Using information technology for dealing with permanently changing situations - thoughts on "Dynamic Planning"

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Abstract

All too often planning is seen as trying to change an existing "actual situation" into a better "planned situation". But there never is a static, stable situation – cities and regions are in permanent change over time. So the problem already starts with defining the "given situation", and the rules and core goals of planning are not as easy to describe as for example in chess. A permanent feedback, if goals and proposed actions are still valid, is necessary - the need for "dynamic planning" is obvious.
Constantly automatically collected data for spatial and environmental development allow the monitoring of spatial development. The crucial factors are how the interrelations of static and dynamic elements can be considered in the planning and implementation process and how time in it´s various manifestations is dealt with. IT-tools such as GIS and Spatio-temporal-Content and Knowledge Management Systems can take an important role in the implementation of "dnyamic planning".

1 "Conventional Planning"

In common plans for spatial development special attention is paid on the goal representation, the means and steps for the achievement of the goal all too do not get enough attention. To formulate it exaggerated: from the analysis of data from the past a (static) actual condition is determined and from this a (static) goal condition is formulated.

Actual Situation	⟶	**Planned Situation**
Knowledge about "actual" situation generated from data representing the past		(What happens after that?)

With consideration of the main goals of an economical handling of scarce (natural) resources and a sustainable spatial development it is highest time also for spatial planning, to think and act in processes, connections and cycles more than in inventory sizes.

A major challenge for each plan is the possibility of unforeseeable developments or the change of the basic conditions within the planning period.

It can happen that defined goals of the plan become obsolete or at worst even counter-productive. For some planning contents it would be quite meaningful not to accurately specify them at the time of planning but to meet an exact regulation only if necessary and as a function of the development of other factors and thus to keep possibilities open, in order to be able to react to developments.

Deficits within the following areas:

- Implementation of planning
- Possibilities to react on unexpected developments
- Unnecessarily strict specifications for individual factors

2 From thinking in static conditions to deal with dynamic processes

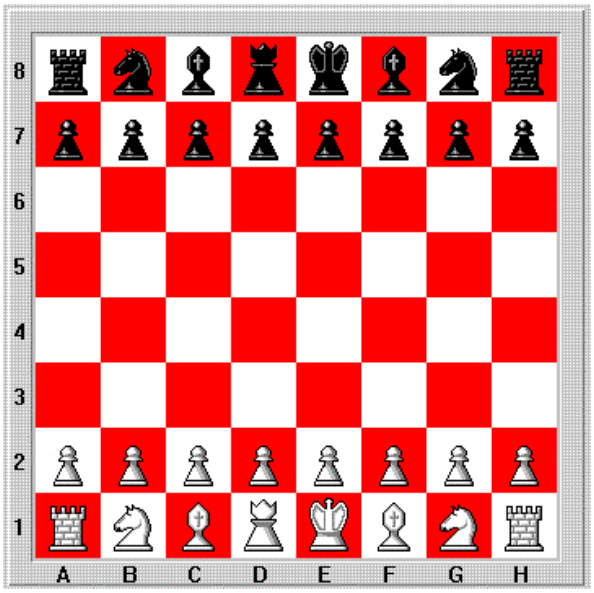
A possible way for a better handling of these tasks is to take additionally up to “conventional” definitions also regulations, which change with the time. Therefore it is necessary to differentiate between plan definitions, whose change at a certain time is fixed in advance, and such, whose change depends on certain basic conditions. As term for planning where contents and definitions change in the course of the planning period according to defined rules, “dynamic planning” is suggested.
Substantial preconditions for the implementation of rule-based dynamic definitions are on the one hand constantly current data of the situation and the development of spatial phenomena, also referred to as “monitoring of spatial development”, and on the other hand tools, with which both plan documents and data base are manageable.
Appropriate data of the development of spatial phenomena are available in constantly rising quantity and quality from current automatic measurements (e.g. automatic traffic counting, air and water quality measurements, satellite photographs etc.). Geographical Information Systems and Spatio-temporal-Content-Management-Systems offer the suitable tools.

