Simulations supporting urban design

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Abstract

This chapter describes three kinds of simulation from a viewpoint of urban design: simulations of probable, possible and desirable futures. That distinction is elaborated in the first section. Following that distinction the examples in the next three sections mainly stem from the autor's Dutch educational context as a professor of Technical Ecology TUDelft, Faculty of Architecture. Starting from that distinction and experience it explores recently published urban simulations from different countries in the fifth section, primarily based on Stolk (2009)[1] in the section ‘Urban simulations, state of the art 2008’.

Probable, possible and desirable futures

Three language games (‘modalities’) about the future context are relevant for environmental, urban, architectural or technical design, its specialists, clients and stakeholders (see Fig. 1).

Language games:	**being able**	**knowing**	**choosing**
Modalities:	possible	probable	desirable
Sectors:	technique	science	management
Activities:	design	research	policy
Reductions as to			
Character:	legend	variables	agenda
Location or time:	tolerances	relations	appointments

Fig. 1 Three language games

Not distinguishing these modes of ‘future’ results in a confusion of tongues between stakeholders aiming at desirable futures, specialists predicting probable futures and designers exploring possible futures.
Distinguishing them properly outline fields of problems (probable but not desirable) and fields of aims (desirable but not probable) as the basis of any integrating design concept.

Subtracting probable and desirable futures

Probable futures we do not want produce a field of problems (see Fig. 2). They are predicted or signalled by empirical studies of specialists. *Desirable* futures we do not expect to happen without action (like desirable but not probable futures) are a field of aims. Clients, stakeholders and their representatives (administrators, managers) deliver a field of aims. Sometimes it is a battlefield. Often not all of them are *possible* in one project. The designer guards and produces possible alternatives by design.

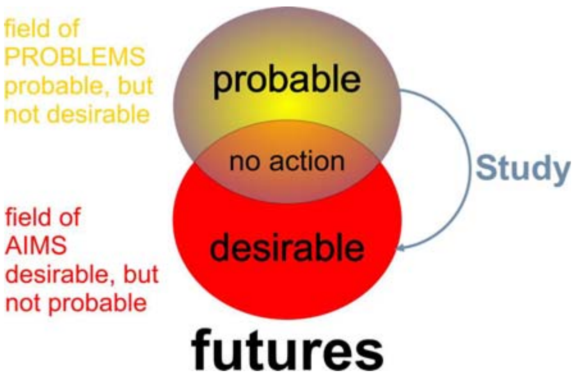


Fig. 2 Subtracting futures to outline fields of problems and aims

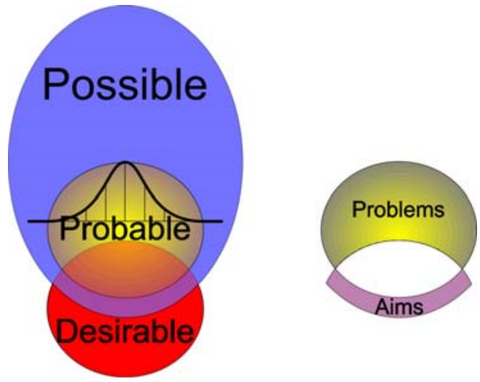


Fig. 3 Adding possible futures, skipping the impossibleones and the desirable ones expected without action

Adding possibilities by design

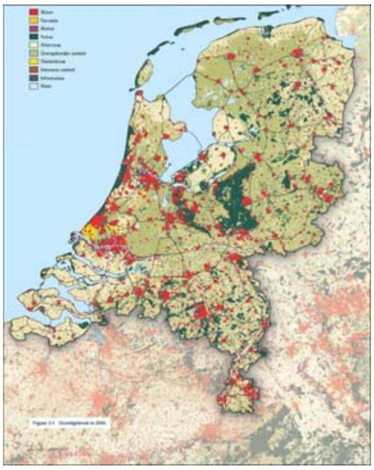
Anything probable is by definition possible, because if something is not possible, it certainly is not probable. But not all possible is also probable (see Fig. 3). There are improbable possibilities. To find these improbable but possible futures (including and using the many probabilities of specialists as possibilities) is the task of the designer. S(he) is supposed to know many possibilities stemming from design~ and typological research. Sometimes s(he) adds possible futures no one in the team could imagine, let alone desire beforehand. Their desires and aims embodied in their programme of requirements were limited by their imagination. Desires could change as soon as new possibilities are imagined. That is why design can change a programme of requirements (see Weeber, Eldijk et al. 2002).

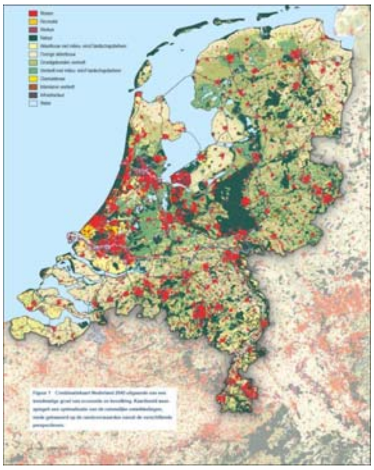
Simulating probable futures

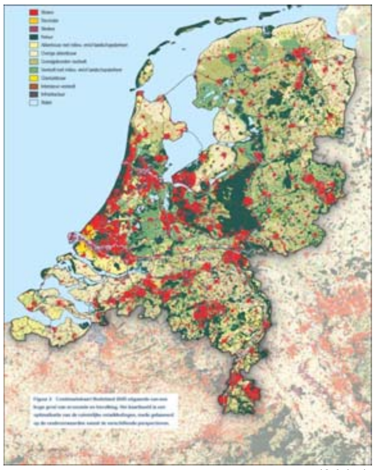
Data as a bottle neck

The first comprehensive land use computer model of the Dutch Randstad was built in 1977[2]. It failed primarily because the collection of appropriate input data failed. Since then, scattered sector GIS model making (macro-economy, traffic, municipal planning) made its progress. However, it was not until 1997 before two design relevant comprehensive working models of Dutch land use, Ruimtescanner[3] and Leefomgevingsverkenner[4] emerged. That happened approximately in the same time at the governmental health and environmental planning bureau RIVM. Attempts to combine both failed, but the Ruimtescanner has been applied most widely.

The RIVM was authorized by the Dutch parliament to use otherwise protected data collections in the Netherlands, crucial for evaluating governmental planning of environment and nature. Since then, the policy advices of RIVM (housing the environment and nature planning bureau MNP) became illustrated with easy-to-understand maps and scenarios on different subjects not matched by other Dutch institutions. Authoritative scenario studies of the MNP were made using the cellular automata of RISK included in the Ruimtescanner. Most recently different land use scenarios until 2040 have been published (see Fig. 4, Fig. 5, Fig. 6)[5].







MNP (2007)

Fig. 4 2000 *Fig. 5 Trend 2040* *Fig. 6 Growth 2040*

This story shows the importance of data availability for reliable simulations of probable developments. The collection of appropriate data is expensive and it is difficult to judge their reliability looking at the convincing glossy map results. The data processing itself contains hidden suppositions making judgment even more difficult. Calibration of probable developments by comparing them with earlier developments is hampered by changing statistical categories. On the other hand, most interesting variables cannot be composed because of different statistical categories. Let me give some examples of shifting and incomparable categories of data.

Shifting and incomparable categories of data

The Dutch standard business classification (SBI[6]) is traditionally based on materials primarily processed by categories of industry (steel, wood, leather and so on). However, contemporary industries combine many different materials by innovation and increasing intermediate deliveries. They can hardly be unravelled from the end product any more to find out what is their own contribution. So, their categorization shifts. And, the intermediate deliveries are difficult to retrieve. They are not included in the usual macro-economic models. They are cancelled out in the gross national or regional product. They may play a role in meso-economic models, using other categories (like velocity of money flow), but these are not usual. They also play a role in micro-economic models, but these can not easily be aggregated into a higher level.

The CBS (Dutch bureau of statistics) changed the categories of land use in the end of the nineties. So, calibrating land use processes on historical examples has become difficult.

