Notes on

Urban design quality, a function of variety

Taeke M. de Jong 2014

This notebook belongs to:.....

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Urban design quality, a function of variety

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1 Criteria for urban design quality, a function of variety[a]

1.1 Environmental quality

For many environmental variables, any species has its own requirements between ‘too little’ and ‘too much’ in order to survive. Curves of ‘ecological tolerance’ show the ‘mi-lieu juste’, the ‘right middle’ for a species (A) with an optimum where they can prosper best, and at both sides where they grow marginally (a) until their boundaries of survival.
These curves are different for any species.

Fig. 1 Ecological quality (Environmental variables)

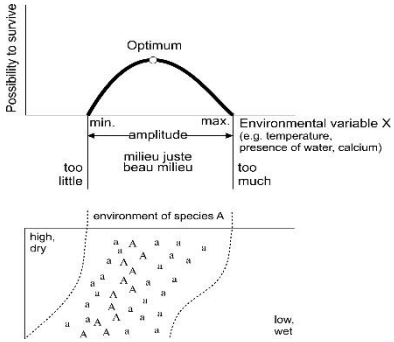
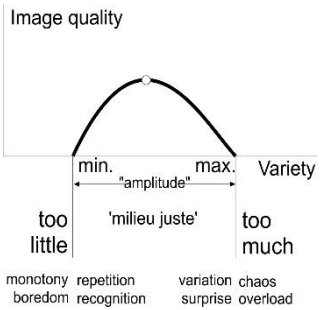


Fig. 2 Image quality (Variety)



A diverse environment then, is a risk-coverage for many species: a risk coverage for biodiversity. You may observe zones of different vegetation at a slope between high (dry) and low (wet) soils. Any requirement of moist is facilitated, and different species can choose their own ‘mi-lieu juste’. Moreover, it is a risk-coverage for change: in wet periods the higher located marginal individuals (a) flower optimally (becoming A), in dry periods the lower ones.

For humans, any individual also has its own ‘mi-lieu juste’, a specific environment to be happy. For the diversity of humans, a variety of environments increases the chance to provide an appropriate place for everybody. It provides more freedom of choice than boring homogeneous residential areas. It supplies more identity (your unique place in time and space: name and address, origin and provenance). Identification with your own environment then also promotes care for this environment.

However, too much variety may cause a feeling of chaos, overload. Just as there may be ‘too little’ variety, there may be also ‘too much’. Between these boundaries, humans move between recognition and surprise. After a busy day, you may look for recognition; after a boring day you may look for surprise. This is a human ‘amplitude’ between repetition and variation. It is the task of urban design to provide both, probably at different levels of scale (repetition at one level, variety at another), in different ‘layers’ of the environment (repetition in one layer, variety on another) and in

[a] This document represents parts of a more extended thesis downloadable from http://www.taekemdejong.nl/Publications/2012/Jong%282012%29Diversifying%20environments%20through%20design%28Delft%29TUD%20thesis%20concept.pdf .

different ‘orders’ of variety. The designer determines measures, and keeping measure at different levels of scale determines the quality of her or his design.

1.2 Criteria for urban design quality

The first criterion for such a quality is an apparent and careful distinction of modes, orders, layers and levels, each with their own kind of possible diversity. The second criterion then is, an appropriate use of their subsequently extending possibilities. It is the aim of this document to explore their potential. This requires more imagination than generally found in a population, disturbed through an overload of precooked, mainly repetitive information. The information obtained at home, at school, at work, on the internet, and during holydays may look diverse, but its variety is little. It is little, compared to what is possible or imaginable. It is particularly little if you take a closer look on living nature, realising that we still ‘know’ so very little. Our education (as it is based on transferring generalizable ‘proven truths’ in mainly one-dimensional verbal language) lacks a notion of possibility (often appearing through active, more-dimensional sketching). Words themselves categorise supposed similarities in tacit generalisations. These hidden presuppositions of ‘equality’ cannot be doubted using other words.
It may be discussed through drawing. Drawings can show diversities and possibilities that cannot be expressed in verbal language. The logic of ‘and’, ‘or’, ‘if’, and so on, may specify words through added characterisations, but these characterisations themselves are generalisations. Their countless combinations may be surprising in poetry and literature, but the ever extending nomenclature in biology and chemistry demonstrates their insufficiency without any reference to images. The logic of a drawing is something else than the formal logic in verbal language.
The third and last criterion then is, that a design should offer more than words can express.

1.3 Environmental variety

Verbal language cannot fully describe a four-dimensional environmental diversity. Section 1 and 2 of this document explores what is verbally expressible: the distinction of different diversities, relevant for any sequence in a design process. Section 3, however, contains mainly pictures and little text, in order to experience the difference if you add a second dimension. It ex-plains (lays out in a plane) the linear course of the previous text. Pictures may extend the description into a second dimension, but the reality of the past, the present and the future is far more complex. Environmental diversity hits our senses in many colours, patterns, tonalities, smells, tastes and qualities of touch and movement. Our choices and behaviour are often unconsciously motivated through a combination of such impressions referring to vague, diverse images of memories, expectations and desires. Motivation is not stimulated through environmental monotony or chaos, but through a sound amplitude between recognition and surprise.

Urban design should provide both, but repetition is easy and diversification is not. The capability of design then, is primarily the ability to diversify. Repetition only requires copying, producing more of the same. In order to get grip on diverse possibilities, however, you at least must distinguish their modes, orders, layers and levels. You should be able to imagine the possible diversities within each of them, and then reduce and combine them in an appropriate composition. This composition should fit in the current administrative, cultural, economic, technical, ecological and physical context, but it will change the environment into something different. This amplitude between ‘known and new’ will hit the involved specialists, stakeholders and future users through recognition and surprise, if you avoid monotony *and* chaos, boredom *and* overload.

