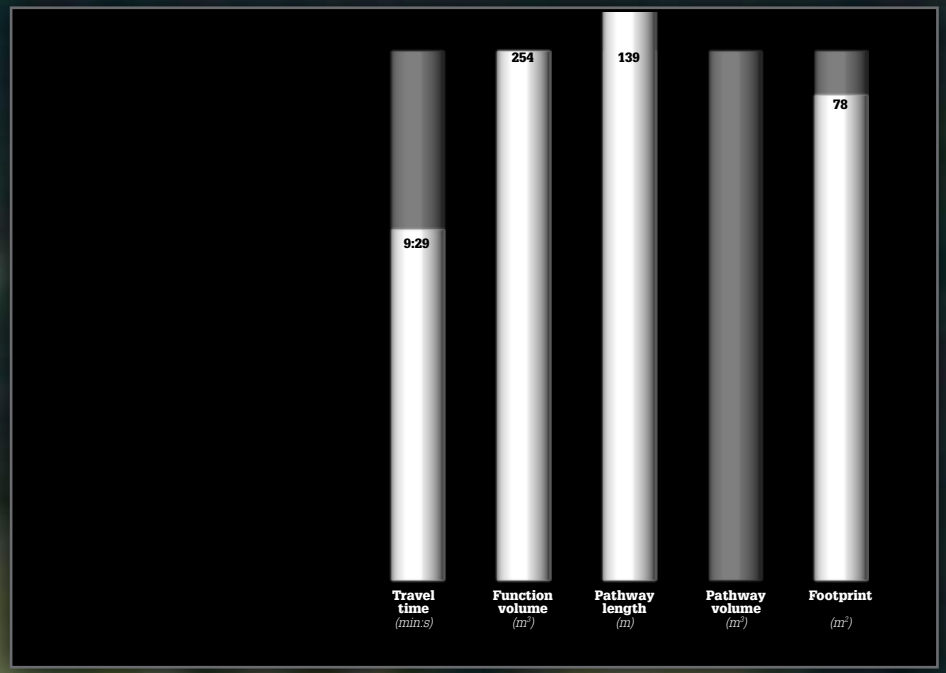
The total volume of the rooms is 254 m³.

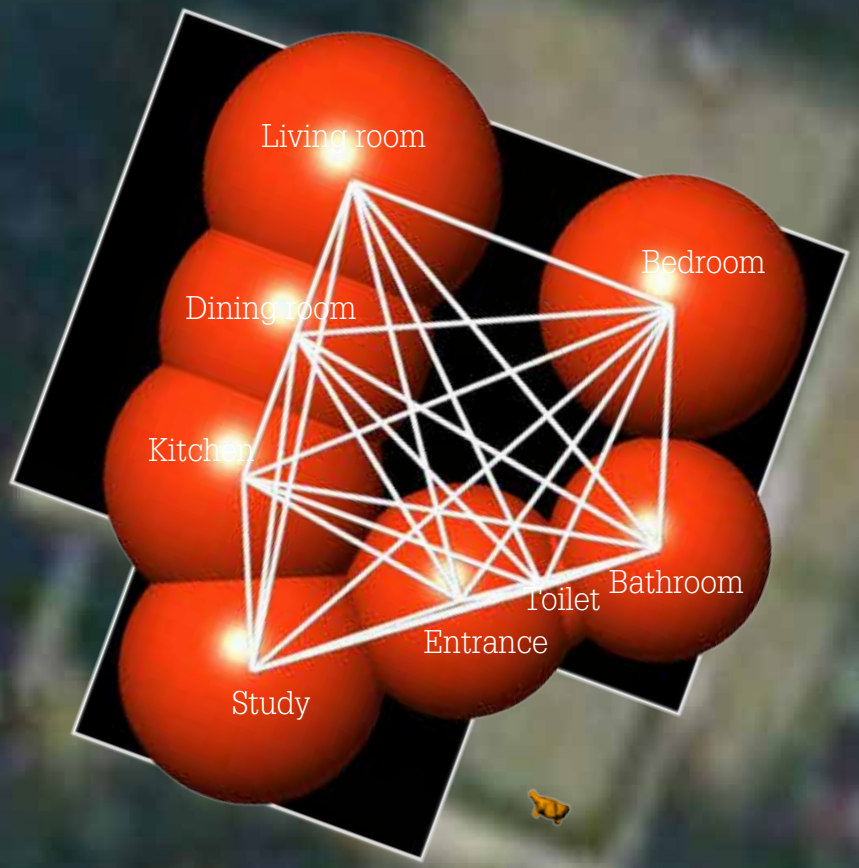
ABSTRACTION

Abstract particles



By abstracting the room volumes into spheres, the total volume of the rooms remains the same: 254 m³.



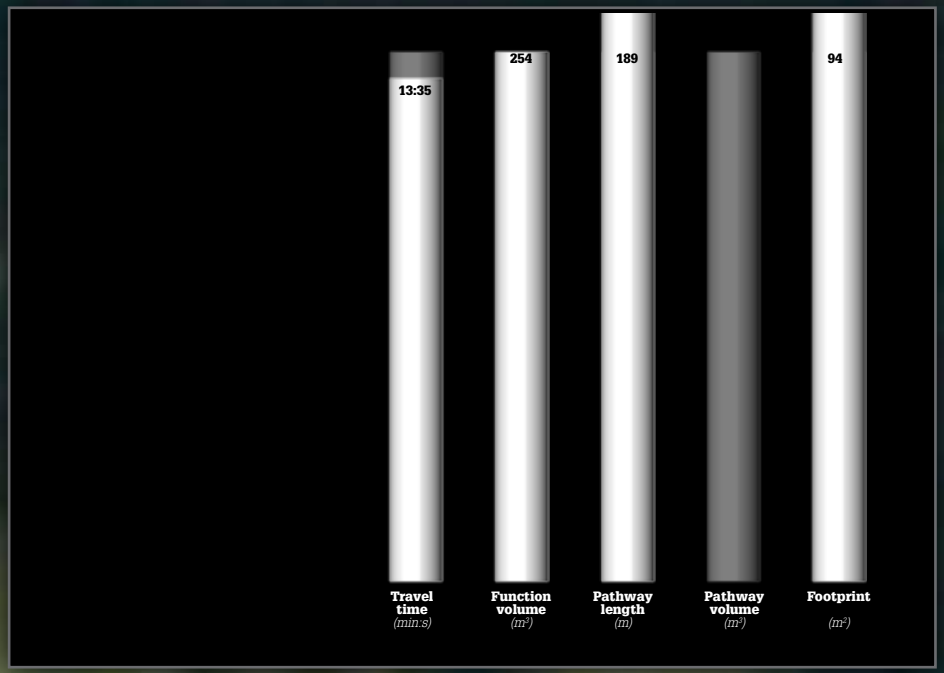


Abstract connections

TOOL 1
RESHAPE
PARTICLES

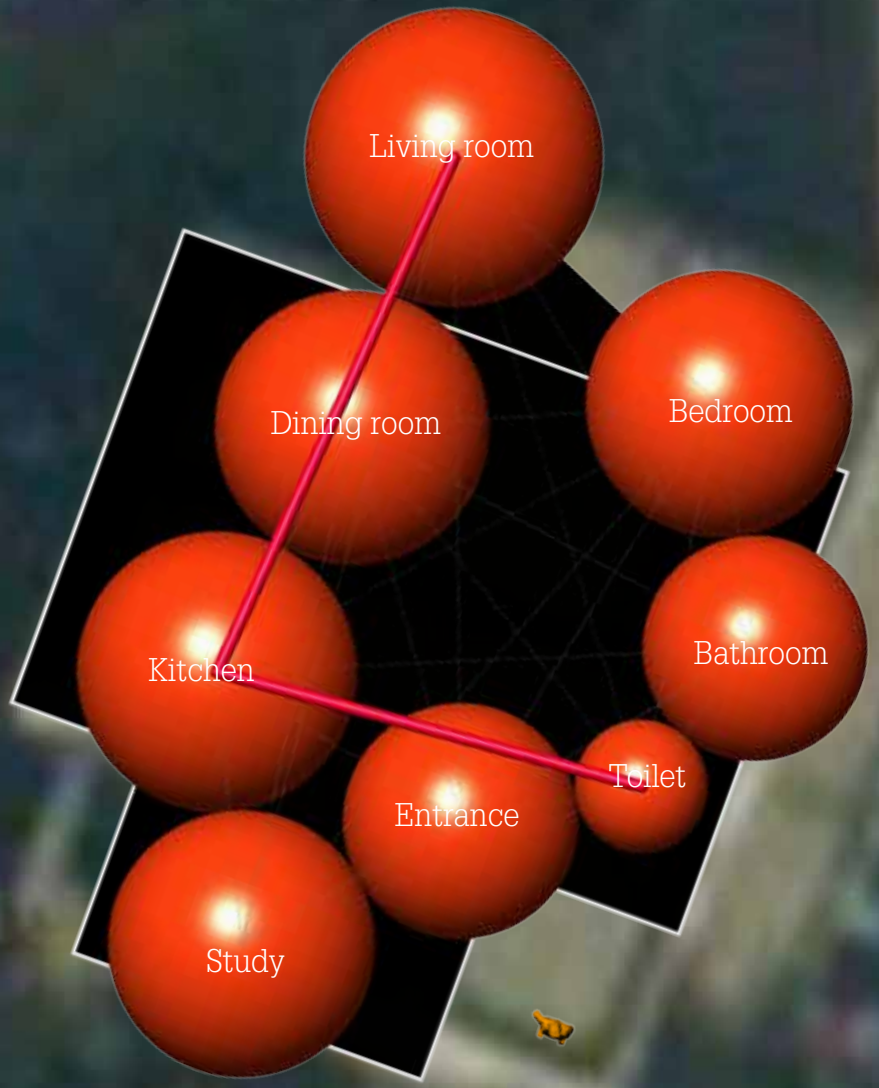
Particles further away

In contrast to the case study Rotterdam, reshaping the particles into spheres will lead to more travel time instead of less travel time, since the spheres move away from each other to avoid interpenetration.



TOOL 2
CONFIGURATION

Connection intensities



The absolute connection intensity (nr of people per connection). The more red, the more people use that connection. The connection intensity is time dependant.

TUESDAY 20:30


tuesday 00:00
saturday 00:00
sunday 00:00
tuesday 02:00
saturday 02:00
sunday 02:00
tuesday 00:10
saturday 00:10
sunday 00:10
tuesday 02:10
saturday 02:10
sunday 02:10
tuesday 00:20
saturday 00:20
sunday 00:20
tuesday 02:20
saturday 02:20
sunday 02:20
tuesday 00:30
saturday 00:30
sunday 00:30
tuesday 02:30
saturday 02:30
sunday 02:30
tuesday 00:40
saturday 00:40
sunday 00:40
tuesday 02:40
saturday 02:40
sunday 02:40
tuesday 00:50
saturday 00:50
sunday 00:50
tuesday 02:50
saturday 02:50
sunday 02:50
tuesday 01:00
saturday 01:00
sunday 01:00
tuesday 03:00
saturday 03:00
sunday 03:00
tuesday 01:10
saturday 01:10
sunday 01:10
tuesday 03:10
saturday 03:10
sunday 03:10
tuesday 01:20
saturday 01:20
sunday 01:20
tuesday 03:20
saturday 03:20
sunday 03:20
tuesday 01:30
saturday 01:30
sunday 01:30
tuesday 03:30
saturday 03:30
sunday 03:30
tuesday 01:40
saturday 01:40
sunday 01:40
tuesday 03:40
saturday 03:40
sunday 03:40
tuesday 01:50
saturday 01:50
sunday 01:50
tuesday 03:50
saturday 03:50
sunday 03:50


tuesday 04:00
saturday 04:00
sunday 04:00
tuesday 06:00
saturday 06:00
sunday 06:00
tuesday 04:10
saturday 04:10
sunday 04:10
tuesday 06:10
saturday 06:10
sunday 06:10
tuesday 04:20
saturday 04:20
sunday 04:20
tuesday 06:20
saturday 06:20
sunday 06:20
tuesday 04:30
saturday 04:30
sunday 04:30
tuesday 06:30
saturday 06:30
sunday 06:30
tuesday 04:40
saturday 04:40
sunday 04:40
tuesday 06:40
saturday 06:40
sunday 06:40
tuesday 04:50
saturday 04:50
sunday 04:50
tuesday 06:50
saturday 06:50
sunday 06:50
tuesday 05:00
saturday 05:00
sunday 05:00
tuesday 07:00
saturday 07:00
sunday 07:00
tuesday 05:10
saturday 05:10
sunday 05:10
tuesday 07:10
saturday 07:10
sunday 07:10
tuesday 05:20
saturday 05:20
sunday 05:20
tuesday 07:20
saturday 07:20
sunday 07:20
tuesday 05:30
saturday 05:30
sunday 05:30
tuesday 07:30
saturday 07:30
sunday 07:30
tuesday 05:40
saturday 05:40
sunday 05:40
tuesday 07:40
saturday 07:40
sunday 07:40
tuesday 05:50
saturday 05:50
sunday 05:50
tuesday 07:50
saturday 07:50
sunday 07:50

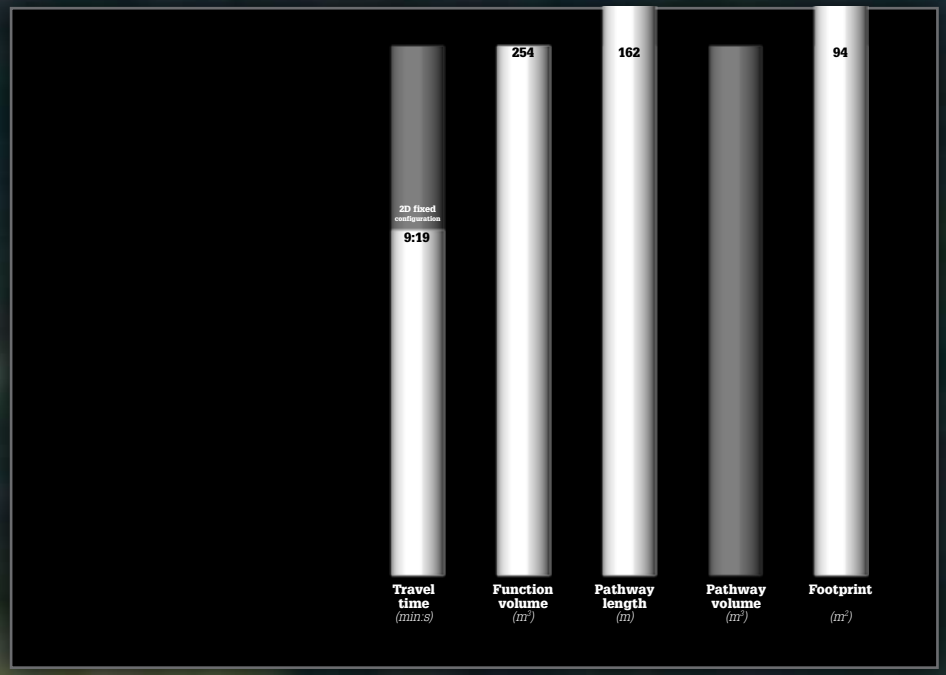

tuesday 08:00
saturday 08:00
sunday 08:00
tuesday 10:00
saturday 10:00
sunday 10:00
tuesday 08:10
saturday 08:10
sunday 08:10
tuesday 10:10
saturday 10:10
sunday 10:10
tuesday 08:20
saturday 08:20
sunday 08:20
tuesday 10:20
saturday 10:20
sunday 10:20
tuesday 08:30
saturday 08:30
sunday 08:30
tuesday 10:30
saturday 10:30
sunday 10:30
tuesday 08:40
saturday 08:40
sunday 08:40
tuesday 10:40
saturday 10:40
sunday 10:40
tuesday 08:50
saturday 08:50
sunday 08:50
tuesday 10:50
saturday 10:50
sunday 10:50
tuesday 09:00
saturday 09:00
sunday 09:00
tuesday 11:00
saturday 11:00
sunday 11:00
tuesday 09:10
saturday 09:10
sunday 09:10
tuesday 11:10
saturday 11:10
sunday 11:10
tuesday 09:20
saturday 09:20
sunday 09:20
tuesday 11:20
saturday 11:20
sunday 11:20
tuesday 09:30
saturday 09:30
sunday 09:30
tuesday 11:30
saturday 11:30
sunday 11:30
tuesday 09:40
saturday 09:40
sunday 09:40
tuesday 11:40
saturday 11:40
sunday 11:40
tuesday 09:50
saturday 09:50
sunday 09:50
tuesday 11:50
saturday 11:50
sunday 11:50


tuesday 12:00
saturday 12:00
sunday 12:00
tuesday 14:00
saturday 14:00
sunday 14:00
tuesday 12:10
saturday 12:10
sunday 12:10
tuesday 14:10
saturday 14:10
sunday 14:10
tuesday 12:20
saturday 12:20
sunday 12:20
tuesday 14:20
saturday 14:20
sunday 14:20
tuesday 12:30
saturday 12:30
sunday 12:30
tuesday 14:30
saturday 14:30
sunday 14:30
tuesday 12:40
saturday 12:40
sunday 12:40
tuesday 14:40
saturday 14:40
sunday 14:40
tuesday 12:50
saturday 12:50
sunday 12:50
tuesday 14:50
saturday 14:50
sunday 14:50
tuesday 13:00
saturday 13:00
sunday 13:00
tuesday 15:00
saturday 15:00
sunday 15:00
tuesday 13:10
saturday 13:10
sunday 13:10
tuesday 15:10
saturday 15:10
sunday 15:10
tuesday 13:20
saturday 13:20
sunday 13:20
tuesday 15:20
saturday 15:20
sunday 15:20
tuesday 13:30
saturday 13:30
sunday 13:30
tuesday 15:30
saturday 15:30
sunday 15:30
tuesday 13:40
saturday 13:40
sunday 13:40
tuesday 15:40
saturday 15:40
sunday 15:40
tuesday 13:50
saturday 13:50
sunday 13:50
tuesday 15:50
saturday 15:50
sunday 15:50


tuesday 16:00
saturday 16:00
sunday 16:00
tuesday 18:00
saturday 18:00
sunday 18:00
tuesday 16:10
saturday 16:10
sunday 16:10
tuesday 18:10
saturday 18:10
sunday 18:10
tuesday 16:20
saturday 16:20
sunday 16:20
tuesday 18:20
saturday 18:20
sunday 18:20
tuesday 16:30
saturday 16:30
sunday 16:30
tuesday 18:30
saturday 18:30
sunday 18:30
tuesday 16:40
saturday 16:40
sunday 16:40
tuesday 18:40
saturday 18:40
sunday 18:40
tuesday 16:50
saturday 16:50
sunday 16:50
tuesday 18:50
saturday 18:50
sunday 18:50
tuesday 17:00
saturday 17:00
sunday 17:00
tuesday 19:00
saturday 19:00
sunday 19:00
tuesday 17:10
saturday 17:10
sunday 17:10
tuesday 19:10
saturday 19:10
sunday 19:10
tuesday 17:20
saturday 17:20
sunday 17:20
tuesday 19:20
saturday 19:20
sunday 19:20
tuesday 17:30
saturday 17:30
sunday 17:30
tuesday 19:30
saturday 19:30
sunday 19:30
tuesday 17:40
saturday 17:40
sunday 17:40
tuesday 19:40
saturday 19:40
sunday 19:40
tuesday 17:50
saturday 17:50
sunday 17:50
tuesday 19:50
saturday 19:50
sunday 19:50


tuesday 20:00
saturday 20:00
sunday 20:00
tuesday 22:00
saturday 22:00
sunday 22:00
tuesday 20:10
saturday 20:10
sunday 20:10
tuesday 22:10
saturday 22:10
sunday 22:10
tuesday 20:20
saturday 20:20
sunday 20:20
tuesday 22:20
saturday 22:20
sunday 22:20
tuesday 20:30
saturday 20:30
sunday 20:30
tuesday 22:30
saturday 22:30
sunday 22:30
tuesday 20:40
saturday 20:40
sunday 20:40
tuesday 22:40
saturday 22:40
sunday 22:40
tuesday 20:50
saturday 20:50
sunday 20:50
tuesday 22:50
saturday 22:50
sunday 22:50
tuesday 21:00
saturday 21:00
sunday 21:00
tuesday 23:00
saturday 23:00
sunday 23:00
tuesday 21:10
saturday 21:10
sunday 21:10
tuesday 23:10
saturday 23:10
sunday 23:10
tuesday 21:20
saturday 21:20
sunday 21:20
tuesday 23:20
saturday 23:20
sunday 23:20
tuesday 21:30
saturday 21:30
sunday 21:30
tuesday 23:30
saturday 23:30
sunday 23:30
tuesday 21:40
saturday 21:40
sunday 21:40
tuesday 23:40
saturday 23:40
sunday 23:40
tuesday 21:50
saturday 21:50
sunday 21:50
tuesday 23:50
saturday 23:50
sunday 23:50

Fixed home configuration



The fixed configuration of the home is based on the total connection intensity per week. The configuration of the home does not change.

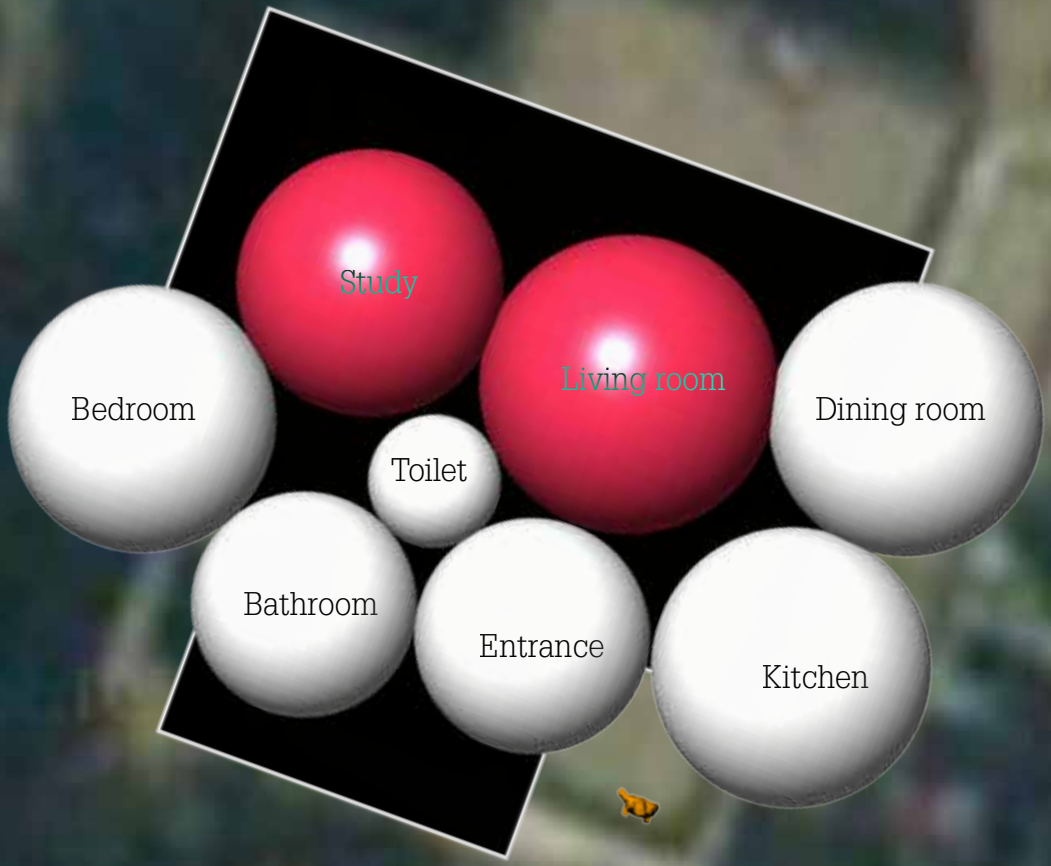
Fixed 3D home configuration

Perspective view of the rooms configured in a 3D configuration.

Top view of the rooms configured in a 3D configuration.