An interesting land use variable is the intensity of use, the time people spend at a land use category per year (for example 48 hours/m2·year in ‘house and garden’, 135 hours/m2·year in ‘shops’[7]). However, the research of time use is based on categories different from those of land use. So, the available data cannot easily be combined. So, the existing categorisation restricts and directs model making.

Context sensitivity of data and assumptions

Land use developments in China occur very fast. The communistic government is the formal owner of the land and the inhabitants accept forced moving easier than elsewhere. So, land use developments are context sensitive. In this example a parameter ‘resistance to change’ could be introduced to make a land use model appropriate in different contexts. Then the ‘resistance to change' is larger in 'democratic' societies by extended procedures. However, the data categorization still may be different and there are more context factors than landownership or acceptance to move. The external variables (determined by context) are often derived from assumed scenarios as changeable parameters. For the future one can suppose an enterprising or just a controlling government or management, an innovative or just traditional culture, a growing or declining economy, a technology combining tasks or just specializing, an impoverishing or enriching ecology, a spatial arrangement tending to accumulation or dispersion. And, these context factors can be different on different levels of scale[8].

External variables determining context factors

Computer models store their assumptions about the context as often hidden 'external variables' (parameters). A nice example of the role of these parameters is shown in a computer model to simulate the dispersion of butterflies in the Dutch town Hoogvliet near Rotterdam, published in the PhD thesis of Snep (2009)[9]. I imitated that computer model for 1 km^2 in Excel with VBA to be able to understand its working. In Fig. 7 left you see 1 km^2 divided in 100 hectares of different landscape types and right the supposed location of two types of butterfly in the same km^2 spotted every 6 minutes and its total residence time per hectare in minutes.

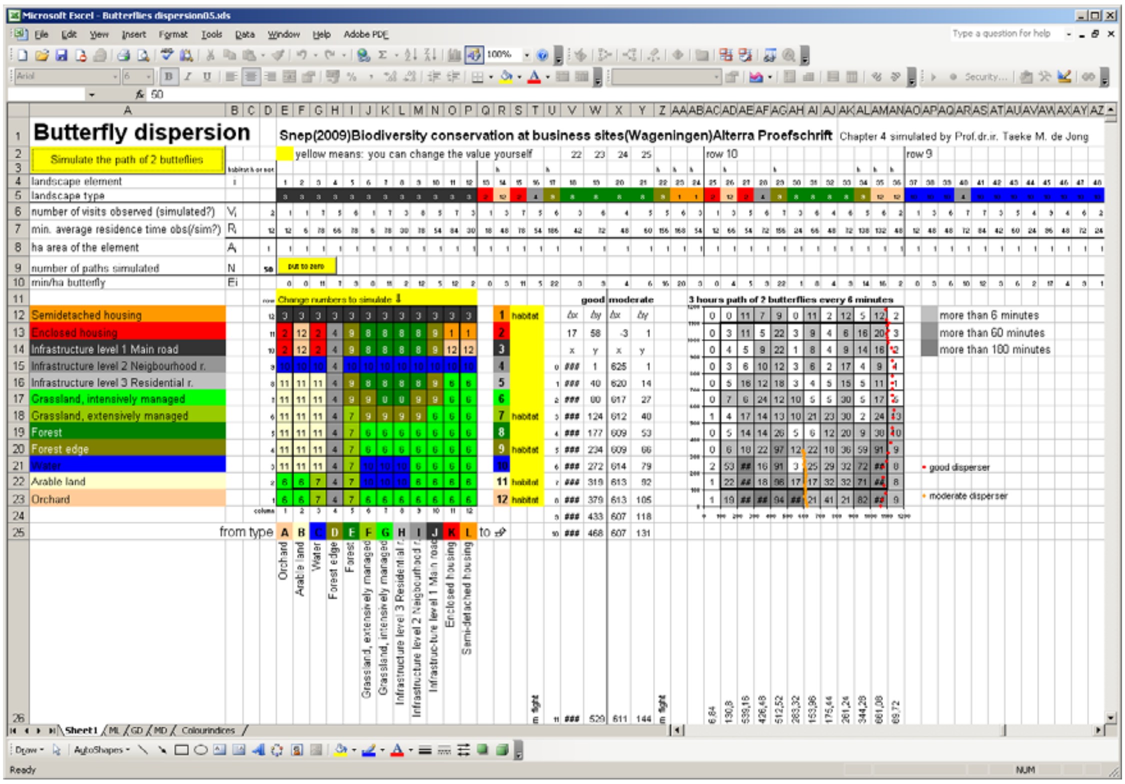


Fig. 7 Simulating butterfly dispersion after 50 runs

I discovered 288 external variables estimating the probability that a butterfly will enter another type of landscape. The model distinguishes 12 types of landscape from which 5 'habitat' and 7 where butterfies do not want to be or fly through as fast as possible. That is estimated for 2 types of butterflies: fast and slow dispersers. So, there are 2 x 12 x 12 = 288 parameters describing the probability a butterfly will enter another landscape type. Some of them are derived from international literature stemming from other contexts than the Dutch Lowlands, but most of them are estimated. However, very important parameters such as the main wind direction are not implemented as far as I could conclude. This illustrates how unreliable computer models with too many or too little paramaters can be if they are applied in a specific context. Their most important function is not to describe reality, but to undermine intuitive suppositions.

Using GIS for design

From time to time since the seventies of the 20th century TUD graduate students urbanism have tried to apply GIS in designing. They had to find out everything about GIS themselves. However, that resulted mainly in a kind of sieve-analysis adding supposed physical and social boundary conditions to determine the space left where still could be built. It reduced possibilities instead of creating them by comprehensive design concepts. The categories used in data collections determined the design legend, while promising combinations were overlooked. The reduced possibilities to build appeared as less convincing designs, inescapable truths doubted by judging teachers because of their not retrievable hidden assumptions. Moreover, even complete GIS applications installed on the Faculty were not used by lack of the expensive data. In the nineties of the last century a complete digital topographical map of the Netherlands cost more than € 300 000 per year. However, one of my graduate students got permission to use the Ruimtescanner for study purposes. It resulted in an interesting graduate study[10], but understanding the professional user interface cost too much time for regular students of a design education.

Databases increasingly available

However, in the mean time crucial databases for design such as the digital topographical map and general altitude database (Algemeen Hoogte Bestand AHN with XYZ coordinates every 5m, approximately 25Gb[11]) became available for study purposes. Students can get AHN parts of 30Mb for study purposes if they sign to destroy the data after use. However, to implement these XYZ data in a GIS application requires too much work for design students. Fortunately the Dutch archaeological association developed a free downloadable application[12] to view the altitude map per part (see Fig. 8).

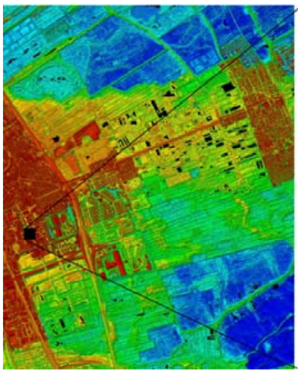


Fig. 8 AHN 5 x 6.25km

Fig. 9 Google Earth 200 x 200m

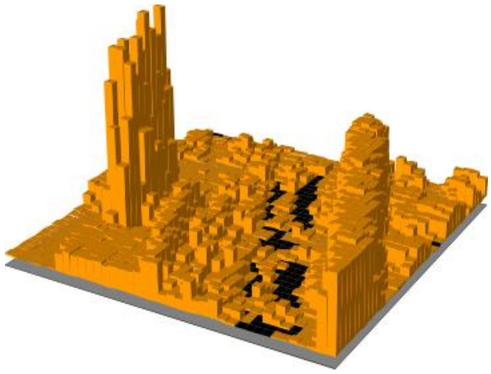


Fig. 10 AHN in Excel 200 x 200m

I made a 3D Excel-application[13] to select even smaller parts and to experiment with water levels and ground displacement (see Fig. 10).
Many economic and social data are available from the internet[14], but for design students it is difficult to find a design-relevant way in that multitude and to translate the data in visual representations. Moreover, fake data suffice for design exercise at school.