2 Modes, orders, levels, layers in spatial design

2.1 Limited imagination

You cannot remember everything you have ever seen, heard, smelled, tasted, touched or felt.
You remind similarities. You grasp similar objects in sets, usually called 'categories'.
You name them (e.g. colours, animals, machines, money, books, parents), in order to re-mind or imagine their presence, even if they are not actually there. Words represent categories.
Once you can speak, you may express the category you want, simply calling its name.
If your parents always give what you ask this way, then calling is getting. Words seem magic.
It will take time to imagine the actions to get it. Actions are named as verbs (e.g. come, take, eat).
You may have learned their names reacting on the commands you hear (come!, take!, eat!).
You may get a rewarding object executing the named actions, but there is an important side-effect.
The result is, that you can connect verbs and objects, be it without any other active subject than 'I'.
The imagination of other active subjects probably appears if someone else takes what you want.
Suddenly you may cry: "He took the apple!", but the result of this frustrating experience of 'not' is, that you have made your first full sentence with an object, a verb and … a subject!

This short introduction is not intended to give a realistic picture of child psychology or language development, but to introduce some problems of categorisation.
The initial mode of thinking in this example is wanting, not yet describing what is actually the case.
Wanting rather expresses what is *not* the case. This 'not' shows the ability of imagination. It is the first condition to imagine actions *if* something is *not* the case. It shows, that imagination already requires 'not' and 'if', before they can play a role as operators determining the *truth*-value of full sentences. Before logic can play a role in human thinking, some conditions of imagination have to be fulfilled first. The example shows, that one of these conditions is a recognition of similarities.
It usually results in generalising categories, limited as sets, expressible in words.
Our education is primarily oriented on generalisation, rather than on generation.
The question of this study is, whether this is the only way of thinking for designers.
It may limit your ability to imagine *possibilities* rather than categorised experiences of *truth*.

2.2 Modes

The example shows two modes of thinking: wanting ("apple!") and describing ("He took the apple!").
Both modes can be expressed in a verbal language.
If the mode of desirability is intended, then they can be distinguished adding a modal verb 'want'.
The mode of desirability is even clear if you skip *any* verb ("Coffee, please!").
If there is a verb without a preceding modal verb, then apparently 'describing a fact' is intended.
Consequently, the mode of 'truth', reporting facts, is the standard mode of our language.
There is, however, a third mode of thinking. If the modal verb 'can' precedes the verb, than you are warned that what follows is not necessarily true or desirable, but *possible*.
Our language tacitly presents 'possibility' as a deviation of the standard mode ('truth').
Modal logic even tacitly supposes that it is *part* of truth accepting a statement such as "It is true that this is possible". If you realise that any truth is possible by definition, but that not all possibilities are true, then you would prefer to say "It is possible that this is true". The set of facts supposed to be true is part of a much larger set of possibilities, not the other way around.
In the last century we learned to speak more carefully of 'probability' instead of 'truth'.
Probability is also part of possibility. You cannot expect a probable event if it is not even possible.

You can, however, imagine possibilities which are not probable, even if they do not yet have a name. Such improbable possibilities require a plan of action in order to realise them.
Imagining possibilities that are not yet true or even probable, is the core of design.

2.3 Orders

You cannot distinguish anything, if it does not differ in colour, sound, smell, taste, touch or any other feeling. If everything would be white, then you could not see anything.
Once you have distinguished objects, you can categorize them, and take action in order to get any of them. The world around you has got '*content*'.
You now can subtract apples from a tree and add them to the pile that you want to take home.
You also can take blocks and build a tower through adding.
This tower, then, is a new object of a larger size than the blocks. It is a composition of objects (the blocks) with a determined distribution in space called '*form*'. Form *supposes* a content taking shape.
In the case of the apple tree, you separate what has been connected. In the case of the tower, you connect what has been separated. It takes time to grasp the connections and separations between the objects you have distinguished. It takes time to understand the '*structure*' of a composition of objects. From the components in a car construction kit, you can make a car. If the structure you have made is stable enough, then you can play with it: it has got a '*function*'. If you want an aircraft construction kit next time, then this is your '*intention*'.

This example shows six 'orders' of diversity, supposing each other in an unavoidable, strict sequence. You cannot have an *intention*, if you cannot imagine the function (working) you want.
You cannot imagine a *function* without an operational structure (a set of connections and separations) performing this function, or a larger structure in which it can 'function'.
You cannot imagine a *structure* without any component that is connected or separated with other components in a proper composition, a determined distribution in space, a form.
You cannot imagine a *form* without anything taking that form, without any *content*.

2.4 Levels

Your tower is an object at a higher level of scale than your blocks. If you take some distance, then you may still distinguish the tower, but no longer the composing objects: your blocks.
Now, imagine a black spot, surrounded with 6 white spots. Imagine, that this hexagonal pattern is repeated infinitely. Comparing patterns of 7 spots, you must conclude similarity, *equality*. Taking a closer look at one spot, however, you must conclude *difference* (there is always a black spot next to a white one and the reverse). Consequently, your conclusion is scale sensitive.
It can even change, if you change the scale of observation only with a linear factor 3.
Name this paradox of 'equal differences' (!), of 'homogeneous mixtures' (!), 'scale paradox'.

Between a grain of sand (1mm radius) and the Earth (say 10 000km radius), there are 10 powers of 10. This is more than 20 powers of 3. Comparing images on 20 different levels of scale, may force you to change your conclusion 20 times. Any neighbourhood may look homogeneous inside, but a district with mutually different neighbourhoods may look heterogeneous. However, if any district has the same composition, then the city again looks homogeneous.
If, in the range of 20 scales, you compare only the 10 odd ones, then you may pretend that you have found a law, valid on any level of scale: 'Urban areas are heterogeneous!'.
The one who takes only the even ones into account, however, will disagree, and propagate an opposite law: 'Urban areas are homogeneous!'. Both of you are wrong.

Anyhow, what you call ‘different’ or ‘equal’ is scale sensitive.
If so, then anything you distinguish as an ‘object’, any difference or *content,* is scale sensitive.
Consequently, changing the level of observation changes the *forms* you will recognise.
The *structure* of an apple tree is substantially different from the structure of an apple.
They *function* different. I suppose you never have had the *intention* to eat an apple tree.
Even intentions are scale sensitive. If you can build a tower, this does not mean that you also can build a city. It is, however, not a *law* that conclusions will change every factor 3 difference of scale. It is only possible, and that is bad enough.