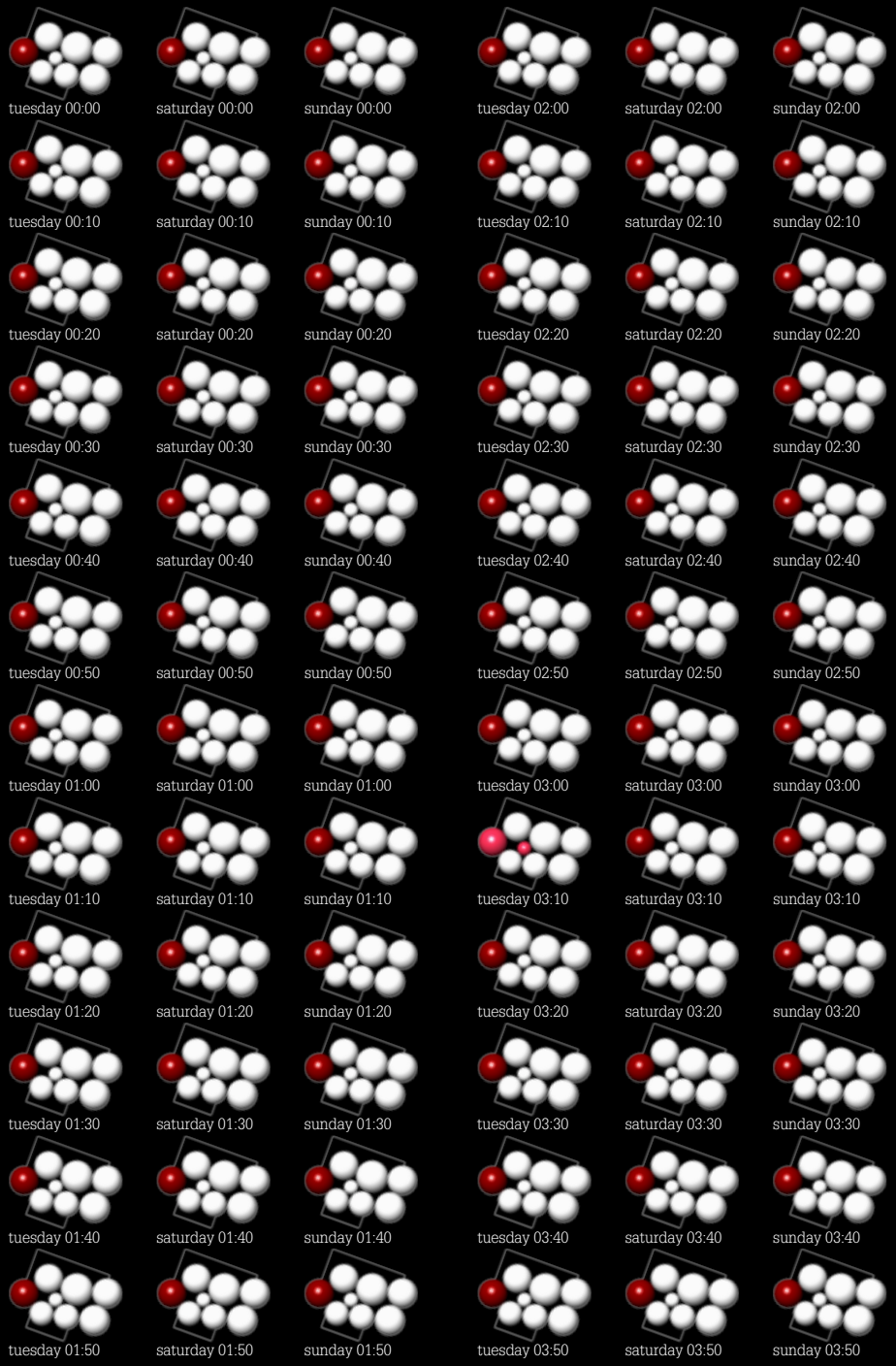
TOOL 3
RESIZING PARTICLES

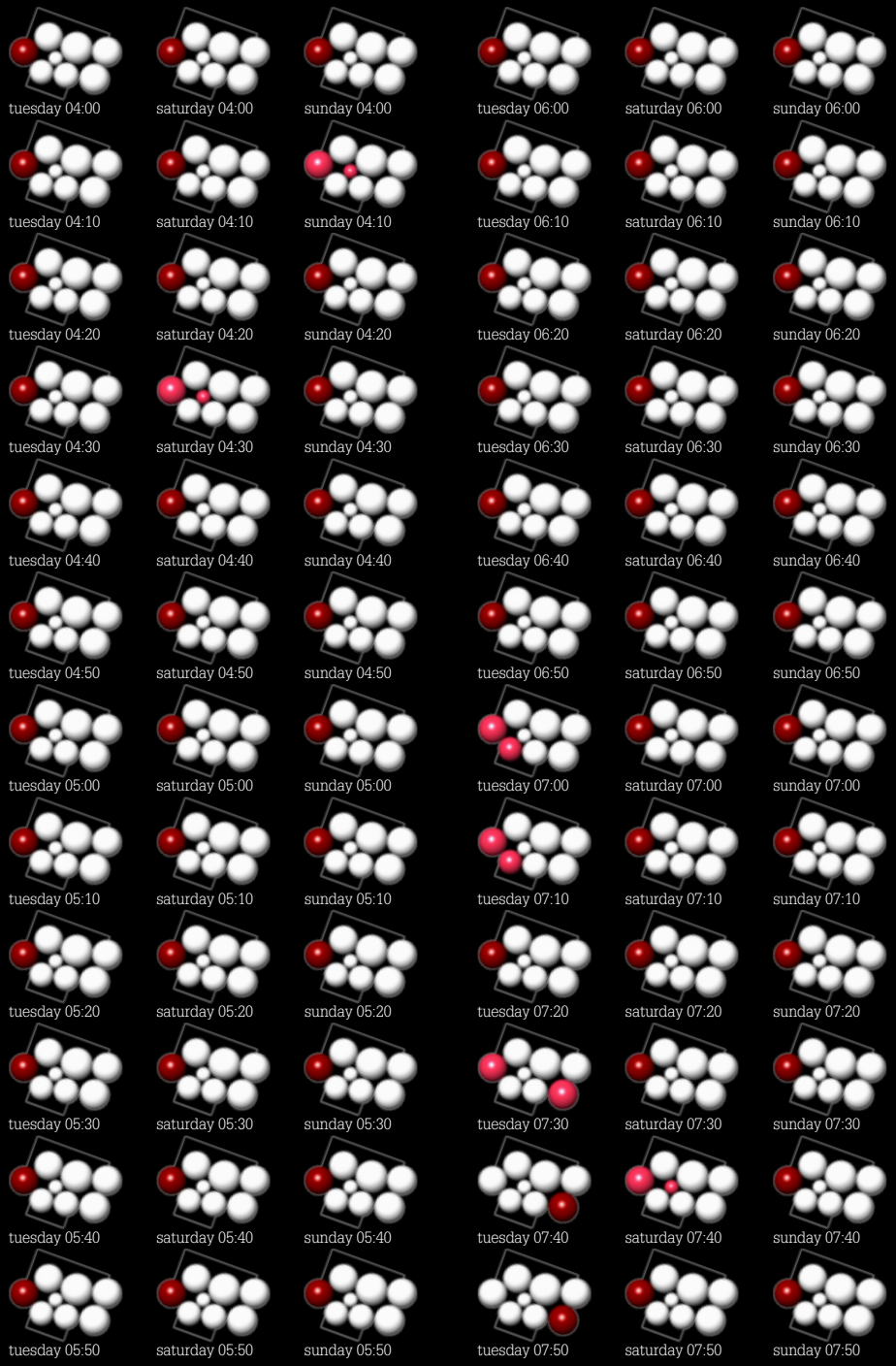
Particle intensities

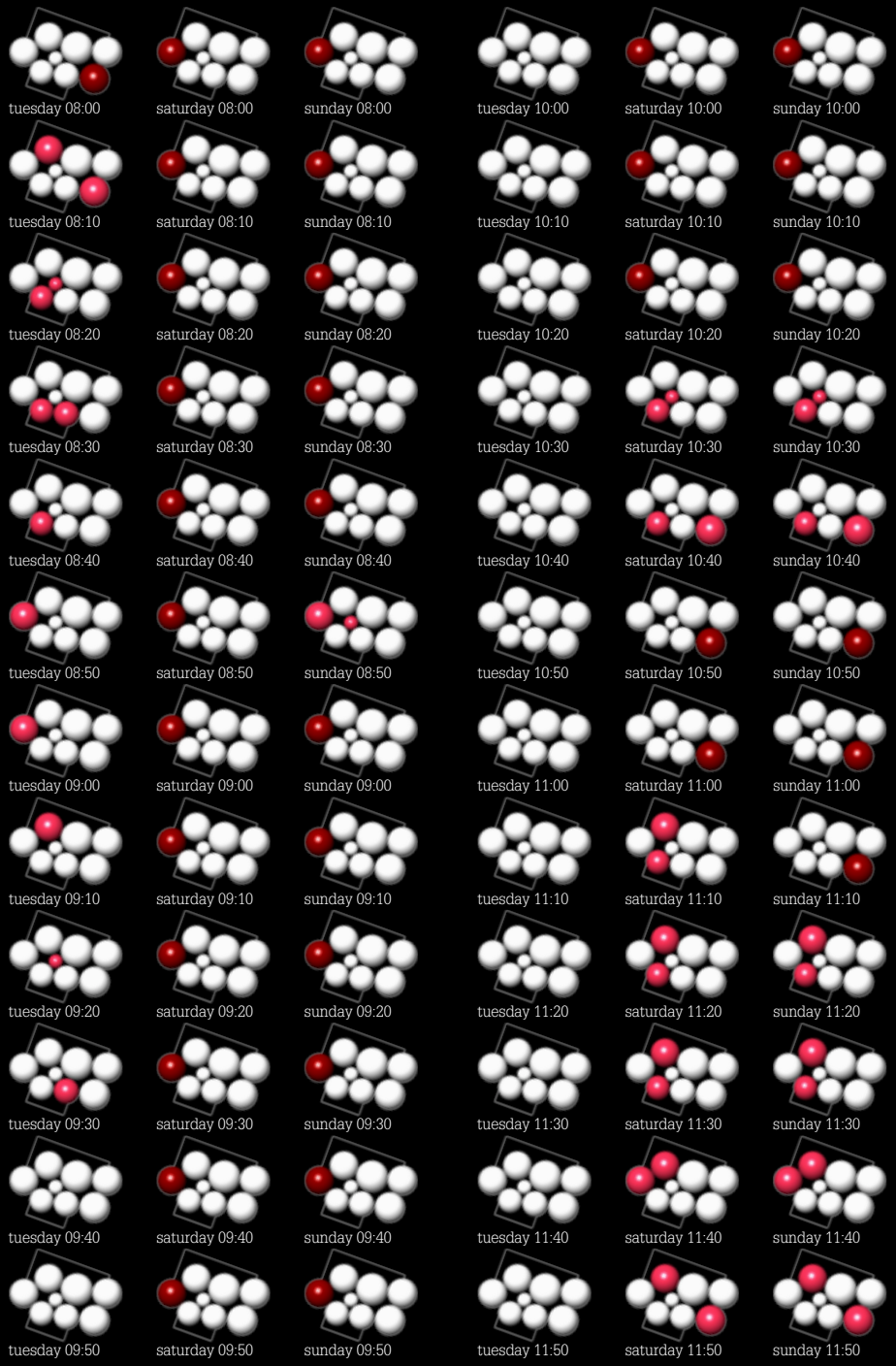


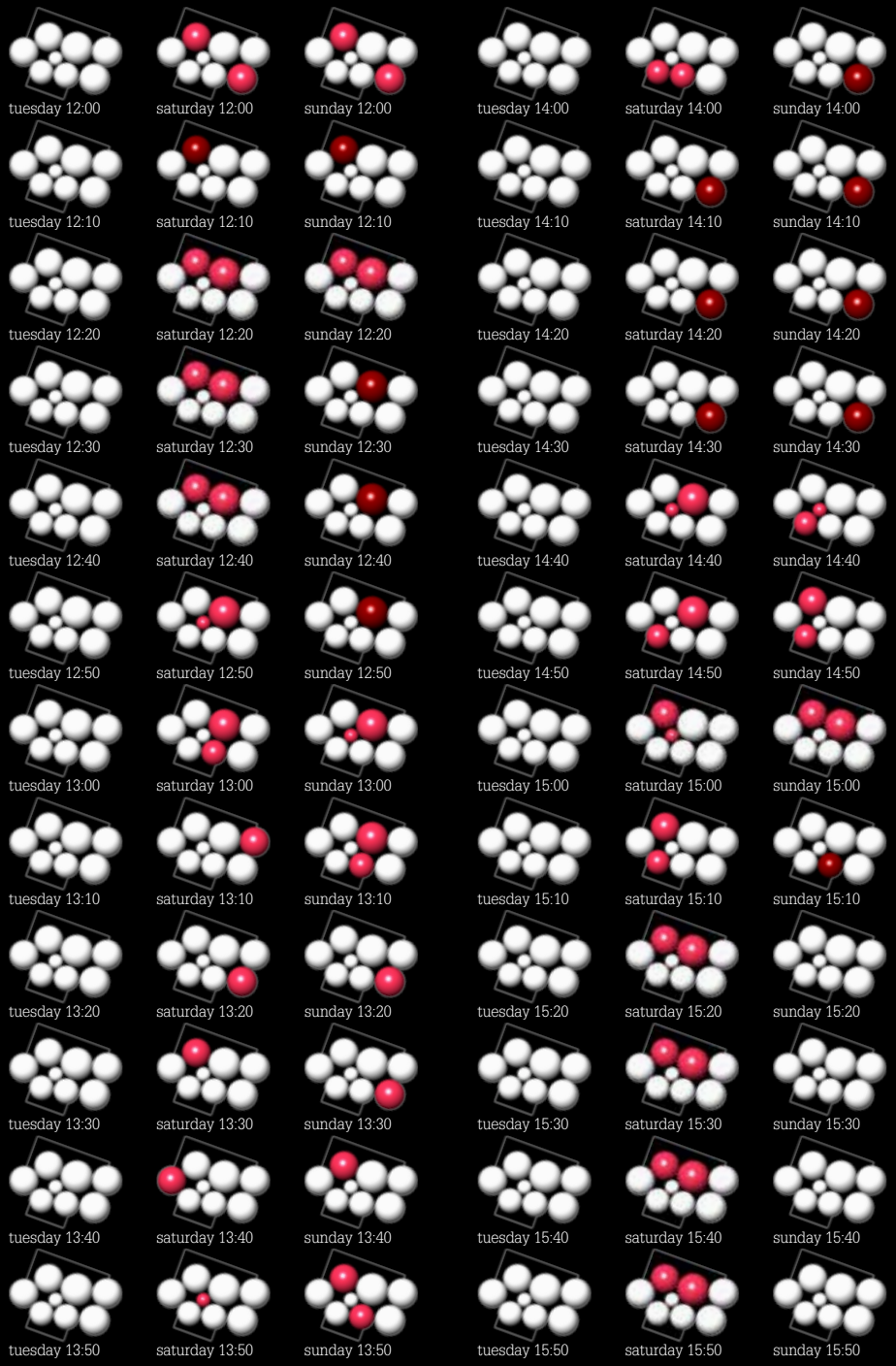
The particle occupancy in terms of percentage (% of maximum particle capacity). The more red, the more the particle reaches it's maximum capacity. The particle occupancy is time dependant.

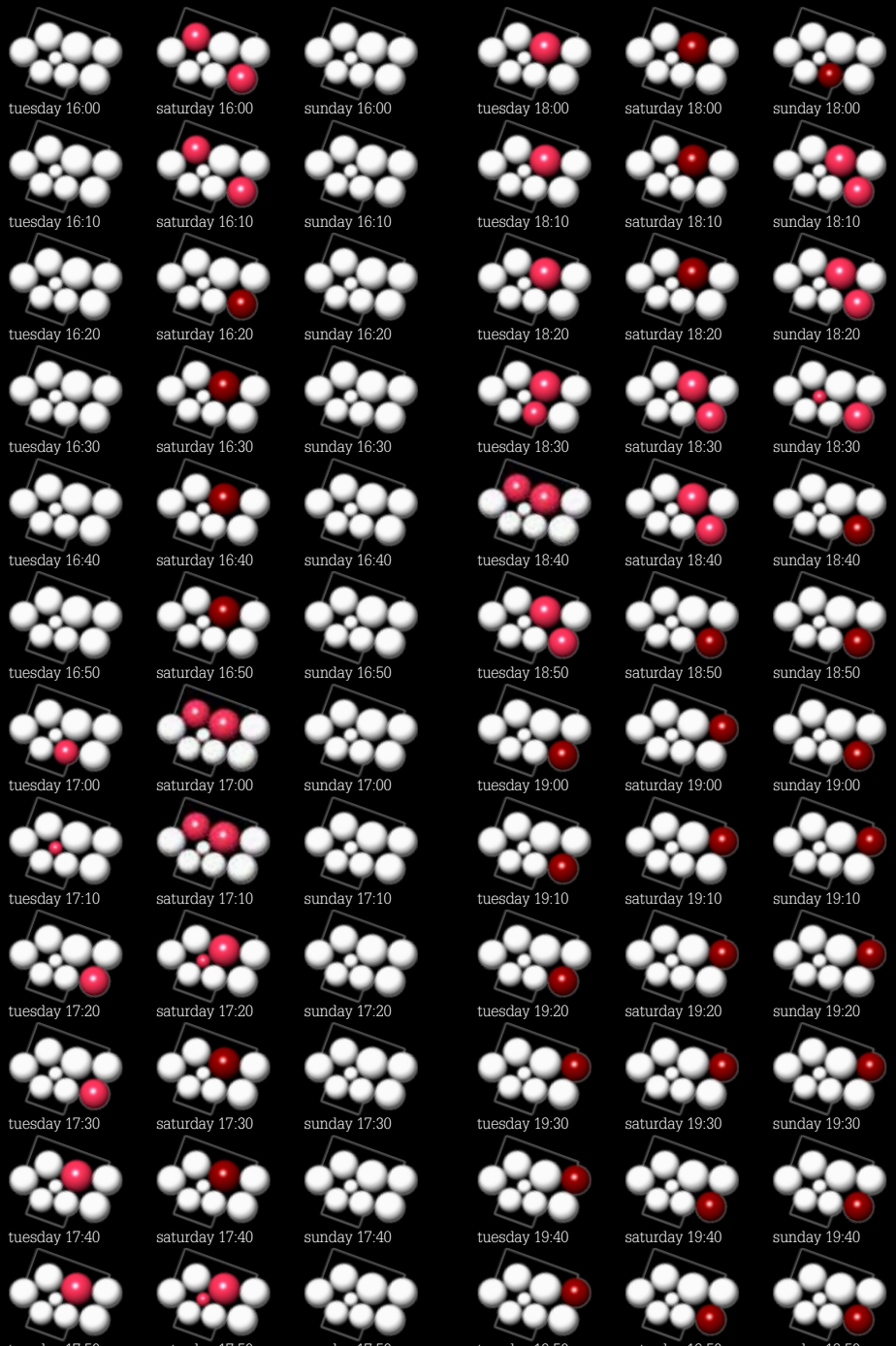
TUESDAY 18:40

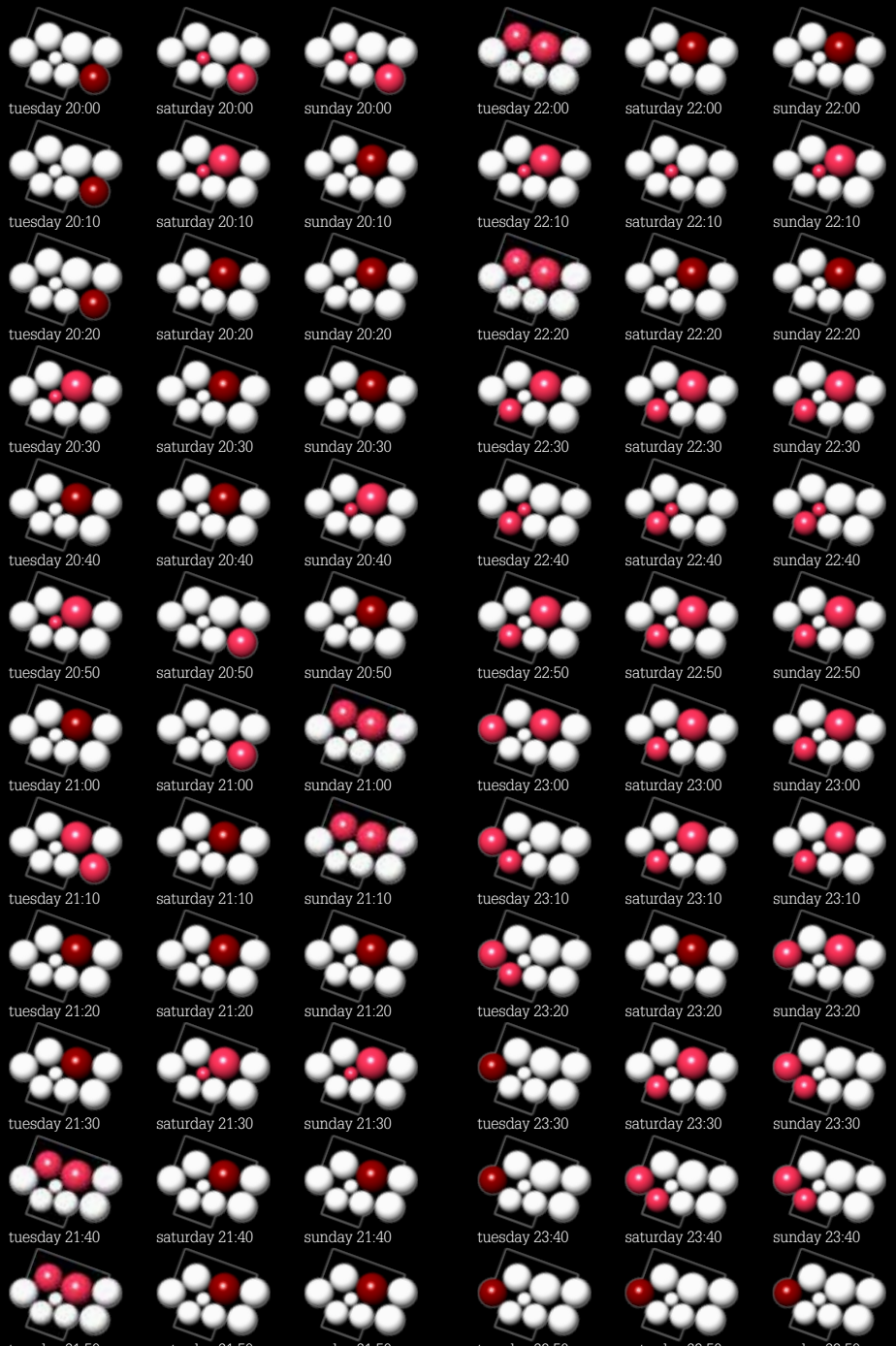

tuesday 00:00
saturday 00:00
sunday 00:00
tuesday 02:00
saturday 02:00
sunday 02:00
tuesday 00:10
saturday 00:10
sunday 00:10
tuesday 02:10
saturday 02:10
sunday 02:10
tuesday 00:20
saturday 00:20
sunday 00:20
tuesday 02:20
saturday 02:20
sunday 02:20
tuesday 00:30
saturday 00:30
sunday 00:30
tuesday 02:30
saturday 02:30
sunday 02:30
tuesday 00:40
saturday 00:40
sunday 00:40
tuesday 02:40
saturday 02:40
sunday 02:40
tuesday 00:50
saturday 00:50
sunday 00:50
tuesday 02:50
saturday 02:50
sunday 02:50
tuesday 01:00
saturday 01:00
sunday 01:00
tuesday 03:00
saturday 03:00
sunday 03:00
tuesday 01:10
saturday 01:10
sunday 01:10
tuesday 03:10
saturday 03:10
sunday 03:10
tuesday 01:20
saturday 01:20
sunday 01:20
tuesday 03:20
saturday 03:20
sunday 03:20
tuesday 01:30
saturday 01:30
sunday 01:30
tuesday 03:30
saturday 03:30
sunday 03:30
tuesday 01:40
saturday 01:40
sunday 01:40
tuesday 03:40
saturday 03:40
sunday 03:40
tuesday 01:50
saturday 01:50
sunday 01:50
tuesday 03:50
saturday 03:50
sunday 03:50


tuesday 04:00
saturday 04:00
sunday 04:00
tuesday 06:00
saturday 06:00
sunday 06:00
tuesday 04:10
saturday 04:10
sunday 04:10
tuesday 06:10
saturday 06:10
sunday 06:10
tuesday 04:20
saturday 04:20
sunday 04:20
tuesday 06:20
saturday 06:20
sunday 06:20
tuesday 04:30
saturday 04:30
sunday 04:30
tuesday 06:30
saturday 06:30
sunday 06:30
tuesday 04:40
saturday 04:40
sunday 04:40
tuesday 06:40
saturday 06:40
sunday 06:40
tuesday 04:50
saturday 04:50
sunday 04:50
tuesday 06:50
saturday 06:50
sunday 06:50
tuesday 05:00
saturday 05:00
sunday 05:00
tuesday 07:00
saturday 07:00
sunday 07:00
tuesday 05:10
saturday 05:10
sunday 05:10
tuesday 07:10
saturday 07:10
sunday 07:10
tuesday 05:20
saturday 05:20
sunday 05:20
tuesday 07:20
saturday 07:20
sunday 07:20
tuesday 05:30
saturday 05:30
sunday 05:30
tuesday 07:30
saturday 07:30
sunday 07:30
tuesday 05:40
saturday 05:40
sunday 05:40
tuesday 07:40
saturday 07:40
sunday 07:40
tuesday 05:50
saturday 05:50
sunday 05:50
tuesday 07:50
saturday 07:50
sunday 07:50

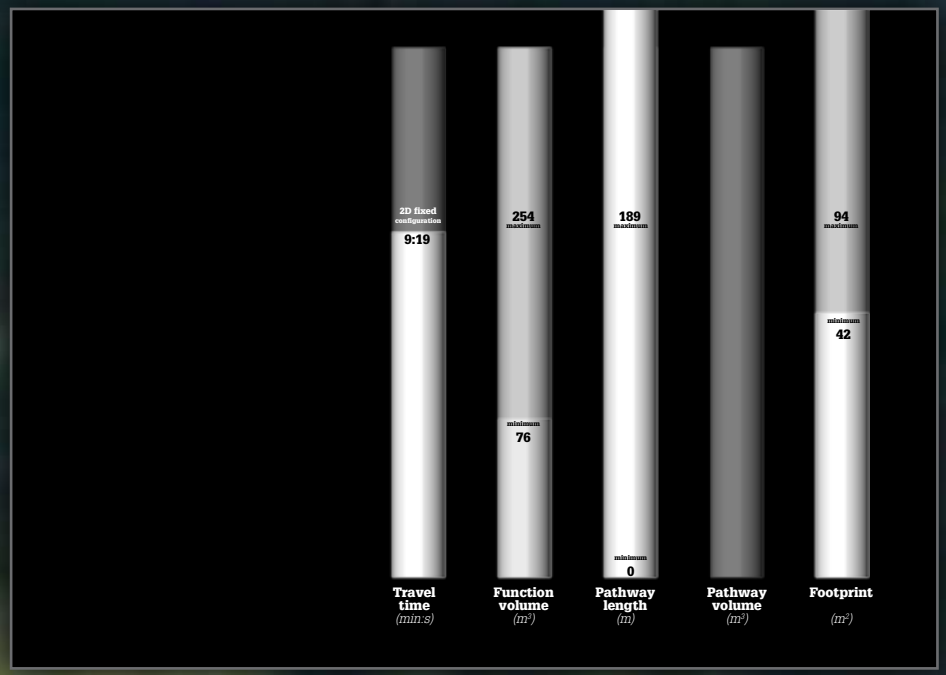

tuesday 08:00
saturday 08:00
sunday 08:00
tuesday 10:00
saturday 10:00
sunday 10:00
tuesday 08:10
saturday 08:10
sunday 08:10
tuesday 10:10
saturday 10:10
sunday 10:10
tuesday 08:20
saturday 08:20
sunday 08:20
tuesday 10:20
saturday 10:20
sunday 10:20
tuesday 08:30
saturday 08:30
sunday 08:30
tuesday 10:30
saturday 10:30
sunday 10:30
tuesday 08:40
saturday 08:40
sunday 08:40
tuesday 10:40
saturday 10:40
sunday 10:40
tuesday 08:50
saturday 08:50
sunday 08:50
tuesday 10:50
saturday 10:50
sunday 10:50
tuesday 09:00
saturday 09:00
sunday 09:00
tuesday 11:00
saturday 11:00
sunday 11:00
tuesday 09:10
saturday 09:10
sunday 09:10
tuesday 11:10
saturday 11:10
sunday 11:10
tuesday 09:20
saturday 09:20
sunday 09:20
tuesday 11:20
saturday 11:20
sunday 11:20
tuesday 09:30
saturday 09:30
sunday 09:30
tuesday 11:30
saturday 11:30
sunday 11:30
tuesday 09:40
saturday 09:40
sunday 09:40
tuesday 11:40
saturday 11:40
sunday 11:40
tuesday 09:50
saturday 09:50
sunday 09:50
tuesday 11:50
saturday 11:50
sunday 11:50


tuesday 12:00
saturday 12:00
sunday 12:00
tuesday 14:00
saturday 14:00
sunday 14:00
tuesday 12:10
saturday 12:10
sunday 12:10
tuesday 14:10
saturday 14:10
sunday 14:10
tuesday 12:20
saturday 12:20
sunday 12:20
tuesday 14:20
saturday 14:20
sunday 14:20
tuesday 12:30
saturday 12:30
sunday 12:30
tuesday 14:30
saturday 14:30
sunday 14:30
tuesday 12:40
saturday 12:40
sunday 12:40
tuesday 14:40
saturday 14:40
sunday 14:40
tuesday 12:50
saturday 12:50
sunday 12:50
tuesday 14:50
saturday 14:50
sunday 14:50
tuesday 13:00
saturday 13:00
sunday 13:00
tuesday 15:00
saturday 15:00
sunday 15:00
tuesday 13:10
saturday 13:10
sunday 13:10
tuesday 15:10
saturday 15:10
sunday 15:10
tuesday 13:20
saturday 13:20
sunday 13:20
tuesday 15:20
saturday 15:20
sunday 15:20
tuesday 13:30
saturday 13:30
sunday 13:30
tuesday 15:30
saturday 15:30
sunday 15:30
tuesday 13:40
saturday 13:40
sunday 13:40
tuesday 15:40
saturday 15:40
sunday 15:40
tuesday 13:50
saturday 13:50
sunday 13:50
tuesday 15:50
saturday 15:50
sunday 15:50


tuesday 16:00
saturday 16:00
sunday 16:00
tuesday 18:00
saturday 18:00
sunday 18:00
tuesday 16:10
saturday 16:10
sunday 16:10
tuesday 18:10
saturday 18:10
sunday 18:10
tuesday 16:20
saturday 16:20
sunday 16:20
tuesday 18:20
saturday 18:20
sunday 18:20
tuesday 16:30
saturday 16:30
sunday 16:30
tuesday 18:30
saturday 18:30
sunday 18:30
tuesday 16:40
saturday 16:40
sunday 16:40
tuesday 18:40
saturday 18:40
sunday 18:40
tuesday 16:50
saturday 16:50
sunday 16:50
tuesday 18:50
saturday 18:50
sunday 18:50
tuesday 17:00
saturday 17:00
sunday 17:00
tuesday 19:00
saturday 19:00
sunday 19:00
tuesday 17:10
saturday 17:10
sunday 17:10
tuesday 19:10
saturday 19:10
sunday 19:10
tuesday 17:20
saturday 17:20
sunday 17:20
tuesday 19:20
saturday 19:20
sunday 19:20
tuesday 17:30
saturday 17:30
sunday 17:30
tuesday 19:30
saturday 19:30
sunday 19:30
tuesday 17:40
saturday 17:40
sunday 17:40
tuesday 19:40
saturday 19:40
sunday 19:40
tuesday 17:50
saturday 17:50
sunday 17:50
tuesday 19:50
saturday 19:50
sunday 19:50


tuesday 20:00
saturday 20:00
sunday 20:00
tuesday 22:00
saturday 22:00
sunday 22:00
tuesday 20:10
saturday 20:10
sunday 20:10
tuesday 22:10
saturday 22:10
sunday 22:10
tuesday 20:20
saturday 20:20
sunday 20:20
tuesday 22:20
saturday 22:20
sunday 22:20
tuesday 20:30
saturday 20:30
sunday 20:30
tuesday 22:30
saturday 22:30
sunday 22:30
tuesday 20:40
saturday 20:40
sunday 20:40
tuesday 22:40
saturday 22:40
sunday 22:40
tuesday 20:50
saturday 20:50
sunday 20:50
tuesday 22:50
saturday 22:50
sunday 22:50
tuesday 21:00
saturday 21:00
sunday 21:00
tuesday 23:00
saturday 23:00
sunday 23:00
tuesday 21:10
saturday 21:10
sunday 21:10
tuesday 23:10
saturday 23:10
sunday 23:10
tuesday 21:20
saturday 21:20
sunday 21:20
tuesday 23:20
saturday 23:20
sunday 23:20
tuesday 21:30
saturday 21:30
sunday 21:30
tuesday 23:30
saturday 23:30
sunday 23:30
tuesday 21:40
saturday 21:40
sunday 21:40
tuesday 23:40
saturday 23:40
sunday 23:40
tuesday 21:50
saturday 21:50
sunday 21:50
tuesday 23:50
saturday 23:50
sunday 23:50

Fixed home configuration



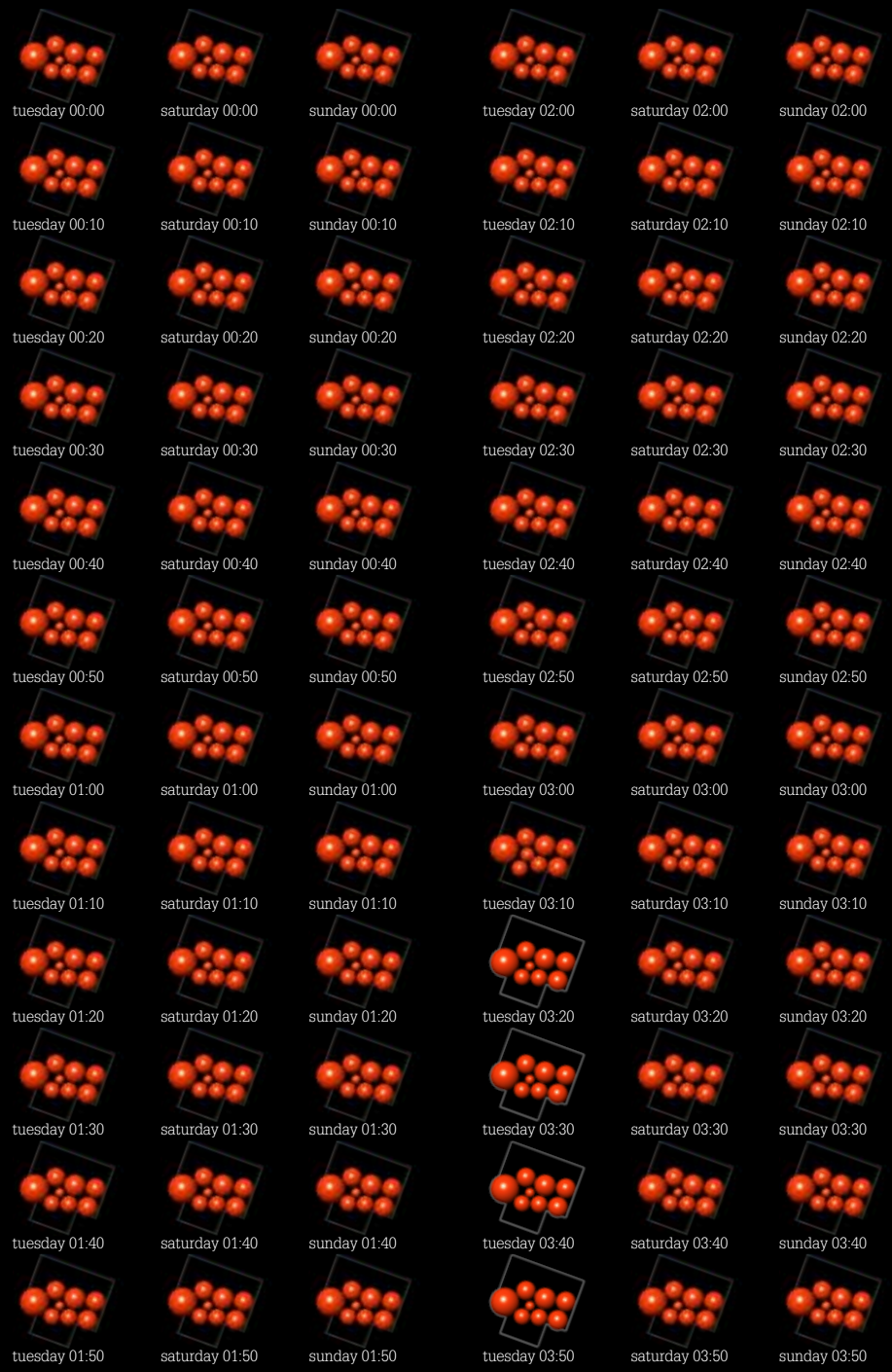
Particles reduce in size when the whole home is empty.