Simulating possible futures

Design evaluation

To avoid interchanging design creativity for computer programming some attempts have been made to evaluate design sketches on different surface capacities afterwards. However, manual drawings have to be made in homogeneous colours to count their surface. It can be done by a free downloadable surgical programme ImageJ intended to count coloured spots in brain scans[15]. The brain scanner also draws the contours of building blocks as if it were cancer cells and numbers them giving a list of m2 built-up area (see Fig. 13).

Fig. 11 An allotment 900 x 1450m

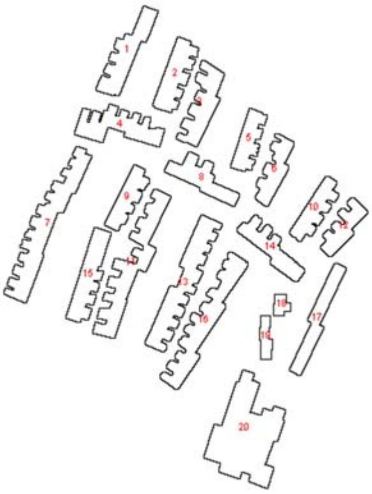


Fig. 12 Tracing and numbering by brain scanner ImageJ

Label	Area	XStart	YStart
1	1092	658	20
2	964	690	49
3	1020	713	71
4	1150	626	112
5	678	757	116
6	732	781	140
7	1925	595	152
8	849	700	157
9	710	649	169
10	746	828	180
11	1722	668	192
12	654	852	200
13	1688	712	216
14	831	762	216
15	1059	612	228
16	1653	738	251
17	894	837	261
18	166	781	290
19	259	768	310
20	2871	751	361
	21662		

Fig. 13 Results in m2 built-up

CAD applications can count such surfaces directly, but it requires a lot of work if the object is still changing in a sketch phase. Moreover, in design practice specialists do so afterwards. So, why a designer should do it? Design students and their teachers are not very enthusiastic to check the capacity of plans hampering the development of a creative concept.

A pointillist interface

In the nineties of the 20th century the Deltametropole association assigned me to compare 25 scenario sketches for the Randstad[16]. However, they did not have the same capacity. A direct comparison would not be honest: designs achieving the lowest capacity seemed to be the best. So, I re-designed them into plans for 1 million inhabitants by drawing dots of 100 000 and 10 000 inhabitants. The dots had the gross urban surface these amounts of inhabitants use in the Netherlands at average. That pointillist representation made the sketches comparable and produced a good impression of the designs. In 2001, I used that method again to evaluate three designs for Almere Pampus on ecological potential (see Fig. 14).

Normalisation into 4 visions of 50 000 new inhabitants within a square of 10x10km.

Zero variant | TKA 'residential' | Hosper 'recreation' | H+N+S 'nature'

Fig. 14 Comparing plans for Almere Pampus

This representation gave a rough, but direct idea of the design concepts. It neglected details applicable in the other concepts as well. For many kinds of specialists like traffic engineers, housing specialists, facility planning experts this representation gives necessary starting points for evaluation and modelling. For every desired square kilometre you also can find the population density or floor-space index (FSI), because every dot represents 1000 inhabitants, now drawn by a circle of 30 000 m^2 floor space (100m radius 'net dots' supposing $30m^2$ floor space per person). If you like to count more or less than $30m^2$ floor space per person, then the circles have to be drawn only with a little larger or smaller radius. Pointillist sketches may be read, counted and evaluated by the computer. So, the idea emerged to develop a pointillist sketching tool for designers with real time impact analysis.

Pointillist sketching

My graduate student David Rutten, well known from his many artistic and mathematical experiments on the internet[17], started to graduate trying to make such a tool (see Fig. 15, Fig. 16, Fig. 17)[18].

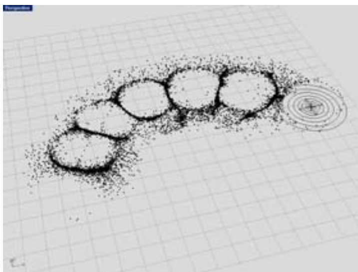


Fig. 15 ScareTool

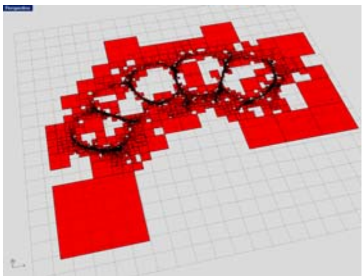


Fig. 16 QuadTreeTool

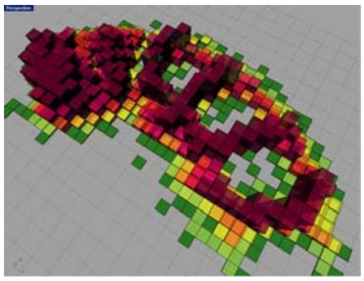


Fig. 17 GridDensityTool

Amongst many other programs he wrote a plug-in 'dotNET' for the CAD program Rhino and accepted a job abroad (among the many offered) without graduating still. His genius came to a preliminary dead end in a university system demanding to fulfil assignments hampering the flight of a creative spirit. However, his many breathtaking experiments documented on the internet promise new possibilities for design no one could imagine without the help of a computer.

Simulating inferences

Mathematics is a combination of many quantitative inferences represented in surveyable formulas.

A computer program is a representation of many logic inferences we can understand one by one, but not all at once. Reconstructing these inferences by electronic simulation (see Fig. 18); we can make programs containing many inferences at once. And designing is making many ‘If a then b’ inferences.

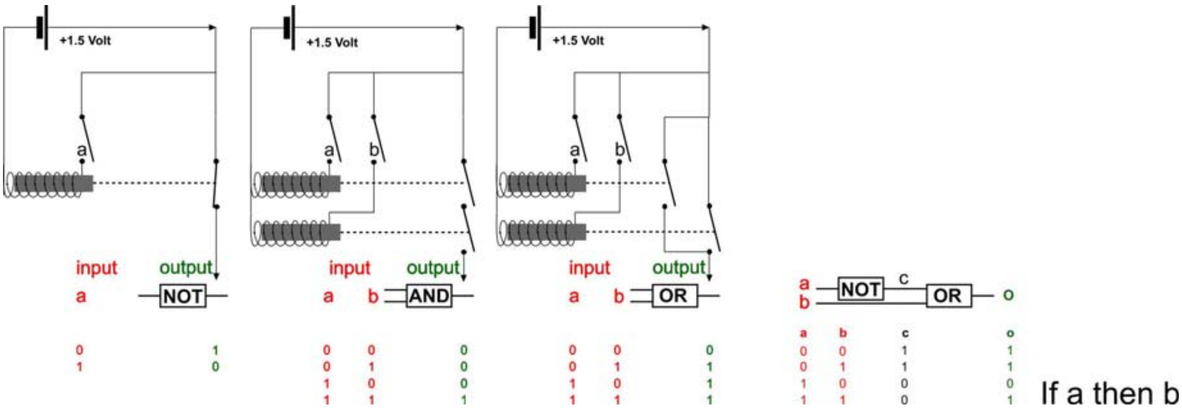


Fig. 18 Reconstructing ‘if a then b’ according to truth tables using electronic relais.

Since 1947[19] fast and small transistors have replaced the old fashioned ‘relais’ drawn in Fig. 18. A transistor separates two poles to be connected by a signal on the third one (the ‘base’). If there is a signal, then there is a connection, if there is no signal, then separation occurs. So, a transistor is a switch, a selector just like a relais. Applying space and time saving transistors multiplied the number of inferences to be processed within surveyable time, often with counter-intuitive results. Intuition is a short cut to a final conclusion based on experience. Intuition replaces inferences if too many inferences are needed to keep overview or if intermediate inferences cannot be found. So, intuition can also be described as ‘experience not to be transferred by language’. However, in complex situations with many actors or agents intuition can be misleading.

