3D City Models – Nice Toy or Basis Information of the City Council?

Bettina PETZOLD, Germany

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SUMMARY

Many cities have already started to build up 3D city models that can be used especially for planning tasks and city marketing. The solutions offered on the market do not follow the requests. Available applications are independent solutions, an integration of cadastral data is usually not possible. But with the 3D data market not only a broad field of activities is offered to the cities, they are in addition able to take part in the design. That is possible since the cities are acting as the source of 3D geocoded data for applications even outside the administration.

RÉSUMÉ

De nombreuses agglomérations ont déjà commencés à établir des modèles urbains tridimensionnels, destinés principalement à l'urbanisme et au marketing. Les systèmes d'information géographique actuellement proposés sur le marché ne satisfont cependant pas encore aux attentes des utilisateurs. Ces applications sont des solutions indépendantes dans lesquelles il n'est généralement pas possible d'intégrer des données cadastrales. Avec les possibilités des logiciels 3D, c'est non seulement un large éventail de possibilités qui est offert aux communes, mais aussi la possibilité de participer à leur conception. C'est possible parce que les communes fonctionnent comme fournisseur de données tridimensionnelles, aussi pour des applications autres qu'administratives.

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1. 3D CITY MODELS: HOW THE IDEA CAME UP (INTO OUR MIND)

Many city councils are planning to build up 3D city models soon, some of them have already started to do so. For the city council of Wuppertal, a city of about four hundred thousand inhabitants in North Rhine - Westphalia, Germany, such a model would also be very interesting. But how to carry it out?

1.1 First try: The Project "Virtual Region"

Within the cadastral offices of the cities of Remscheid, Solingen and Wuppertal a long and fruitful co-operation is existing and meanwhile is established as a standard within the administration. It especially concerns data processing and the GIS systems used. The jumble of the three cities helped to reach synergy effects especially in cartography. Since years for example the city map of these three cities has been revised and edited as one single product, the last years on CD-ROM in addition.

Building up a common 3D city model for the region, for these three cities, was thought to be a possible project within the REGIONALE2006. With the arrangement of the so called REGIONALE the ministry of urban development supports the preparing, realization and presentation of projects and initiatives within a region to sharpen its profile. It is thought to be necessary establishing a regional profile with regard to structural changes and especially to the international competition. The ministry sets great store by presentations since the attraction of a region is thought to be elucidated by the means of varied and high quality presentations. Even if the construction of a 3D city model is not really a project of urban development in its classic sense, the link to the presentation brought up the hope to get some support within the REGIONALE.

In the preparatory phase it became rather clear that professional help was necessary to come out with a successful application and presentation. 3D software on the market was too half baked and especially too different with regard to the data structure. The visualization of 3D city models seemed to be the most advanced, but none of the solutions enabled the direct link to the GIS databases. All systems were using own data structures or those quasi-standards that are intended for presentational purpose only.

To convince the decision-makers, it was decided to present the facilities of 3D city models with the help of three examples. The main focus was set on tourism, urban planning / urban development and participation of citizens. This was carried out with a strong support of the University of Bonn, Institute of Cartography and Geoinformation and Institute of Photogrammetry. The examples on CD-ROM were given as an "amuse-gueule" and thought to convince the decision-makers, but finally the project failed. This was partly due to the

financing; the cities have to pay eighty percent on their own. On the other hand building up a 3D city model was not considered as a typical project of urban planning or urban development. The only possibility to take part in the REGIONALE was as data provider for one of the accepted projects, that means for a very small area within one of the cities.