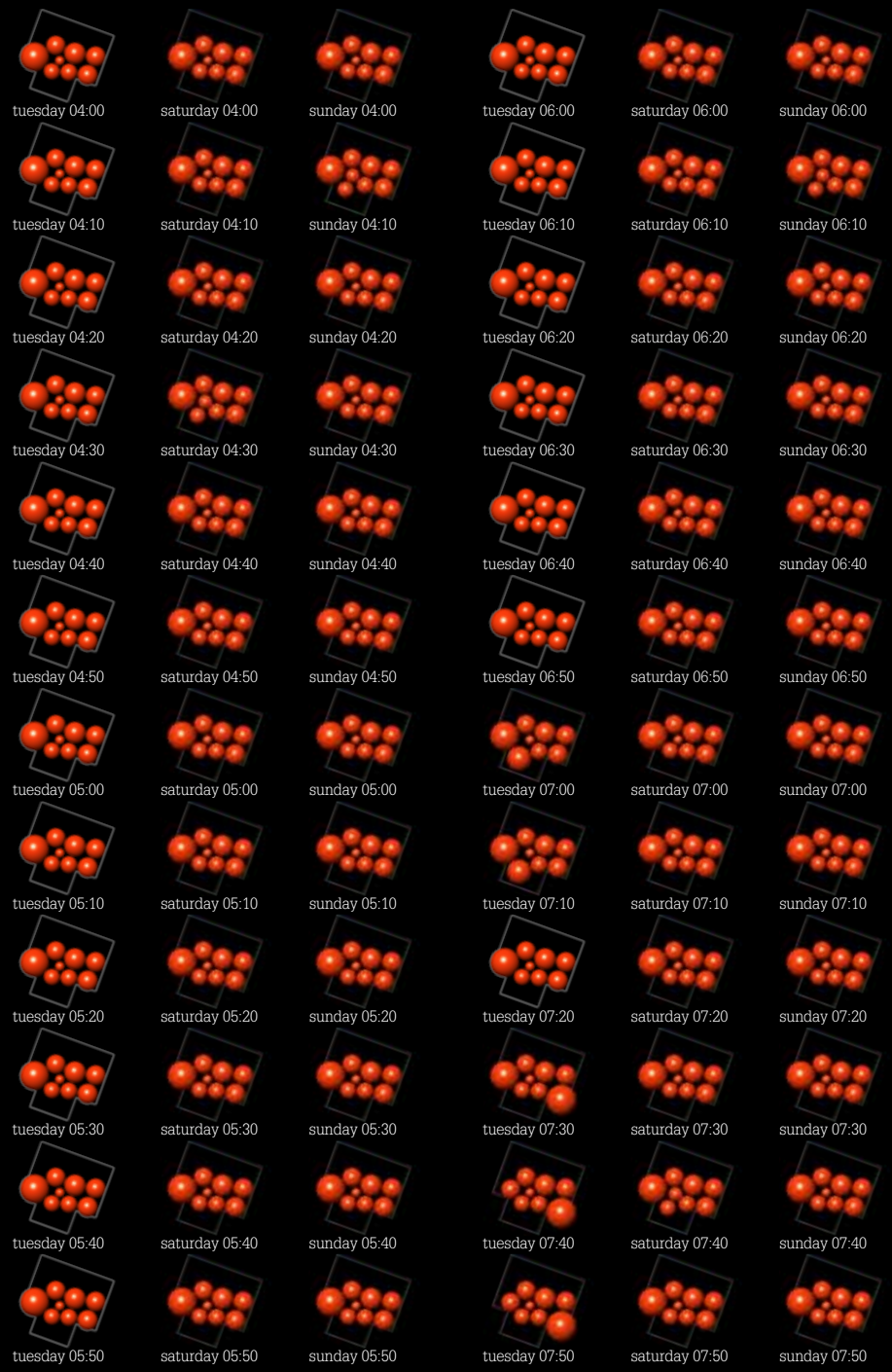
TUESDAY 20:30

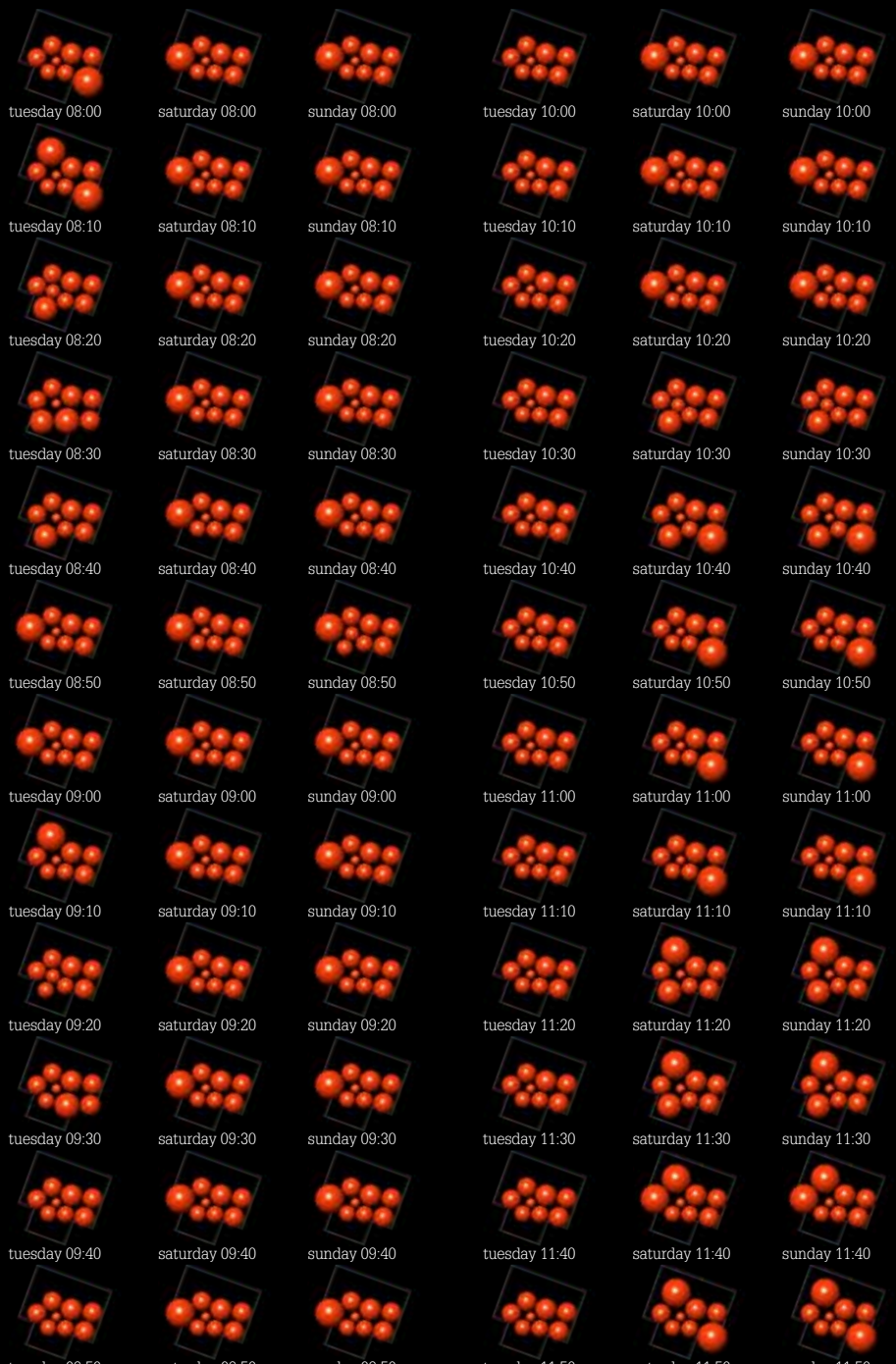
Fixed home configuration

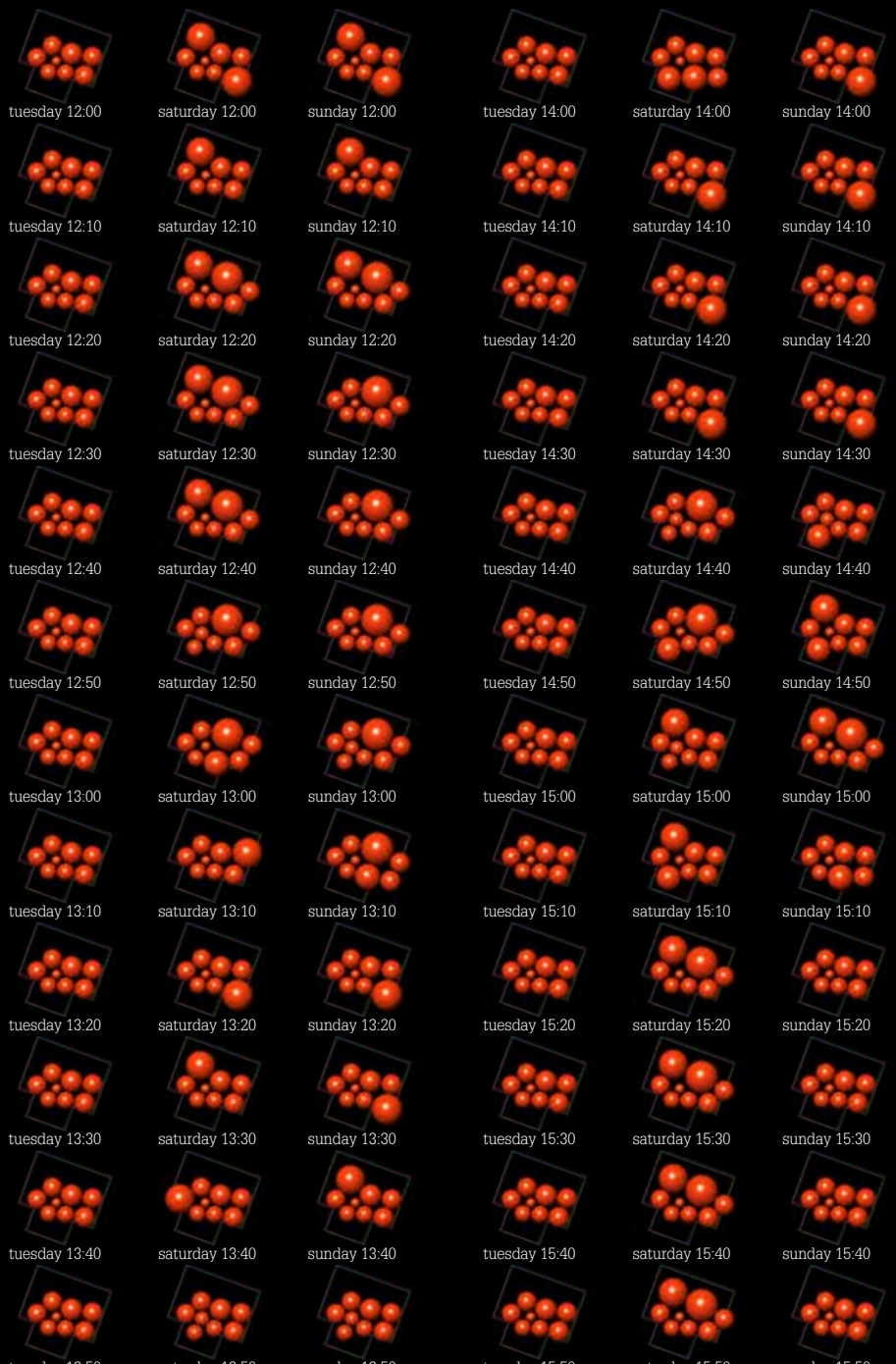
Each particle reduces in size when the particle is not used.

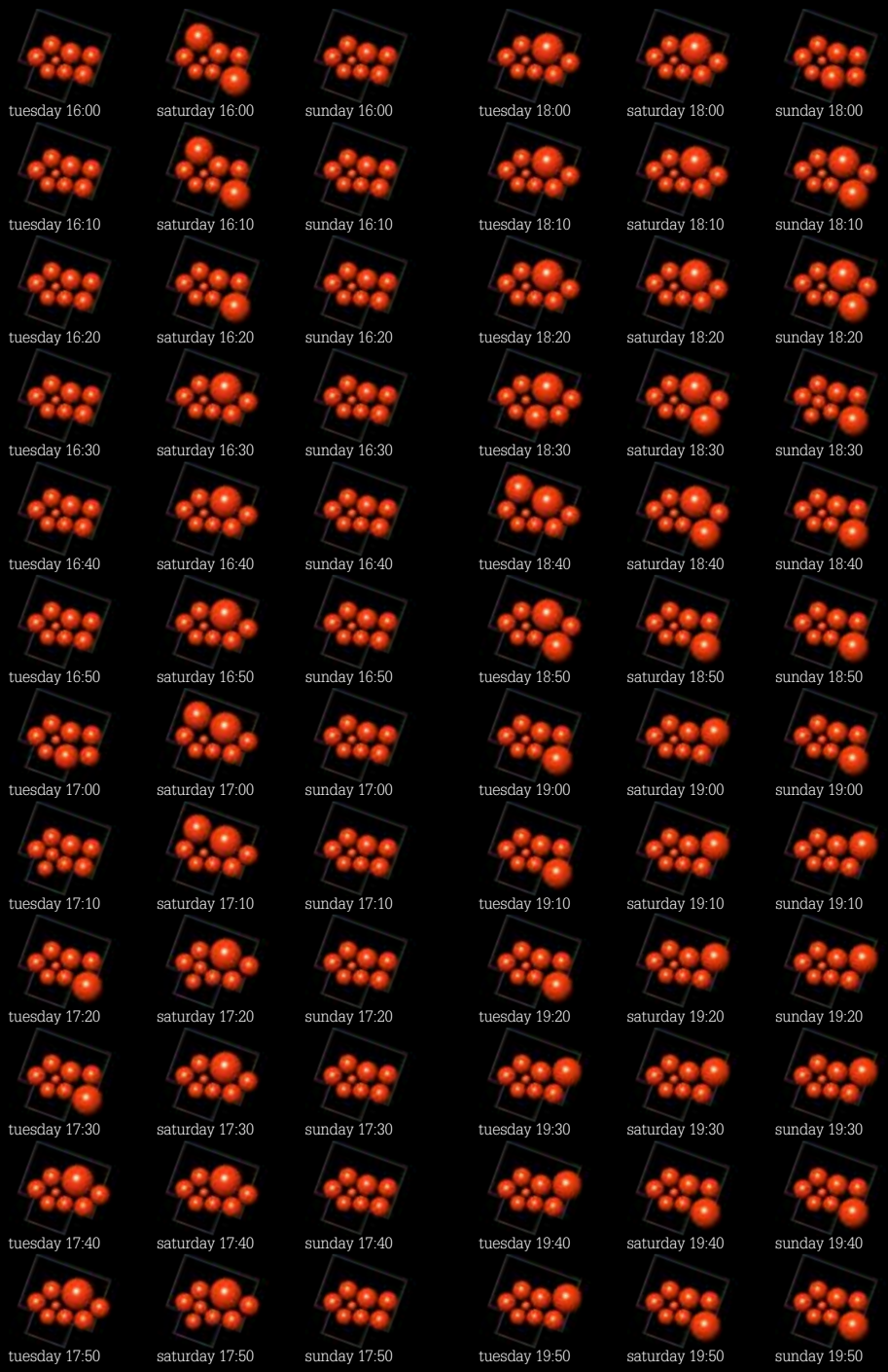
TUESDAY 20:30

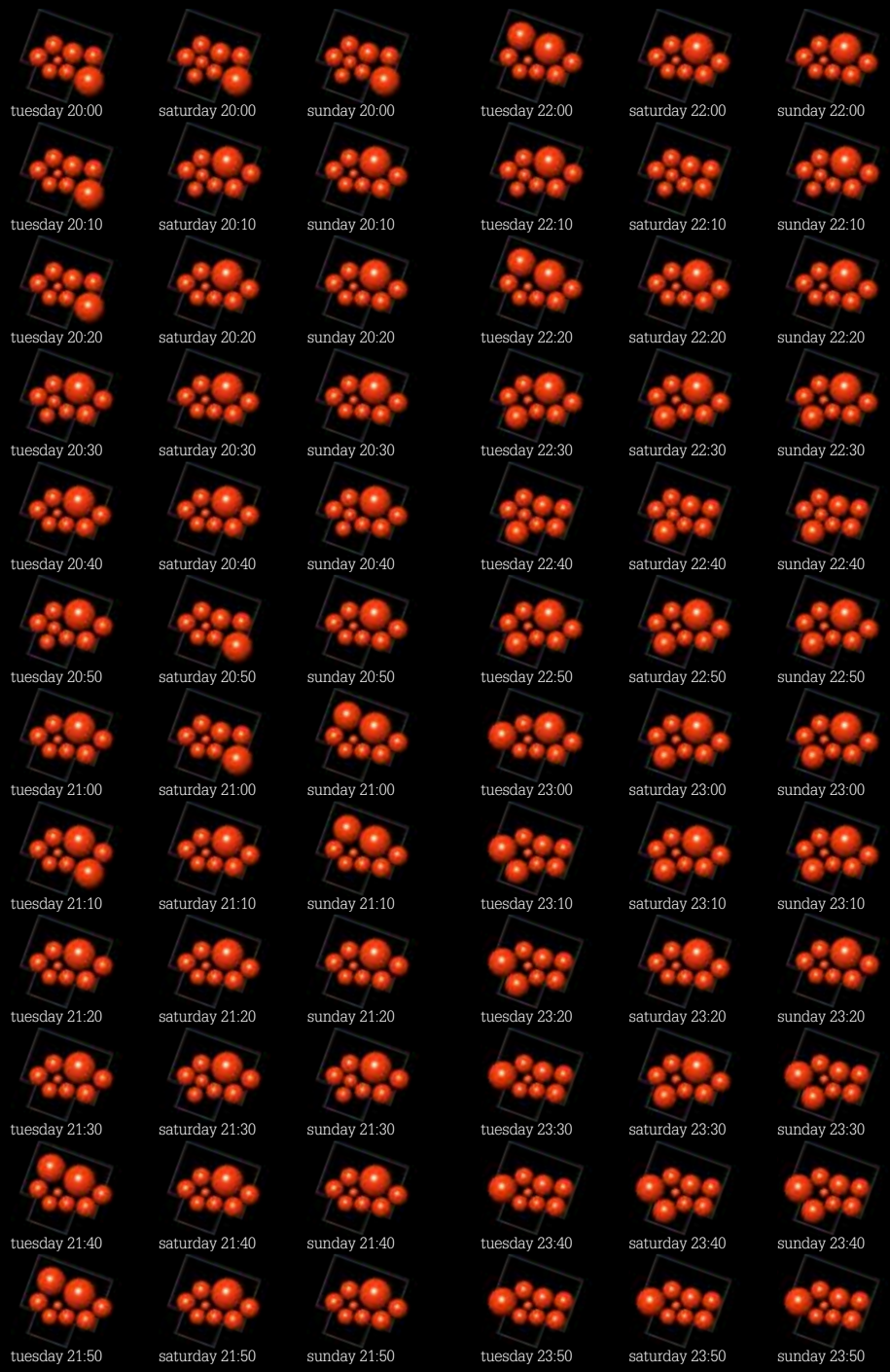

tuesday 00:00
saturday 00:00
sunday 00:00
tuesday 02:00
saturday 02:00
sunday 02:00
tuesday 00:10
saturday 00:10
sunday 00:10
tuesday 02:10
saturday 02:10
sunday 02:10
tuesday 00:20
saturday 00:20
sunday 00:20
tuesday 02:20
saturday 02:20
sunday 02:20
tuesday 00:30
saturday 00:30
sunday 00:30
tuesday 02:30
saturday 02:30
sunday 02:30
tuesday 00:40
saturday 00:40
sunday 00:40
tuesday 02:40
saturday 02:40
sunday 02:40
tuesday 00:50
saturday 00:50
sunday 00:50
tuesday 02:50
saturday 02:50
sunday 02:50
tuesday 01:00
saturday 01:00
sunday 01:00
tuesday 03:00
saturday 03:00
sunday 03:00
tuesday 01:10
saturday 01:10
sunday 01:10
tuesday 03:10
saturday 03:10
sunday 03:10
tuesday 01:20
saturday 01:20
sunday 01:20
tuesday 03:20
saturday 03:20
sunday 03:20
tuesday 01:30
saturday 01:30
sunday 01:30
tuesday 03:30
saturday 03:30
sunday 03:30
tuesday 01:40
saturday 01:40
sunday 01:40
tuesday 03:40
saturday 03:40
sunday 03:40
tuesday 01:50
saturday 01:50
sunday 01:50
tuesday 03:50
saturday 03:50
sunday 03:50


tuesday 04:00
saturday 04:00
sunday 04:00
tuesday 06:00
saturday 06:00
sunday 06:00
tuesday 04:10
saturday 04:10
sunday 04:10
tuesday 06:10
saturday 06:10
sunday 06:10
tuesday 04:20
saturday 04:20
sunday 04:20
tuesday 06:20
saturday 06:20
sunday 06:20
tuesday 04:30
saturday 04:30
sunday 04:30
tuesday 06:30
saturday 06:30
sunday 06:30
tuesday 04:40
saturday 04:40
sunday 04:40
tuesday 06:40
saturday 06:40
sunday 06:40
tuesday 04:50
saturday 04:50
sunday 04:50
tuesday 06:50
saturday 06:50
sunday 06:50
tuesday 05:00
saturday 05:00
sunday 05:00
tuesday 07:00
saturday 07:00
sunday 07:00
tuesday 05:10
saturday 05:10
sunday 05:10
tuesday 07:10
saturday 07:10
sunday 07:10
tuesday 05:20
saturday 05:20
sunday 05:20
tuesday 07:20
saturday 07:20
sunday 07:20
tuesday 05:30
saturday 05:30
sunday 05:30
tuesday 07:30
saturday 07:30
sunday 07:30
tuesday 05:40
saturday 05:40
sunday 05:40
tuesday 07:40
saturday 07:40
sunday 07:40
tuesday 05:50
saturday 05:50
sunday 05:50
tuesday 07:50
saturday 07:50
sunday 07:50


tuesday 08:00
saturday 08:00
sunday 08:00
tuesday 10:00
saturday 10:00
sunday 10:00
tuesday 08:10
saturday 08:10
sunday 08:10
tuesday 10:10
saturday 10:10
sunday 10:10
tuesday 08:20
saturday 08:20
sunday 08:20
tuesday 10:20
saturday 10:20
sunday 10:20
tuesday 08:30
saturday 08:30
sunday 08:30
tuesday 10:30
saturday 10:30
sunday 10:30
tuesday 08:40
saturday 08:40
sunday 08:40
tuesday 10:40
saturday 10:40
sunday 10:40
tuesday 08:50
saturday 08:50
sunday 08:50
tuesday 10:50
saturday 10:50
sunday 10:50
tuesday 09:00
saturday 09:00
sunday 09:00
tuesday 11:00
saturday 11:00
sunday 11:00
tuesday 09:10
saturday 09:10
sunday 09:10
tuesday 11:10
saturday 11:10
sunday 11:10
tuesday 09:20
saturday 09:20
sunday 09:20
tuesday 11:20
saturday 11:20
sunday 11:20
tuesday 09:30
saturday 09:30
sunday 09:30
tuesday 11:30
saturday 11:30
sunday 11:30
tuesday 09:40
saturday 09:40
sunday 09:40
tuesday 11:40
saturday 11:40
sunday 11:40
tuesday 09:50
saturday 09:50
sunday 09:50
tuesday 11:50
saturday 11:50
sunday 11:50

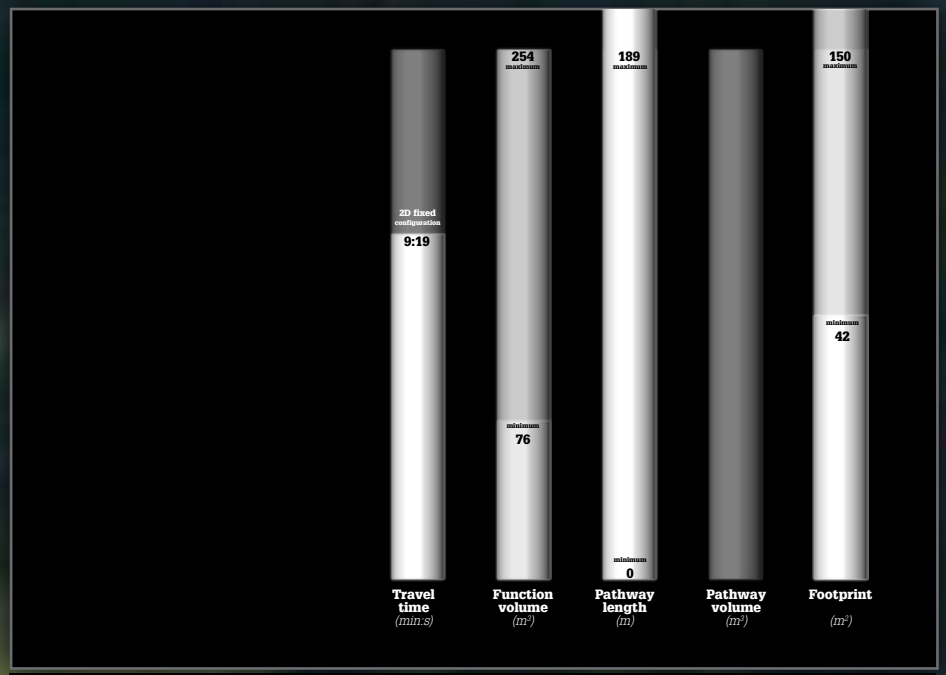

tuesday 12:00
saturday 12:00
sunday 12:00
tuesday 14:00
saturday 14:00
sunday 14:00
tuesday 12:10
saturday 12:10
sunday 12:10
tuesday 14:10
saturday 14:10
sunday 14:10
tuesday 12:20
saturday 12:20
sunday 12:20
tuesday 14:20
saturday 14:20
sunday 14:20
tuesday 12:30
saturday 12:30
sunday 12:30
tuesday 14:30
saturday 14:30
sunday 14:30
tuesday 12:40
saturday 12:40
sunday 12:40
tuesday 14:40
saturday 14:40
sunday 14:40
tuesday 12:50
saturday 12:50
sunday 12:50
tuesday 14:50
saturday 14:50
sunday 14:50
tuesday 13:00
saturday 13:00
sunday 13:00
tuesday 15:00
saturday 15:00
sunday 15:00
tuesday 13:10
saturday 13:10
sunday 13:10
tuesday 15:10
saturday 15:10
sunday 15:10
tuesday 13:20
saturday 13:20
sunday 13:20
tuesday 15:20
saturday 15:20
sunday 15:20
tuesday 13:30
saturday 13:30
sunday 13:30
tuesday 15:30
saturday 15:30
sunday 15:30
tuesday 13:40
saturday 13:40
sunday 13:40
tuesday 15:40
saturday 15:40
sunday 15:40
tuesday 13:50
saturday 13:50
sunday 13:50
tuesday 15:50
saturday 15:50
sunday 15:50


tuesday 16:00
saturday 16:00
sunday 16:00
tuesday 18:00
saturday 18:00
sunday 18:00
tuesday 16:10
saturday 16:10
sunday 16:10
tuesday 18:10
saturday 18:10
sunday 18:10
tuesday 16:20
saturday 16:20
sunday 16:20
tuesday 18:20
saturday 18:20
sunday 18:20
tuesday 16:30
saturday 16:30
sunday 16:30
tuesday 18:30
saturday 18:30
sunday 18:30
tuesday 16:40
saturday 16:40
sunday 16:40
tuesday 18:40
saturday 18:40
sunday 18:40
tuesday 16:50
saturday 16:50
sunday 16:50
tuesday 18:50
saturday 18:50
sunday 18:50
tuesday 17:00
saturday 17:00
sunday 17:00
tuesday 19:00
saturday 19:00
sunday 19:00
tuesday 17:10
saturday 17:10
sunday 17:10
tuesday 19:10
saturday 19:10
sunday 19:10
tuesday 17:20
saturday 17:20
sunday 17:20
tuesday 19:20
saturday 19:20
sunday 19:20
tuesday 17:30
saturday 17:30
sunday 17:30
tuesday 19:30
saturday 19:30
sunday 19:30
tuesday 17:40
saturday 17:40
sunday 17:40
tuesday 19:40
saturday 19:40
sunday 19:40
tuesday 17:50
saturday 17:50
sunday 17:50
tuesday 19:50
saturday 19:50
sunday 19:50

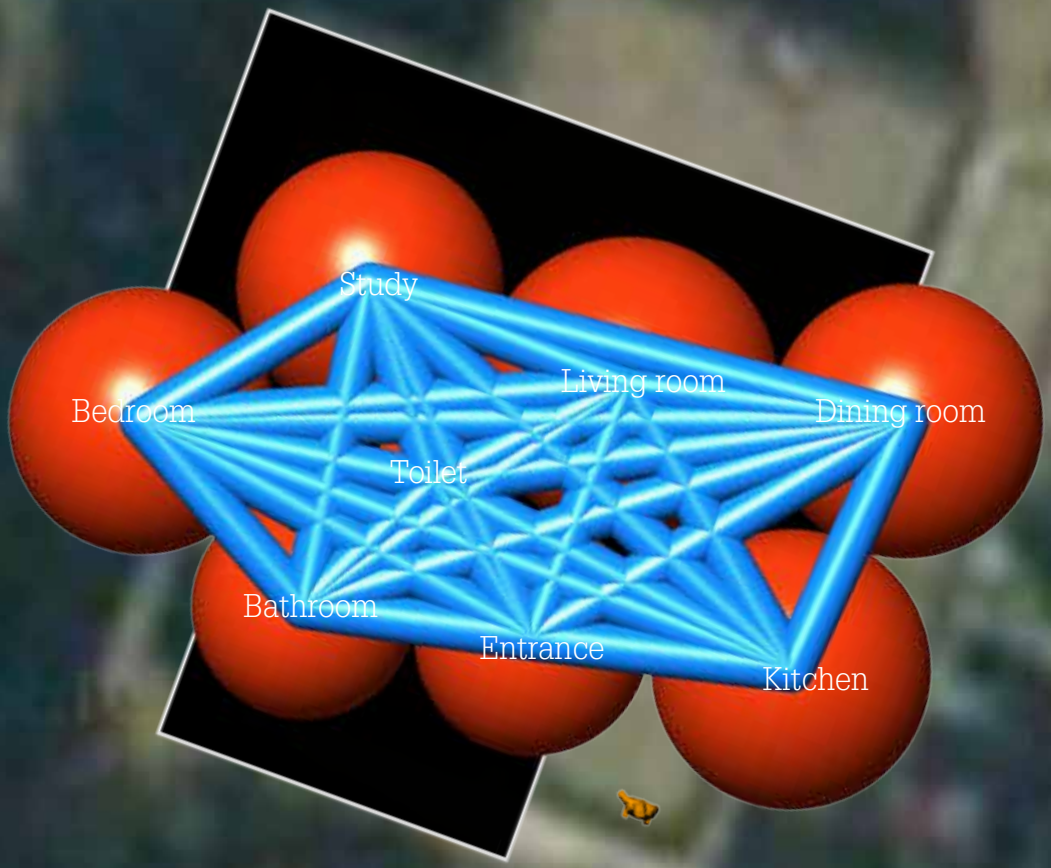

tuesday 20:00
saturday 20:00
sunday 20:00
tuesday 22:00
saturday 22:00
sunday 22:00
tuesday 20:10
saturday 20:10
sunday 20:10
tuesday 22:10
saturday 22:10
sunday 22:10
tuesday 20:20
saturday 20:20
sunday 20:20
tuesday 22:20
saturday 22:20
sunday 22:20
tuesday 20:30
saturday 20:30
sunday 20:30
tuesday 22:30
saturday 22:30
sunday 22:30
tuesday 20:40
saturday 20:40
sunday 20:40
tuesday 22:40
saturday 22:40
sunday 22:40
tuesday 20:50
saturday 20:50
sunday 20:50
tuesday 22:50
saturday 22:50
sunday 22:50
tuesday 21:00
saturday 21:00
sunday 21:00
tuesday 23:00
saturday 23:00
sunday 23:00
tuesday 21:10
saturday 21:10
sunday 21:10
tuesday 23:10
saturday 23:10
sunday 23:10
tuesday 21:20
saturday 21:20
sunday 21:20
tuesday 23:20
saturday 23:20
sunday 23:20
tuesday 21:30
saturday 21:30
sunday 21:30
tuesday 23:30
saturday 23:30
sunday 23:30
tuesday 21:40
saturday 21:40
sunday 21:40
tuesday 23:40
saturday 23:40
sunday 23:40
tuesday 21:50
saturday 21:50
sunday 21:50
tuesday 23:50
saturday 23:50
sunday 23:50

TOOL 4 PATHWAY VOLUME

Fixed home configuration

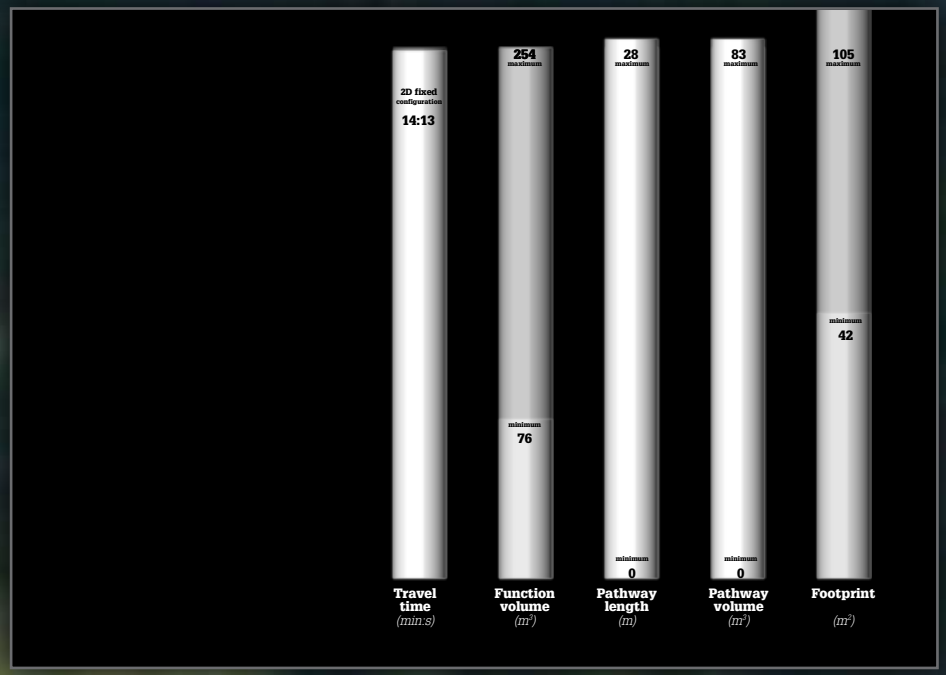


Pathway volume disappears when the whole home is empty.