Awareness of counter-intuitive processes

Mathematics and computer programs often show counter-intuitive results, and that is important for designing. For example, if you draw an allotment with a determined building length, width, depth, height per storey, width of streets and courts, reaching an acceptable solar angle into different directions, you could think by intuition that any added storey should increase the density. But, based on these starting points a graph such as Fig. 19 can be drawn. That mathematical exercise shows that the increase of density has a limit. Adding more storeys necessitates widening the streets and courts to keep an acceptable solar angle and that takes increasingly more space than the profit of an increasing number of storeys.

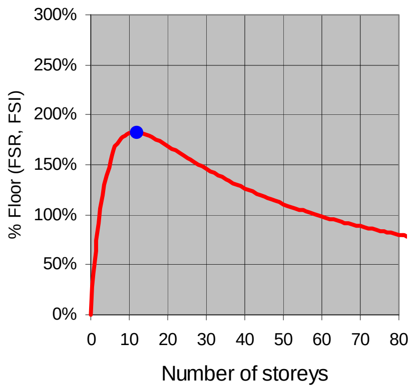


Fig. 19 Density(number of storeys)

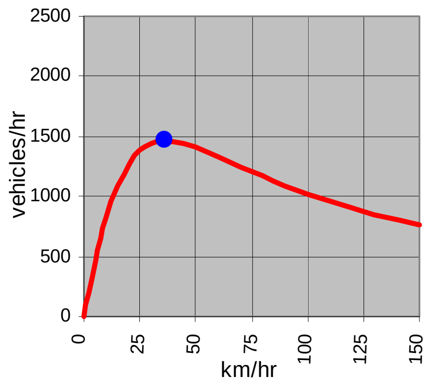


Fig. 20 Capacity/lane(velocity)

The same kind of graph (see Fig. 20) demystifies the intuition that driving faster will always increase the traffic capacity of lanes. A traffic engineer showing Fig. 20 will claim the capacity of lanes is highest at an average velocity between 25 and 50km/hr. People take more distance to the next car the faster they drive and that increasingly decreases the road capacity. However, a designer should ask about the assumptions concerning braking efficiency, reaction time, their relation and the average length of cars taken as specialist's assumptions.

Simulating specialist's contributions in a design process

A designer is vulnerable in the company of specialists using models and simulations with many hidden assumptions known as 'external variables' or 'parameters'. So, after many years of programming first in C and then Basic, I returned to Excel to clarify specialists' hidden suppositions to design students. Everybody knows Excel; all inferences are retraceable as an open source and a little bit of Visual Basic for applications is enough to introduce sliders (see Fig. 21). Sliders change input variables intuitively, but in the same time they change the output. So, by interaction the student can use the same slider imagining (s)he gets immediately a desired output, a short cut to the conclusion.

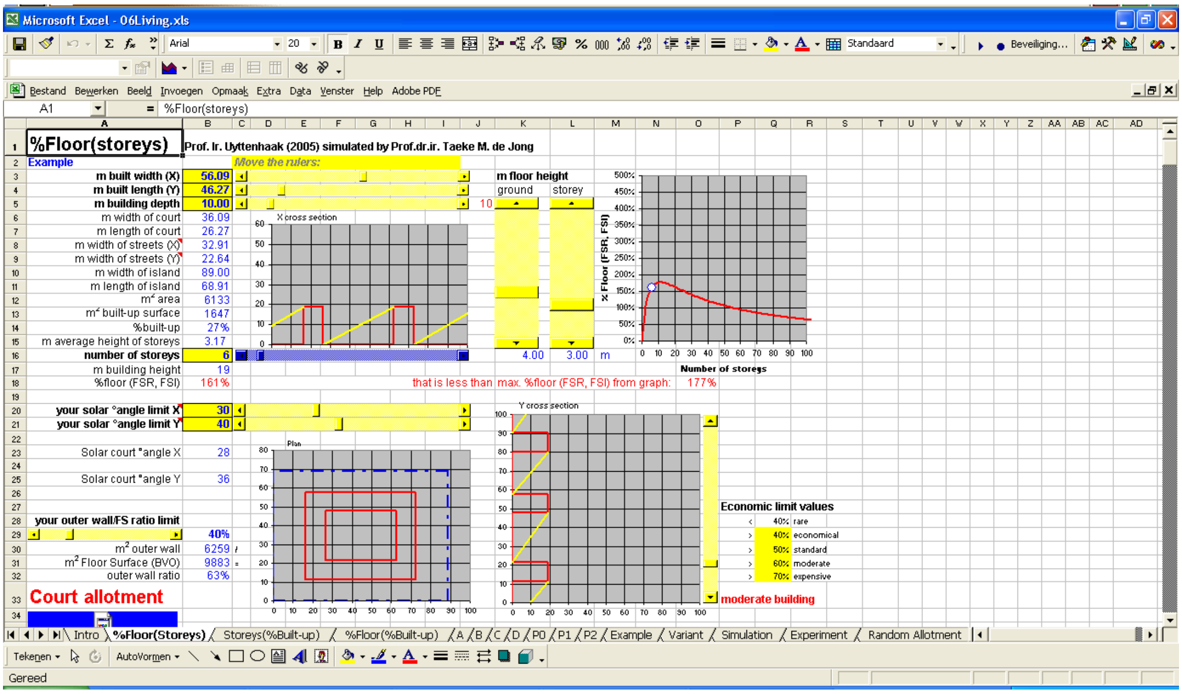


Fig. 21 Sliders in Excel[20]

Shifting sliders in these spreadsheets is fun, because everything changes, including drawings and graphs. If you change a starting point for design or a parameter for calculation, you immediately see its impact. It is a step into gaming. Last years I spent much time to make such interactive spreadsheets concerning sun, plantation, wind, noise, water, traffic, earth, ecology, density, economy, distribution of green areas according to different standards, mathematical functions and so on[21]. Even mathematics becomes fun[22]. Any hidden supposition (parameter, yellow slider) or input variable (blue slider) can be changed by shifting the sliders. It produces an active awareness of the way specialists think. It is the very basis of an ability to ask them critical questions in practice. The aim is to make designers less vulnerable in their company.

Simulating desirable futures

Design games to raise public awareness of their possibilities, desires and impacts

In 1986 NNAO assigned me to develop a computer program to design the Netherlands of 2050 by laymen. Is should be publicly applicable at an exhibition ‘Nederland Nu Als Ontwerp’ (NNAO, the Netherlands Now As a Design)[23] visualising four scenarios by large physical models in 1987. These scenarios represented the ideas of four political movements: liberal, socialist, Christian democratic (freedom, equality and brotherhood) and technocratic. The program was made by 8 urban design students, 4 industrial design students and C-programmer Alexander Kyrkos. It resulted in the computer game ‘Momentum’ with a timer running from 1990 until 2050 allowing to change every square kilometre of the Netherlands into other legend units with an immediate report of costs and political reactions. To report the costs of transformation of any square kilometre was not difficult, but how to report the political judgement of your interventions?

A brainstorm with urban design student Wient Mulder at one evening produced the following solution. We should program four doll faces laughing and crying at every intervention according to the four political movements. Between laughing and crying there should be intermediate expressions. From research by the University of Amsterdam we knew there were three rather stable political opinions about the distribution of urban area in the Netherlands the past 30 years. They could be styled in 'accords' of the concentration (C) and dispersion (D) of urban areas on national, regional and local levels (see Fig. 22)

In a radius of	100km	30km	10km
	(sub)national	regional	sub regional
Liberal	C	D	D
Socialistic	D	C	C
Christian-democratic	D	C	D
Technocratic	C	D	C

Fig. 22 Political 'accords' of urban dispersion

Traditionally, the liberals have wanted a national concentration of urban areas, because that would benefit the competitive position of the Randstad. However, on regional and local levels, they have always preferred dispersion to allow free choice of establishment (accord CDD).
In contrast, up to the 1980s, the socialists favoured dispersion on the national level to encourage a fair distribution of residence and employment opportunities throughout the country, but concentration on the regional and local level for the benefit of public transport and the political cohesion of minority groups (accord DCC).