2.5 Layers

Physics covers the largest range of scales in space and time: from light-years until nanoseconds.
Biology covers a smaller range, from evolution until biochemical compositions.
The humanities cover an even smaller range, from world history until local human action.
Moreover, their different objects of study suppose each other.
You cannot imagine people without life, and you cannot imagine life without matter and energy.
If you want to design a landscape, an urban area, or a house, then you cannot avoid to involve physics, ecology, technology, economy, culture and management. These are the ‘layers’ of your object and its context. These layers require different kinds of imagination, but they suppose each other.
If a manager cannot count on commonly shared suppositions concerning tasks and conditions, then (s)he cannot manage a company. Culture is nothing else than a set of shared suppositions and material conditions. Management thus *supposes* a culture. Any culture, on its turn, requires economic conditions, required to survive. Without these material conditions, you cannot share any expectations as common suppositions in a community. In that case, the community falls apart in individual attempts to survive without anything you could call ‘culture’. Economics, on its turn, supposes a technology to survive. You may think, that technology is part of human culture, but culture only concerns its development through discovery and invention. As soon as techniques for survival, such as dikes, artificial manure and medicines have been invented and commonly applied, the available technology has become part of our physical conditions, making an economy *possible*.
On the other side, the biology of any species provides its members with techniques for survival: walking, swimming, flying, gathering, eating. It provides any organism with inborn specialised utensils such as legs, fins, wings, claws, tooth and so on. So, technique is *part* of our ecology, and it *supposes* biology, even if it has been extended through human interventions. On its turn, biology is conditioned through its physics.
It *supposes* a physical environment with sun, air, water and soil. At any level of scale you can distinguish such layers in different resolutions.

2.6 Conclusion

Common sense reduces your imagination in different modes. The strictest reduction is to be realistic. It allows you to imagine only real or probable things, proven by experience. In order to design, however, you must widen your scope into what is possible, and that is more than the things you remember as true or probable.
Imagining improbable possibilities requires conditional thinking, rather than causal reasoning only. Conditional thinking includes causes making events probable, but it extends into other conditions making them possible, realisable, even if they are not yet ‘true’.
In order to shape the conditions to make something possible, you primarily need an imagination of

material that can be shaped (content). This content may be solid, liquid, gas or even more abstract matter such as colours on your screen. Form cannot be imagined if there is nothing to take form. You may postpone the precise determination of content, but in order to draw a form on a white paper you need at least one contrasting colour for its outline or the filling of its shape. Form supposes content. If the form becomes realised, then material is a condition to realise a form.

Fig. 3 Conditions of imagination

modes	**orders**	**levels**	**layers**
probable	intention	…	managerial
possible	function	1mm	cultural
imaginable	structure	…	economic
	form	1m	technical
desirable	content	3m	biological
		10m	physical
		…	

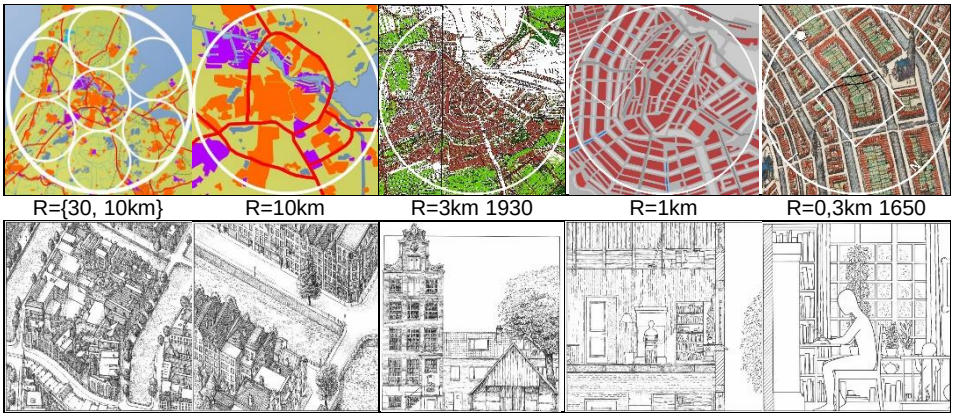
Fig. 3 shows successive conditions (orders, levels and layers) that must be fulfilled in order to imagine possibilities. Any intention supposes intended functions; any function supposes a structure by or in which it can function; any structure supposes a distribution of components in space and time: a form.
Within each of these orders you must choose the level of scale of the object and its impacts, and within any level of scale there are layers that require a different kind of thinking.
And, that is the case for every level of scale in space and time, for every order, and for every mode as well. All of them require a different kind of thinking.

3 Possibilities of urban design

3.1 Levels of scale are bounded between frame R and grain r

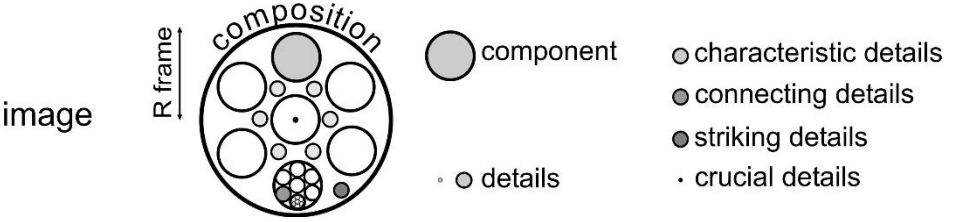
Any level of scale (determined through nominal[a] radiuses R and r) shows other differences. These differences may be useful in urban design if they are recognised and named.

Fig. 4 Which are the differences (possible, to be reinforced or to be weakened) within each radius?



How could you diversify or equalise components in these compositions?

Fig. 5 A composition (frame R) has components and 4 kinds of details (grain r).



[a] 'Nominal' refers to the measure as a 'name' for a *range* of measures netween the previous and the next one. R=300m then refers to the range 100-1000m.