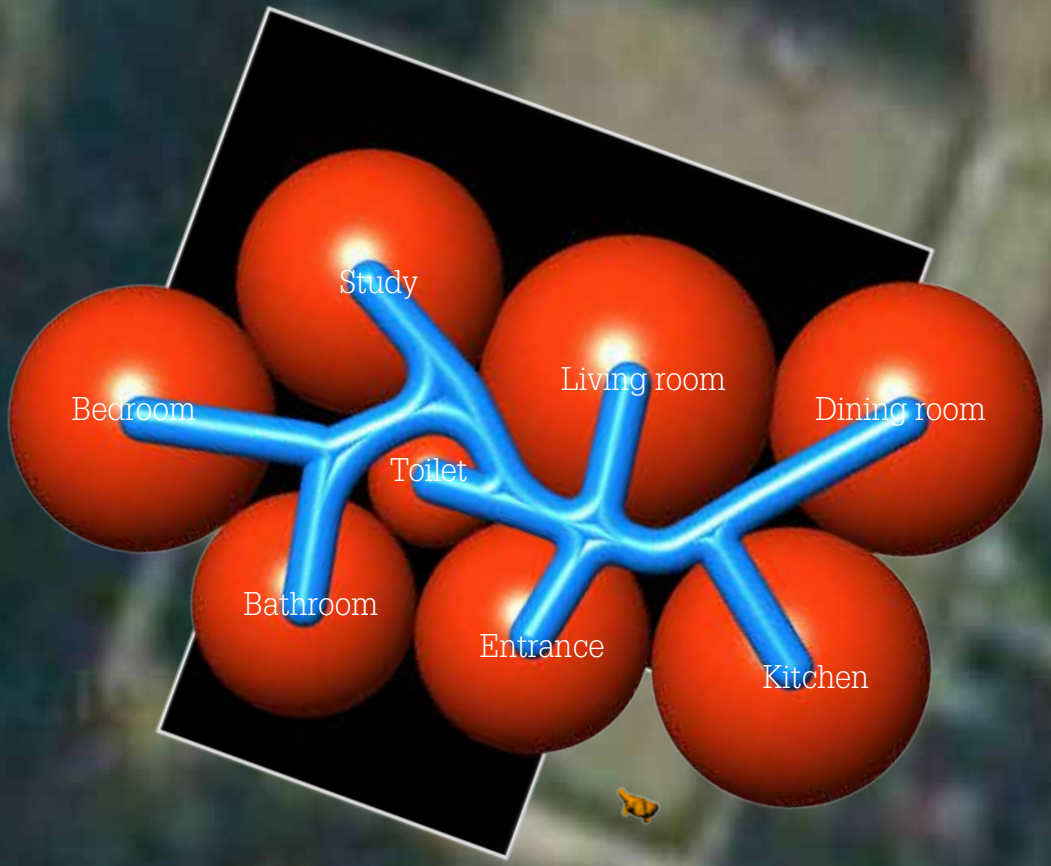


TOOL 5 PATHWAY MERGING

Fixed home configuration



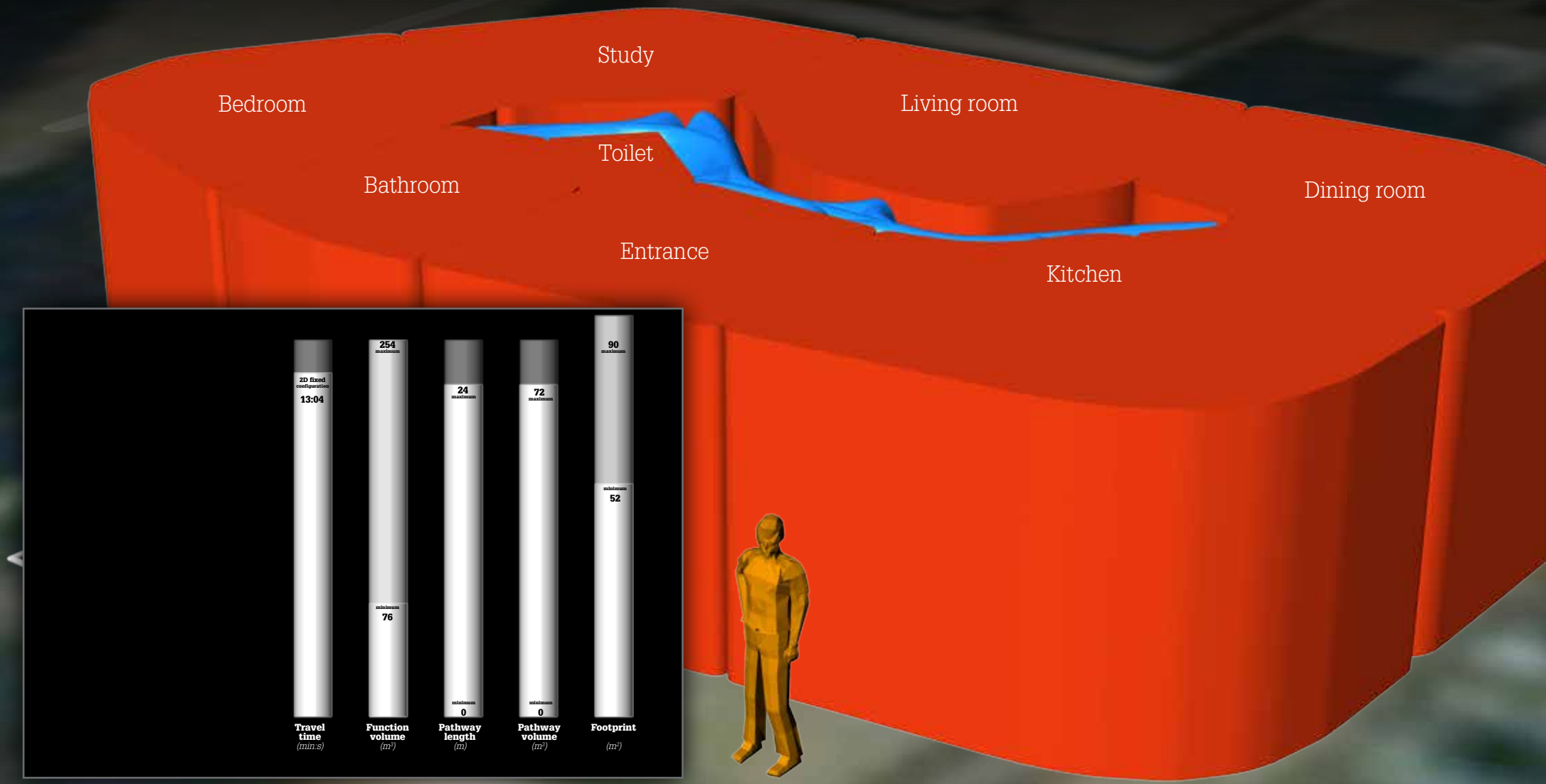
Pathway volume disappears when the whole home is empty.



AWAY FROM ABSTRACTION

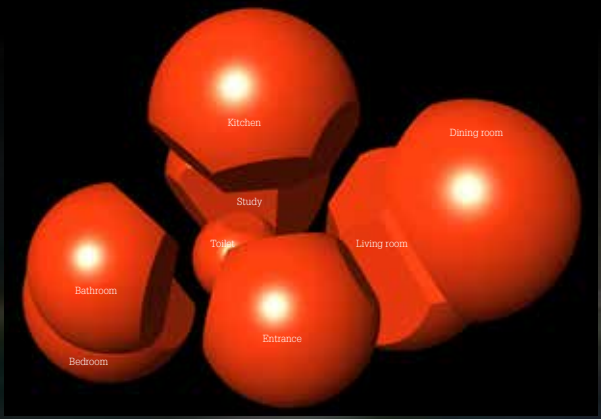
Fixed home configuration

The configuration is fixed. And since the apartment consists of only few rooms, the volumes can be packed together, closing the gaps between them by turning into voronoi shapes. By closing the gaps, the apartment becomes smaller and therefore more suitable for a faster city.

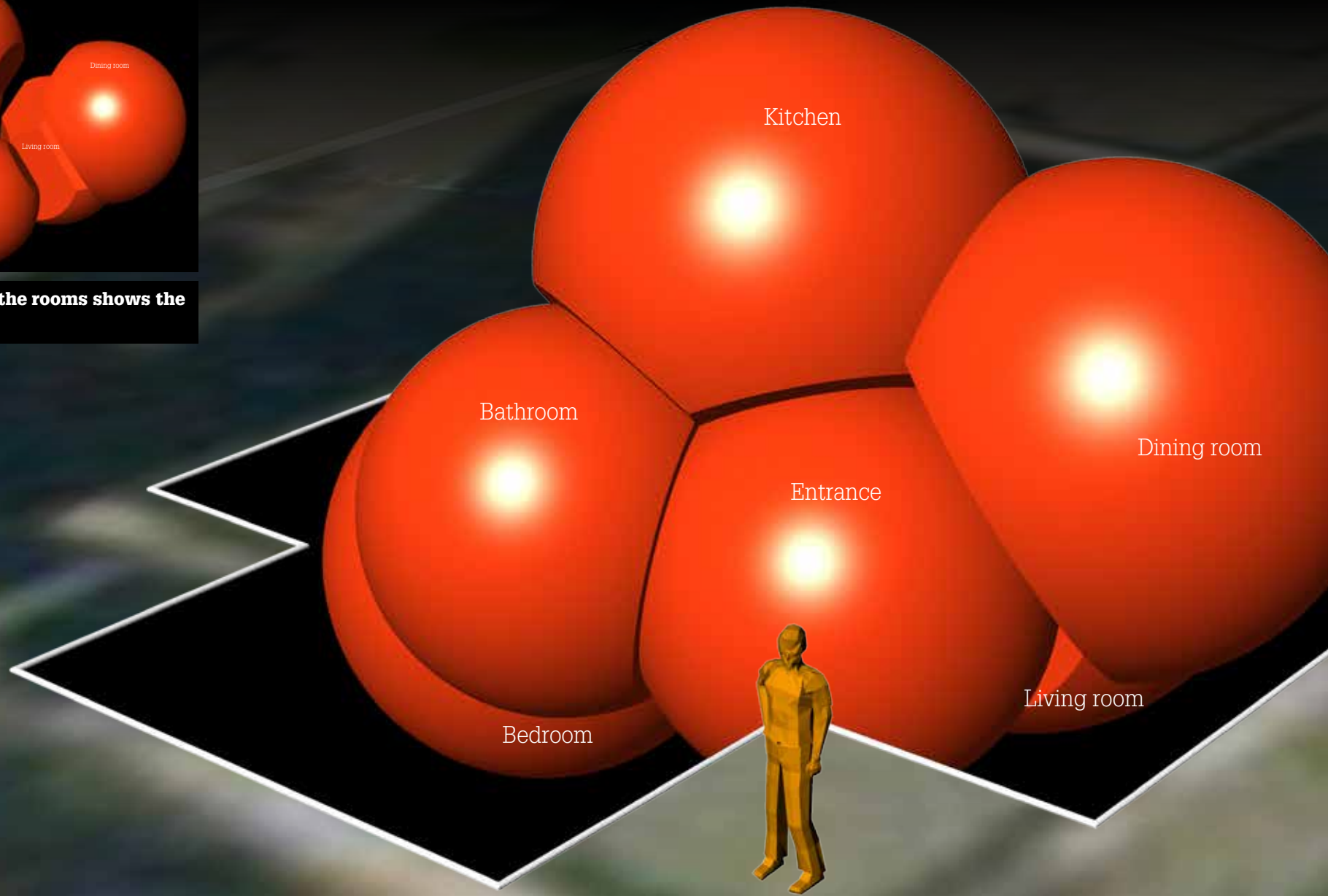


Fixed 3D home configuration

The configuration is fixed. And since the apartment consists of only few rooms, the volumes can be packed together, closing the gaps between them by turning into voronoi shapes. By closing the gaps, the apartment becomes smaller and therefore more suitable for a faster city.



The exploded view of all the rooms shows the voronoi shaped rooms.



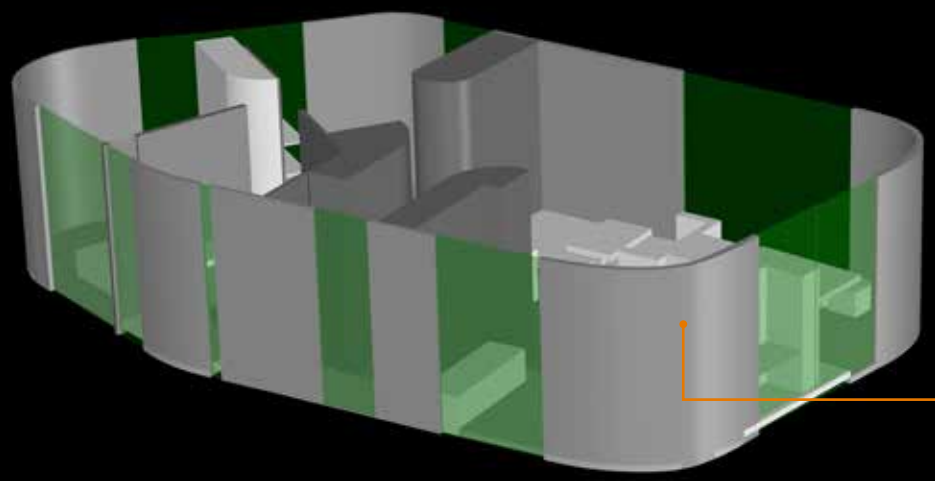
PART 5

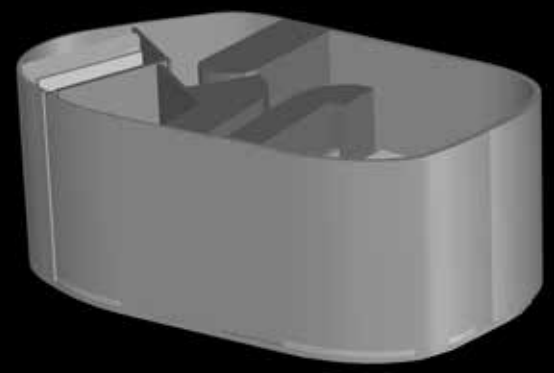
FEASIBILITY AND APPEARANCE OF THE CITY

CONTINUOUSLY 2D CONFIGURING AND RESIZING CITY

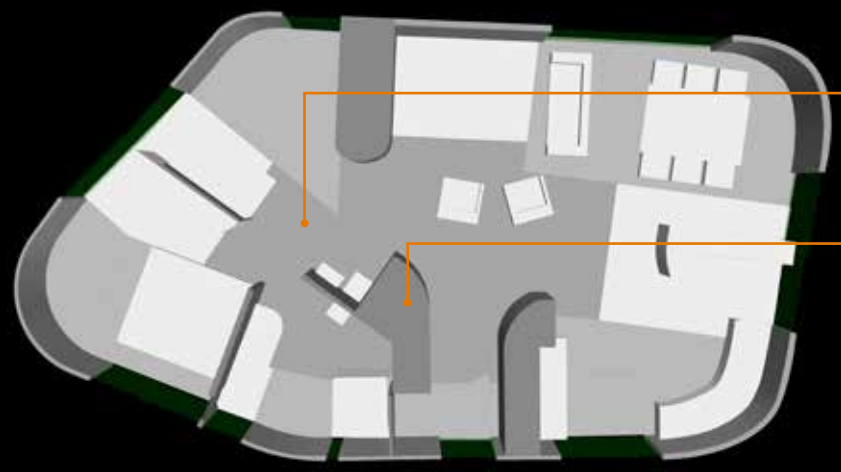
A resizing and moving home

As visible in the image, the design needs some minor alterations for floors and windows to fit within the outer walls when the home is reduced in size.
The design of the home can be further developed by integrating the vehicle(s) into the home design. At the moment the design does not allow any storage space for vehicles when the residents are at home. Integrating the vehicle storage space into the design could enable smooth transitions between vehicle and home and efficient use of space for parking.



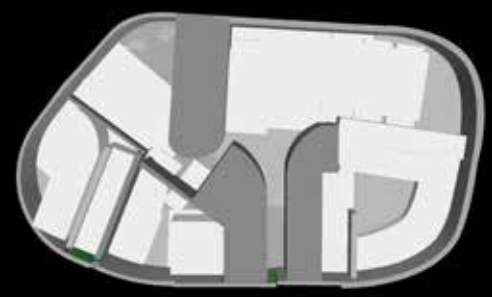


Round building corners, derived from cilindrical shapes during the creation process, but at the same time suitable for vehicles to pass the building.



Sliding doors for privacy (They open when the home is reduced in size)

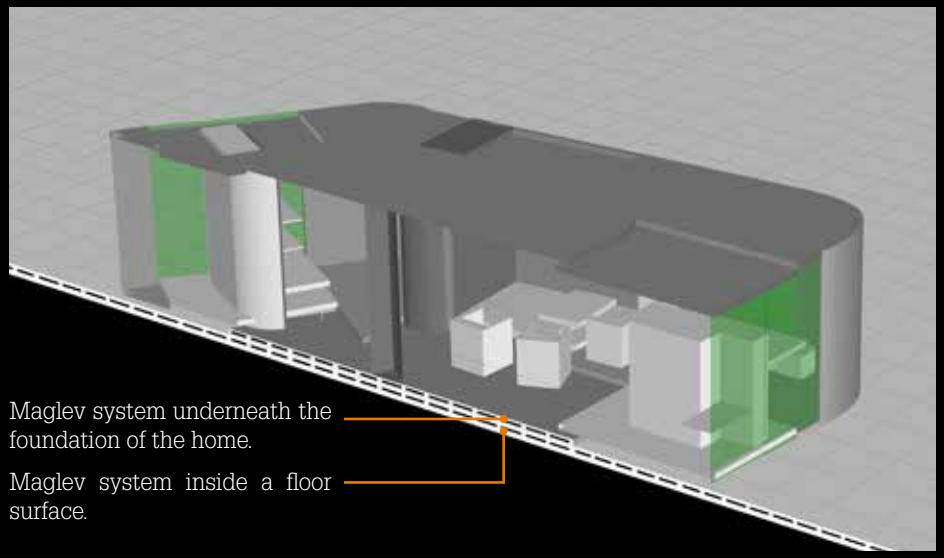
Room deviding storage space with round corners derived from the merged pathways connecting the rooms.

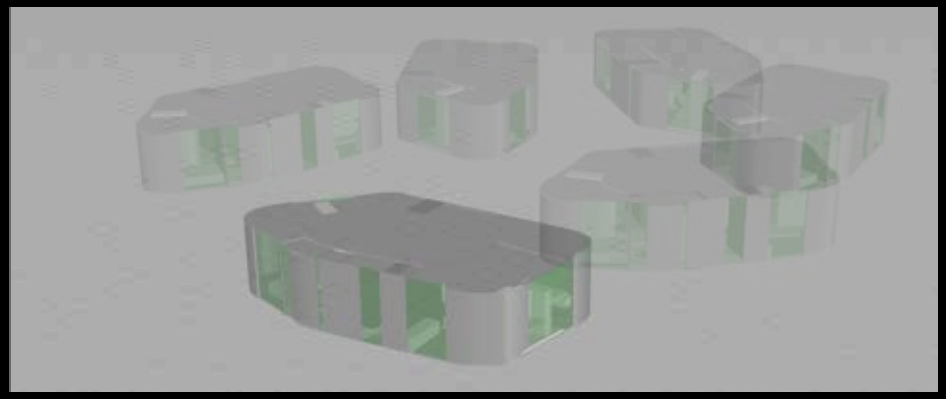


The home at it's largest size, when the home is in use.

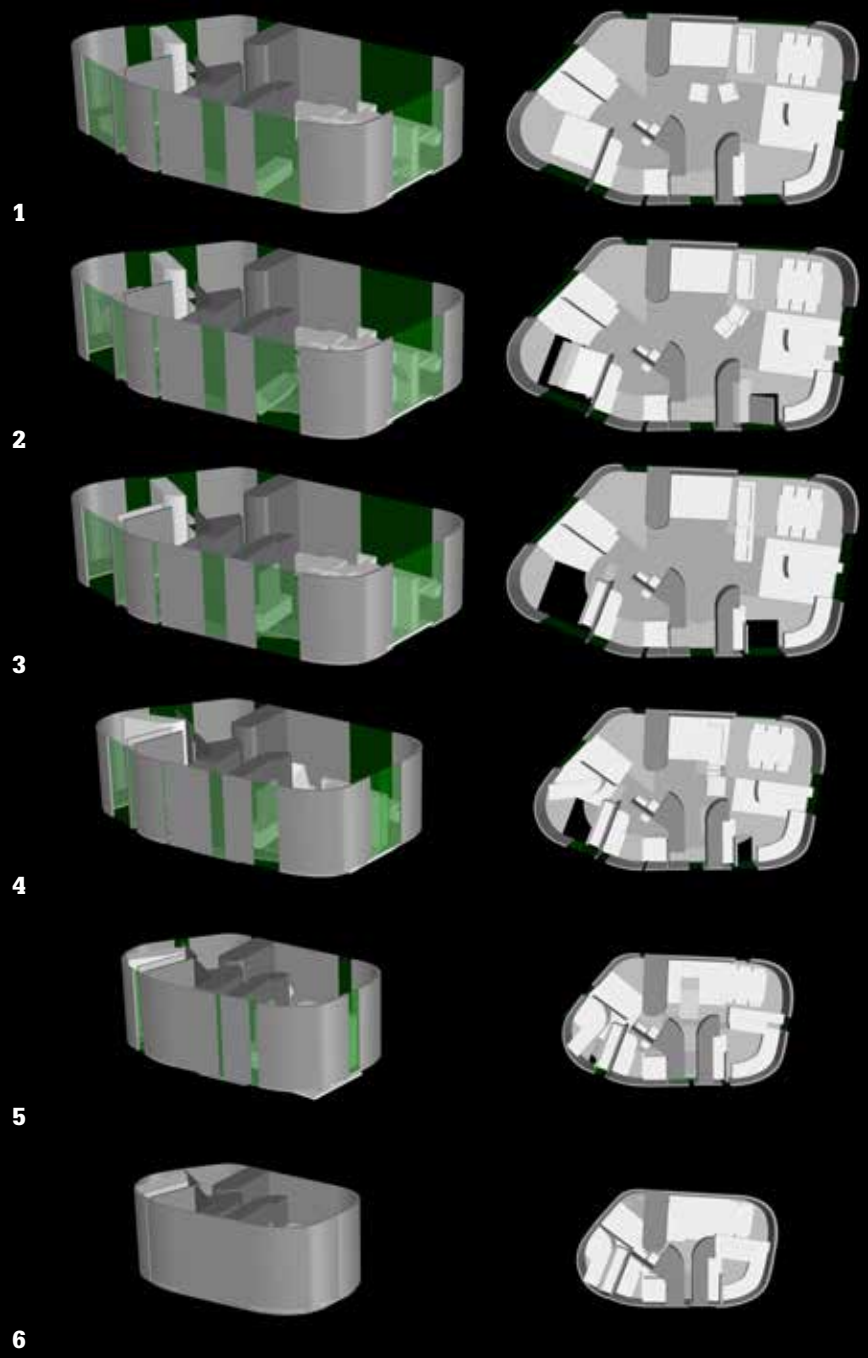
The home at it's smallest size, when the home is in use.

A resizing and moving home





Moving the home with a maglev system



Reducing the size of the home.

Maglev on a plane

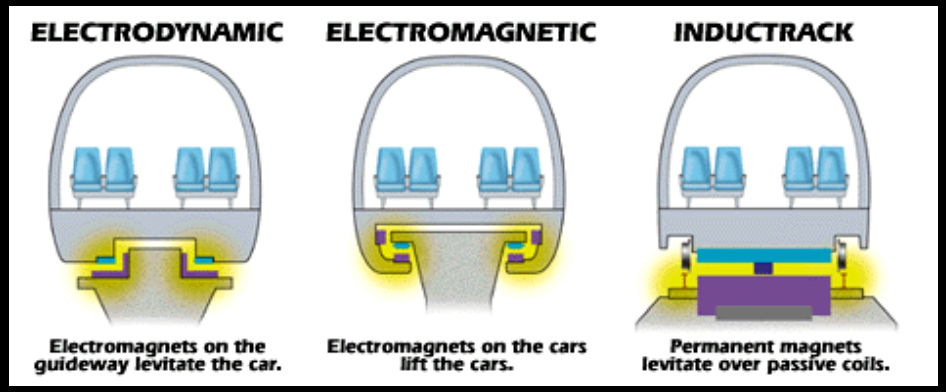
The advantages of a maglev (Magnetic Levitation) system as a transport system are the facts that it is noiseless, frictionless and the vehicle is easily accelerated.

The most commonly known use of a maglev (Magnetic Levitation) system is the use in maglev trains: a system which uses an electromagnetic suspension system or an electrodynamic suspension system. Both systems need a track with magnets for the train to follow. [1]

But what if we have a building that should be able to move in any direction and thus cannot use fixed tracks? For a solution I refer to new research:

"A group of Aoyama Gakuin University researchers has demonstrated a magnetic-levitation disk that can be moved using lasers. The trick is in the materials: when the laser heats one part of the disk, the magnetic properties change in a small area. The resulting differential in the force applied to the disk makes it move [...]. The graphite disk starts by being levitated over a magnet, with its height determined by the strength of the magnetic field and the diamagnetic properties of the disk. [...] If you heat it locally, it will move in the direction of the beam. The trick even works with sunlight, the researchers claim [...]. If the researchers could overcome the challenges of scaling this system up to a decent size, they say their system could even offer a new approach to converting light to electricity. In a more blue-sky scenario, they even imagine it being used for a transport system propelled by magnetism and light." [2]

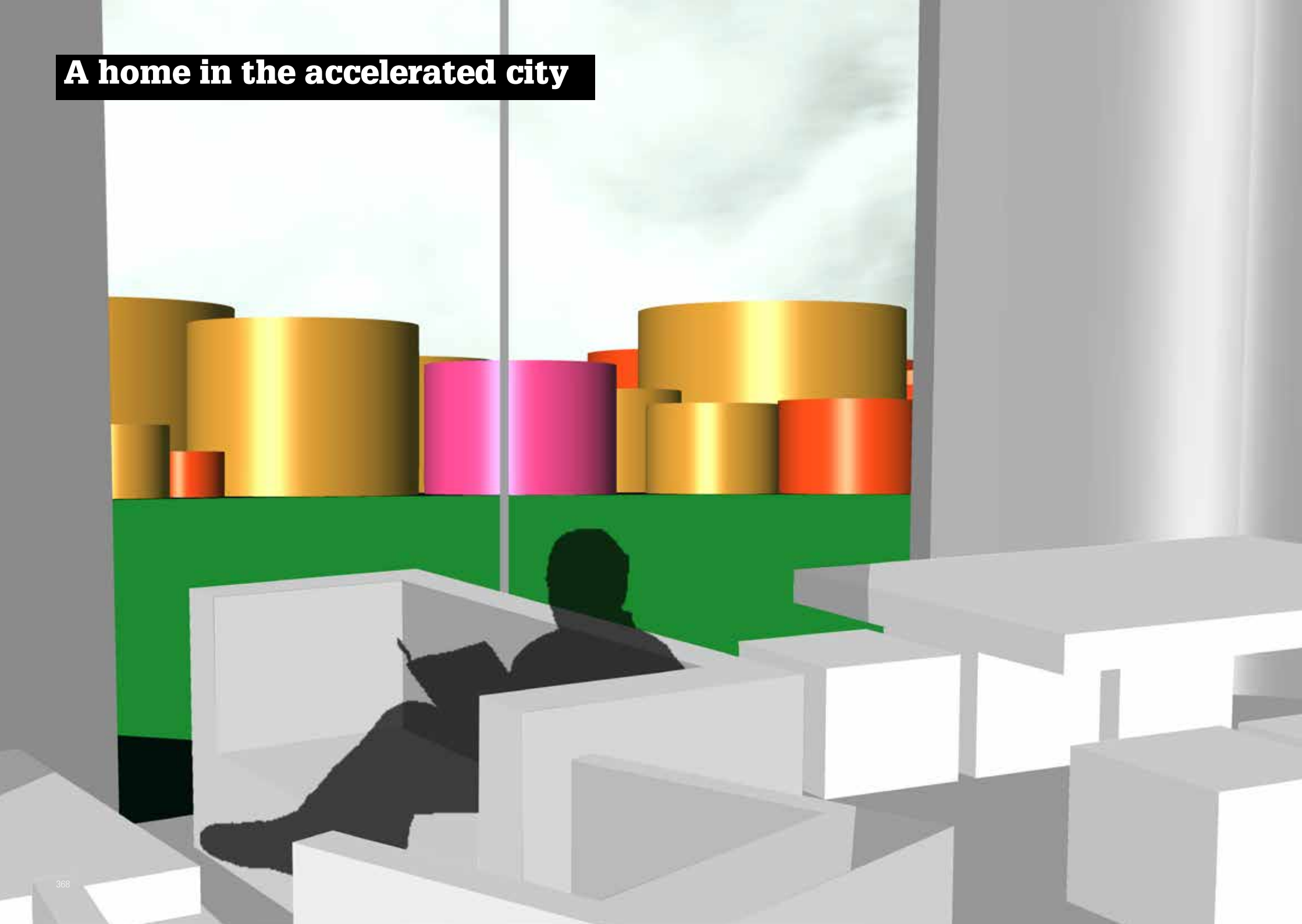
For this project I assumed this principle would also work on larger scale levels, such as objects the size of a home or a building block.



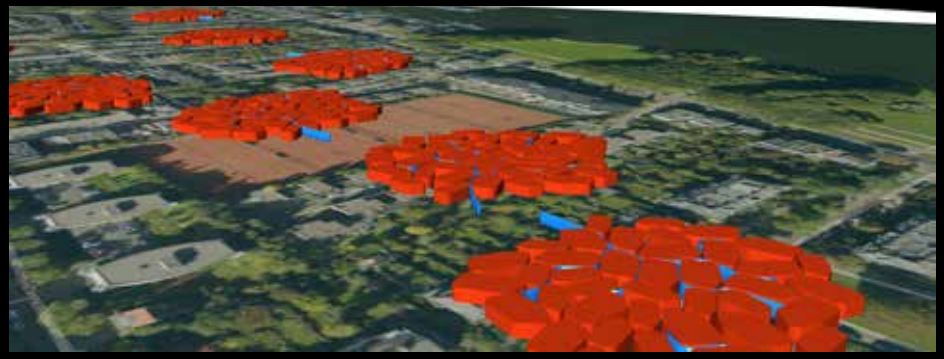
Levitation techniques [3]

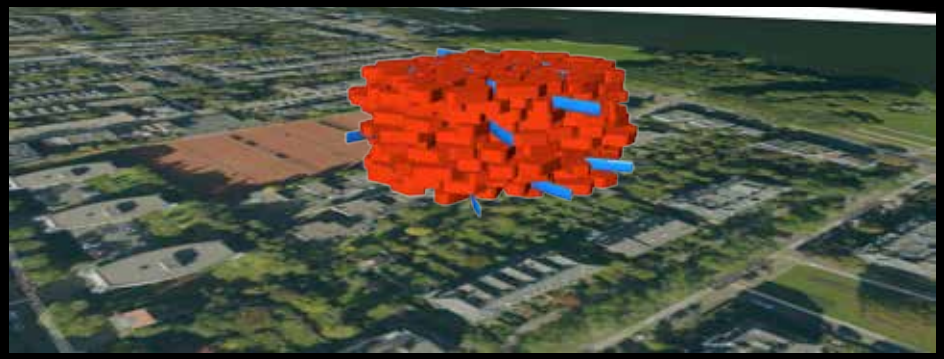
Magnetic levitation and movement by local heating.

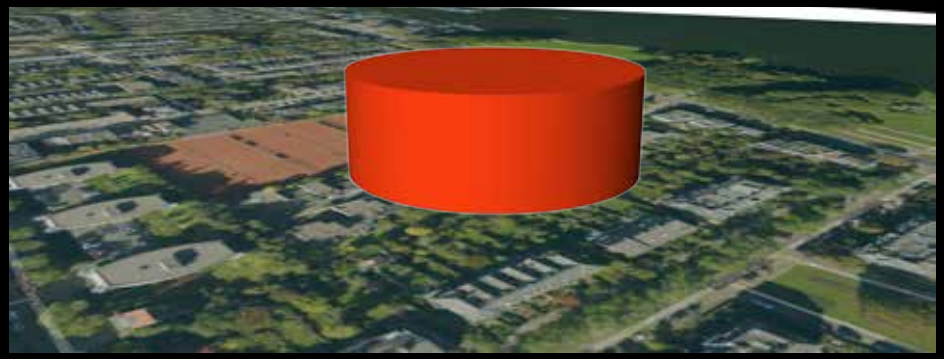
A home in the accelerated city



Housing block







By stacking all the neighbourhoods of the housing district, we reduce the footprint of the housing district. This reduces the travel time.
The stacked tower approaches the shape of a cilinder. Cilinders are the shape of the volumes after the city lost its abstraction.

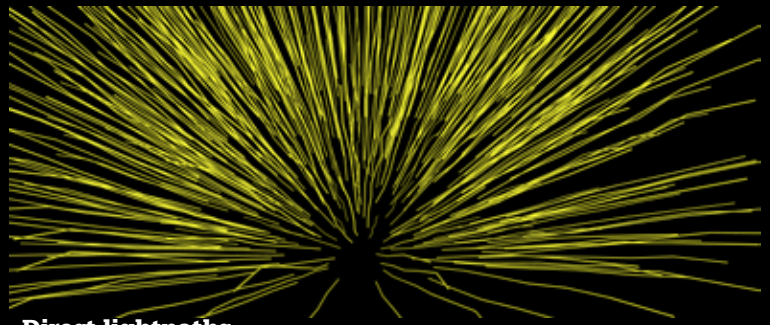
Demands for daylight entrance

- Reduce the amount of space for daylight entrance as much as possible to keep the volume as compact as possible.
- Currently, each home particles contains 40% air volume for light/view. If the amount of light after application of this tool is lower than 40% this means travel time will be reduced.

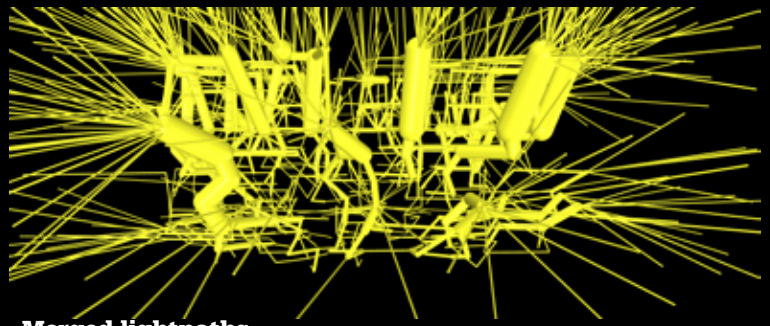
Daylight tool decription

Rule:

- When daylight is necessary in a home, the home should get it. When there is no need for light, it doesn't have to get it. This means that the amount of space used for daylight entrance is adaptable.
- Just like pathways, space should be kept free for light transportation. To save space for these "light paths" we could use tool 5 to merge them.