To preserve the historical identity of the provinces, the Christian Democrats have favoured national dispersion. On a regional level, they have favoured concentration in order to have provincial capitals with recognisable regional religious and civil administrations. On local levels, they again favoured dispersion (suburbanisation) because, in their view, only small communities can offer a caring society in which the family, the corner-stone of society, can flourish (accord DCD).
The technocratic solution was assumed to be the reverse according to a scenario I wrote earlier for NNAO[24] (accord CDC).

In this way, freedom, equality and brotherhood become recognisable and controllable in different design principles and on various levels of scale. It could be programmed by counting the number of urban square kilometres around any square kilometre in a radius of 10, 30 and 100km weighted to their distance. Three maps determining the 'degree of concentration' were the result. Urbanising in any of these maps could mean concentration or dispersion making the doll's faces laugh of cry.
After 10 years on the timer the concentration maps were recalculated and the judgement of the doll's faces could have changed. For example, if the Liberal doll had cried for ten years because you realised a big urban concentration in the South of the country at the cost of the Randstad it could begin to laugh if you continued to concentrate there the next decade. Four real politicians played the game publicly and appeared to agree with their respective dolls. Approximately 100 000 people played the game on the NNAO exhibition and later in the Amsterdam Museum of Technology.

Alas, the most appropriate computer platform we chose that time (Acorn, with at that time the fastest and easiest programmable ‘risc processor’) does not exist anymore and SimCity running on the winning Windows platform took over, be it representing another level of urban planning scale. Many students in urban design got the assignment to play SimCity and to sum up the differences with Dutch urban planning.

Role conflicts clarified in a game workshop

In the nineties of the 20th century Dirk Frieling organised a Metropolitan Debate in cooperation with the National Government and the municipalities of the Randstad. He sent hundreds of stakeholders and officials in the Western, Northern, Eastern and Southern part of the Netherlands an invitation to attend a game workshop within their region and a sophisticated query to prepare that workshop. The query contained many challenging statements about the lay-out of the region and the results were sent back to the respondents within a week with a new query totalling three queries. It gave the participants the opportunity to change their opinion if it appeared to be eccentric compared to the common previous results. So, it brought the attendants of the workshop together in a less dispersed set of opinions beforehand. The questions of the successive queries slightly changed getting more focus. And, any proposition had to be answered in two modes: “Do you think it probable?” and “Do you think it desirable?”. That was much better than the usual “Do you agree or not?”, because both answers could be different. If the answers were different you could conclude a problem (probable but not desirable) or an aim (desirable but not probable).

So, at the workshop the attendants had prepared their opinion, aware of the other opinions present. The workshop room was carefully prepared in four sections: one side with tables occupied by private and public developers and financers, one side with officials and citizen groups permitting or objecting the execution of projects, one side with professional consultants and on side with four politicians defending the perspective hanging on the wall behind them. In between there was a dealing room (see Fig. 23). On an extended list of projects any attendant could sign in for a project and had to find co-operators, a developer, finance and permits avoiding citizens’ protests to get his or her project on a central map. However, the day began by speeches of the politicians propagating their scenario.

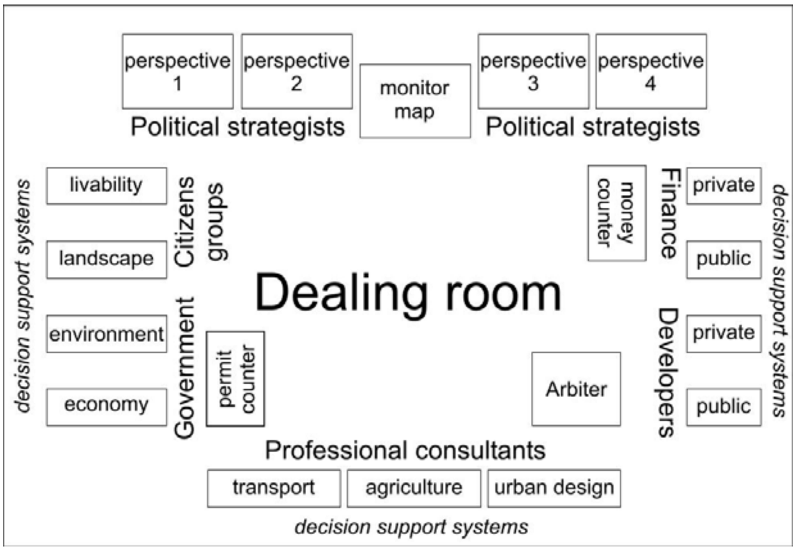


Fig. 23 The Metropolitan Debate workshop room

"The decision process addresses participants in three roles: as individuals deciding on their own place of residence, as agents in initiating and realising projects and as citizens in defining and selecting perspectives.
The decision process itself consists of decisions in a series of four steps, starting at home where everybody cherishes his or her own opinions. The next step is to study available perspectives and projects and to decide on personal preferences, eventually preparing an individual strategy. The third step is confronting all these personal preferences in a dealing room, facilitating transactions and trade- offs between participants. This will lead to a hybrid strategy combining features of several perspectives and a mix of projects. The fourth step is evaluation of the results of the dealing room by parliament."[25] And that is also where a workshop ended: looking together at the map with all realised projects as a parliament discussing: "Is this the country we want to live in, the country we want to leave to our children?"

Putting opinions in motion

This method to involve people in the future of their country puzzled me. Different from many decision support systems the method does not stabilise opinions to get a reliable input for multi criteria analysis or linear programming. It mobilises them interactively by confronting the participants with:

- other opinions in the query results;
- own diverging opinions stemming from different roles played by the same person in action;
- changing contexts developing on the monitor map;
- impacts of own choices if everybody would have the same preferences;
- the image of the developing map compared to the possible scenarios shown.

By doing so, the method stimulates modesty and flexibility in the participants, it avoids loss of face, a situation by which no compromise can be made to extend the common solution space. People slow down the development of their choices waiting for complementary opportunities by other one's choices. Could this be elaborated into a computer game?

Professional consultants assisting a decision process

The professional consultants were hardly consulted in the hectic dealing process. From the early debates about the method I remember the question if the professional consultants could be simulated by a computer. Answering that question brought so many problems to the fore that at last physical persons were chosen instead of computers. Models would have been too slow if the participants had to inform the model about all context variables of the project. Moreover, which model could handle all context factors (parameters) playing a role in the decision about different projects ranging from housing, traffic, industry, agriculture to nature projects? There were many models from different institutions available giving different answers depending on their suppositions. How to give the participants an opportunity to choose the model sharing their own suppositions?

Explicit suppositions about external variables in simulations

I developed a simple computer program to analyse the supposed future context of a project, determining the external variables (parameters) simulations need as suppositions[26]. Even if the project is not yet completely determined, you can make your suppositions about the probable and desirable future context explicit. These determine your choices and the way they have to be evaluated. Subtracting them into both directions will deliver you a field of problems (probable but not desirable) and a field of aims (desirable but not probable) to design a suitable project. That makes the project definition more flexible and context dependent than predefined projects such as offered in the Metropolitan Debate. The field of problems and aims still can result in different projects. In the same time suppositions about external variables in an assumed probable and desirable future context are available for simulations. Let me explain in some more detail how that kind of context analysis could work.

Context analysis

Any project will have impacts in its context on different levels of scale, hitting interests of other stakeholders on that level (for example from government officials into manufacturers of building materials). The first step of context analysis is, to make these impacts explicit. The positive impacts you expect in the future context are your programme of requirements, your desirable future. Perhaps you share it with stakeholders wanting to join your project. If there are negative impacts, you should hear the people responsible on that level to minimise or compensate such effects by your project. However, these impacts depend on probable future contexts.

Physical and social contexts

The context of a project is not limited to its physical environment (mass and space in time, ecology, technology). It has to fit in social (economic, cultural and managerial) environments as well.