3 Goals and complexity of planning

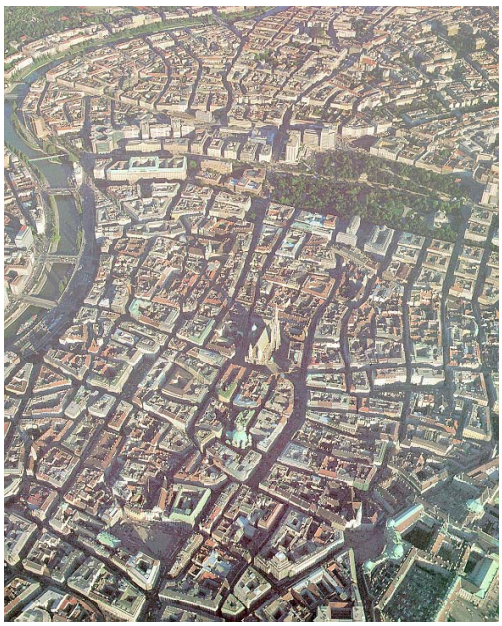
When talking about tools and instruments it is important also to spend some thoughts on the general purpose and goals of (spatial) planning.
From the authors point of view there are two aspects that make it very difficult to judge whether the instruments are sufficient

a) the complexity of urban / spatial systems
b) the difficulty to formulate clearly defined goals

The following figures illustrate these points.



•2 opposite interests
•16 participants with exactly defined action patterns
•closed system



•numerous opposite interests
•numerous participants with multiple possibilities to (re)act
•open system

- 1 winner, 1 loser
  „The winner takes it all!"

- „Long-term co-opetition"

Compared to spatial planning chess appears as a very simple and easy game, as there are very limited possibilities and the goals of all involved parties are clearly defined.

4 Dimensions of time

When talking about time and decisions / rules / changes depending on time it has to be taken into acount that time has very different dimensions.
On the one hand it is suggested to differentiate between

- unique events (directed time-line)
- recurring events (rhythms)

on the other hand it has to be seen that like in spatial dimensions there are a lot of different "time-scales", from very short to very long.
Some examples:

(Parts of) Seconds	Many things happen very fast, decisions have to be made very quickly, for example in car-traffic (steering, collission-warnings, …)
Minutes	
Hours	Cities look/behave completely different during night time or during rush-hour
Days / weeks	
Seasons	For tourism and fashion seasons are very important
Years	Buildings are created / changed / removed, "Short term" and "long term" spatial planning is meant for years
Decades	Most People live for decades Buildings last for decades, some for centuries, some plants and animals live for centuries
…	
Million Years	Geological changes happen in thousands and millions of years – but on the other hand geologic activity in form of an earthquake can have great impacts within seconds …

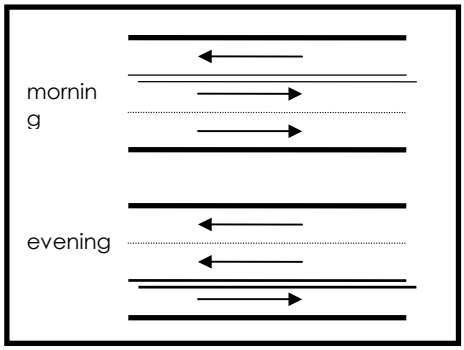
5 Examples from transport sector

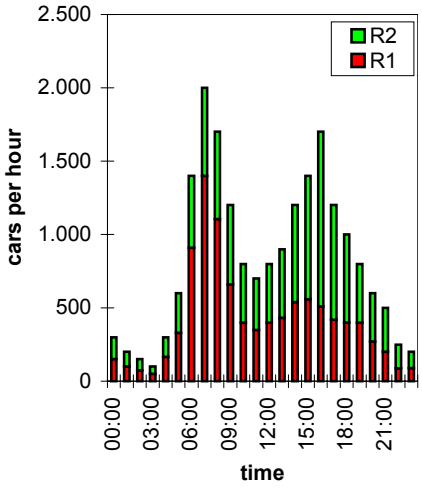
5.1 Situation-dependently road signs

It´s not so much the total number of cars a day that is crucial to judge whether a road is sufficient for the actual needs, but the load during peak traffic.
The very same is true for public transport systems.
Dynamic signposts are meanwhile widely used to influence transport flows and to improve utilization of available infrastructure