Direct lightpaths

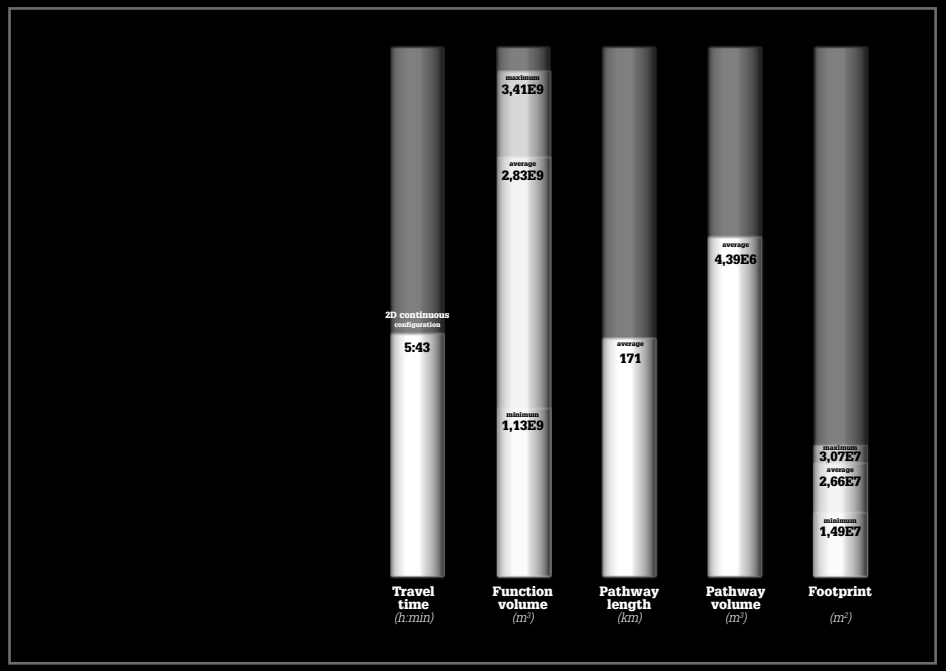


Merged lightpaths

Air volumes per function

	Original function volume	original % of function volume for light/view air	new % of function volume for light/view air
Hospital	m^3 18.212.000	% 20%	17%
General practitioner	153.998	20%	17%
Dentist	118.997	20%	17%
Pharmacy	292.005	20%	17%
Specialists	149.998	20%	17%
Supermarket	715.999	10%	10%
Retail of large goods	19.904.000	5%	5%
Other shops	4.557.000	15%	15%
Personal care	199.000	20%	17%
Daycare	320.994	20%	17%
Nursery school	61.999	20%	17%
Primary school	1.849.000	20%	17%
Afterschool program	110.998	20%	17%
Secundary school	1.132.000	20%	17%
Mbo	561.997	20%	17%
Hbo	666.977	20%	17%
University	6.377.900	20%	17%
Housing	620.170.000	40%	17%
Nursing home	2.284.000	40%	17%
Hotel	1.740.000	40%	17%
Fire station	166.005	20%	17%
Library	177.993	30%	17%
Police station	238.991	30%	17%
Railway station	5.545.000	20%	17%
Airport	1.996.500.000	10%	10%
Cemetery	15.311.000	30%	17%
Religious building	2.534.000	10%	10%
Prison	635.012	10%	10%
Sports	112.600.000	10%	10%
Cafe	1.162.000	30%	17%
Restaurant	856.985	30%	17%
Cinema/theatre	776.000	10%	10%
Stadium	9.600.000	5%	5%
Park	52.320.000	30%	17%
Leisure centre	263.995	10%	10%
Zoo	10.247.000	30%	17%
Museum	3.504.900	10%	10%
Students' union	83.999	10%	10%
Playground	4.846.000	30%	17%
Centre for the arts	237.998	30%	17%
Industry	184.690.000	0%	0%
Offices	140.450.000	30%	17%
Agriculture	161.420.000	0%[1]	0%[1]
Forest	192.540.000	30%	17%

Values after new air volume

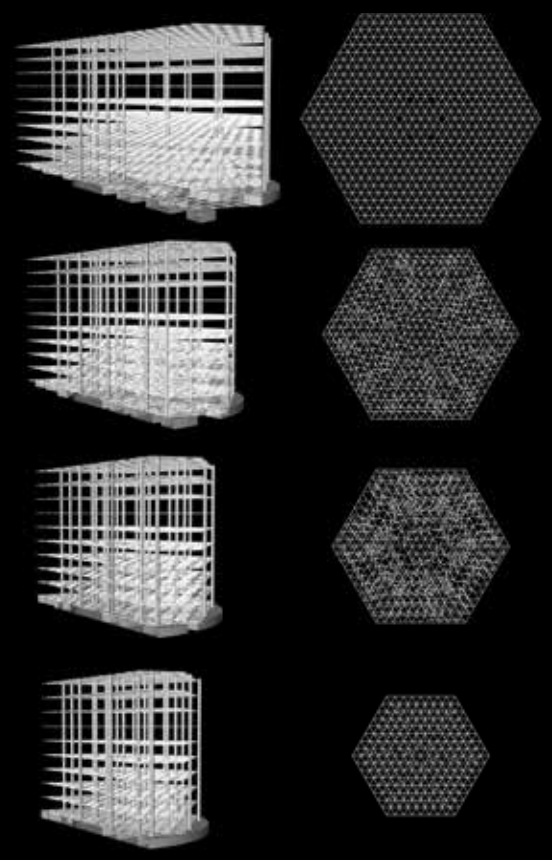


With the new percentages for air volume for light/view, the average city volume reduces with 5% to 2.8298E+9 m³. Travel time reduces with 6%.

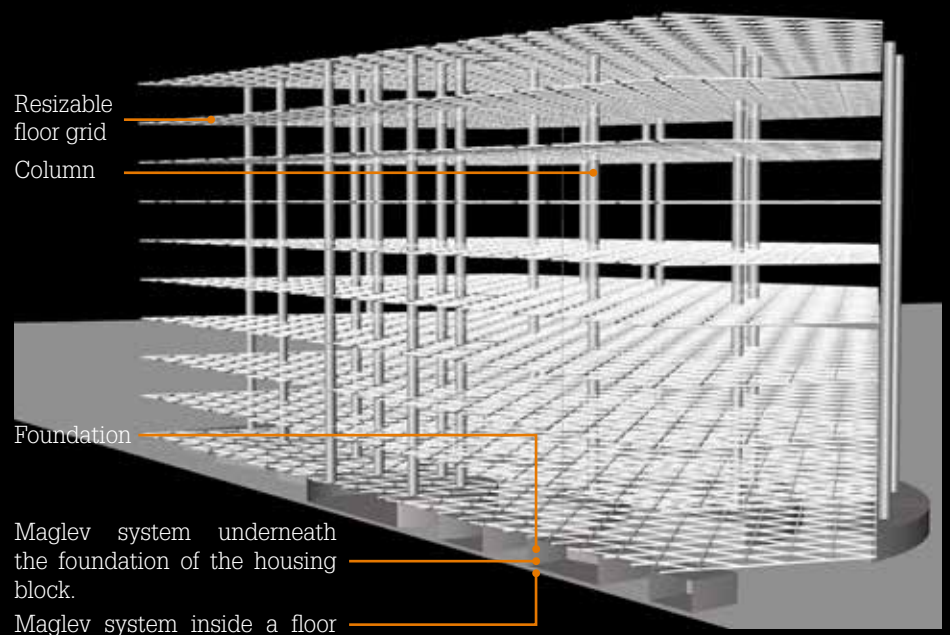
Demands for construction

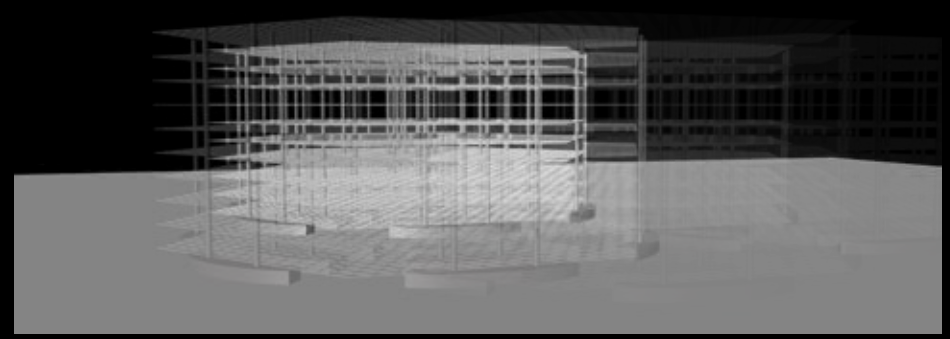
- **The construction should have an open floor plan to allow the homes to move freely.**
- **The construction should be resizable, to keep the volume as compact as possible.**
- **The construction should be movable, to enable a continuously configuring city.**

Reducing the size of the housing block construction. Aside from moving the building block as a whole, the maglev system underneath the foundation could also reduce and increase the size of the construction by moving away and towards each other. Left: perspective view of the housing block. Right: top view image of one grid plane.



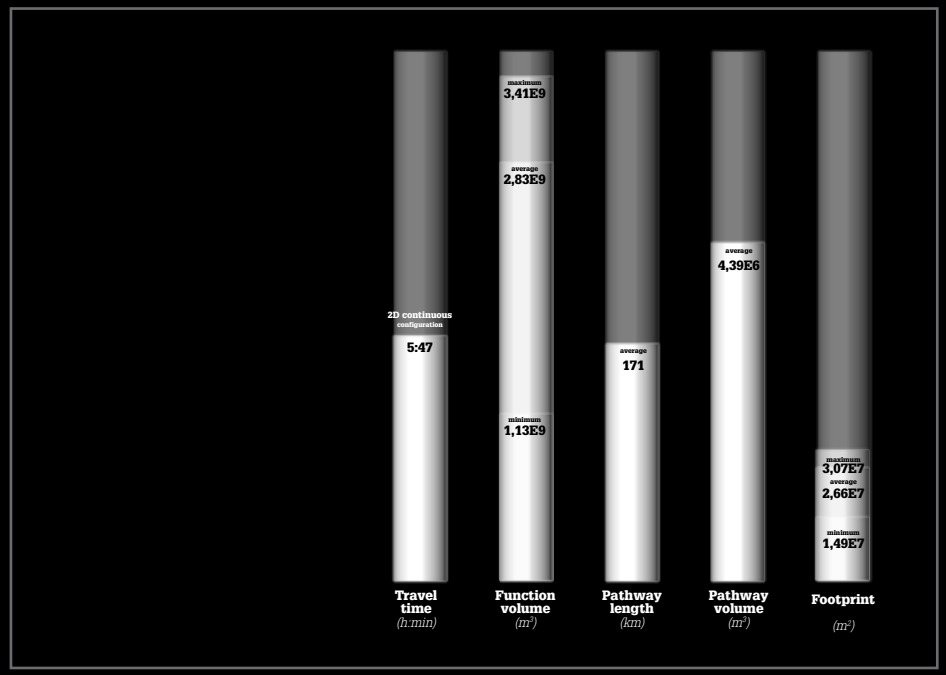
Resizing and moving construction





Moving the housing block with a maglev system

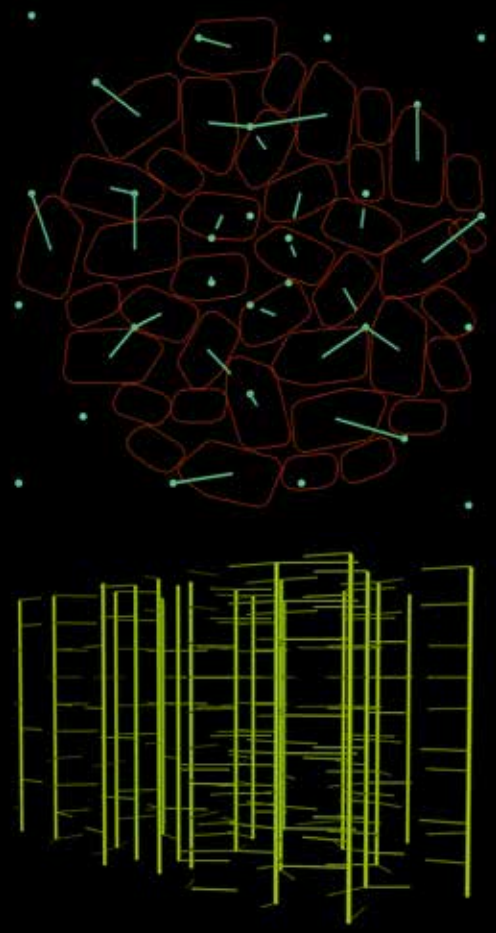
Values after construction added



Demands for services

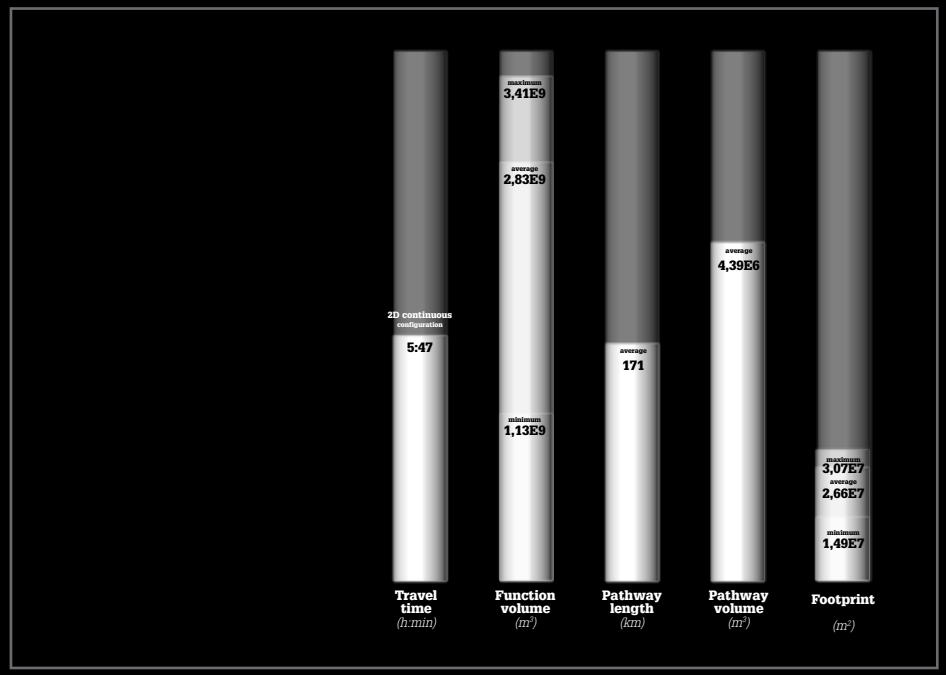
- Services, such as water and sewage ducts, should be adaptable because homes are continuously moving.

Services system



Horizontal ducts can reduce and increase their lenght, connecting to and disconnecting from fixed vertical ducts in the columns.

Values after services added

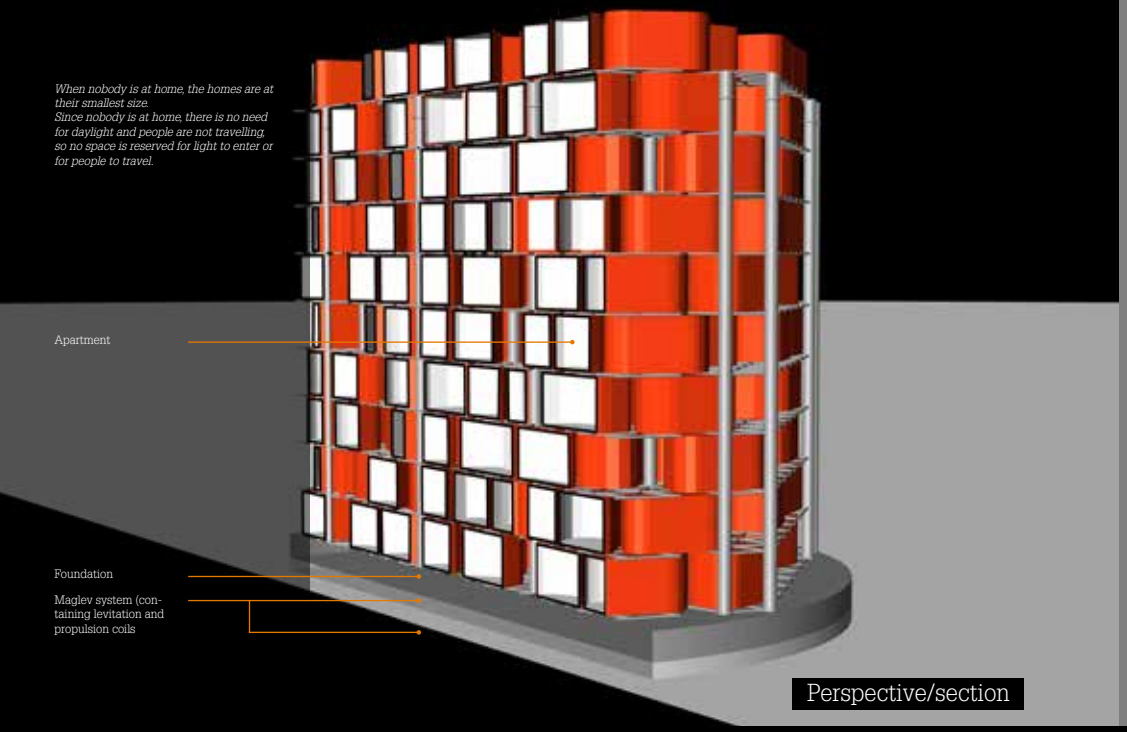


The volume necessary for serves is so small in comparison to the function and pathway volumes, and the volume needed for air for daylight and construction, that it does not impact travel time.

Housing block

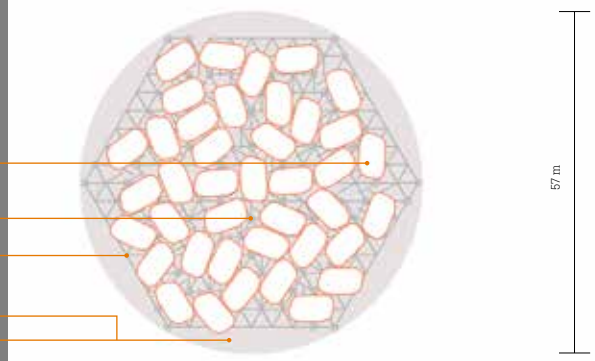
All homes empty

When nobody is at home, the homes are at their smallest size.
Since nobody is at home, there is no need for daylight and people are not travelling, so no space is reserved for light to enter or for people to travel.



Perspective/section

When nobody is at home, the homes are at their smallest size.
Since nobody is at home, there is no need for daylight and people are not travelling, so no space is reserved for light to enter or for people to travel.

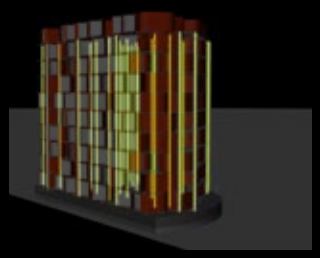


Ground floorplan

Homes

Pathways

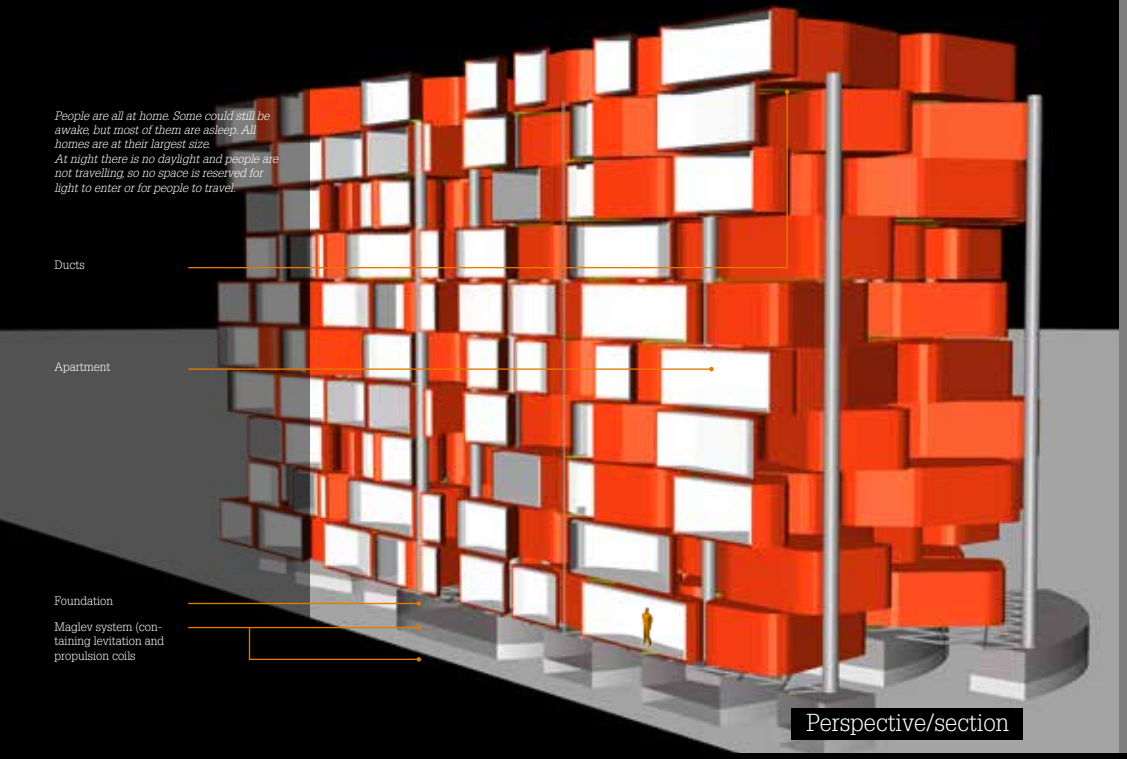
Construction



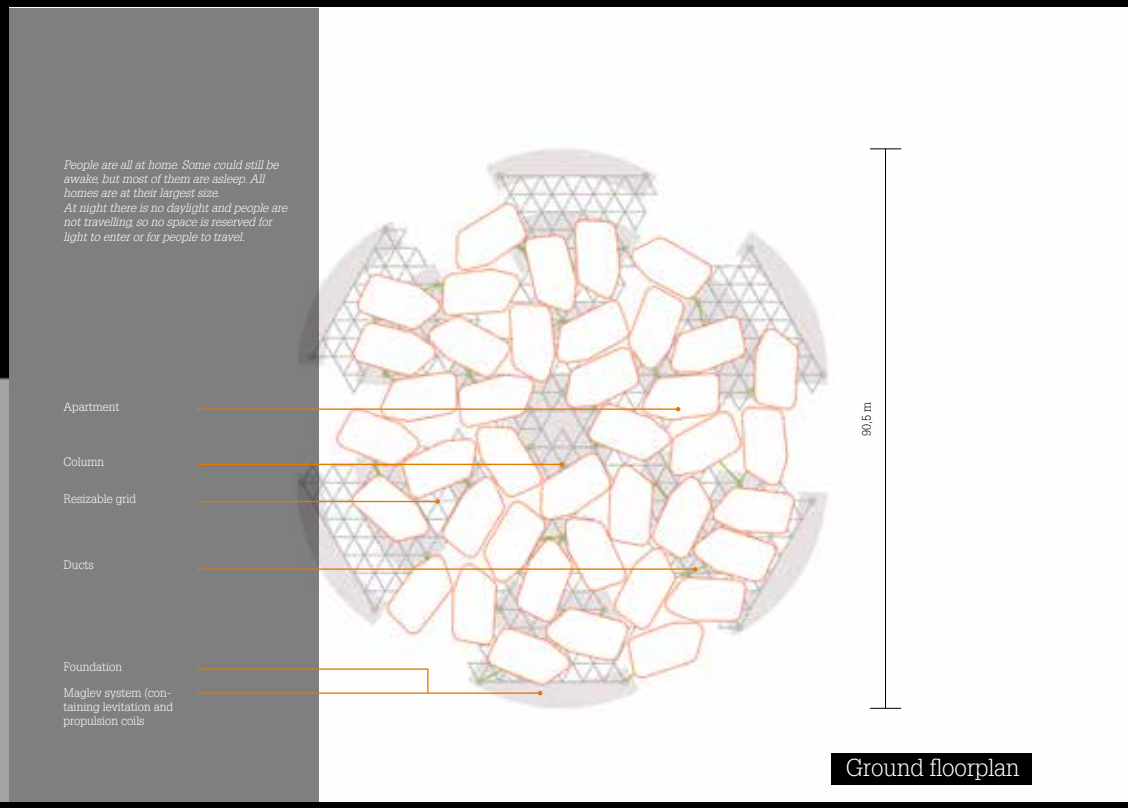
Ducts

Daylight

Housing block **Nighttime**



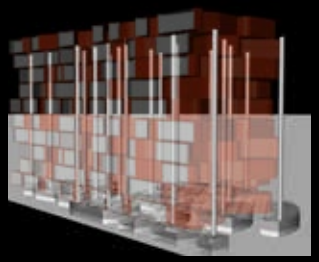
Perspective/section



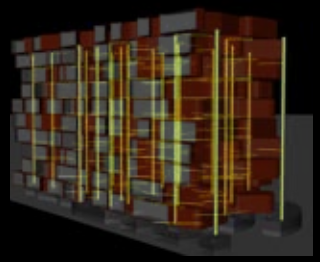
Ground floorplan

Homes

Pathways



Construction



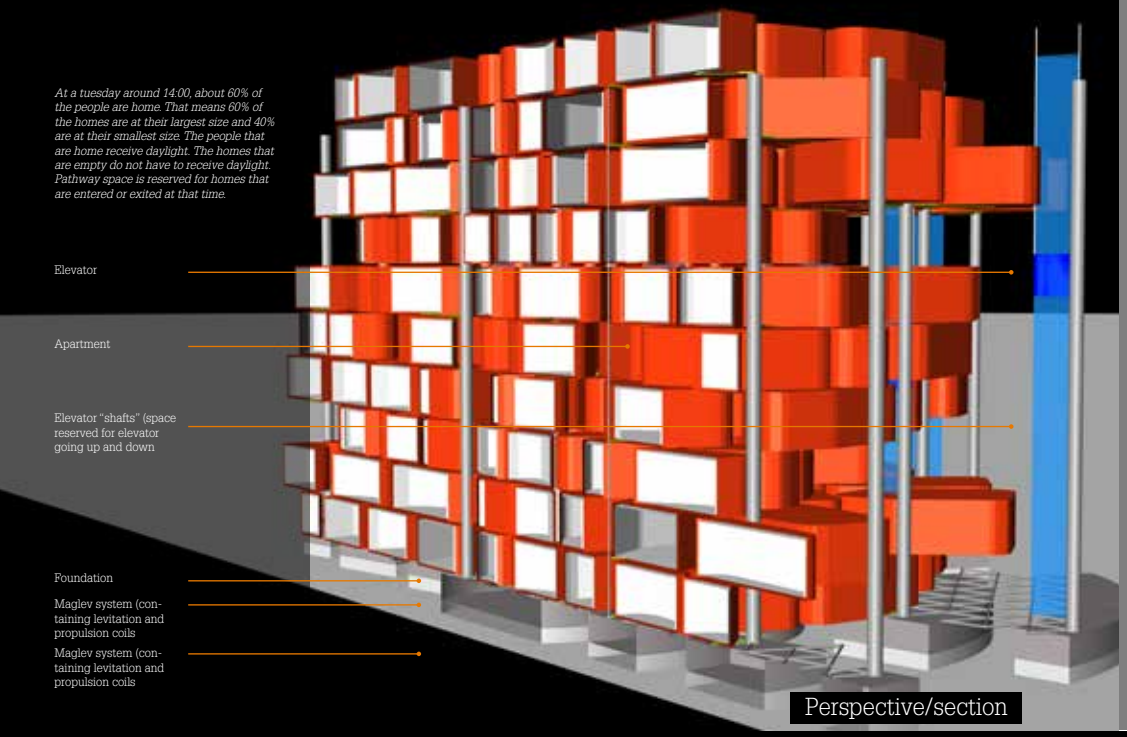
Ducts

Daylight

Housing block

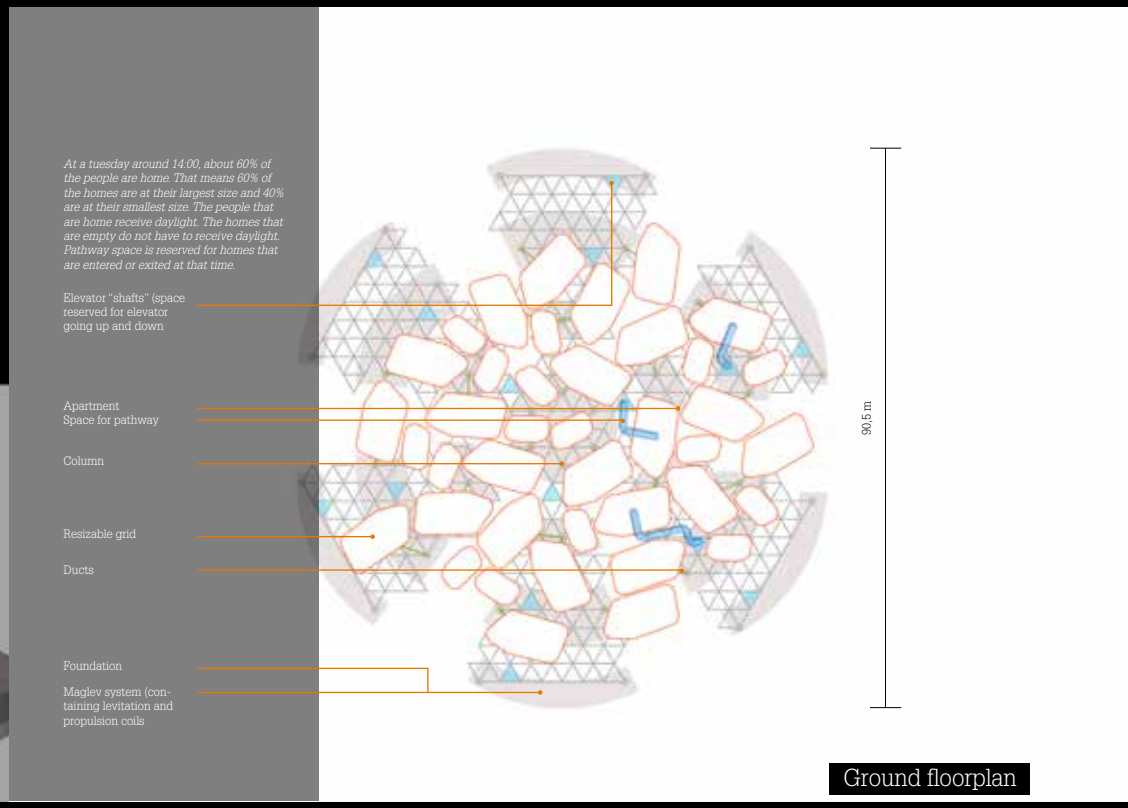
Daytime, tuesday 14:00

At a tuesday around 14:00, about 60% of the people are home. That means 60% of the homes are at their largest size and 40% are at their smallest size. The people that are home receive daylight. The homes that are empty do not have to receive daylight. Pathway space is reserved for homes that are entered or exited at that time.



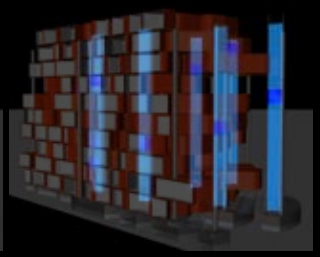
Perspective/section

At a tuesday around 14:00, about 60% of the people are home. That means 60% of the homes are at their largest size and 40% are at their smallest size. The people that are home receive daylight. The homes that are empty do not have to receive daylight. Pathway space is reserved for homes that are entered or exited at that time.