Urban and architectural designers give account to physical and social stakeholders and specialists in different 'layers' of their sketches and drawings. These participants have their own problems and aims, their expectations and desires, supposing different probable and desirable futures. By design these futures have to be combined into one common spatial vision or concept of a possible future to outline a road for cooperation. Sometimes it may be wise to start defining a common future context before defining an object.

Layers at different levels of scale

To analyse or to compose a common future context, you have to distinguish different physical and social layers. In Fig. 24 six layers are chosen, relevant in urban and architectural design. They are chosen in a way they are imaginable on any level of scale, be it not always all relevant for every object of study. On any level of scale they have a different meaning. For example, in The Netherlands management(R = 3000km) means European government, management(R = 10km) or (R = 3km) means different forms of municipal administration, R = 10m means household management and on lower levels of scale it means different forms of technical management on the building place, in maintenance or within the industry of building materials.

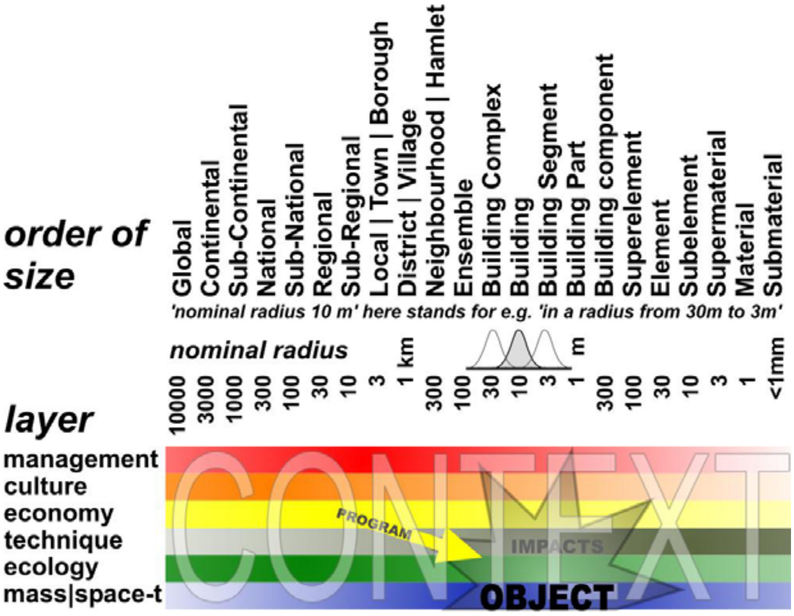


Fig. 24 Locating a spatial object of study within its context

Locating the object and its impacts

Once you have determined the scale (upper and lower limit) of the projected object in this scheme, the rest is 'context'. The project will have impacts within that context, on different levels of scale and in different layers. Some of them are desirable. The programme of requirements is nothing else than the set of desirable impacts. The Visual Basic form of Fig. 25 does not specify these impacts, it solely shows their origin. You can consider these impacts even before you choose a specific object on a specific location. So, the scheme can help outlining your project from outside inwards.

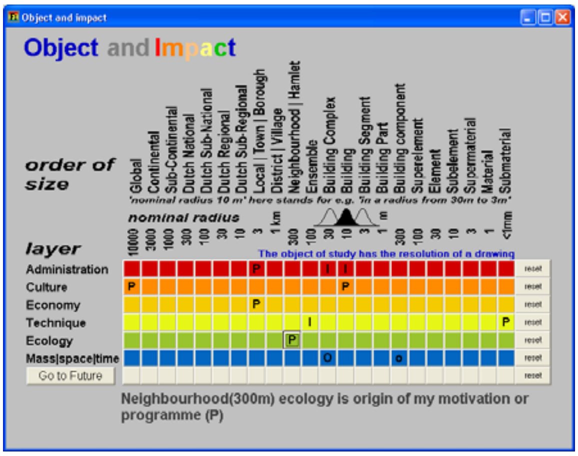


Fig. 25 Locating impacts (I) and the origin of a programme (P) as set of desired impacts

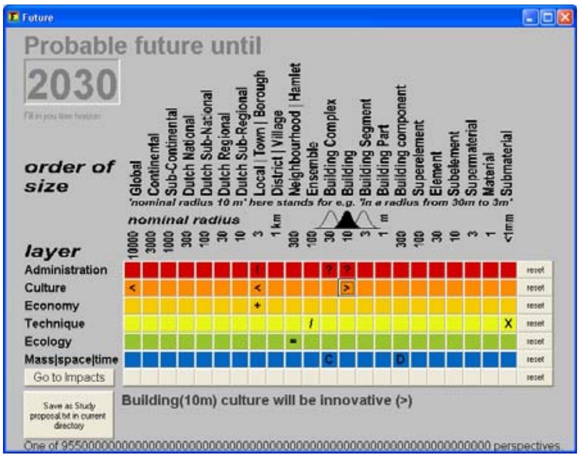


Fig. 26 Making expectations about the probable context in 2030 explicit to assess the impacts

Different impacts in different probable futures

Impacts will be different in different future contexts. For example, the local economic impact will be different in a growing local economy compared with a stagnating local economy. So, you also have to specify your expectations about the probable future within which your object will have its impacts (see Fig. 26).

In the form of Fig. 26 you can choose an enterprising (!) or just a controlling (?) government or management, an innovative (>) or just traditional (<) culture, a growing (+) or declining (-) economy, a technology combining (x) tasks or just specializing (/), an impoverishing (=) or enriching (|) ecology, a spatial arrangement tending to concentration (C) or to dispersion (D). And these context factors can be different on different levels of scale.

Scenarios

It is important to be explicit about these expectations, because people with other probable future contexts in mind will judge your project with other suppositions about the probable future. They can reject your project solely on that basis. If you made your suppositions explicit beforehand, you can ask them to judge the qualities of your project again but now within that perspective. It could raise an essential debate about the robustness of your project in different future contexts. And that is the very aim of scenario studies: suppose another scenario occurs, will the project still be useful in that scenario? However, there are many scenarios imaginable. Choosing the categories of scale and layer of Fig. 24 produces a combinatory explosion of approximately 10^{65} possible scenarios. So, to check the robustness of a project you should choose a limited number of diverging scenarios.

Using the FutureImpact program in design education and research

Approximately 3000 students from different course years at the Faculty of Architecture TUDelft were assigned to use the program in making a preliminary graduate study proposal, even if they still did have no idea about the object of study. Once they filled in the forms of Fig. 25 and Fig. 26, the button below left in Fig. 26 produced a text concerning a preliminary study proposal to be specified and elaborated further. It describes a field of problems and aims subtracting the desirable and probable futures filled into both directions.

Design studies are context dependent case studies. So, their results are not comparable if the context is not comparable. If any design study would be accompanied by a context analysis, design research of existing designs afterwards could choose cases with comparable contexts to arrive at more general scientific conclusions about which design means are appropriate in which context.

I thought it was a sophisticated way to make progress in the often discussed scientific nature of design research. However, the design students fulfilled their task obediently, without commend. Only some reported me they experienced an eye-opener. So, I still doubted if we can make progress by simulations at all if even future professionals in urban design are not interested in their own suppositions, making them accessible to others in their simulations.

Urban simulations, state of the art 2008

With this experience I witnessed the presentations of an INTI conference edited and published by Stolk (2009)[27] with increasing admiration about what has been achieved. Against the previous background I will give my impressions and critical questions as the chairman of the conference.

Van Delden: Design and development of SDSS for urban and regional planning

Hedwig van Delden, director of the Research Institution for Knowledge Systems (RISK) in Maastricht, showed impressive predictions of probable future urbanization all over Europe by cellular automata such as Fig. 5 and Fig. 6. She reported the way such predictions could play a role in Spatial Decision Support Systems (SDSS) choosing indicators for policy measures in different scenarios. RISK is building a system GEONAMICA to which modules from other specialist institutions can be connected. The former links of RISK with the school of Prigogine were still recognizable. Hedwig assured me the models were calibrated on more historical examples than the first time I got acquainted with RISK's contribution to the Ruimtescanner.