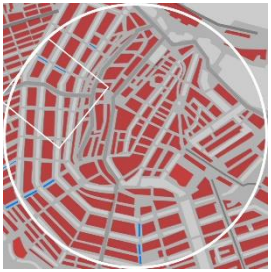
3.2 Content diversifies space

Any level of scale has its own variables (determining possible legend units), for example:

Fig. 6 Example 6x6km 1930[a]

	0 ├	3km
$Ecology_{3km}$	lifeless	many species
$Housing_{3km}$	attached	detached
$Agriculture_{3km}$	fields	settlements
$Technology_{3km}$	energy	information
$Economy_{3km}$	consumption	supply
$Meeting_{3km}$	home	work
$Culture_{3km}$	traditional	experimental
$Management_{3km}$	laissez-faire	initiative
...	…	…

Fig. 7 Example 2x2km



	0 ├	1km
$History_{1km}$	-300 000 000yr	+10yr
$Occupation_{1km}$	natural	urban
$Network\ Density_{1km}$	0.7km/km^2	7km/km^2
$Intensity_{1km}$	0hrs/yr	8 760hrs/inh*yr
$Pollution_{1km}$	clean	contaminated
$Routing_{1km}$	points	surfaces
$Image_{1km}$	homogeneous	heterogeneous
...	…	…

Fig. 8 Example 600x600m[b]

	0 ├	300m
$Soil_{300m}$	rock	water
$Zoning_{300m}$	natural	artificial
$Density_{300m}$	vacant	built
$Access_{300m}$	pedestrians	cars
$Building\ Size_{300m}$	small	large
$Centrality_{300m}$	centre	periphery
$Pattern_{300m}$	repetition	variation
...	…	…

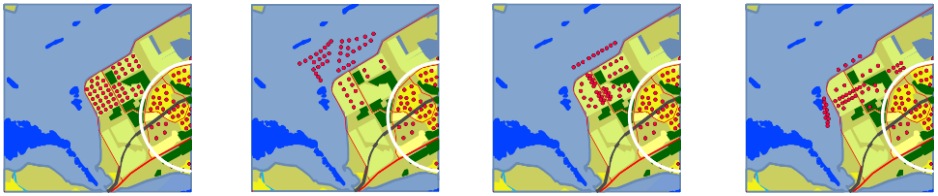
Try to find more variables, choose some (in between) values as possible legend units.

[a] Bonnekaart(1929)
[b] Blaeu(1649)[b]

3.3 Forms may distribute the same content in many ways

Form is the distribution of some content in space, for example material or people.
Plans already roughly show their form if you dot the distribution of floor space:

Fig. 9 Alternatives for 50 000 inhabitants in Almere R=3km, 10^3 inhabitants/dot[a]



Zero-alternative TKA Hosper H+N+S

If you count 30m^2 *floor space* per inhabitant, 1000 people cover a dot with a nominal radius r=100m (πr^2). Where no urban space is left between the dots, the floor space must be stacked as high rise.

Fig. 10 The Hague R={10km, 3km}
10^3 inhabitants/dot
(30m^2 floor space/inhabitant)

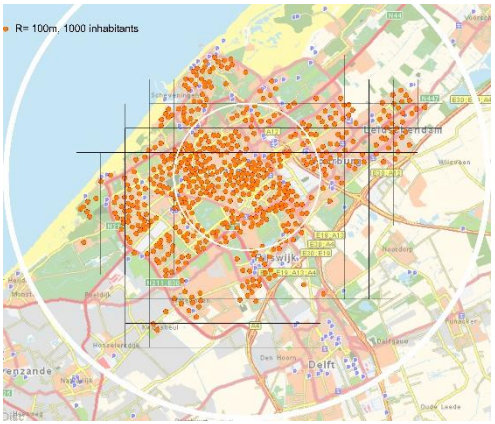
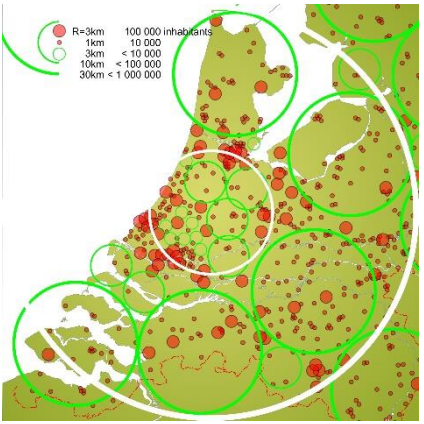


Fig. 11 the Netherlands R={100, 30km}
10^5 and 10^4 inhabitants/dot
(300m^2 urban space/inhabitant)



If you count 300m^2 *urban space* per inhabitant, 10 000 people cover a dot r=1km, and 100 000 people a dot r=3km. You then may call a region (R=30km) with more than 1mln people 'urbanised'.

[a] Jong (2001) Ecologische toetsing van drie visies op Almere Pampus (Zoetermeer) MESO

3.4 Structure (set of separations and connections) stabilises form

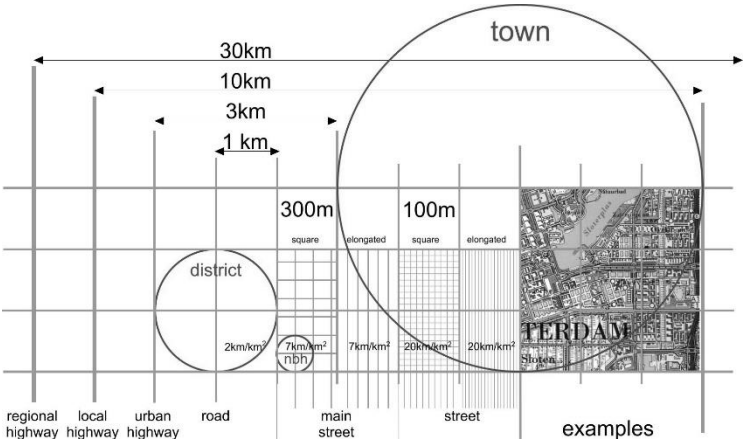
Every third road or waterway is usually of a higher intensity and level:

Fig. 12 Wet and dry networks

NETWORK		WET		DRY	
km/km^2 density	km mesh size	m width 1%	NAME	m width	NAME
70	0,03	0.3	trench	10	residential path
20	0,1	1	small ditch	20	residential street
7	0,3	3	ditch	30	neighbourhood road
2	1	10	watercourse	40	district road
0,7	3	30	race	60	urban highway
0,2	10	100	brook/canal	70	conurbation highway
0,07	30	300	river/waterway	80	regional highway
0,02	100	1000	stream/pond		national highway
	300	3000	lake		fluvial highway
	1000	≥10000	sea		continental highway