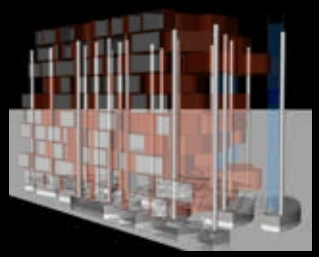


Ground floorplan

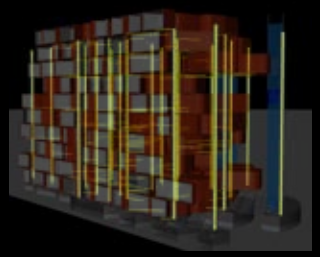
Homes



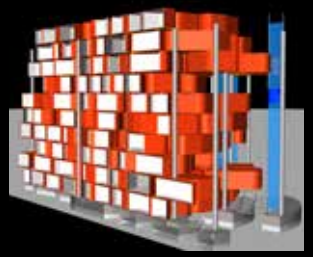
Pathways



Construction



Ducts

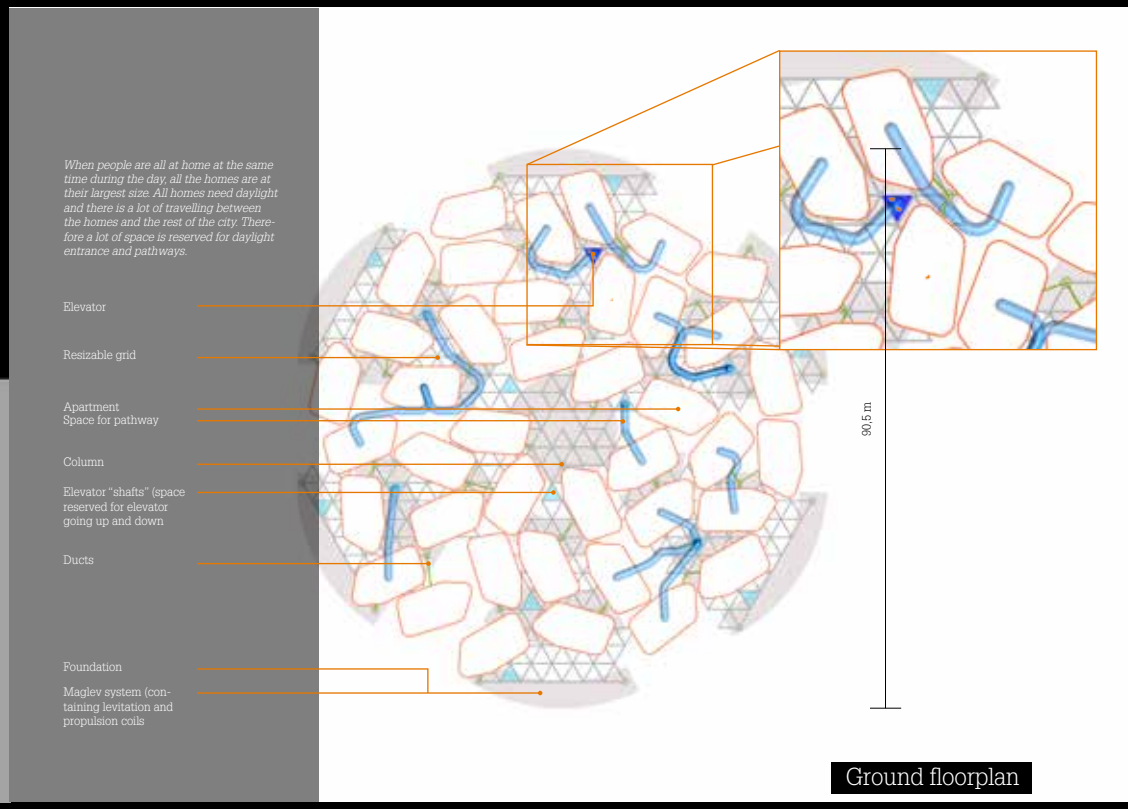


Daylight

Housing block

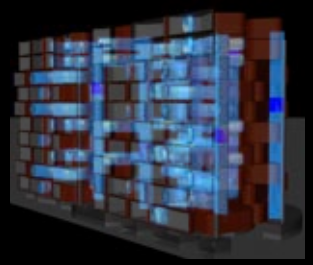
Daytime, all homes used

Perspective/section

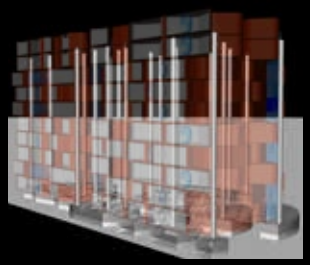


Ground floorplan

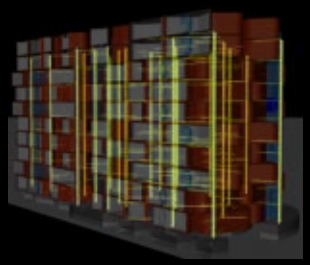
Homes



Pathways



Construction



Ducts

Daylight

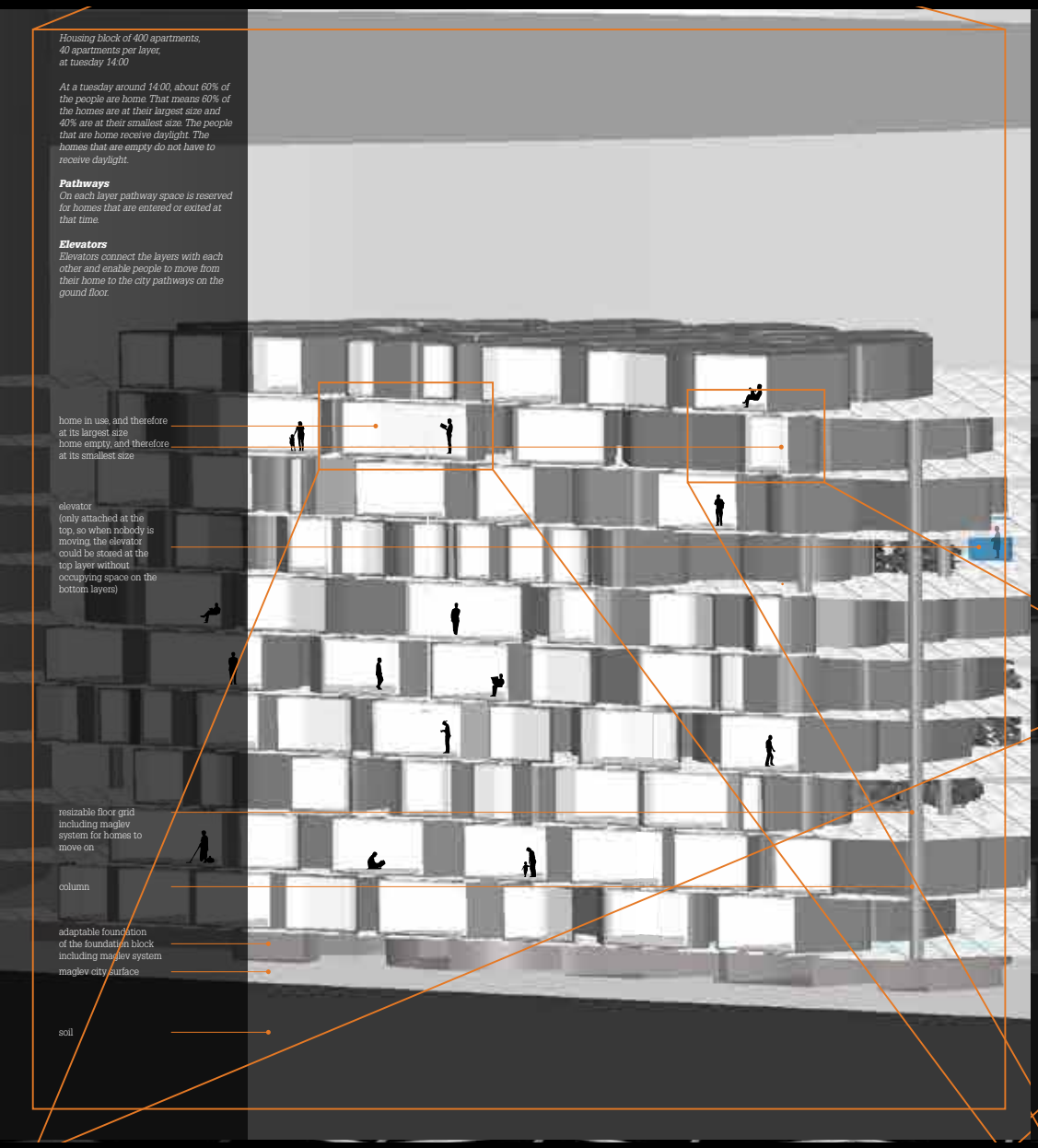
Housing block

Housing block of 400 apartments,
40 apartments per layer,
at tuesday 14:00

At a tuesday around 14:00, about 60% of the people are home. That means 60% of the homes are at their largest size and 40% are at their smallest size. The people that are home receive daylight. The homes that are empty do not have to receive daylight.

Pathways
On each layer pathway space is reserved for homes that are entered or exited at that time.

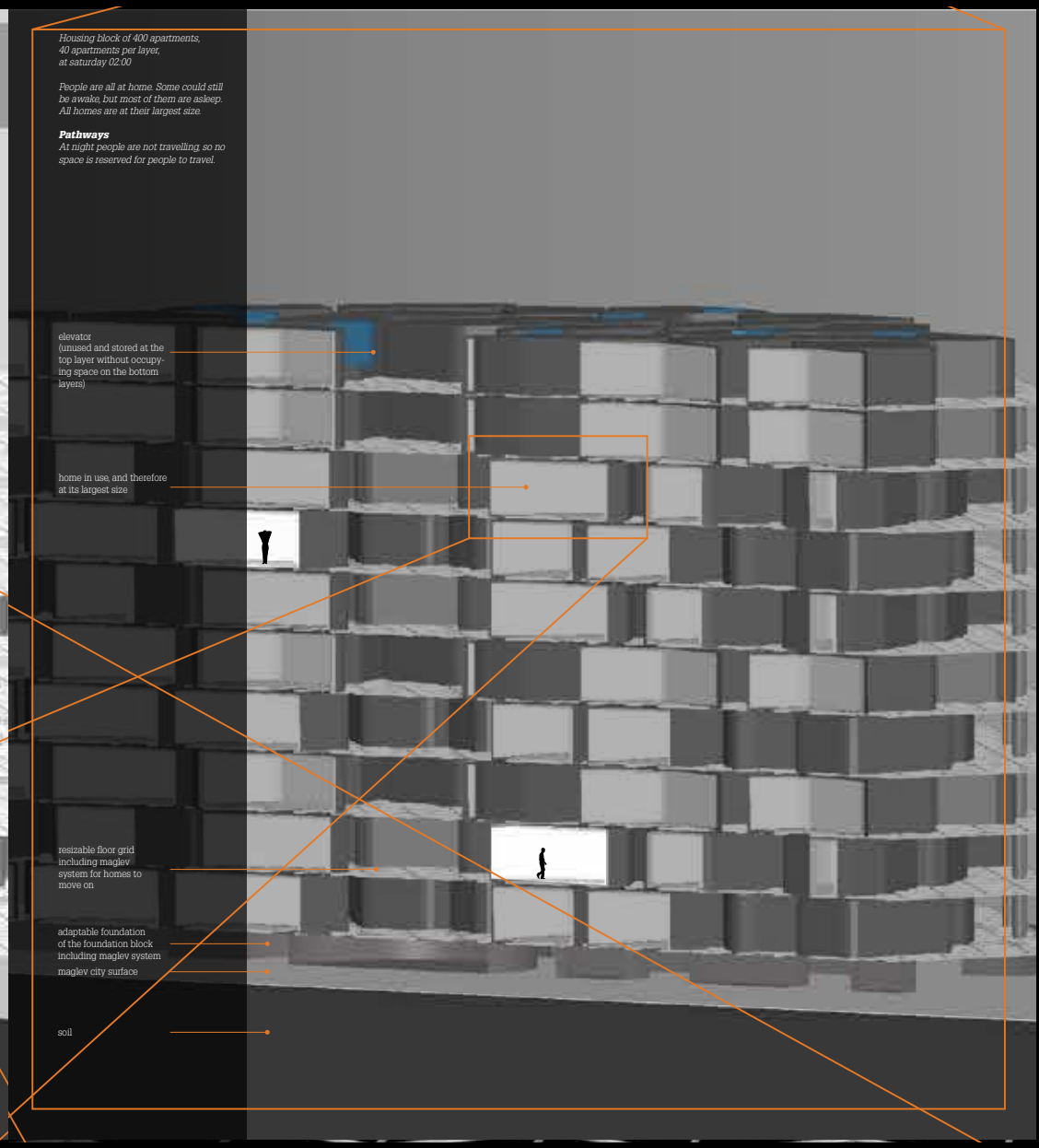
Elevators
Elevators connect the layers with each other and enable people to move from their home to the city pathways on the gound floor.



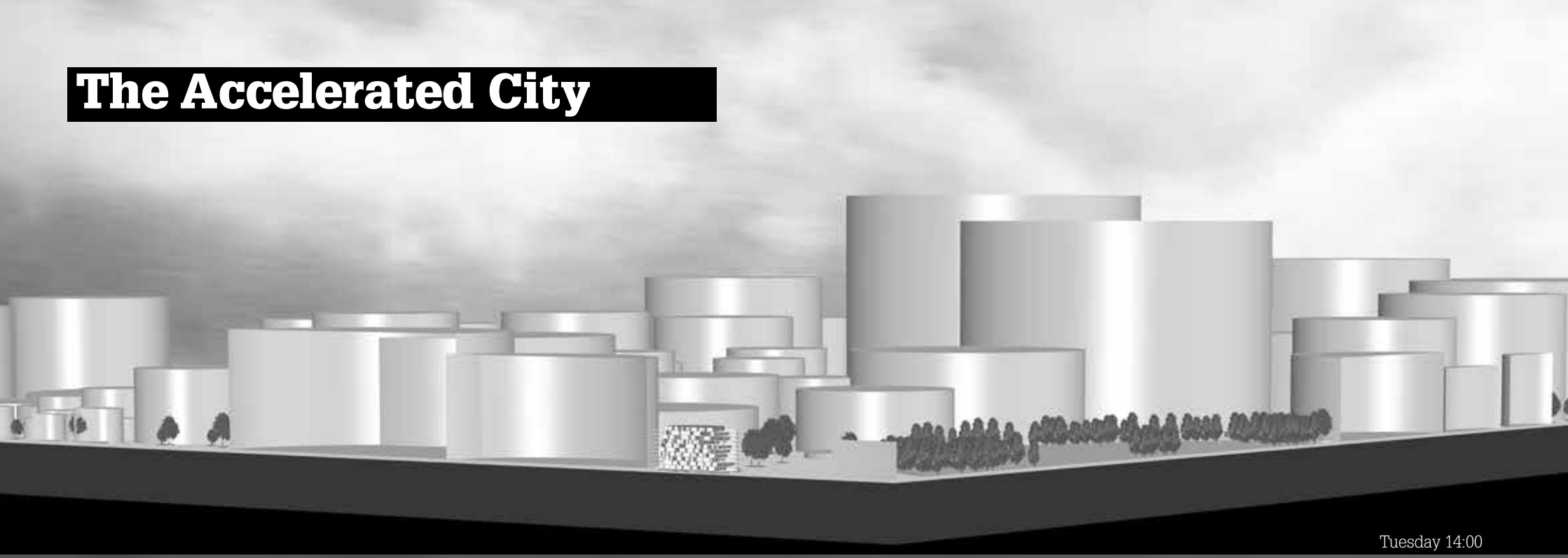
Housing block of 400 apartments,
40 apartments per layer,
at saturday 02:00

People are all at home. Some could still be awake, but most of them are asleep. All homes are at their largest size.

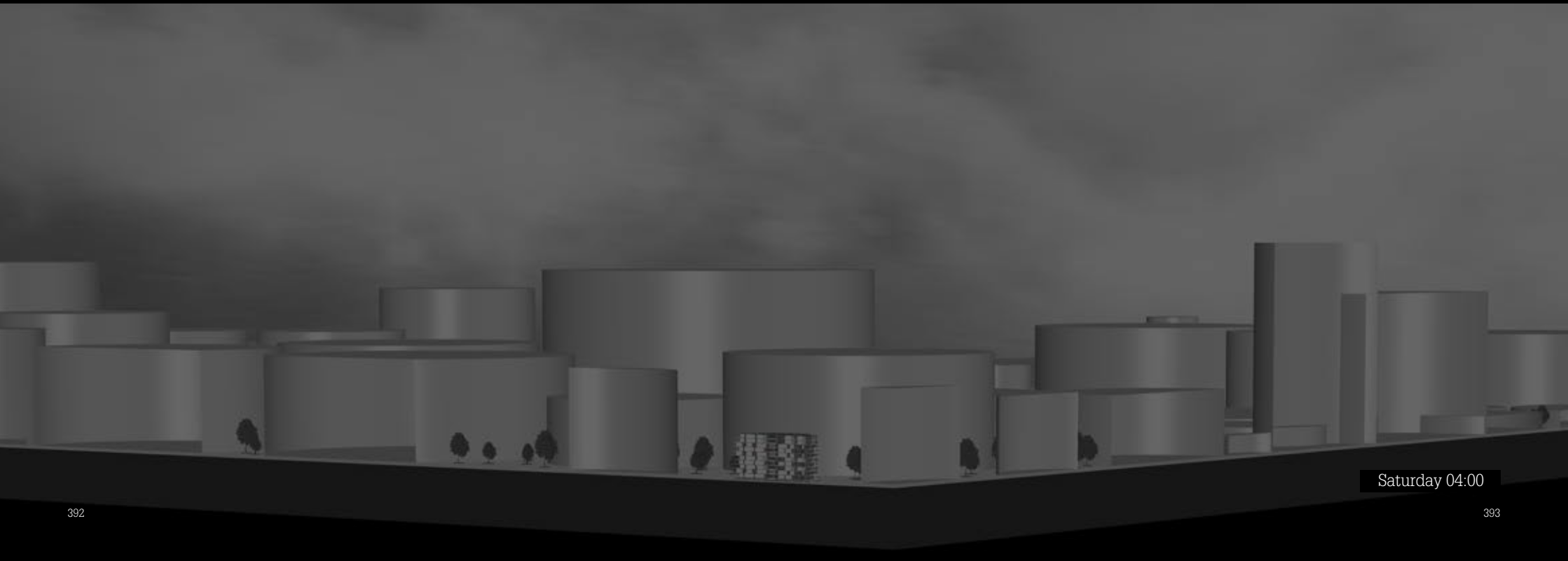
Pathways
At night people are not travelling, so no space is reserved for people to travel.



The Accelerated City

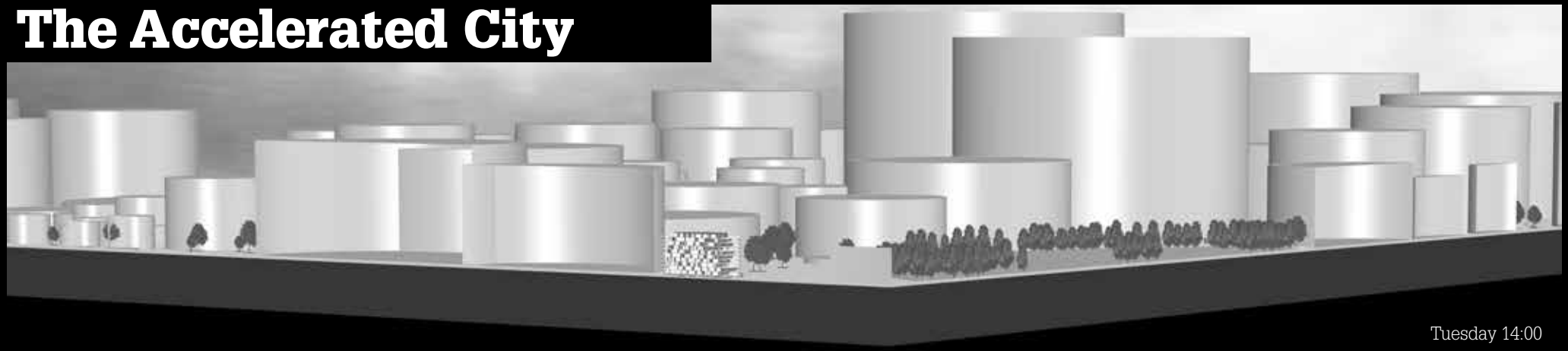


Tuesday 14:00

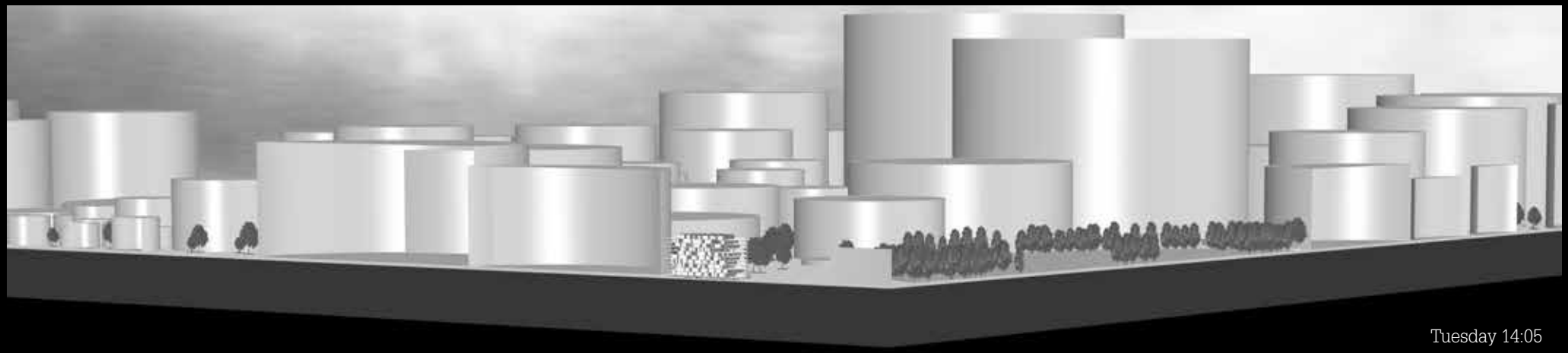


Saturday 04:00

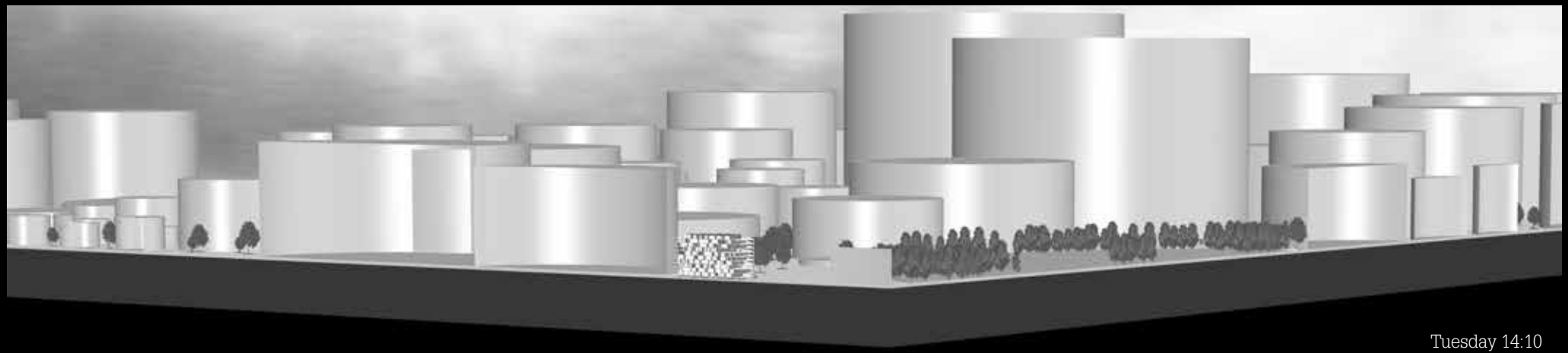
The Accelerated City



Tuesday 14:00

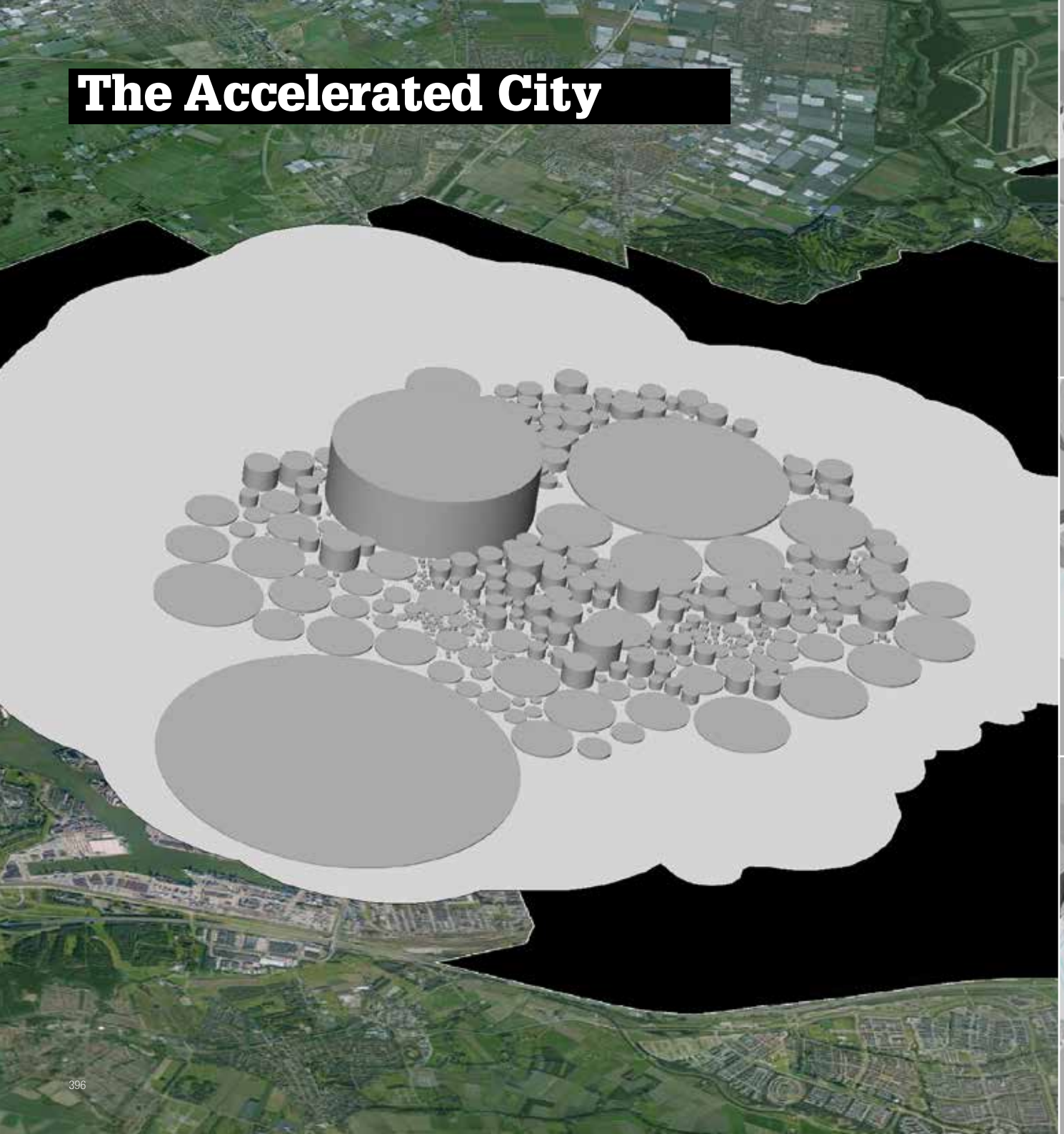


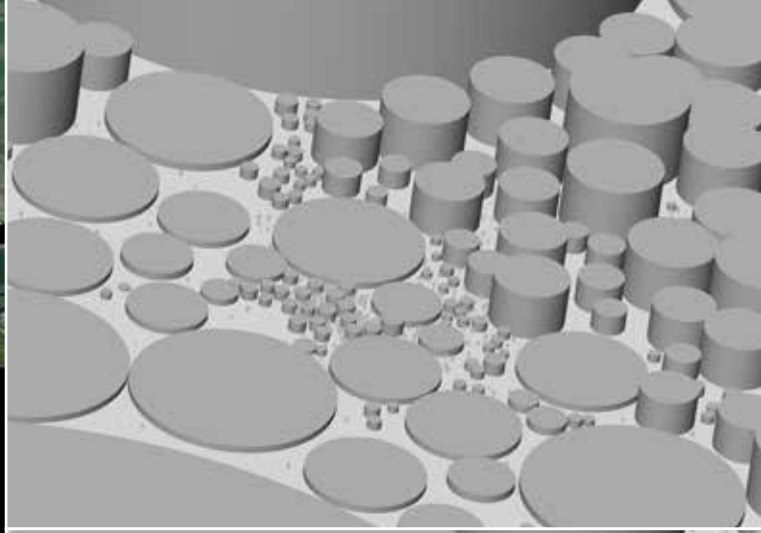
Tuesday 14:05

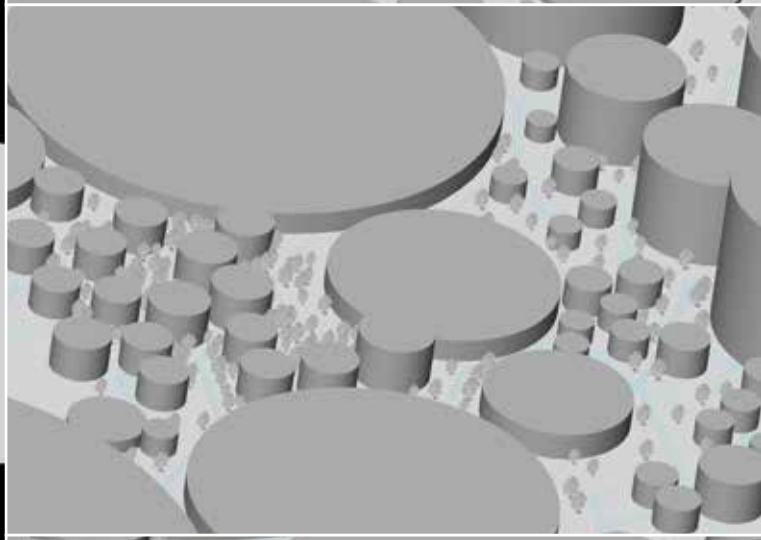


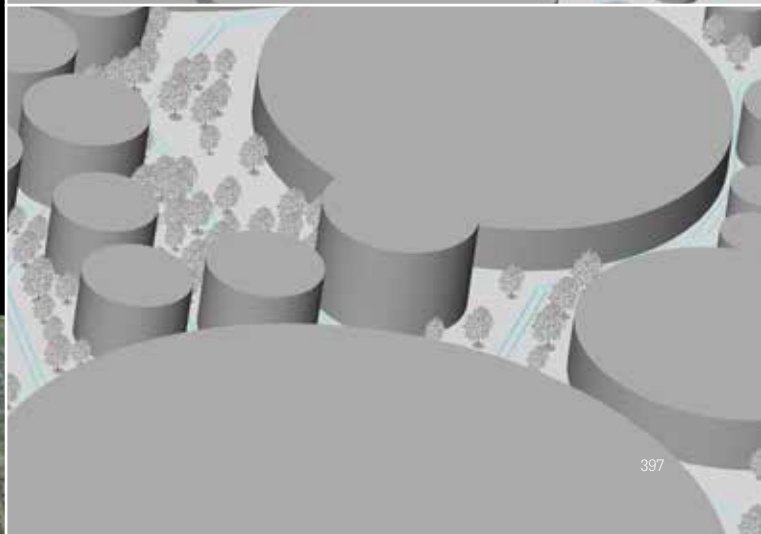
Tuesday 14:10

The Accelerated City









Vehicles for a 2D configured city

Demands:

1. vehicle should be able to drive itself, this does not necessarily have to be for the entire trip, because the vehicle should only be able to adjust location and speed at these moments:

- **entering and exiting a function, because speed of the vehicle and speed of the function could be different. A self-driving vehicle could gradually adjust its speed to fluently transition between pathway and function.**
- **when the vehicle, when it is driven by the passenger, moves too slow (for the city) or tends to leave the pathway.**

2. since the vehicle needs to be able to drive itself, and the city is already covered with a maglev surface, it makes sense to have maglev system underneath the vehicles for vehicles to move forward. (even though wheels etc.. are also possible, als long as the vehicle is able to drive itself)

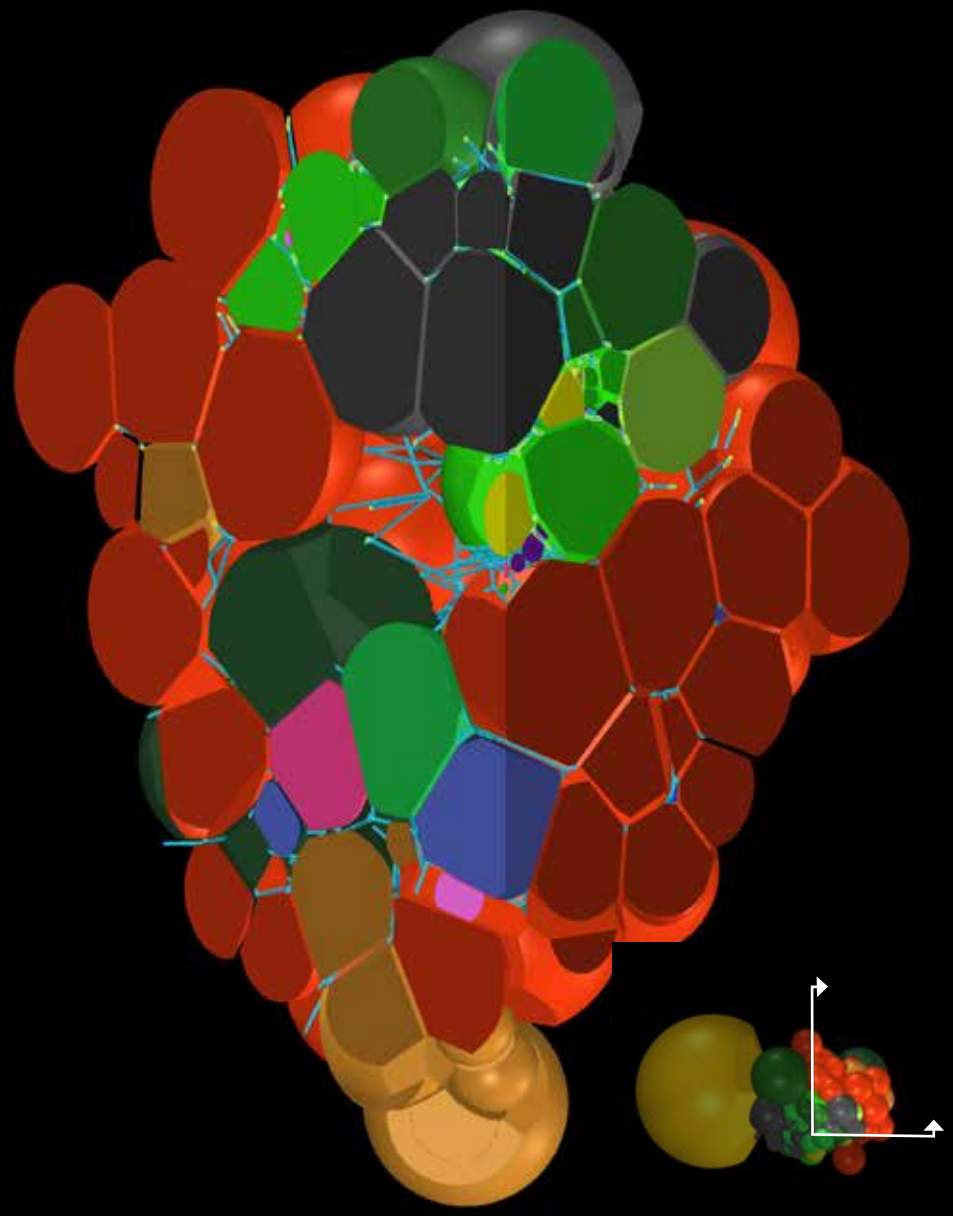
3. The vehicles are used to travel from door to door, thus from the front door of the home situated at for example the 6th layer of the housing block to the front door of the destination. Within the housing block, elevators connect the layers with the city layer. Thus, the vehicles have to fit within the dimensions of the elevator.