Timmermans: Dynamic and quasi-dynamic multi-agent models of activity-travel patterns for urban planning and design

Harry Timmermans, professor at Eindhoven University of Technology, managed to simulate the behaviour of all 16 000 000 inhabitants of the Netherlands as agents in his activity-traffic model Albatros with impressive results used by the Ministry of Transport. However, how did he program the agent representing me? If all agents would have been programmed the same way I expect traffic jams everywhere. However, Timmerman's agents are learning!

Karimi: New Towns of England in Transition: reshaping through understanding the reasons of failure

Kayvan Karimi, Director Space Syntax Limited, shows the correlation between the visual inaccessibility of shopping centres and their decline in England's new towns. However, the vicinity of attractive historical centres and the declining social status of the inhabitants play a role difficult to be distinguished. The visual accessibility can be simulated by the Space Syntax method introduced by Hillier, determining the number of visual interruptions (corners to turn) one has to overcome to reach other urban addresses. Simulating an urban area that way shows differences in visual accessibility demonstrably correlated to the number of visitors. However, as an ecologist I like hidden enclosed places in the city and I wonder if Space Syntax advocates purely orthogonal grid cities with maximum visual access everywhere.

Stabilini: From urban time policies to time-oriented urban planning

Stefano Stabilini, professor and director of CoDE lab representing his work and that of Sandra Bonfiglioli, professor at Politecnico di Milano, presents different beautiful and innovative visualisations of time use related to space. I always have suspected the possibilities of urban time policies and planning, but I never found a way to relate it directly to urban design. The detailed maps are difficult to understand the inference completely, but I suspect a fruitful connection with the agents of Harry Timmermans. In particular the different ways urban inhabitants use their time in a daily, weekly and yearly rhythm could unveil different life styles indicating different urban lay-outs.

Portugali: Complexity, new towns and urban simulation

Juval Portugali, professor at Tel Aviv University, reported his surprising and well-known experiments on urban self-organisation, strongly related to the work Michael Batty. As always, he started to refer to Bénards experiment from 1904 showing 'self-organisation' in carefully heated fluids inspiring Nobel Prize winner Prigogine as well. However, I question if that kind of emerging 'order' is not the same as entropy resulting in the regularly hexagonal patterns of soap bubbles between transparent sheets as well. Is our cognitive recognition of regularities really a sign of organisation in the observed phenomena? Organisation originally is a biological term indicating specialised organs, functions, differentiation, related to diversity. Diversity (seemingly disorder) is the basis of evolution and a risk-cover for life. If all organisms would be the same, they would have been extinct by the first disaster. Individuals seem to cooperate according to

Haken’s cooperative phenomena[28]. But is that the same cooperation as cooperation based on specialisation? Reading Nobel prize winner Gell-Mann[29] on complexity, I still doubt.

Portugali emphasises the role of cognitive mapping and recognition in human behaviour and planning. However, the promising role of dissimilarity in pattern recognition has been elaborated in the dissertation of Pekalska[30], whose PHD ceremony I had the honour to chair. So, recognising similarities, regularities should not be the only basis of cognition. And, cognition is not the only basis of human behaviour. Organisms are set into motion by emotion. And choosing the object of cognition is steered by emotion. What if we choose other categories?

However, spontaneous bottom-up urban developments without planning based on simple rules applied by most of its many agents show remarkable regularities on another level of scale than that of individual behaviour. And, these regularities can be simulated. A designer has to know what happens spontaneously if s(he) does nothing. So, that kind of study is absolutely useful for designers. But are these emerging regularities also signs of a desirable urban organisation? It would be interesting to find out which small interventions could change one phase of self organisation into a more desirable one.

Koenig: Generating urban structures, a method for urban planning and analysis supported by cellular automata

Reinhard Koenig, PHD at the University of Karlsruhe is well known by the open source computer programs he has published at the internet. His experiments are amazing like those of David Rutten (see page 8) and surprised us reporting a simulated urban phase-transition. His programmes produce 3D urban maps as if they are designed. They look self evident and natural. However, if he changes a parameter, another ‘design’ variant appears, also looking natural. Are urban designers so simple that they can be replaced by a Koenig-programme? The same feeling I get from the work of Alex Lehnerer, but Alex insists his programmes do not replace designers. I doubt.

Koenig and Lehnerer do not program agents or users looking what kind of patterns they produce, the reverse they simulate physical patterns (cellular automata) looking what kind of possibilities they offer the users. So, here we leave the area of probability entering the area of possibility and design. Our human behaviour is no longer predicted by simulations, we get a free, unpredictable choice of alternatives. Or not? At last Koenig shows an experiment concerning segregation of inhabitants. In one of his experiments he discovered a parameter that suddenly changes the state of a heterogeneous system into a segregated one: an unexpected phase transition! It looks like catastrophe mathematics[31].

Beirão: Urban design with patterns and shape rules

José Nuno Beirão from the Technical University of Lisboa shows many beautiful and inspiring examples of applying pattern language and shape rules for analysis and generation of urban designs. In his approach urban design becomes an art or craft enriched and inspired instead of hampered by rules.

Lehnerer: Kaisersrot Research

Alex Lehnerer, from ETH Zurich started to show the well-known Voronoi-like distributions of detached dwellings with road systems separating the plots adapting themselves real time according to individual programmes of requirements per plot. The plots arranged themselves anew if specific proximity requirements were added. But that appears to be only the beginning of a breathtaking sequence of simulations with increasing urban and architectural complexity. It culminated in generating architectural 3D alternatives with different arrangements of functions in four stories for a real and sensitive location in Zurich. It helped the municipal government of

Zurich to get an overview of the real choices they had to make. Here the audience got the impression that the computer defeated the designer, an impression Lehnerer tries to prevent with little success.

Batty: Generating ideal cities

Michael Batty, professor at the University College of London showed his well-known fractal-like urban growth simulations based on adding particles at the boundaries according to a limited set of rules. It reminded me of snow crystals growing in more than 400 observed types. Why are there so many types of crystallisation of one simple molecule? Is it the accidental primary nucleus of condensation, or the unique history of falling through layers of air with different sequences of temperature and moist? As an ecologist context sensitive diversity fascinates me more than similarity. Ecologically equality is a sign of disturbance, disorder.

That is why Batty's use of the term 'organic growth' as 'unplanned growth' puzzled me. The genetic program ruling the growth of living organisms may be not an example of 'planning', but it is an unmatched example of organisation in the literal sense of the word. The 'order' we recognise by our limited faculty of cognition is something else than biological organisation. It is regularity or similarity rather than organised diversity. The self-similarity we recognise in leafs may be an efficient outer form at the boundaries of life where entropy rules freely, but it does not represent their inner driving force, the physical-chemical-biological complexities, different for every species. There, any modelling of the numerous feed-back mechanisms per millimetre still fails[32]. Our limited cognition forces us to coarse-graining in order to fit life in analogies of simple physics or even better, mathematics.

Overmars: Serious games for urban planning and design

Mark Overmars, professor at Utrecht University, demonstrated the increasing influence of computer games in contemporary society, their use in education, training and simulation, decision making, marketing, art and as a user interface. Their use for city marketing was demonstrated simultaneously at the conference by the Municipality of new town Zoetermeer, to be found in the internet game Second Life. It is not difficult to imagine how reconstructions or extensions of cities can be publicly communicated by location based games.

Mayer: Gaming & complex 'multi actor' decision making

Igor Mayer from the Delft University of Technology at the INTI conference invited six people from the audience and grouped them around a hoop. With one finger under the hoop they got two assignments: keep in touch with the hoop and together try to bring its level as low as possible: it is the level of CO2 discharge to be minimized. The CO2 level started to rise immediately into the highest level, because keeping in touch with the hoop supposes a little pressure upwards unless everybody lowers his or her finger exactly in the same time. And, that never happens if there are no very precise cognition based appointments. For me, this experiment demonstrated how destructive self organization can be without planning interventions. Mayer stresses the full complexity of social interaction in low-tech experiments with many stakeholders in different roles, sometimes conflicting, clarifying the total impact. It reminded me to the Metropolitan Debate (see page 13).