In a wet land the dry network interferes with the wet one through bridges or tunnels.
Any urban area has a hierarchy of roads roughly obeying such a factor 3 in between.[a]

Fig. 13 Dry networks

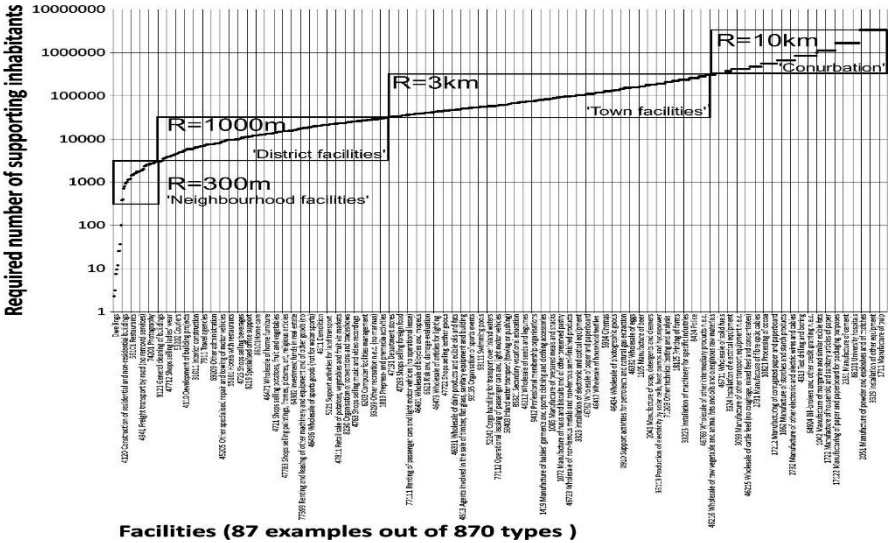


At any level of scale, it diversifies the area in polarities from quietness into accessibility with different functional possibilities from business into park.

[a] Nes;Zijpp(2000)Scale factor 3 for hierarchical road Networks, a natural phenomenon?(Delft)Trail

3.5 Function contains different uses at every level of scale

Fig. 14 The average number of inhabitants required for each of the 870 facilities distinguished[a]



Urban specialisations may become more recognisable in order to diversify the urban environment:

	Specialisation	**Urban facilities**
Administration	legislative power	town hall
	legal/administrative	law court/government services
	executive power	police station, prisons, military facilities
Culture	religion/ ideology	churches, monuments, signs
	art/science	museums, institutes, libraries
	up-bringing/education	schools
Economy	production	companies, offices
	exchange	infrastructure, shops, banks
	consumption	hospitals, leisure facilities, parks, dwellings

Fig. 15 Social and urban specialisation recognisable in modern towns

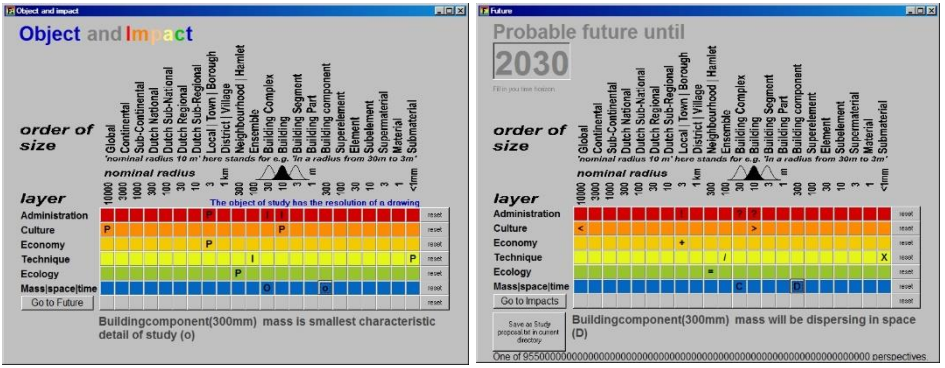
…. if you make them different in a recognisable way.

[a] Most of these numbers have been derived from the database of the Dutch Central Bureau of Statistics (CBS) in 2012. The ranking, however, is very dynamic. It changes per year. The graph is intended only to give an impression. In the graph every 10th facility is named at the horizontal axis, the others are specified in http://team.bk.tudelft.nl/Publications/XLS/06aLiving.xls .

3.6 Intentions of stakeholders, specialists and users change

The administrative, cultural, economic, technical, ecological and physical context can be analysed in a matrix of these layers at 22 levels of scale.

Fig. 16 Future impact[a]



As a designer, you cannot define your object 'O' in the beginning. It still has to be designed. You may, however, determine its physical size R and the level of detail r ('O' and 'o' in the left figure). From this range of levels in the lowest row (physical layer), you may expect administrative, cultural, economic, technical and ecological impacts at different levels of scale in the future. These impacts may be positive (P) or incidental (I). If these impacts are positive, they may produce a 'Programme of requirements' as 'desired impacts'. They also indicate the position of appropriate participants in the design team with an interest in realising the project (stakeholders, specialists, future users). Do not forget to include people that will experience other (eventually less desirable) impacts.

Any participant has hidden suppositions about the future (right figure). This gives direction to her or his intentions during the design process. It is wise to document these expectations beforehand. You then may refer to them if the context, the expected impacts, and thus their intentions change.
For example, you may ask the next questions. Do you expect that the administration (at the level of the project, the municipality, the province and so on) will be full of initiative (I) or more of a 'laissez faire' (?) character? Will the local culture be traditional (<), while the company is intended to innovative experiments (>)? Expectations of economic growth (+) or decline (-) may change the intentions dramatically. What do you expect from technology? Will it be inclined to combine functions (x) at one level of scale and to separate (/) them at another level? Combining functions may save space at the cost of time, while separating them may save time at the cost of space. At which level of scale you can expect a decrease of ecological diversity (=) or an increase (|)? It may be different at different levels of scale, and this is also the case for built-up density. Do you expect concentration (C) at neighbourhood-level, but in the same time dispersion (D) of neighbourhoods at district-level?