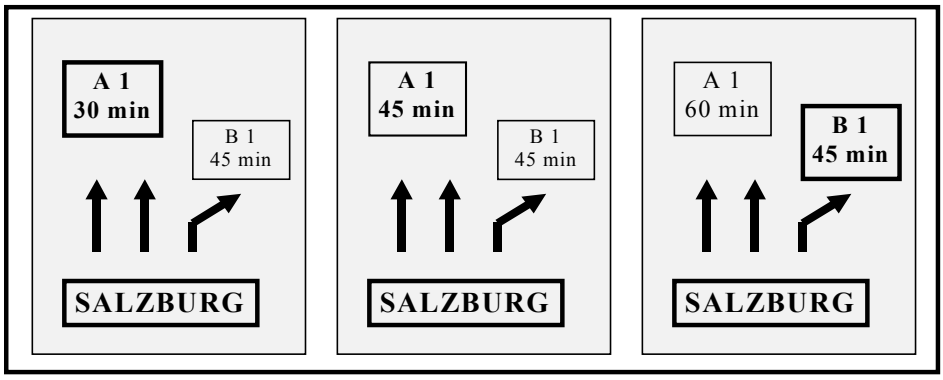
Example of a typical traffic-time-line

time period					
from	until	cars per hour	direction 1 (to town)	direction 2 (out of town)	percentage d1
00:00	01:00	**300**	150	150	50%
01:00	02:00	**200**	100	100	50%
02:00	03:00	**150**	75	75	50%
03:00	04:00	**100**	50	50	50%
04:00	05:00	**300**	165	135	55%
05:00	06:00	**600**	330	270	55%
06:00	07:00	**1.400**	910	490	65%
07:00	08:00	**2.000**	1.400	600	70%
08:00	09:00	**1.700**	1.105	595	65%
09:00	10:00	**1.200**	660	540	55%
10:00	11:00	**800**	400	400	50%
11:00	12:00	**700**	350	350	50%
12:00	13:00	**800**	400	400	50%
13:00	14:00	**900**	432	468	48%
14:00	15:00	**1.200**	540	660	45%
15:00	16:00	**1.400**	560	840	40%
16:00	17:00	**1.700**	510	1.190	30%
17:00	18:00	**1.200**	420	780	35%
18:00	19:00	**1.000**	400	600	40%
19:00	20:00	**800**	400	400	50%
20:00	21:00	**600**	270	330	45%
21:00	22:00	**500**	200	300	40%
22:00	23:00	**250**	88	163	35%
23:00	00:00	**200**	90	110	45%
total		**20.000**	10.005	9.996	





Problem of the peak traffic – control of utilisation as a function of the current load - daily variation line of traffic flow



Dynamic signposts are meanwhile widely used to influence transport flows

5.2 Alpine-crossing traffic at the start and end of holidays

Each holiday-season, millions of tourists travel from northern to southern Europe and return. The highways crossing the alps are absolutely sufficient to take up the traffic flows for more then 90% of the time of the year or even look over-dimensioned sometimes – but during those "mass movements" they become the needle eyes of the north-south movements and often induce huge traffic jams.
During these events, people have to wait in their vehicles for hours in the midst of very stressful situations instead of relaxing and enjoying their holiday-time. These events add up to the traveller's state of happiness and alertness and consequently effect the driving safety for themselves and other drivers who share the same highway.

What about pleasant alternatives to those situations?
During a trip from northern Germany to Alpine Italy for example, there are a lot of very interesting tourist spots on the route, which are rarely visited by tourists in transit. Existing electronic trip planners either make optimisations for the shortest path (kilometric distance or time) or least expensive route (reduced toll roads). In addition, it is quite uncomfortable at the moment to navigate and search for specific locations on a map at the same time. This fact often discourages potential interested tourists from exploring these tourist spots.

To improve the situation there are basically two approaches:

Route optimisation in the planning phase:

Before heading for the holidays the route can be planned so that "predictable traffic jams" are avoided. The car ride can already be seen as part of the holiday as it leads through interesting and attractive areas away from the main routes (maybe just in sections where congestion tends to occur on the main roads). There are several small but beautiful side-

trips, where maybe there is an overnight stop at a nice place and the timing can be optimised so that predictable congestion can be avoided.