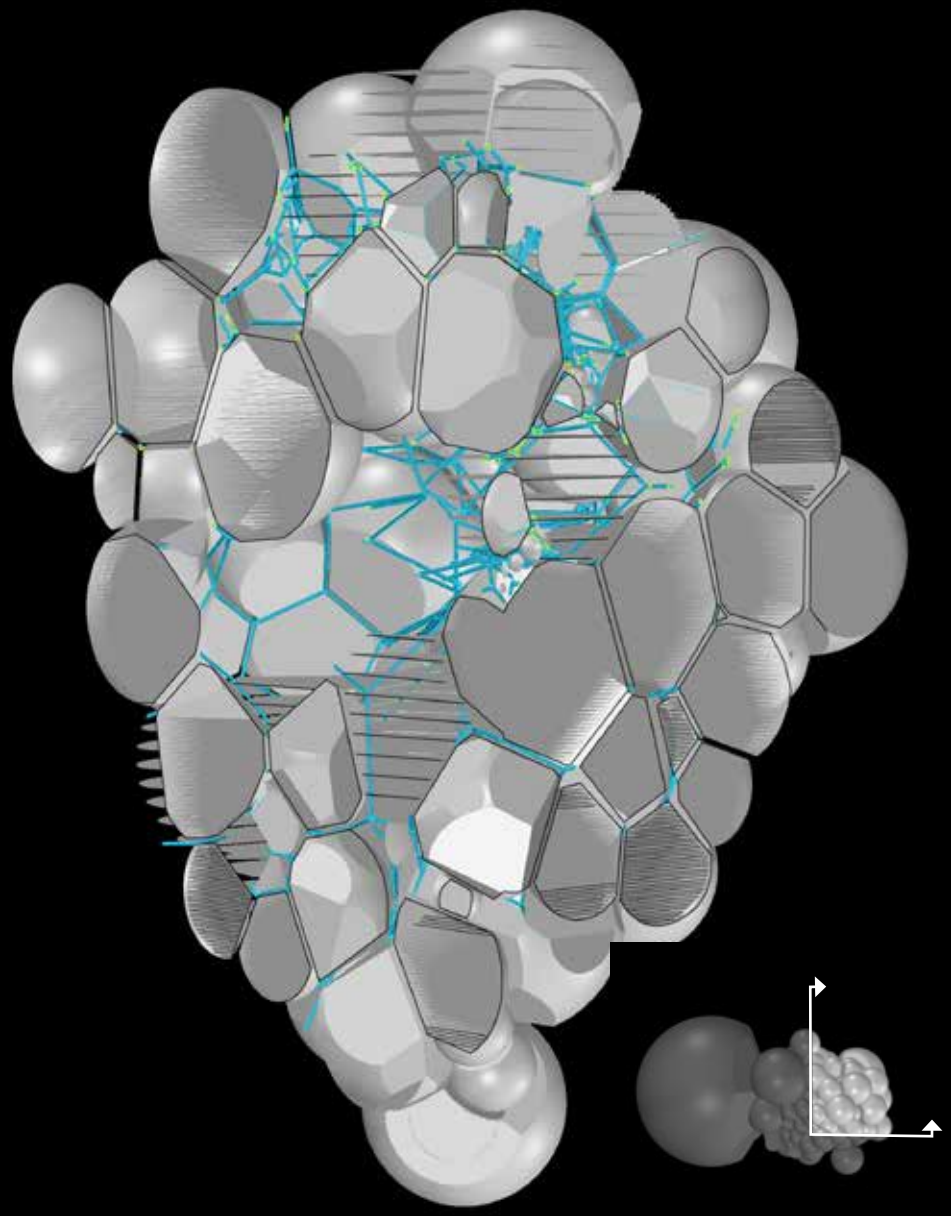
(Self driving) maglev pod

Maglev E-bike

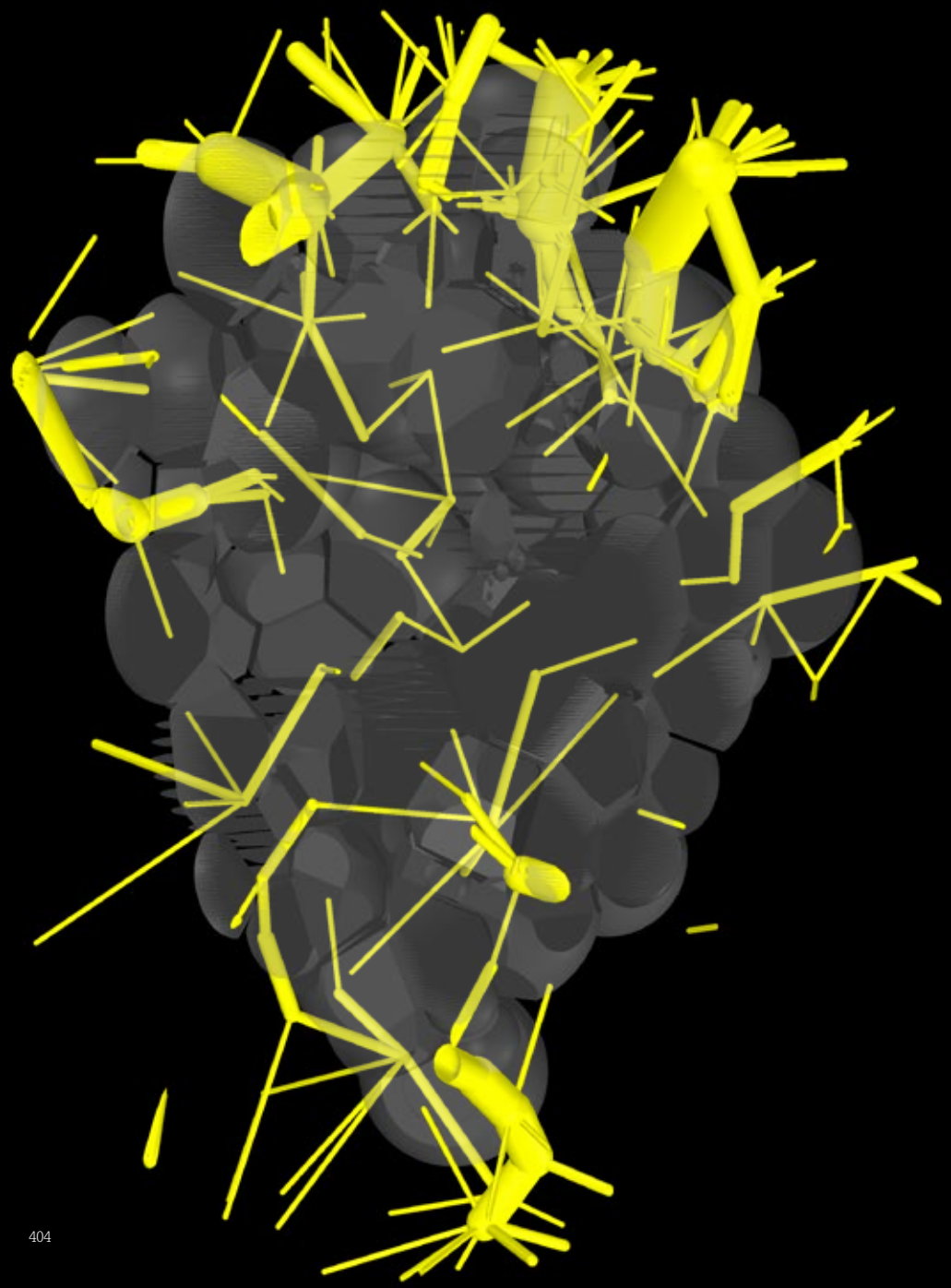
FIXED 3D CONFIGURED CITY WITHOUT RESIZING

From volumes to usable space

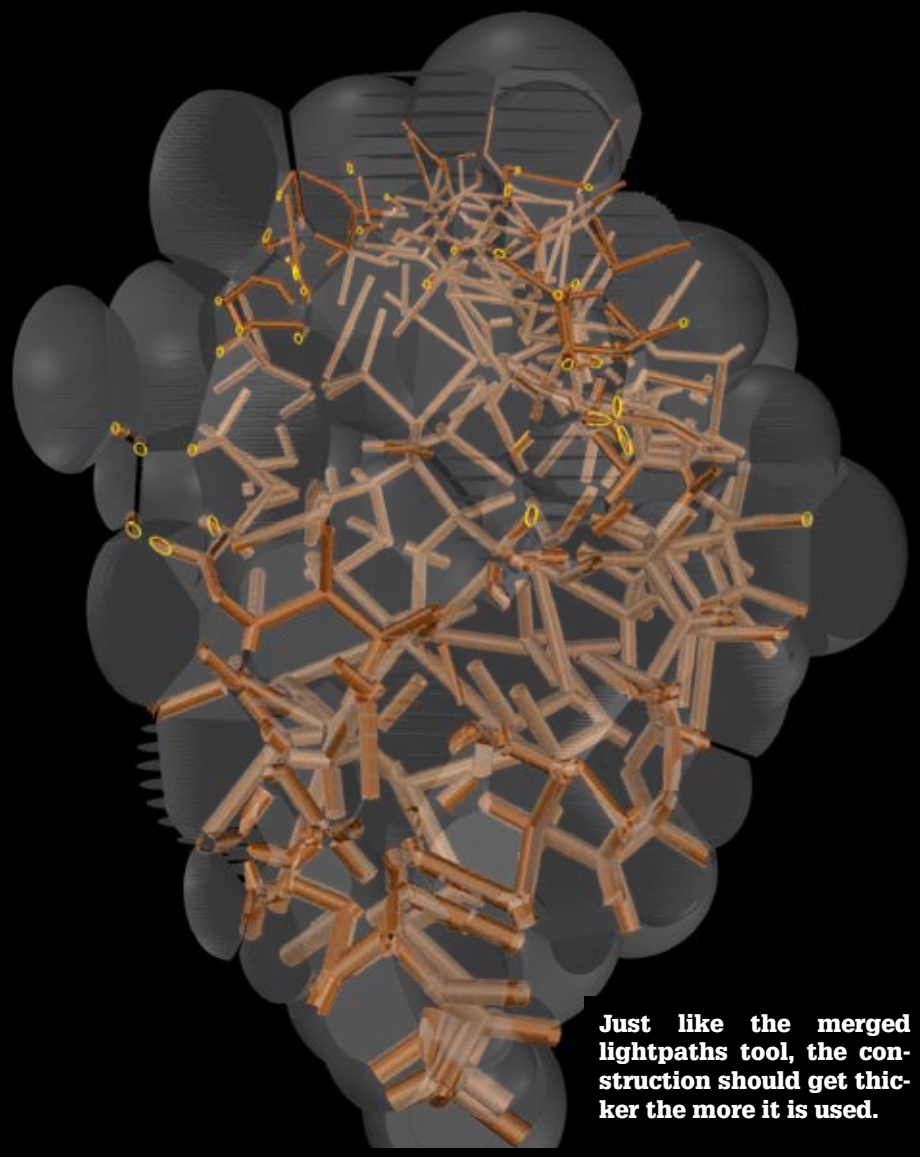




Light



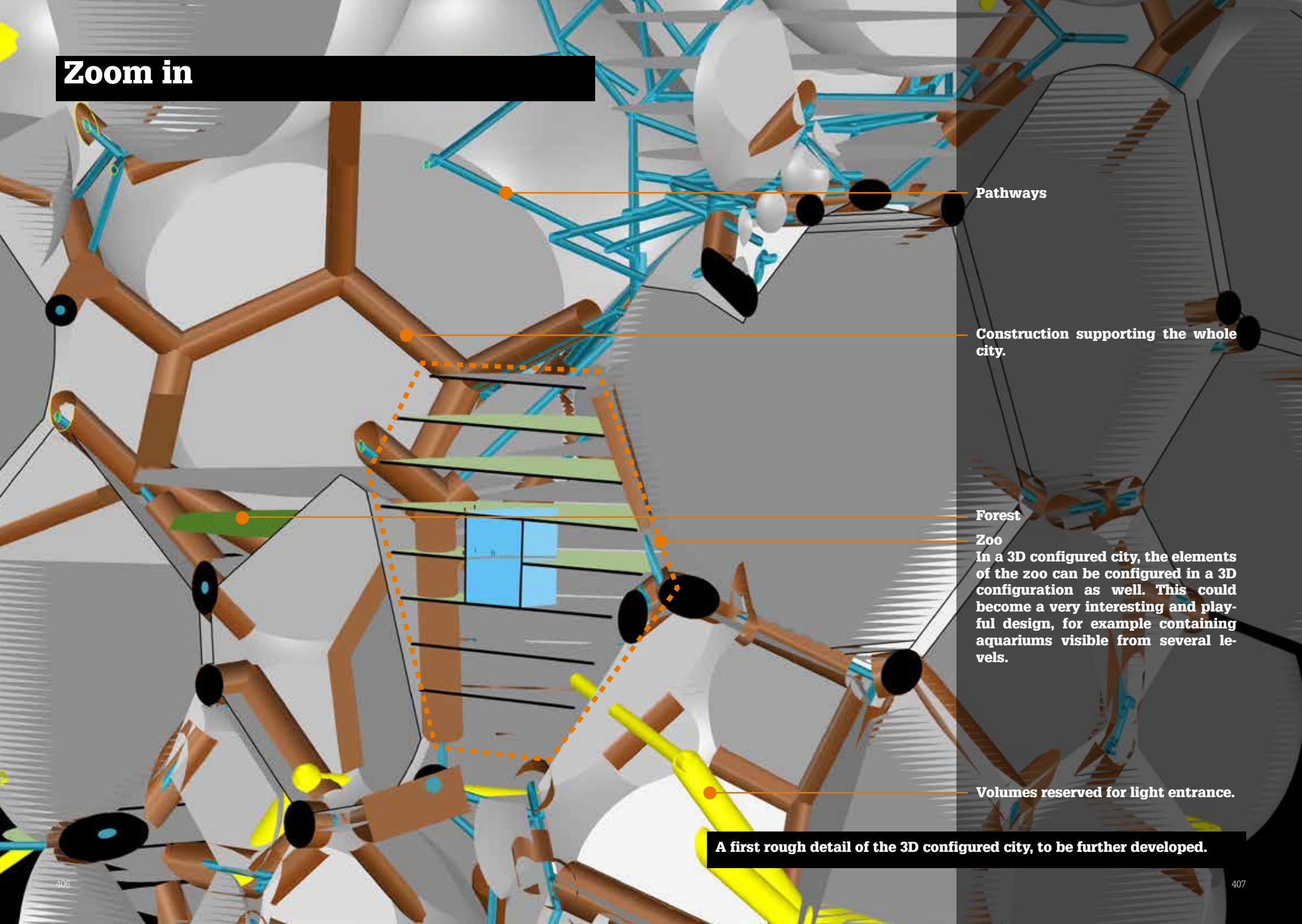
Construction



Just like the merged lightpaths tool, the construction should get thicker the more it is used.

A fixed city configuration without resizing volumes makes it possible to use a fixed construction. With these kind of shapes we could think of framing each volume in a stable construction frame.

Zoom in



A first rough detail of the 3D configured city, to be further developed.

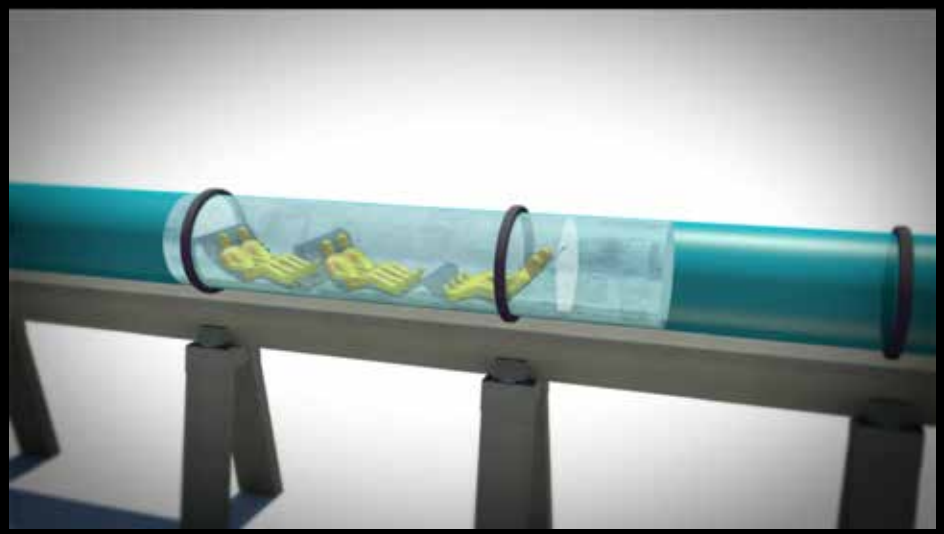
Vehicles for a 3D configured city

Demands:

1. vehicle should be able to drive itself, this does not necessarily have to be for the entire trip, because the vehicle should only be able to adjust location and speed at these moments:

- entering and exiting a function, because speed of the vehicle and speed of the function could be different. A self-driving vehicle could gradually adjust its speed to fluently transition between pathway and function.
- when the vehicle, when it is driven by the passenger, moves too slow (for the city) or tends to leave the pathway.

2. vehicle has to be able to travel at steep pathways.



A possibility: automated pods moving through pipes.
Why a pipeline system?
Even though there are other possibilities, with the pathway network with its steep pathways it makes sense to use a pipeline system.

SYSTEM AND WAYFINDING

Wayfinding with smartphones

An example of using a smart technology is a smartphone app. What if the city of Rotterdam had it's own app to help you travel through the city?

You can insert your destination and let the app calculate your route. The app could keep a list of your recent destinations to improve the app's user friendlyness.

When opening the app, it connects to satellites and determines your gps coordinates.

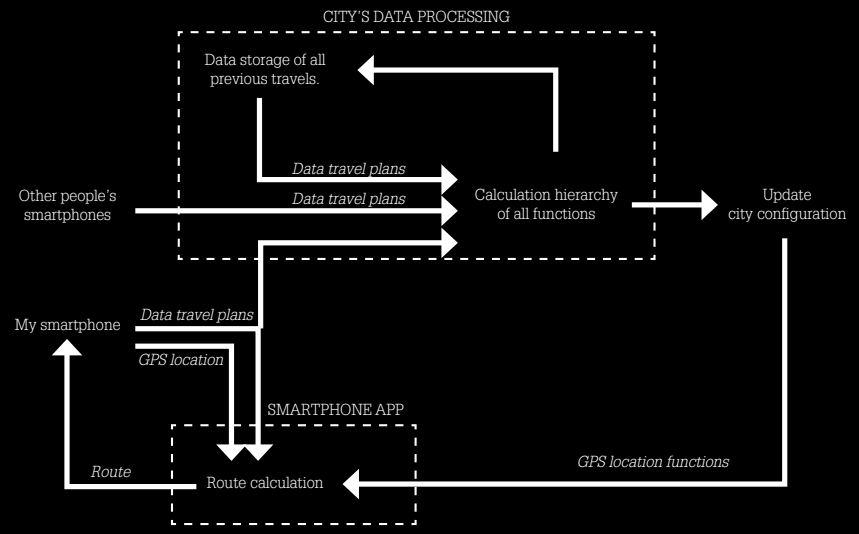
The app is connected to the city system which regulates the building's locations and can thus find the location of your destination and determine the shortest route.

Once it has determined your destination you can insert your destination.

Then you could dock your phone into your vehicle. Smart vehicles necessary in the city will, based on the information coming through from the smartphone, move you in the correct direction towards your destination.

Because buildings are constantly moving you will get lost in the city. Therefore we need smart technologies to help us move from starting point to destination.

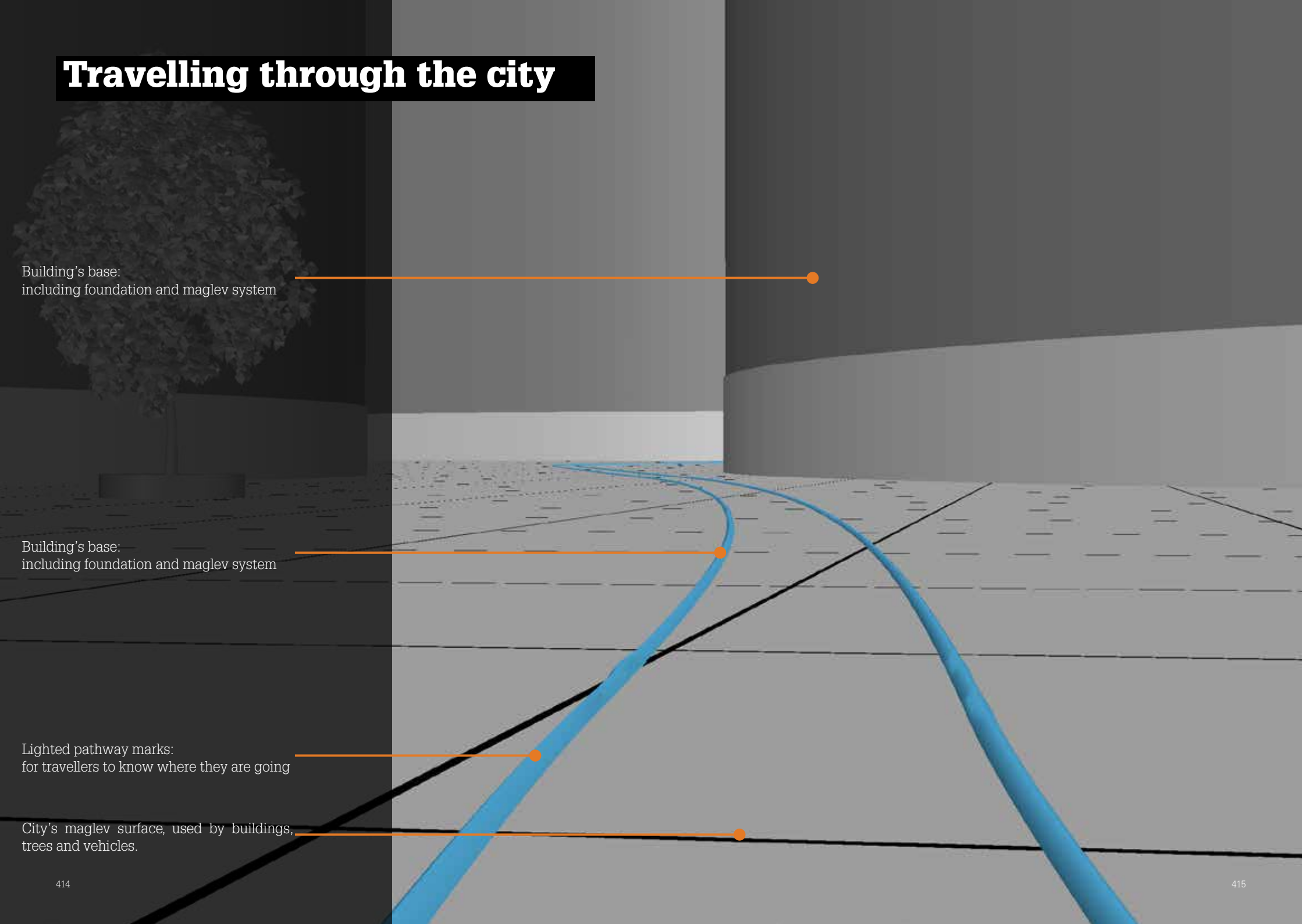
The city's system



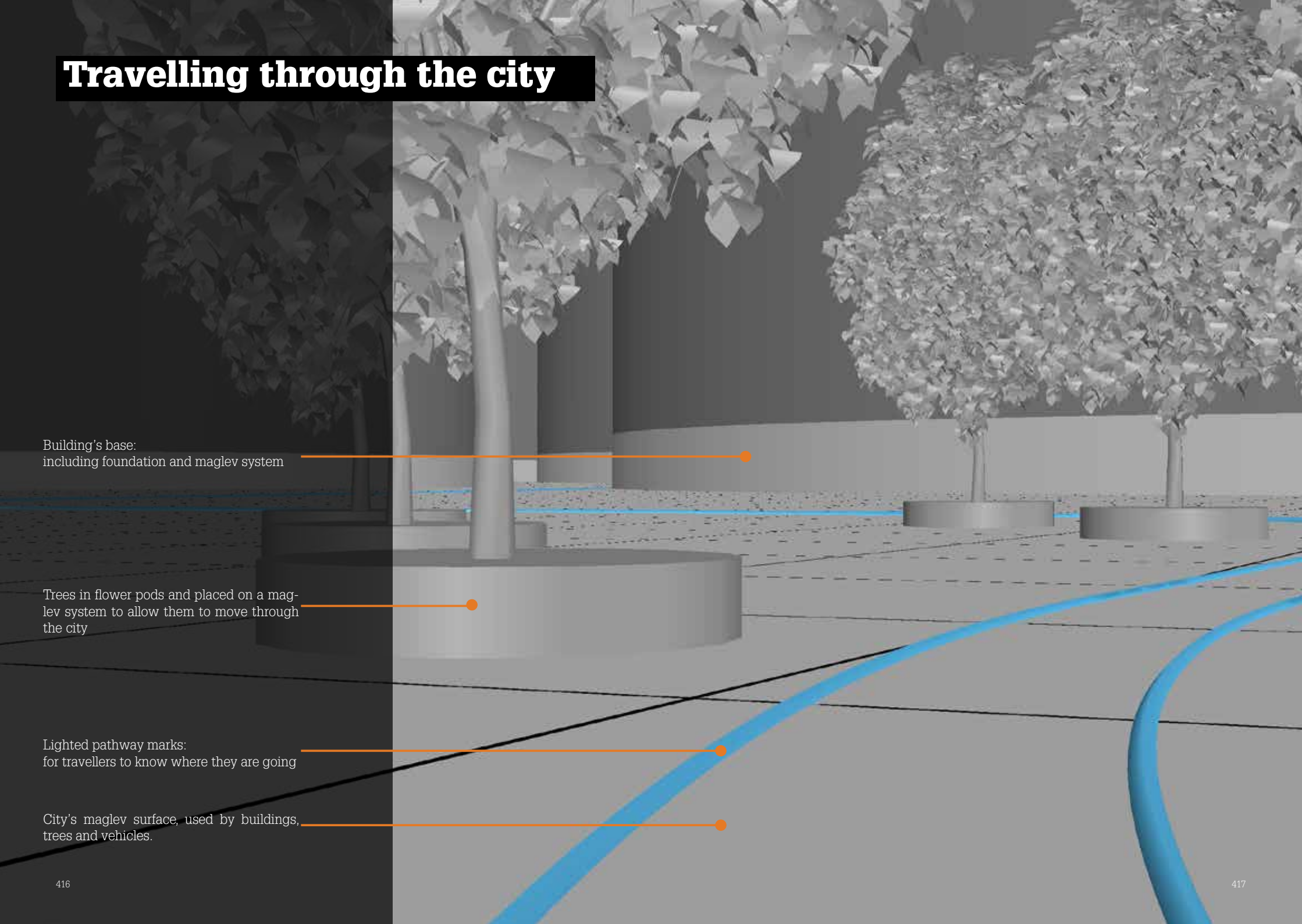
Wayfinding with smart roads

With the maglev system we might not need road marking since the system can move you in the right direction. The choice to display road marking is based on a psychological factor: for passengers it is comfortable to know the directions of the vehicle to avoid motionsickness.

Travelling through the city



Travelling through the city



PART 6

CONCLUSION AND REFLECTION

CONCLUSION TRAVEL TIME IMPACT

Research questions

What if the city could reduce travel time?

1.
How can the city reduce travel time as much as possible?

Firstly, by applying the five tools to the city:

- **Tool 1: Reshaping the particles could lead to a travel time reduction of 66%**
- **Tool 2: Configuring the city based on connection intensities reduces travel time with 12% to 50%.**
- **Tool 3: Resizing the particles reduces travel time slightly with 7%.**
- **Tool 4: Direct pathways for a shorter travel time.**
  To calculate the travel time impact more research is needed.
- **Tool 5: Limiting space for pathways by merging them.**
  To calculate the travel time impact more research is needed.

There are possibilities to adapt the rules of the tools to research if travel time could be reduced even more.

Secondly, by limiting space for construction, utilities and air for daylight.

2.
How much can the city reduce travel time?
How much of the 3,9 years will we be able to spend on other things than travel?

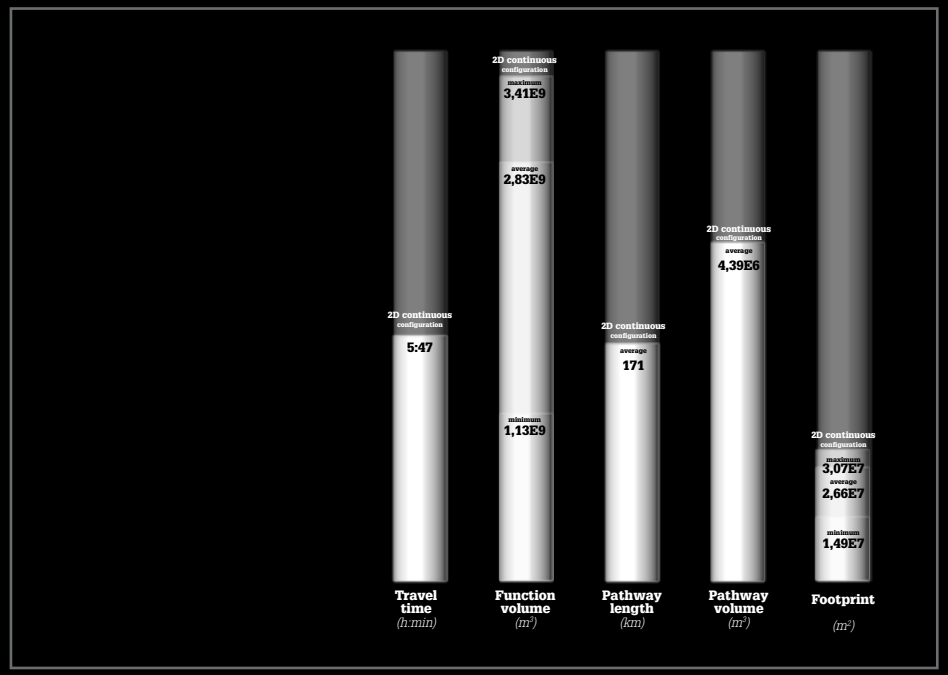
Applying all tools on the city of Rotterdam will result in a travel time reduction of 51%.
Travel time decreases with 6% by changing the amount of air volume for daylight.
Travel time increases with 1% by construction limitations.