TNO, TUD, the municipality of new town Zoetermeer

TNO developed a serious game 'Urban Strategy'[33], showing a complete 3D digital map of Rotterdam and its harbour as one of the many examples. Many local data are retrievable from that map, supporting decisions of stakeholders and local administration. The map can be changed introducing new projects, assessing their environmental impacts.
TUD developed a practice of serious gaming in a 'Decision Room'[34], mainly based on determining a solution space of complex urban projects by linear programming.

Atelier Almere[35] focused on design, modelling potentials of Almere by distinguishing different layers of design.
New town Zoetermeer[36] and an increasing number of settlements of its companies are present in the Internet game Second Life. Here anybody can become an agent in full freedom to decide without professional suppositions.

Conclusion

The state of the art of urban simulations shows a great variety of fast developing approaches to get grip on the probable and sometimes desirable or possible future. Their main function is awareness of counter-intuitive developments at another scale than we as humans are used to. They signal problems, but less aims or possibilities. Some simulations give an overview of our possibilities by design. Their function is awareness of possibilities, they change our desires. However, these possibilities outnumber our imagination, they confuse our choice. Computer games could help giving direction to our choice. Perhaps Second Life is the place where we can collect all simulations to determine what kind of life we want to live and what kind of environment we want to leave for our children.

References

[1] Stolk (2009) *Model town* (Amsterdam) SUN
http://www.sunarchitecture.nl/catalogue/categori/urbanism/model_town_9789085068044.html

[2] Thomson, W.C.; e.a. (1977) *Midden Randstad Study. Part II: Final Report. Volume V: Plan Area Models* Colin Buchanan and Partners; Adviesbureau Arnhem B.V.; Grontmij N.V

[3] RIVM, Rijksinstituut voor Volksgezondheid en Milieu (1997) *De Ruimtescanner, geïntegreerd ruimtelijk informatiesysteem voor de simulatie van toekomstig ruimtegebruik.* (Bilthoven) RIVM

Koomen, E. (2002) *De Ruimtescanner verkend. Kwaliteitsaspecten van het Informatiesysteem Ruimtescanner* (Amsterdam) Economisch en Sociaal Instituut van de VU Amsterdam

[4] RIVM, Rijksinstituut voor Volksgezondheid en Milieu (1998) *Leefomgevingsverkenner. Proeve van een prototype* (Bilthoven) RIVM

Nijs, T. de; e.a.; RIVM (2001) *De Leefomgevingsverkenner. Technische Documentatie* (Bilthoven) Rijksinstituut voor Volksgezondheid en Mileu

[5] MNP (2007) *Nederland later; Tweede Duurzaamheidsverkenning; deel Fysieke leefomgeving Nederland* (Bilthoven) Uitgeverij RIVM

[6] CBS (1993) *Standaard Bedrijfsindeling (SBI),* (Rijswijk) Centraal Bureau voor de Statistiek

[7] Jong, Taeke M. de (1985) *Programma NNAO scenario* (Den Haag) MESO

[8] Jong, Taeke M. de (2007) *Context Analysis.* **In:** Bekkering, Henco; Hauptmann, Deborah; Heijer, Alexandra den; Klatte, Julius; Knaack, Ulrich; Manen, Sanne van [eds.] *The Architecture Annual 2005-2006. Delft University of Technology* (Rotterdam) 010 Publishers; 92-97

[9] Snep (2009) *Biodiversity conservarion at business sites* (Wageningen) LUW thesis Alterra

[10] Steekelenburg, Marco van (2001) *Self sufficient world* (Den Haag) VROM, RPD

[11] http://www.ahn.nl/index.php
[12] http://www.archeologie.nl/index1.php?pagina=http://www.archeologie.nl/projecten/ahn/ahn.html
[13] http://team.bk.tudelft.nl/ > Publications 2007 > Earth.xls
[14] http://www.cbs.nl/en-GB/default.htm?Languageswitch=on
[15] http://team.bk.tudelft.nl/Databases/2004/GebruiksaanwijzingImageJ.doc
[16] Jong, T.M. de; Achterberg, Jayand (1996) *Het Metropolitane Debat. 25 Varianten voor 1mln inwoners* (Zoetermeer) Stichting MESO
Jong, T.M. de; Dieters, M.; Boelen, A.J. (1996) *Het Metropolitane Debat. Voorlopige Morfologische Analyse van Twaalf Plannen voor de Randstad* (Zoetermeer) Stichting Meso
[17] http://www.reconstructivism.net/
[18] http://www.urbanproximity.net/
[19] William Shockley, John Bardeen and Walter Brattain assembled the first point-contact transistor at Bell Labs in 1947.
[20] http://team.bk.tudelft.nl/ > Publications 2007 > living.xls
[21] http://team.bk.tudelft.nl/ > Publications 2009 > Sun .xls; Energy .xls; Wind .xls; Windvelocity(heigth) .zip; Sound and noise .xls; Water.xls; Trafficnetworks .xls; Earth .xls; Earthquakes .xls; Life .xls; Human population .xls; Living .xls; Standaardverkaveling .exe; Environment .xls; Legends .xls; FutureImpact .exe; FutureImpact .rar; SchermBytes .xls; Mathematical functions: Statistical functions .xls; Logaritmic functions .xls; Power functions .xls; Trigonometric functions .xls; Integrals .xls; Lineair .xls; Linear algebra .xls; Bifurcation .xls; Bifurcation .xmcd.
[22] Mathematical applications like MathCad and MatLab advertise: “Computers do the math, you do the learning.”.
[23] NNAO, Stichting Nederland Nu Als Ontwerp (1987) *Nieuw Nederland 2050 deel I achtergronden* (Den Haag) SDU
NNAO, Stichting Nederland Nu Als Ontwerp (1987) *Nieuw Nederland 2050 deel II beeldverhalen* (Den Haag) SDU
[24] Jong, T.M. de (1985) *Programma NNAO scenario* (Den Haag) Stichting Meso and Sociaal-geografisch instituut UvA
[25] Frieling, D.H. (2002) *Design in strategy* **In:** Jong, T.M. de; Voordt, D.J.M. van der [eds.] *Ways to study urban, architectural and technical design* (Delft) DUP Science
[26] Jong, T.M. de (2007) *Context Analysis.* **In:** Bekkering, Henco; Hauptmann, Deborah; Heijer, Alexandra den; Klatte, Julius; Knaack, Ulrich; Manen, Sanne van [eds.] *The Architecture Annual 2005-2006. Delft University of Technology* (Rotterdam) 010 Publishers; 92-97
[27] Stolk (2009) Model town (Amsterdam) SUN
http://www.sunarchitecture.nl/catalogue/categori/urbanism/model_town_9789085068044.html
[28] Haken, H.; Wagner, M. [eds.] (1973) *Cooperative Phenomena* (Berlin / Heidelberg / New York) Springer-Verlag
[29] Gell-Mann, Murray (1994) *The Quark and the Jaguar* (London) Abacus
[30] Pekalska, Elzbieta (2005) *Dissimilarity representations in pattern recognition. Concepts, theory and applications*. (Delft)Thesis Delft University of Technology
[31] Daams, J.H. (1989) *Catastrofen. Bedreigingen van het bestaan* (Amsterdam) Nijgh & Van Ditmar
[32] see for example the failure of modelling in Cornelissen, Annemiek J.M. (2001) *Distribution and Control of Coronary Blood Flow* (Delft / Amsterdam)Thesis Delft University of Technology
[33] http://www.tno.nl/content.cfm?context=markten&content=product&laag1=186&laag2=155&item_id=795
[34] http://www.tudelft.nl/live/pagina.jsp?id=6d533596-00ff-426d-ac8d-f9d167df4f59&lang=nl
[35] http://www.atelieralmere.bk.tudelft.nl/
[36] http://www.zoetermeer.nl/index.php?mediumid=2&stukid=17809