Ad-hoc reaction to stressful situations when already on the road:

If there is a traffic jam ahead, or a road closure due to natural causes, the system can provide information on alternatives: 1) you can wait for five hours in front of this tunnel; 2) you can take the old road (excludes trailers) that is very beautiful, but already overcrowded and takes 4 hours; or 3) you can take the next exit, that leads you to a small town with an interesting roman theatre, a gothic church, a small lake, and excellent restaurants. The last option, which can be seen as part of the vacation, offers the traveller a nice and relaxing day and allows him to continue his trip in several hours or the next morning.

6 Situation in land-use planning and residential developments

Some of the points illustrated with the examples from transport planning are similar in land-use and spatial planning.

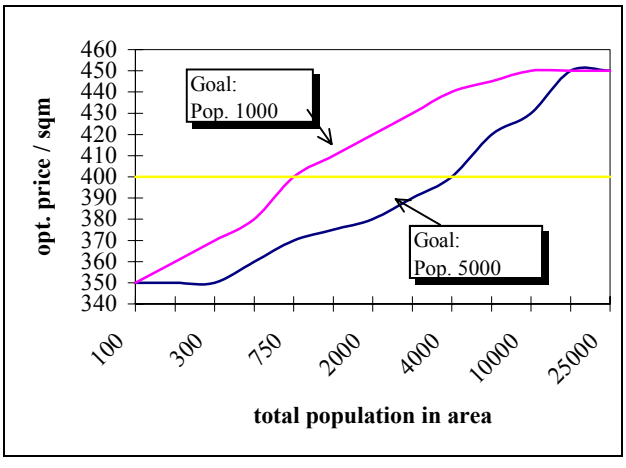
Take the example of residential developments:

Usually a socio-economically very homogenous group of people moves to new areas, in many cases: young families having or expecting babies. These babies will need a Kindergarten in 2-3 years, a primary school in 5-6 years and so on. And almost no one will need a Kinder-garten or a primary school in 10 or 15 years there, but the buildins will still exist. One question is if there is a way to build multi-functional structures that can be easily adopted to the needs over time?

Also the dimension of all other infrastructure is optimized for a certain number of people, so usually a city wants approximately that number of people there.

So the question raises: Are there ways to influence the price of land or appartements to achieve the optimal number of population within an area and thereby optimize the extent of utilization of infrastructure?

average price of land per sqm for plots in the surrounding areas		**400,-**
actual Population within area	opt. No. of Population 5000 "supposed price"	1000
100	350,-	350,-
200	350,-	360,-
300	350,-	370,-
500	360,-	380,-
750	370,-	400,-
1.000	375,-	410,-
2.000	380,-	420,-
3.000	390,-	430,-
4.000	400,-	440,-
5.000	420,-	445,-
10.000	430,-	450,-
15.000	450,-	450,-
25.000	450,-	450,-



7 Tools for “Dynamic planning”

7.1 Monitoring and change detection in spatial development

Data collection is frequently time-consuming and expensive. That’s why for current projects often data from the past are used. In the ideal case planning bases should be available at short term. Apart from the synopsis of the available data also the question about co-operation possibilities and synergies with data collection are crucial.

Briefly to basic problems: Up-to-date we refer a large part of our knowledge of status and development of the space and the environment from systematically created manual measurements and collections. This method of data collection has the disadvantages to be expensive and intensive and thus only in relatively large time intervals can be repeated. Besides snapshots are created, which supply a more or less coincidental picture of a status at a certain point in time, with very reduced interpretation possibility of the genesis of this status and especially how it will develop, instead of only realizing ex-post that a modification has taken place.

In order to be able to meet political and planning decisions responsibly, the knowledge of development dynamism and interrelations between the individual factors is crucial.

Due to the technological developments of the last years the advancement of this methodology is possible today. More and more environmental information is made available continually, e.g. are entered by fully automatic measuring points, and also satellites supply detailed information with high repeating frequency - one can speak of "Monitoring of Spatial Development " or of ENVIRONMENTAL MONITORING IN REAL TIME.