[a] From http://www.taekemdejong.nl/Publications/XLS/FutureImpact04.exe you can download the computer program. Different experiments may extend your imagination and inspiration for design.

4 Exercises in imagination

Thinking in different modes, orders, levels and layers requires exercises in imagination.

4.1 Diversify your content

Make a selection of locations and levels of scale, and prepare them as I did randomly in Fig. 4.

Question yourself for each of them:
1 which differences could I see here, at this level of scale and resolution?
2 which could I imagine to be possible here at all?
3 how could I name their extreme values?
4 which one is the zero-value (below which no value is imaginable at all)?
5 can I imagine or even draw intermediate values that could serve as legend units?
6 can I give the variable containing these values a proper name?
7 can I write down the name of possible variables I found, their extreme and intermediate values, eventually with sketches?
8 can I present them in the group, writing down additions, additional remarks and critique?
9 can I write a report with 1-9 as chapters; adding the relevant maps with sketches about the position and direction of the variables found in the map?
10 can I add a chapter 10 comparing my variables with the variables presented by other participants, signalling overlaps and proposals to make them more precise, eventually separating them from each other into separate variables.

4.2 Diversify your form

Choose a block, draw it in realistically sized dots r=3m (representing 30m^2 floor space for 1 person).[a]

Fig. 17 Redrawing R=30m (100inh.), r=3m (1inh.)

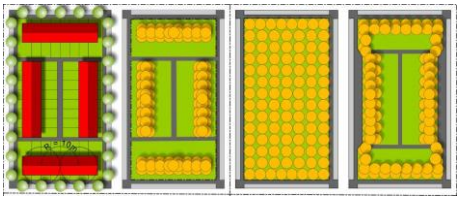
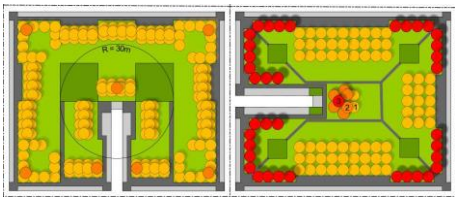


Fig. 18 Redrawing R=30m (200inh.)

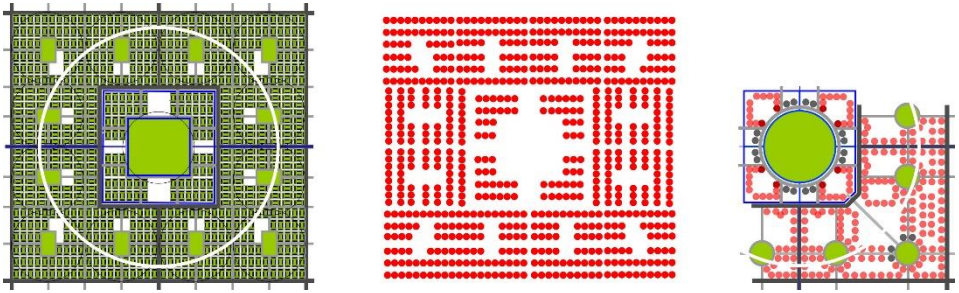


1 Which re-arrangement of the same amount of dots would represent the least diversity of form?
2 Could you diversify the form through a useful re-arrangement of dots within the same boundaries?
3 Could you diversify it further through the combination of two blocks, saving pavement?
4 Could you diversify it further through piling up dots representing high-rise building?
5 Could you transform the dotted result into a useful urban design?

[a] Drawing real sized dots can produce quantified lines, surfaces and volumes, not the reverse.

Choose a district, draw it in real sized dots r=30m (3000m^2 floor space for 100 inhabitants).

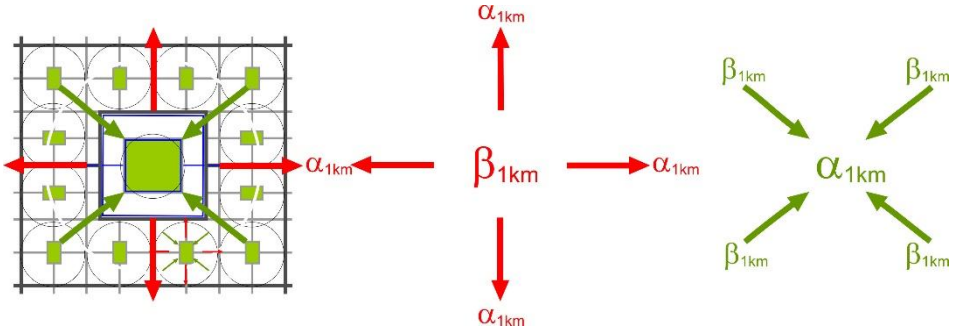
Fig. 19 Redrawing R=1km (70 000inh.), r_1=30m (100inh.), r_2=100m green, r_3=300m green



6 Could you make the same exercise at this level of scale?
7 Could you introduce other variables that you may have defined in the previous exercise?
8 Could you motivate the dispersion in space of their values (legend units)?
9 Could you make the same exercise at other levels of scale?
10 Which legend units you may use then?

4.3 Diversify your structure

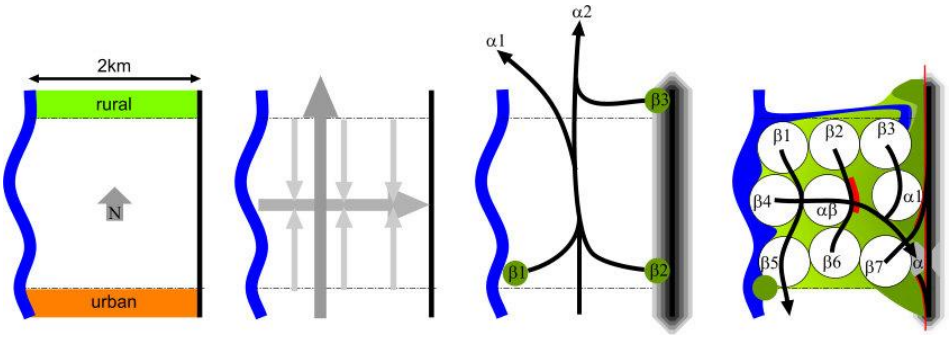
Fig. 20 Motoric and sensoric polarities between more 'open' (α) and 'closed' (β) environments



1 Imagine a R=1km network of district roads every km and neighbourhood roads every 300m.
2 Which environments are most 'open' (α) and 'closed' (β) in a motoric and in a sensoric sense?
3 Could you imagine such polarities at other levels of scale (e.g. house, neighbourhood, land)?