Both the tools to reduce travel time and feasibility measures will result in a total travel time reduction of 54% for the city of Rotterdam.
This saves us:
6 hours and 41 minutes a week,
more than 14 days a year,
2,2 years in a lifetime.

3.
What would the city and life in the city look like then?

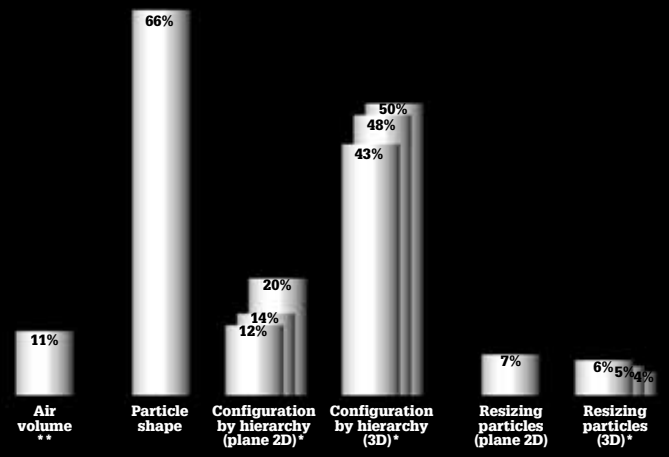
You see buildings moving and changing.
You can feel yourself moving when you are in a building (block).
You have a lost sense of place, because the city continuously changes.
To travel we need smart technologies, such as self driving vehicles, smart pathways and smartphones apps.

Values Accelerated City



Travel time reduction (%)

Which tool has the biggest impact on travel time reduction?
The graphs show the impact of the tool when only that tool would be applied to the city.



* Front bar: fixed configuration
Middle bar: daily configuration
Back bar: continuous configuration
** When all light/air volume is removed.

Travel time in life time

Applying the 5 tools on the city and taking the feasibility measures will save us 2,2 years of our lives.

If we eliminate all travel time during our lives, we gain 3,9 years in our lives to spend on other activities.

*based on a life expectancy of 77,3 years (Dutch average) *Source:CBS*
*based on an average travel time per day of 73 minutes
Source:De mobiele stad, van den Boomen, Venhoeven, 2012
* based on 8 hours of sleep each night

Total years in our lives we are awake

REFLECTING ON THE ACCELERATED CITY

Implications of living in the accelerated city

1.

Would the Accelerated City be a 'nice' city to live in? What things could people miss in the city?

People could miss a sense of place, a sense of "belonging". People tend to have an emotional connection to the area they live in. Since the area people live in continously changes this emotional bond will be absent.

2.

Based on TTB of 1.1 hours a day, people living in the accelerated city will then travel further (to a supermarket further away). Or they'd spend more travel time outside the city because inside the city their travel time is low. Thus increasing the speed in the city does not necessarily reduce people's travel time.

Implications of the accelerated city

1.

The maglev system used to move buildings and people, could be very energy consuming.

2.

People are forced to use certain types of vehicles.

PROJECT REFLECTION

Adding tools

Which tools can be added to create an even faster city or a city which is more realistic towards pathway limitations or necessary elements in the city? Here some elements to be incorporated in new tools or to be added to existing tools.

Turning radius
The minimum turning radius of a vehicle sets limitations to the pathways.

Crossings
Crossings increase travel time. This tool could include research on the impact on travel time by different types of crossings (same level crossings / fly overs), and applying the type which has the least amount of increase in travel time.

Inclination
The inclination of a pathway increases or decreases the speed of a vehicle. Especially in a 3D configuration of the city this data determines the travel time in the city.

Volume for parking
The city now consists of function volumes and pathway volumes. The volume needed for parking vehicles is also an interesting one since the size of it depends on the properties of the vehicle. Just as particles can resize when they are not in use, so can parking space.

View
To create a liveable city, rules could be set up to assure certain or all functions to have some kind of a view.

Reflection on the current state of the tools, how they are used and future development

Tool 1: Reshape particles

The first tool of this project is also the least complicated one. Therefore it already works really well.

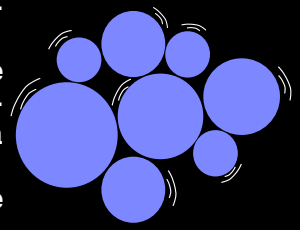
Even so, the tool has some possibilities for future development. Currently, only the effect of changing the current volumes of Rotterdam into spheres is tested in this tool. This tool could be further expanded by adding possiblities such as reshaping the particles into cubes or other shapes. It could also be interesting to test within this tool the effect of different types of functions reshaped in different types of shapes. Which type of function has the biggest effect on travel time when it is reshaped? Which type of shapes have the biggest effect on travel time reduction?

Tool 2: Configuration

The tool is not very user-friendly yet, since creating correct configurations involves several types of software, multiple separate scripts and a lot of time. (Combining the software and scripts into one is exceeds computer capabilities)

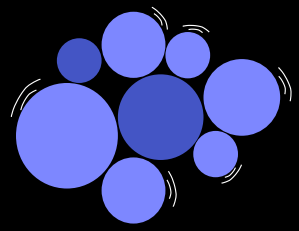
Experiments in this project:

- **All spheres will have a fixed position, with a configuration based on the total connection intensities per week.**
- **All spheres move at the same time during the night, creating a configuration based on the total connection intensities for the following day.**
- **All spheres can continuously move with configurations based on the current connection intensities.**



Experiments for continuation of the project:

- **Several spheres can move, and others remain in a fixed position. Which particles will have the biggest impact on travel time reduction when they can move?**



- **City's configuration based on not only connection intensities between particles in the city, but also connection intensities between the particles and the city's main transit exits.**

Tool 3: Resizing particles

Currently, the tool is applied on volumes that still include air volume (see (Tool 6) Optimizing air volume) It is then confusing to understand if the air volume resizes as wel or not. Therefore it would improve the clarity of the story to include Tool 6 as a tool which removes air volume. Then it's clear that when tool 3 is applied to the city, only used function volume is reduced and increased in size.

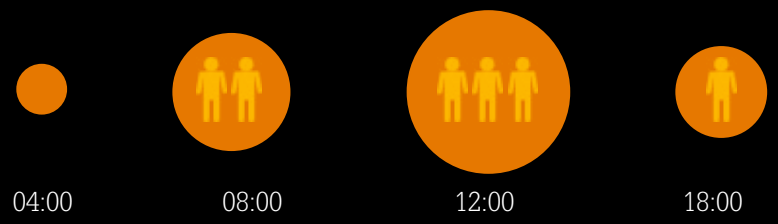
Apart from this issue, the tool is not that complicated and therefore works fine and is very user-friendly.

Experiments in this project:

- **Spheres only get smaller when no people are in the function. When at least one person uses the function, the sphere grows to its maximum size.**

Experiments for continuation of the project:

- **Spheres can continuously resize, based on the number of people using the function at that time: with fewer people the sphere is smaller, with more people the sphere is larger.**

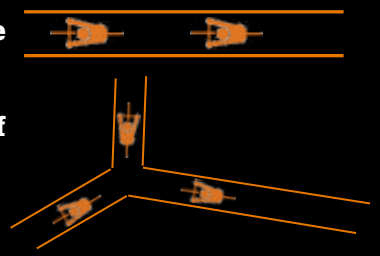


- **Not all of the spheres resize. Which of the functions have the biggest impact on travel time reduction when they reduce in size when they are not used? Which functions are more likely to be able to resize?**

Tool 4: Pathway volume

Experiments in this project:

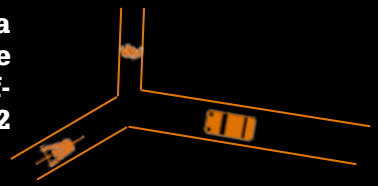
- **Only one type of vehicle is used by all travellers. This project tested a vehicle with the same dimensions, capacity and speed as a bicycle. so:**
- **Within one connection only one type of vehicle is use.**
- **For each connection the same type of vehicle is used.**



Experiments for continuation of the project:

- **Multiple types of vehicles are used within a connection. This will result in separate lanes for each vehicle type and thus a larger pathway volume.**

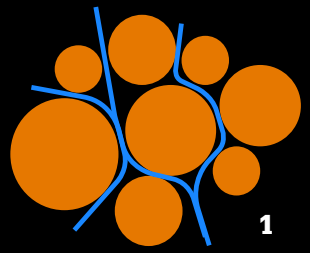
- **Each connection could be used by a different type of vehicle. Difference in vehicle speed could lead to a different configuration of the city. Tool 2 could be adjusted based on that.**



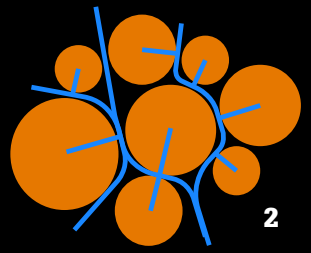
Tool 5: Pathway merging

Experiments in this project:

- **Each connection will find its shortest route inbetween the particles. (image 1)**

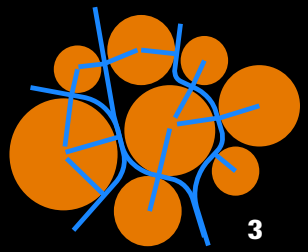


- **Each particle has one entrance. (image 2)**

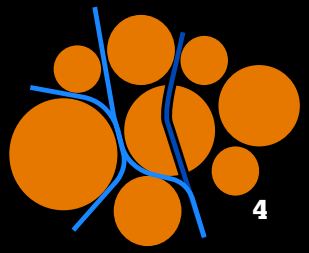


Experiments for continuation of the project:

- **The larger the pathway volume, the more travel time. But at the same time: the smaller the pathway volume, the longer the pathways and the more travel time. Where lies the optimum for travel time reduction?**



- **Vehicle's turning radius limitations. If a pathway's curve is to small for the vehicle's speed, either find a new route or adjust the pathway.**



- **Test the theory that travel time reduces when (certain) particles have more than one entrance. (image 3)**
- **At some moments pathways are allowed to pass through particles, e.g. with certain functions (e.g. forests) and when travel time is reduced with more than x% when a pathway goes through the function. (image 4 and 5)**

(Tool 6) Optimizing air volume

Within the timeframe of this project, the optimization of air volume in the city is not developed enough to be considered a "tool". Still, in continuation of this project it could be developed into a multipurpose, usable tool, since the start of its development is present in this project.

To develop this tool, it should have a proper placement in the City Accelerator story along tool 1 to 5. I'd place this tool between tool 1 and tool 2: after the particles are reshaped into spheres and placed as close to each other as possilbe, the current amount of air could be extracted from them, after which the particles will be configured in tool 2.

At the moment lightpaths are merged in the "feasibility" part of the story, air is inserted back again in the volumes, perhaps in different amounts than in current Rotterdam. Telling the story in this way clarifies the effect of the amount of air in the city on travel time. In the current story, this effect is a bit vague. The amount of air in the city could be visualized throughout the whole story by adding an extra graph bar next to travel time, function volume, pathway lenght and volume and footprint called "air volume" while the tools are applied to the city.

(Tool 7) Lightpath merging

Currently, the amount of volume for lightpaths is optimized to benefit both travel time and liveability. This optimization could use more development.
For example, currently the amount of light transmitted and reaching its destination is not evaluated. It does not visualize the amount of light each home receives and if that amount is sufficient. Therefore, the effectiveness of the tool is still unclear. The tool needs rules that answer questions such as: what minimum amount of light does each home need?

Tools used for other purposes than to reduce travel time

Tool 1: Reshape particles

Can we use this tool for a purpose other than to reduce travel time?

Example 1

As already shown in this project, reshaping the particles can have a large impact on the city's footprint, and this tool could thus be used to increase or reduce the city's footprint.

Tool 3: Resizing particles

Can we use this tool for a purpose other than to reduce travel time?

Example 1

Just like the first tool, resizing the particles can have an impact on the city's footprint, and this tool could thus be used to increase or reduce the city's footprint.

Example 2

What if one building has different functions during the day or week? For these different functions the building should have (slightly) different sizes. The tool could be used to calculate the size of each room when the room changes its function. The size of the room is then not based on the number of people present in that room but the number of people present in combination with the room type.

Tool 2: Configuration

Can we use this tool for a purpose other than to reduce travel time?

Example 1

The hierarchy index can be used for repulsion (instead of attraction), creating a distance between certain particles (e.g. housing and industry, e.g. kitchen and bedroom) to avoid for example sound/air pollution. To determine the hierarchy index, not the connection intensity, but data on sound/air pollution for each combination of two particles determines the hierarchy. The more disadvantageous a combination of two particles, the further they should be placed away from each other.

Example 2

The hierarchy index can be used to create not a lowest travel time possible, but a highest travel time possible or a desired travel time.
To create the highest travel time possible the hierarchy index is created by the rule: the more people use a certain connection, the further the particles should be placed away from each other.
To create a city with a desired travel time, the rules are more complex and the tool should be further developed, but in essence the configuration is still based on a hierarchy.

Example 3

The tool could be used to control densities in the city or building. In the case a designer has the ambition to control the location of people in the city, the tool could be used to organize functions to (for example) concentrate all/most people in one area of the city or to spread people over the city as much as possible. In the last example the hierarchy might be determined in this way: the more people in each combination of two particles, the further they should be placed away from each other.

Example 4

The tool might be able to create certain (city) typologies: e.g. monocentric or polycentric typologies. Certainly, the tool should be further developed and the rules should be changed.

Example 5:

What if we want to create the safest city possible? How could all particles be positioned in relation to the fire department, the police and the hospitals? The hierarchy could then be based on sets of particles that have a high need to be close to each other (e.g. police and cafes). It could really become interesting when this hierarchy is combined with another hierarchy, for example the one to reduce travel time. When is travel time more important then safety?

Example 6:
Finally, the tool could also be used with the Value of Travel Time Savings. The higher the VTTS for a connection, the more important it is to reduce the travel time on that connection.

Tool 4: Pathway volume

Can we use this tool for a purpose other than to reduce the amount of volume?

Example 1

Currently, the tool creates pathways with the most compact dimensions possible. Still, data can be adjusted within the tool, creating for example broad pathways that enable placement of trees and benches to create a more pleasurable travel experience.

Example 2

Since the tool only creates a volume based on instensities of objects going from start to finish the volume could represent anything. In this case it represents a pathway, but it could also represent water ducts, automated freight transport etc.

Tool 5: Pathway merging

Can we use this tool for a purpose other than to reduce the amount of volume?

Example 1

Within the City Accelerator project this tool has already been used in a different way. To optimize the amount of air within a building block, the tool was used to merge lightpaths. The purpose of using the tool with lightpaths was to optimize the amount of light in the building block: the volume for light should be kept

as low as possible, while still having enough light volume to create a liveable building.

Example 2

Since the pathways could represent anything travelling from start to finish, this tool could also for example merge water ducts, electricity cables or construction columns/beams (forces travelling from top to bottom). Of the latter, one first quick test was already executed with the design of the 3D configured city.

(Tool 6) Optimizing air volume

Can we use this tool for a purpose other than to reduce the amount of volume?

Example 1

The "tool" allows you to remove as much air volume as you'd like or even add more air volume. This means the total air volume could be set to 0 to create a super dense city or building (without any daylight). Or they it be given a very high amount of volume creating a super porous city or building.

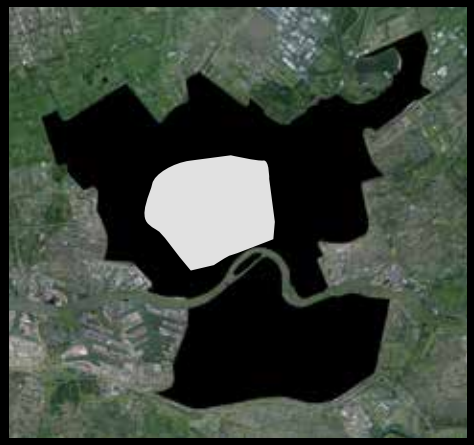
(Tool 7) Lightpath merging

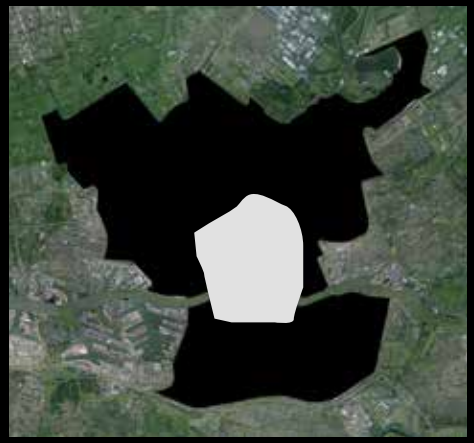
Can we use this tool for a purpose other than to reduce the amount of volume? Currently, the amount of volume is optimized to benefit both travel time and liveability.

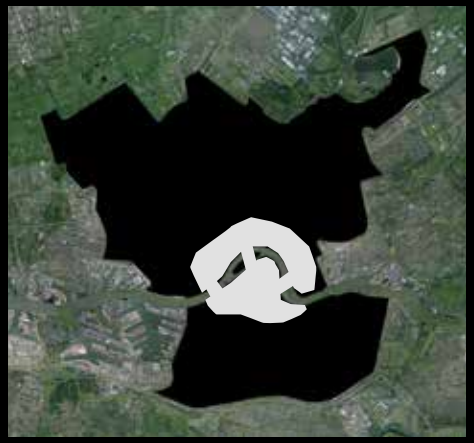
Example 1

Apart from optimizing the amount of volume for lightpaths, the volume could be reduced to 0 to create a super dense city or building (without any daylight), the volume could be increased to create a superporous city or building.
This could be done in two different ways. The first is to reduce/increase the level of pathway merging: the more pathways are merged, the less volume lightpaths take. The second is to reduce/increase the lightpath radii: the thicker a lightpath, the more volume it occupies and the more light it transmits.

The accelerated city and its sourroundings

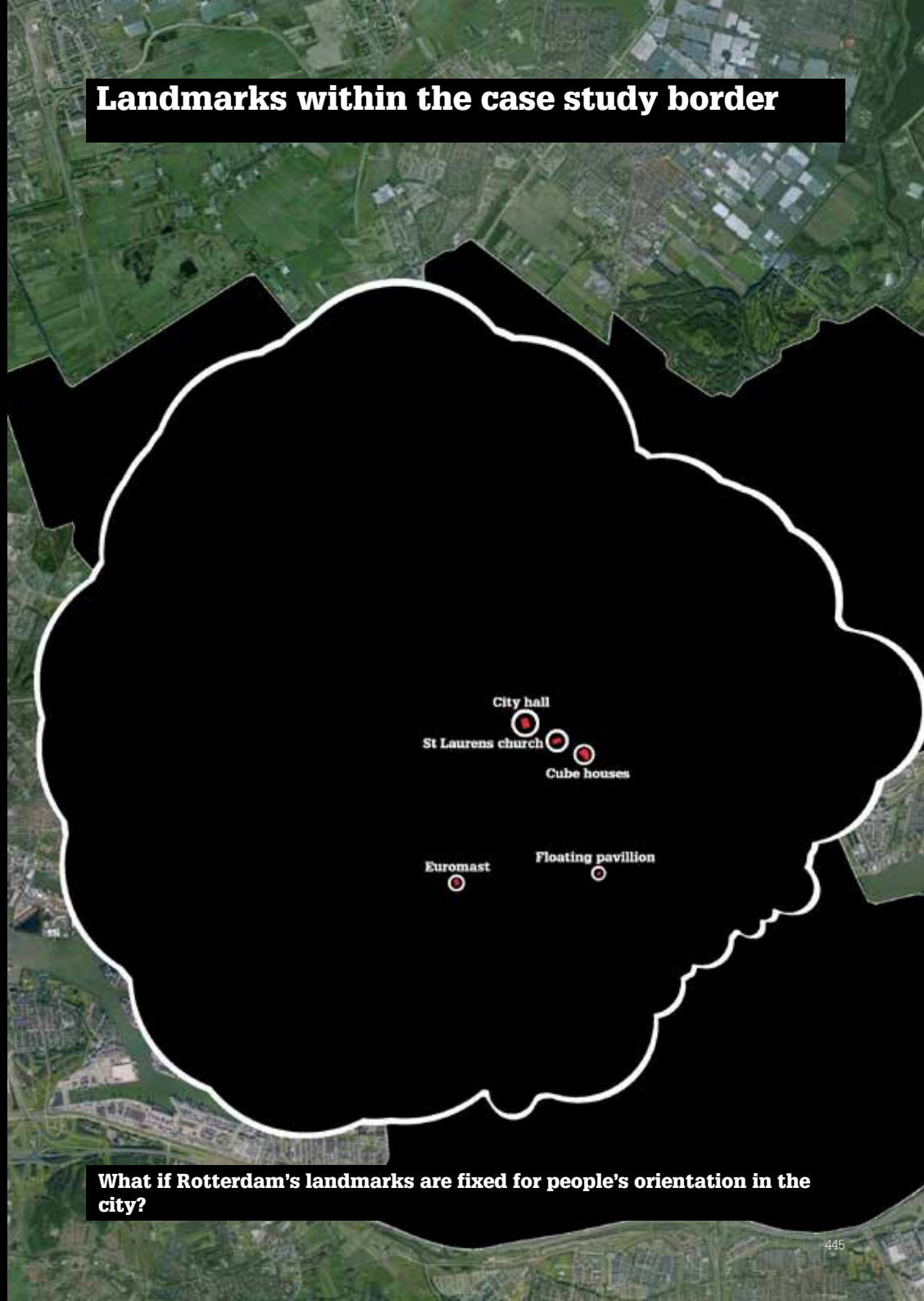






What is the relation of the Accelerated city to Rotterdam's surroundings, for example the river Maas? Is the city situated next to the Maas? Does it cover the maas?

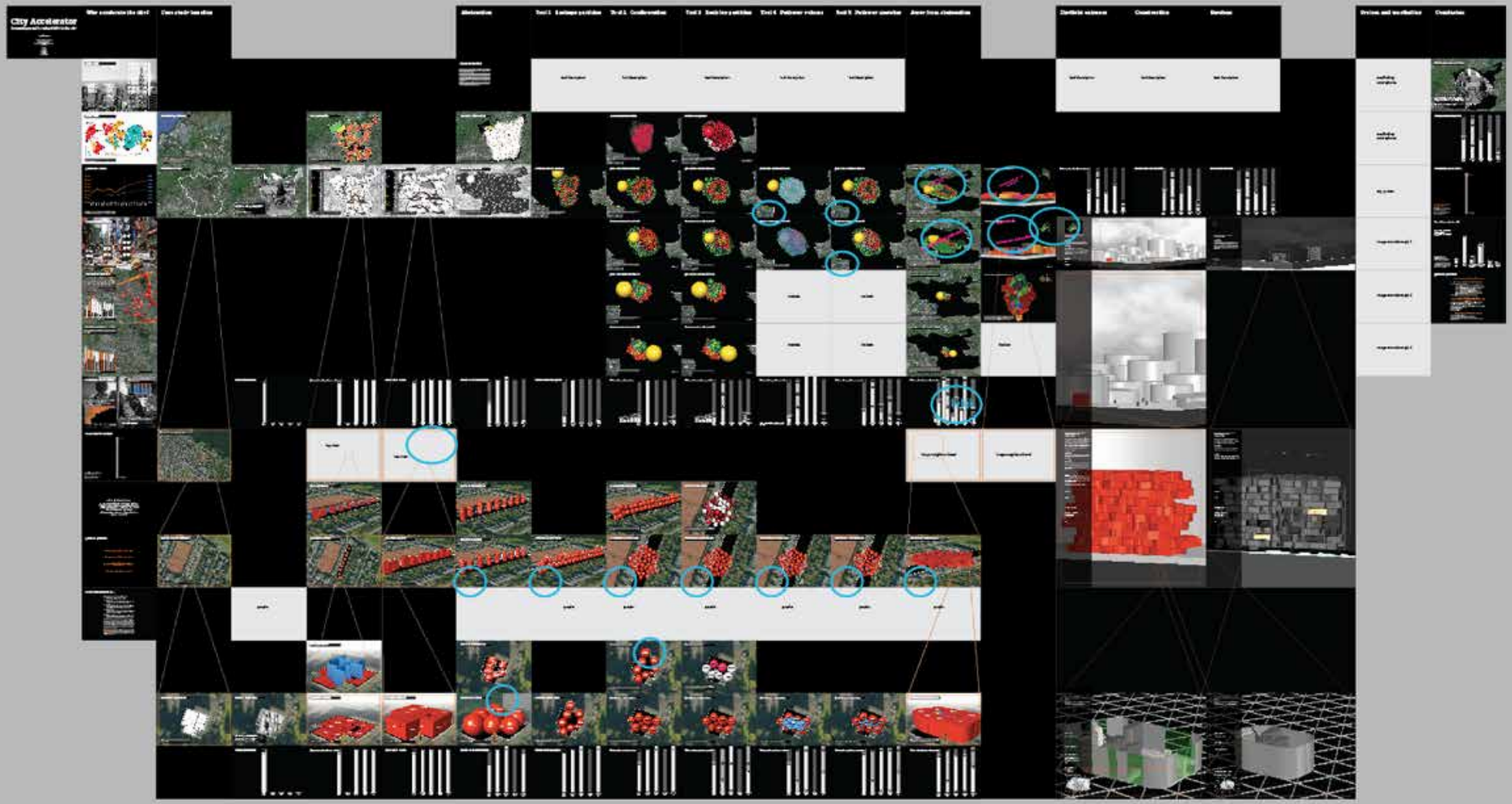
Landmarks within the case study border



What if Rotterdam's landmarks are fixed for people's orientation in the city?

APPENDIX

Presentation wall



NB: at the moment of production of this booklet, the presentation wall was still a work in progress.

Sources

Why do we travel?

[1] [2] [3] [4] [5] Mokhtarian, Patricia & Salomon, Ilan (2009) *How Derived is the Demand for Travel? Some Conceptual and Measurement Considerations*. Institute of Transportation Studies, UC Davis.

Mobility trends

[1] [2] [3] Boomen, Tijs van den & Venhoeven, Ton (2012) *De mobiele stad*. Nai010 Uitgevers, Rotterdam
[4] http://globalchange.mit.edu/research/publications/327
[5] Tomorrow's transportation: changing cities, economies and lives.GarrisonWard.2000
[6] In perpetual motion. Travel behavior research opportunities and application challenges. 2002. Setting the research agenda: response to the new transport alternatives and policies. Peter Jones

Importance of mobility

[1] [2] [3] [4] Tomorrow's transportation: changing cities, economies and lives.GarrisonWard.2000

Value of travel time savings

[1] Tseng, Yin-Yen & Verhoef, Erik T. (2008). *Value of time by time of day: a stated-preference study*. Transportation research Part B, 607-618.
[2][3][4][5][6] NA
Image based on:
Victoria Transport Insitute. *Policy Transportation Cost and Benefit Analysis II - Travel time costs*.
Wardman, Mark (2001b). A review of British evidence on time and service quality valuations. Elsevier Science Ltd., 107-128.
Zamparini, Luca & Reggiani, Aura (2007). Meta-analysis and the value of travel time savings: a transatlantic perspective in passenger transport. Springer Science, 377-396.
Hill, Alexandra & Noti, Julian (2009). Costing customer time
Victoria Transport Insitute. *Policy Transportation Cost and Benefit Analysis II - Travel time costs*.
Litman, Todd & institute, Victoria transport policy (2008). *Build for Comfort, not just speed. Valuing service quality impacts in transport planning*.
McDonald, John F. (1974). *Variations in the value of reductions in commuting time*. Journal of urban economics 2, 265-277.
Shires, J.D. & Jong, G.C. de (2009). *An international meta-analysis of values of travel time savings*. Evaluation and program planning, 315-325.
Department for transport (2011). *Personal travel Factsheet. Commuting and business travel*.
Tseng, Yin-Yen & Verhoef, Erik T. (2008). *Value of time by time of day: a stated-preference study*. Transportation research Part B, 607-618.
Wardman, Mark (1997). *A review of evidence on the value of travel time in Great Britain*.
Wardman, Mark (2001). *Inter-temporal variations in the value of time*.
Wardman, Mark (2004). *Public transport values of time. Transport Policy*, 363-377

Cities grow

http://www.fastcodesign.com/1669244/by-2050-70-of-the-worlds-population-will-be-urban-is-that-a-good-thing
http://www.who.int/gho/urban_health/situation_trends/urban_population_growth_text/en/

Rotterdam grows

http://www.rotterdam.nl/COS/publicaties/Vanaf%202005/12-3583.Bevolkingsprognose%20Rotterdam%202013-2030.pdf

Urban travel increases

http://www.adlittle.com/reports.html?&view=528

Congestion increases

http://www.elsevier.nl/Nederland/nieuws/2013/4/Nederland-tweede-op-Europese-ranglijst-52-uur-in-de-file-1238807W/
http://www.theatlantic.com/business/archive/2013/02/the-american-commuter-spends-38-hours-a-year-stuck-in-traffic/272905/

Polluted streets due to congestion

http://www.nrc.nl/nieuws/2013/09/05/dit-zijn-volgens-milieudefensie-de-twintig-meest-vervuilde-plekken-in-nederland/

Travel time: waste of time?

NA

Travel time in lifetime

CBS
Boomen, Tijs van den & Venhoeven, Ton (2012) *De mobiele stad*. Nai010 Uitgevers, Rotterdam

A typical week in 2013

Graph based on:
[1] http://statline.cbs.nl/StatWeb/publication/?DM=SLNL&PA=81123NED&D1=0&D2=0&D3=a&D4=0,25-38,40,44&D5=0&D6=l&HDR=T,G4,G1,G5,G2&STB=G3&VW=T
[2] Kennisinstituut voor Mobiliteitsbeleid. *Mobiliteitsbalans 2007*, p. 31.

Function volumes

[1] http://stadsregio.nl/kerncijfers-2012
[2] http://www.openingstijden.nl/Zuid-Holland/Rotterdam/Supermarkten/#10
[3] http://www.hbd.nl/pages/15/Winkels/Detailhandel-totaal/Aantal-winkels-per-gemeente.html?subonderwerp_id=25
[3] http://www.openingstijden.nl/Zuid-Holland/Rotterdam/Supermarkten/#10
[4] http://10000scholen.nl/zoeken/basisschool/zuid-holland/rotterdam
[5] http://www.zorgkaartnederland.nl/huisarts/rotterdam

Maglev on a plane

[1] http://en.wikipedia.org/wiki/Maglev#Technology
[2] http://www.theregister.co.uk/2012/12/30/maglev_disk_moves_with_lasers/
[3] http://www.ece.neu.edu/faculty/nian/mom/img/Inductrack.gif

For movies visit:
www.laratomholt.nl

People travel more and more. And as cities grow, and travel in the cities increases, we need to find new solutions to enable people's need to travel while avoiding congestion. Travel speed increases with new vehicle technologies. But what if not only vehicles, but also the city itself could get us faster from starting point to destination? How can the city achieve a decrease of our travel time?

City Accelerator investigates tools to reduce travel time in the city. And even though the tools were developed to reduce travel time, they could be used in a different way to optimize other elements of the city as well.

The tools are generic and could be applied to any city or building. *City Accelerator* uses different scale levels of the city of Rotterdam as case studies to test these tools.

The main hypothesis of the *City Accelerator* is: the more adaptable the city, the lower the travel time. *City Accelerator* tests the impact of each tool and the impact of the level of adaptivity on travel time in the city.

What would the accelerated city and life in the accelerated city look like? To enable adaptability, the *City Accelerator* tests the use of new construction technologies and specifies the requirements for vehicles in these cities. It also reflects on people's independence to move through the city: can we travel on our own or do we need new technologies to help us travel?

City Accelerator is one of the graduation projects of the *Adaptive City* graduation studio (2013-2014) led by The Why Factory.