A possible new problem, which results in the case of this type of collection, may not be ignored: it is the resulting quantity of data, which are manually hardly evaluable and not at all linkable. It is therefore necessary to structure and interpret this data flood, in order to be able to draw an appropriate use from it. This again is possible only automation-supported. Thereby the following requests must be the center of attention:

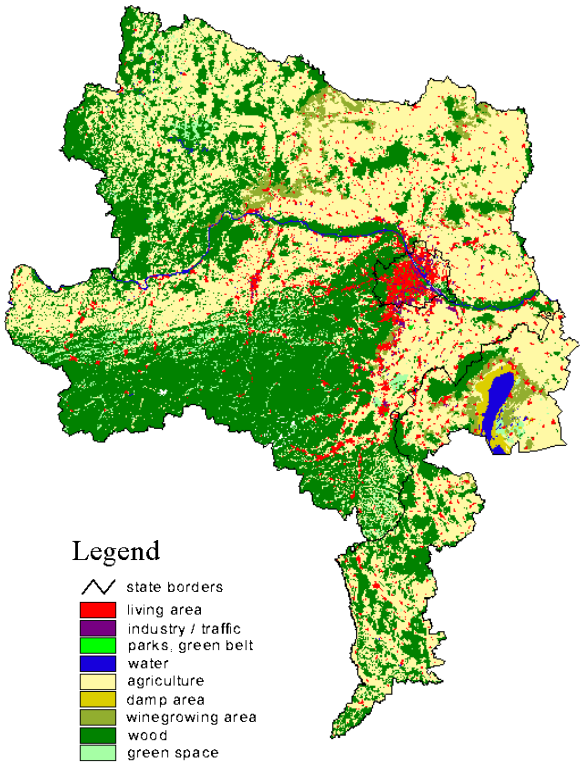
- only unique analysis of the source data by experts for the handling of these data and offering the data to as many as possible users – otherwise too much expenditure is put into the pure data handling and the use remains small
- the reduction of the complexity, so that developments remain understandable and interpretable – a beginning in this connection is the derivation of indicators, with their assistance the interpretation of complex circumstances is enabled
- the prognosticating of future developments on base of the observation of passed and present developments. A beginning in this case is the creation of a concept with appropriate analysis and variation options (e.g. sensitivity analyses, extreme-scenarios, prognosis funnels...)

Plenty of continually collected planning bases are already offered today. For example:

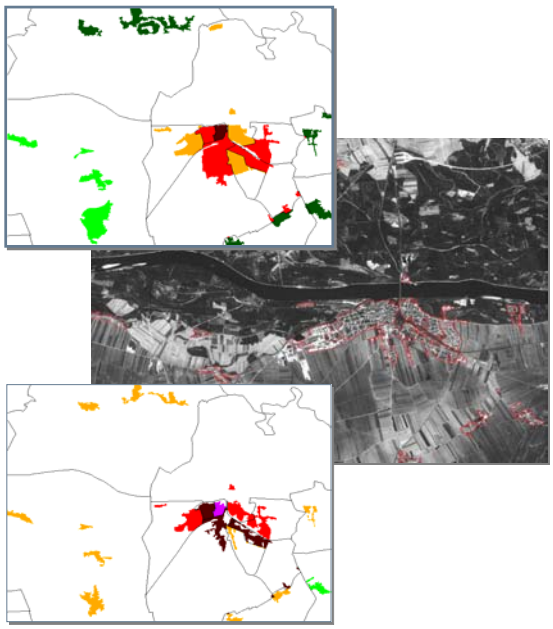
- environmental data, like weather situation or air quality
- data bases for traffic planning, which are entered automatically
- Geographical on-line services, like world-wide map displays, route search or traffic information
- Airport statistics, which offer information about passenger numbers, cargo statistics or flight movements as well as –delays

From particular use for spatial planning on regional level are remote sensing data. They supply transnational comparable planning bases. In particular rank among it:

- registration of land use
- modification of the land use in timing
- deduction of spatial indicators



Settlement mask of the "Vienna region", derived from satellite data



Change detection, derived from satellite data (Steinnocher, Köstl)

The linkage with socio-economic data and the integration of these as well as other continually collected spatial information in geographical information systems extend the evaluation possibilities for planning functions up to the spatial-temporal modeling and simulation of processes.

Especially for modern planning instruments such as regional management for co-operation in metropolitan regions, coordination of projects over administrative boundaries away or environmental impact assessment such bases are indispensable.

7.2 3D-GIS, 4D-Content-Management-Systems

3D-models are permanently rising in popularity. More and more cities and tourism regions rely on the effects of 3D modelling. New techniques and fast hardware allow to produce stunning illustrations relatively cheap and quick.
But improved visualisation opportunities do not necessarily result in better plans and advantages in the development of cities and regions.
It will be the planners task to use these tools and opportunites to improve their plans, to develop “4D City & Landscape Models” and deploy all of their advantages.