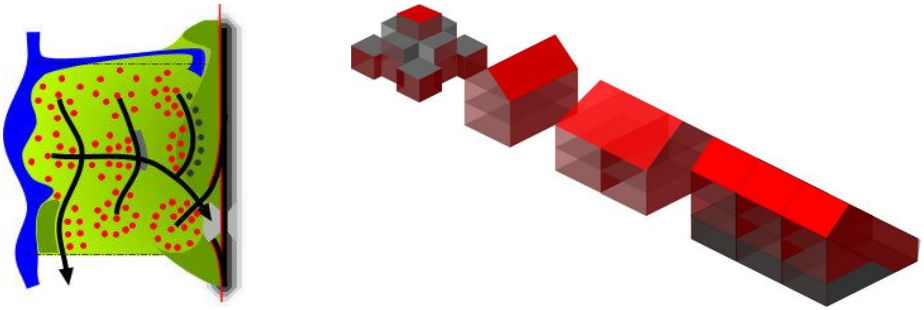
Choose an area R=1km (approximately 2x2km) to be developed.
4 Draw the motoric and sensoric potential of the site with arrows from β into α.
5 Look for appropriate variables with more 'open' and 'closed' values in order to enrich them.

Fig. 21 Analizing, splitting, curving and combining sensoric and motoric polarities



6 Could you diversify their course through splitting, curving and combining?
7 Could you distinguish levels of scale primarily structured motoric, and other ones sensoric?
8 Indicate locations where separations are required in order to ensure or reinforce a β-character.
9 Draw the required residential floor space in dots *r=30m (100inh.)* indicating their 'closedness$_{10m}$'.
10 Draw non-residential floor space in dots with a different colour.

Fig. 22 Structured dots and different types of 'closedness$_{10m}$'



4.4 Diversify your functions

1 Could you locate non-residential floor space in terms of fig. 14,15[a] according to the structure?
2 Could you diversify their locations and requirements r={300, 100, 30, 10m}?
3 Could you arrange them in a recognisable sequence as the different details of fig. 5[b]?
4 Could you diversify residential locations according to life style[c]?
5 Could you diversify them according to stage in the life cycle[d]?
6 Could you diversify them according to income?
7 Could you specify the spatial requirements of each category?
8 Could you then estimate the public (pavement and greenery) and private space required?
9 Could you then estimate the costs of public space to be covered through private space?
10 Could you make an agenda for the design team?

4.5 Diversify your intentions

1 Are your intentions different from these of possible stakeholders, specialists and users?
2 At which levels of scale would administrative, cultural and economic officials be interested?
3 At which levels of scale would technical, ecological and physical specialists be interested?
4 Invite all representatives of these parties, or subsequently play their role.
5 Could you estimate their intentions?
6 Could you estimate their expectations about the future?
7 Could you give different intentions different places in the plan area?
8 If not, play the computer game FutureImpact[e] with them (or on your own).
9 Could you imagine that their intentions change if their expectations about the future change?
10 Document different intentions and expectations as a stable starting point in the beginning.

[a] legislative power, legal/administrative, executive power, religion/ ideology, art/science up-bringing/education, production, exchange, consumption
[b] characteristic, connecting, striking and crucial details
[c] careerism, familism, consumership, see Michelson(1970)Man and his urban environment(Reading)Addison Wesley referring to Bell (1978)
[d] children of different ages, singles, pairs, families of different size, elderly.
[e] http://www.taekemdejong.nl/Publications/XLS/FutureImpact04.exe

5 Conclusion: design requires another mode

5.1 Cause and condition

Verbal language is primarily functional, describing actions. This has been its primary task form prehistoric times onwards: to coordinate human actions. A full sentence can be noted shortest as y(x): y as a function (a working) of x. In this formula, the active subject of the working is x. The passive object is y: object(subject). The verb is symbolised through the brackets, and it hides a supposition of causality: x causes y. Consequently, verbal language is time based: first the cause, then the effect. It describes a process. The *conditions* making the particular process *possible*, however, are taken for granted as a hidden, self-evident con-text. This context is rather spatial than temporal. Any causal sequence tacitly supposes an environment where it *can* 'take *place*'. Describing these necessary circumstances requires another mode of thinking than causal thinking. It is *conditional* thinking. If necessary, verbal language may describe the environment of action with verbs, in terms of action, but that is a long way if you take the numerous possible side-paths of space into account. It requires endless references into other authors, footnotes, end notes and attachments as branches of a tree. It never describes space completely, not to mention its possibilities. Even traditional logic and mathematical reasoning is direction-sensitive, at most describing a grid, neglecting or generalizing its gaps in between.

5.2 The possibilities of space

A picture, then, is more efficient in this sense. It contains infinite routes that can be described in a sequence of one-dimensional sentences. Moreover, it allows the contradictions, usually avoided in a linear language. They can appear perpendicular to the line of reasoning: 'the bridge is open *and* closed'; 'the road connects *and* separates'. A cup is closed in 5 directions, but open in 1 direction, in order to allow drinking; a pipe or cable is closed or isolated in 4 directions, but open in 2 opposite directions in order to operate as a connector; and so on.
Any organism or device counts numerous of such contradictory (open *and* closed) elements ('selectors'). Their operation is immediately clear in a drawing, but not easily expressible in a verbal language. To avoid side-paths, verbal language then restricts itself mainly to the functional direction, the direction of the relevant process or action, the connection: 'the cable connects the house with the electric power plant', 'this road connects A and B'. This way, the context that *enables* the process (its perpendicular separations), and the side-effects on this context, are silently neglected. Side-effects fitting in traditional linguistic categories, can be discovered through impact-analyses, but these cannot properly cover the *possibilities* of space.