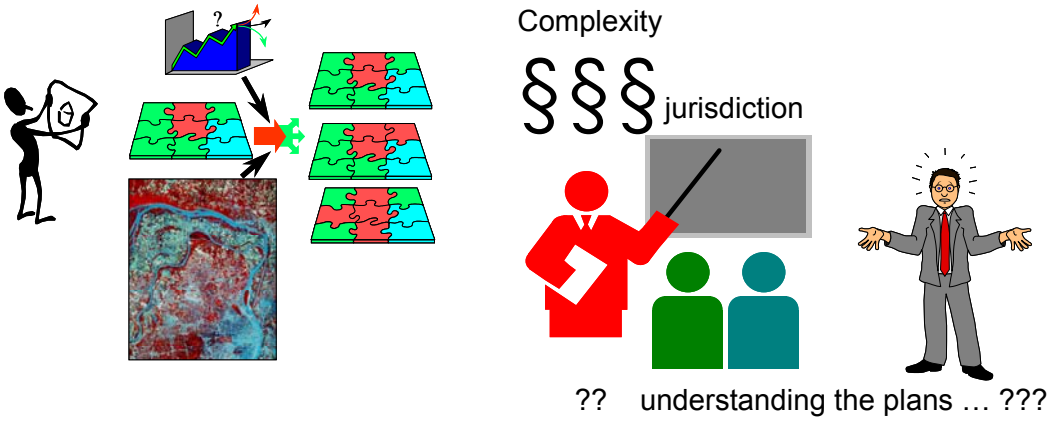
8 Problems ahead

Problems with a stronger dynamic sampling of planning contents are the high complexity of spatial developments and the associated uncertainty over implications of effects.

With the combination of several conditions and/or rules the number of scenarios grows exponentially. As a consequence plans become even more obscure for the persons affected by the planning, than they now already are, and by overloading with an abundance of rules they hardly remain comprehensible also for experts.

An important part of the problems, which result in case of the application of regulations described above, will probably concern the legal range. Since it can happen that individual

scopes are substantially affected by the acting of others, basic questions of juristic principles are concerned.



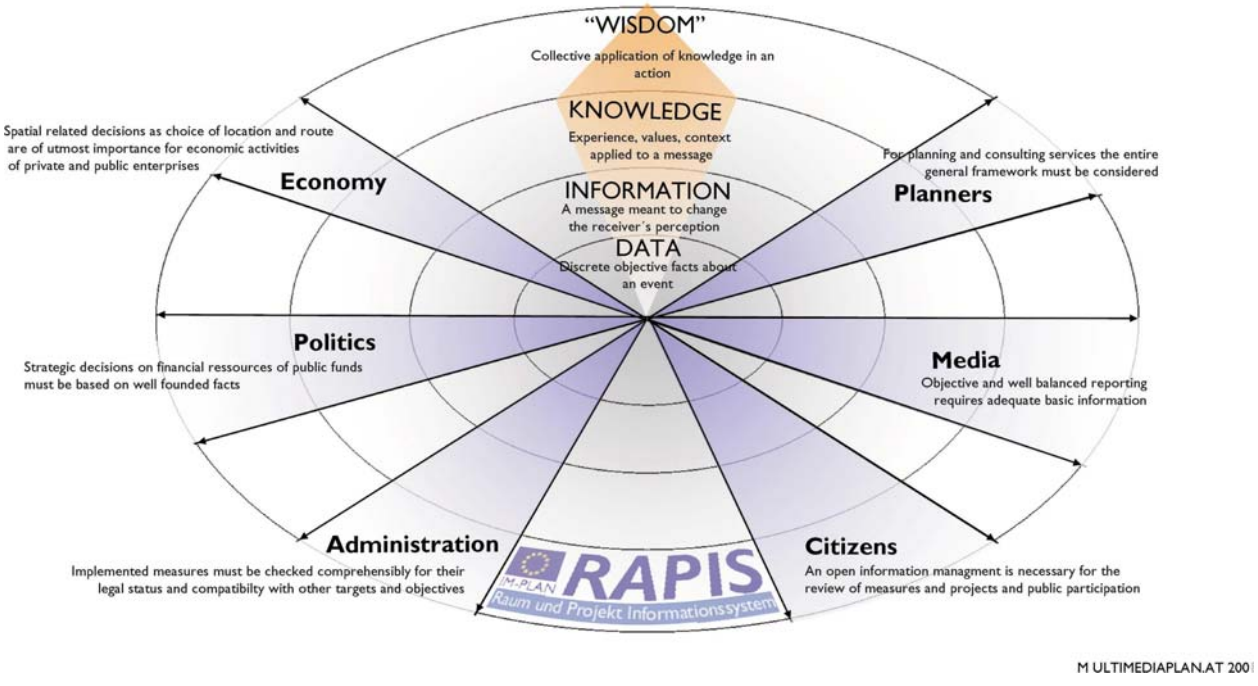
9 Hopes and expectations

Hopes of the mentioned approach are not so much a change of the planning objectives than rather in an improvement of the implementation as well as the more effective usage of existing resources (fight against the “phenomena of simultaneousness”), made possible by short-term supervision and steering interferences.

Reaching certain characteristic values or deviating from the planning conceptions can be determined right away through monitoring of spatial development, immediate small corrections instead of later, usually more complex, repairs enable the observation of planning objectives.

A fully automatic adjustment of planning contents appears meaningful and justifiable only in exactly defined, always recurring situations, where implications of effects are well-known and visible.

The vision ahead is the common positive shaping of our cities and regions on the basis of the best possible information, to make this information to knowledge about spatio-temporal relations and developments and to be able to find “wiser” democratic decisions.



10 Resumée

An again and again a raised demand is the building of a new spatial and environmental monitoring system aligned to the sustainability concept. Constantly automatically collected data for spatial and environmental development and Geographical Information Systems must form the basis of a monitoring of spatial development.
The question, which arises meanwhile, is not: ”Do we need that at all?” but much rather: “For how long can spatial planning still afford it to do without this information and these facilities and in consequence without the steering and control instruments enabled thereby?”
To get it straight: dynamic planning contents can only be seen as valuable addition, not as substitution for conventional planning contents. In practice it will not always be easy, to find the correct relationship between fixed and dynamic planning contents, because on the one hand it makes no sense to develop a planning, which is constantly only adapted and has no substance, on the other hand not more than necessary should be rigidly specified too early and thus prevent better solutions.

11 References

ARBTER, Roland: ESPON: European Spatial Planning Observation Network; in: Schrenk, Manfred (Ed.) Proceedings of CORP2002, Vienna, 2002

BENENSON, Itzhak; PORTUGALI, Juval: Internal vs. External Spatial Information and Cultural Emergence in a Self-Organizing City; in: FRANK, A.U. & KUHN, W.: Spatial Information Theory - Proceedings of COSIT´95; S.431ff; ISBN 3-540-60392-1

COOK, P.D.; O´PACKI P.: Urban Regional Planning Application Issues: Linking Transportation Models with GIS and Updating Networks within Transit Agencies; in: SELIS, T.; GEORGOULIS, D. (Eds.): Samos Conference - First International Conference on Geographic Information Systems in Urban Regional and Environmental Planning, 1996

DURWEN, K.J.; BORTT, W.: Dynamisierung der kommunalen Umweltplanung durch Verbesserung der Informations- und Präsentationsmittel; in: DOLLINGER, F.; STROBL, J. (Hg.): Angewandte Geographische Informationsverarbeitung VII, Beiträge zum GIS-Symposium 5.-7. Juli 1995; Salzburger Geographische Materialien, Heft 22, S. 65f; Salzburg, 1995

FORKERT, Gerald: Virtuelle Stadtmodelle im Internet; in: Schrenk, Manfred (Ed.) Proceedings of CORP2002, Vienna, 2002

SCHRENK, Manfred; DORAU, Uschi: RAPIS – Raum- und Projekt-Informationssystem für die Vienna Region; in: Österreichische Zeitschrift für Vermessung & Geoinformation (VGI), Heft 4/2001

STEINNOCHER, Klaus; KÖSTL, Mario: Verdichtung oder Zersiedelung? Eine Analyse des Flächenverbrauchs im Umland von Wien; in: Schrenk, Manfred (Ed.) Proceedings of CORP2002, Vienna, 2002