5.3 Rare cases

Neglecting the side-effects is not only a deficit in programming space, it is a problem of the current scientific approach in general. For example, rare case-specific side-effects of medicines cannot be discovered in a statistical approach, they are consequently not mentioned in the leaflet. The other way around, (and that is even worse) statistical means cannot prove that a rare side-effect is caused by a medicine. This would be no problem, if these rare cases seldom appear, but there may be as many incomparable cases as there are people. Everybody is different, and reacts differently on the same medicine due to the inconceivable diversity of life, its chemical contents and environments. The current scientific approach tacitly supposes *comparable* cases, but the comparability is determined by the traditional categories of verbal language, mentioned in the

beginning of this study. This is precisely the problem that spatial designers feel if they are advised through empirical scientists. Designs are different by definition, otherwise they would be copies, and not an object of design. Any context of a spatial object that still has to be designed is rare. Anything that *can* be generalised *is* already generalised and useful, but what is left are rare, context-sensitive cases. The current scientific approach, oriented on generalisation, cannot cope with such diversity. How then to cope with rareness in spatial design?

5.4 Spatial design

A spatial designer is supposed to shape the *conditions* for activity, not the actions themselves. (S)he is supposed to make many actions *possible*. A house does not *cause* a household, it makes many different households *possible*. Spatial conditions for a well-defined operation are shaped through goal-directed design, but if you have to integrate a *field* of problems, aims and intentions in a spatial concept, then a means-directed approach may be more effective.
In this case, the context may include a location and many participants in the design process: stakeholders, specialists and potential users. They all have got their desires and expectations, resulting in particular problems and aims, looking for, or projected in a location. They will speak in different language games: the mode of wanting or expecting, but seldom in the mode of potential. The object of study does not exist, it still has to be designed. A study without an object or a well-defined problem and goal, with the perspective of an infinite amount of possibilities any space can offer, is bizarre in empirical science. But, for a designer, in the beginning there is only a context to be analysed at different levels and layers, and there are design tools to be explored in different levels and orders.

5.5 Levels and layers of context

An experienced designer has a portfolio, and consequently a repertoire of design tools at different orders and levels. The context, however, determines the priority of orders and levels in the design process. The analysis of the context can be done systematically, if you determine the layer and level of interest from every participant. Any representative of management, culture, economy, technique, ecology or physical characteristics of the site mainly has an interest at a determined level of scale. This level is not necessarily the level of the site and consequently of the object of design. For a museum, for example, there may be municipal, provincial and even national interests and specialists in the layers of economy, culture and management. A systematic analysis of the context may unveil lacks and overlaps, suggesting an extension or decrease of the number of participants involved.
The composition of people involved in the project influences the possibility of a successful concept. An active designer may propose the involvement of other participants fitting his repertoire.
You may call such a proposal a design tool of context, preceding design tools for the object.

5.6 Levels and orders of design

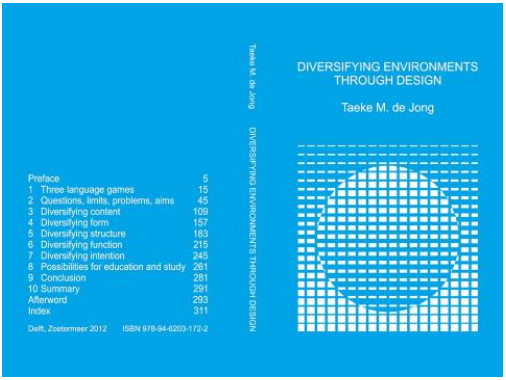
The analysis of context may suggest a sequence of design tools in the design process.
If the function is sufficiently clear, fitting the potential of the site and your repertoire, then you may start with the function at the level of the site.
If you see more potential of the site, then it may be useful to study the environment at a larger level of scale, and review the intended function.
If the function is not sufficiently clear, then you may draw an evocative, means directed concept, based on possible structures, forms or even content. The content appears as a legend of the

drawing, the form as a distribution of the legend units in the drawing, and the structure as a set of separations and connections stabilising the form for potential use.
The possibilities of content are closest to the language and the categories of empirical science, mainly represented by the specialists. Explore them as possible values of variables: legend units. Which variables may diversify the site, and which values of the chosen variables can be used as legend units in a drawing? This content is the 'palette' of the drawing, but it may also include the quantity of legend units, expressed in sizes and surfaces of legend units. It may inspire ideas of form, structure, function and intention.
The possibilities of form (the distribution between total concentration and total dispersion of arbitrary legend units in space) may be limited through the contour of the site. They can, however, be explored by sketching, even if the legend units are not yet determined. Forms may evoke ideas about the legend, the structure, the function and even the intention of the participants. It may be not the most usual way of sketching, but drawing in dots allows more freedom of interpretation than lines and surfaces. A dispersion of dots can suggest surfaces, lines *and* points. The possibilities of structure can be explored drawing lines, arrows or soft transitions representing separations, connections and directions.

5.7 Conclusion

Any study on tools of spatial design must be written in the mode of possibility, because finding unexpected possibilities is the core of design. Variety or difference is the key to possibility. Possibility supposes conceivability ('imaginability'), but it *is* supposed in the modes of probability and realistic desires. Studying possibility must contain the order of content. Content is closest to the tools of usual empirical study, and content is supposed in any other order (form, structure, function *and* intention). Any order must be studied at different subsequent levels of scale, because conclusions may change, if the scale of study changes. At any level of scale, every layer must be explored, because at different levels of scale they may have a different meaning for design.

This document contains parts of my second thesis[a]:



After this PhD graduation, the promoters Maurits de Hoog and Dirk Sijmons insisted to write a shorter document in addition, but it took time to obtain sufficient distance. This time has been shortened substantially through Mick Eekhout's patiently urging to do so, and his suggestion about the form.

[a] Free downloadable from:
http://www.taekemdejong.nl/Publications/2012/Jong%282012%29Diversifying%20environments%20through%20design%28Delft%29TUD%20thesis%20concept.pdf