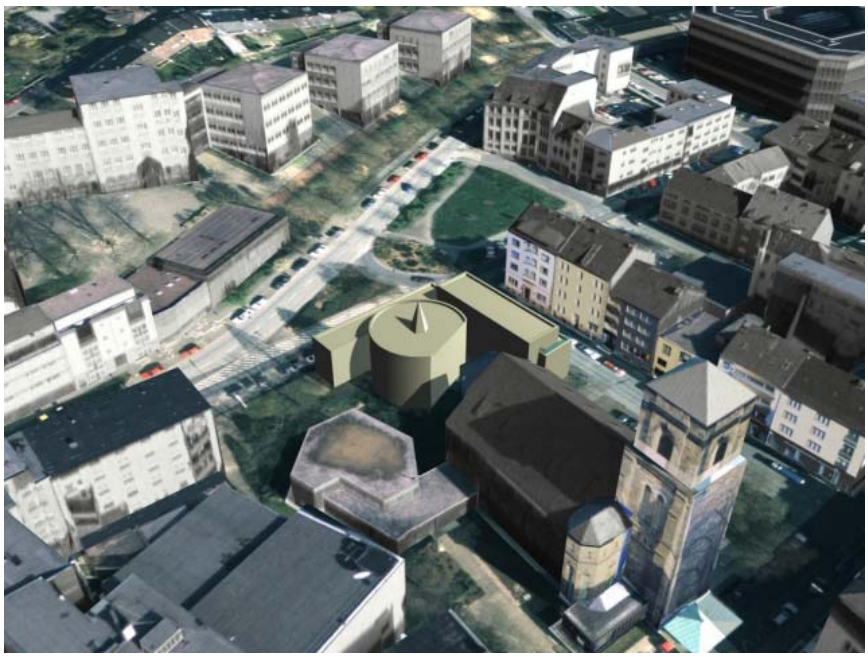

Figure 1: Example for applications: the planned synagogue within the 3D model

1.2 The Actual Situation: Why are we Still Talking about it

But there is another chance: the sealed surfaces, might be the roofs and the sealed surfaces on the ground are gathered by a photogrammetric restitution for the whole area of the city of Wuppertal. These surfaces on the ground may be streets, parking places, foot paths, terraces and so on, in most cases made of concrete or asphalt, and have to be bigger than one square metre to be gathered. The restitution is done for tax calculations, but since a photogrammetric restitution has been chosen, these data can of course be used for the derivation of a 3D city model, too. The aerial photographs have a scale of 1:3500, so the position accuracy is about that of the cadastre, and the height precision is about ten centimetres. The data structure is at first view very simple, but at least the surfaces are gathered as closed areas.

So the question was if - that was very certain - and how the data can be used for the derivation of a 3D city model. The university of Bonn was asked to look at the data more in detail and to elaborate a proposal how these data can be used, if and how the result can be improved by the integration of cadastral data and, finally, how they can be stored in a database. The proposal to this last point should take into consideration that an interface for a standard format used for presentation should exist and that the data should be transferred automatically towards a real 3D database – if it really exists; and we hope that this should not be that fare away!

2. THE BASIC IDEAS: WHY 3D CITY MODELS ARE THAT INTERESTING

Many city councils are planning to build up 3D city models soon, some of them have already started to do so. Why is it that interesting?

2.1 State of the Art

There are many reasons for building up city models. For example landscape or architectural planning can be integrated and presented in a virtual landscape or city model. With the help of multi media techniques, spectators can dip into the virtual world and experience the planning close to reality. If there are suggestions for changes, they can be integrated before realizing the project. The process to come to a final decision is supported by the mean of a realistic visualization and finally leads to a planning that is accepted by the citizens.

In addition 3D models are necessary for the derivation of noise level maps. In the Federal Republic of Germany the cities are forced by legal requirements to set up those noise level maps. One of the driving factors within the calculation are walls, maybe of houses or a noise barrier.

3D data can also be used for different kind of publicity campaigns. Virtual flights through the terrain or a walk through can be created. Both, walks and flights, can be made either for the individual tourist, for example in digital tourist guides, or for promoting the local industry and commerce (business development). In difficult times like ours the data should be used to establish companies. In addition, the companies can use the data for their own promotion.
Finally users of geobasis data are more and more expecting 3D data to be provided by the councils.

The first 3D city models are more or less solutions valuable only within one project, leading to an inconsistency between the two data sets. In most cases a connection to the cadastre is not built up and is not even planned since there is no connection to the ALKIS data model, the official cadastre information system in Germany.

2.2 Possible Reasons

Modelling 3D data within the GI systems is until now neglected for different reasons. One is that the separation of the digital terrain model and the digital situation model, as it is called within ATKIS and ALKIS, is passed on the GIS world. The GIS tools put the automation of maps that have been stored for a long time only in analogue form into effect. Thereby the third dimension is of no importance. In addition in surveying and in cadastre height is considered as attribute of points and not as an independent element that can be modelled. Finally, no 3D GIS model was produced since there was no demand neither from the private sector nor from the public one.

Applications found on the market now are more or less independent solutions. Only some of them are automatically able to derive the basis data from the cadastral data or other databases of the city council, but normally interactive handling is necessary to a great extend. For

example some solutions are able to extract the building perimeters from the cadastre, the height is calculated by the help of the number of floors. But even this very simple version of a 3D city model can not be derived automatically and it is not integrated into the cadastre data basis. The market of presentation software is growing more and more, but up to now no real 3D data base exists, supporting the automatic derivation of those presentations.

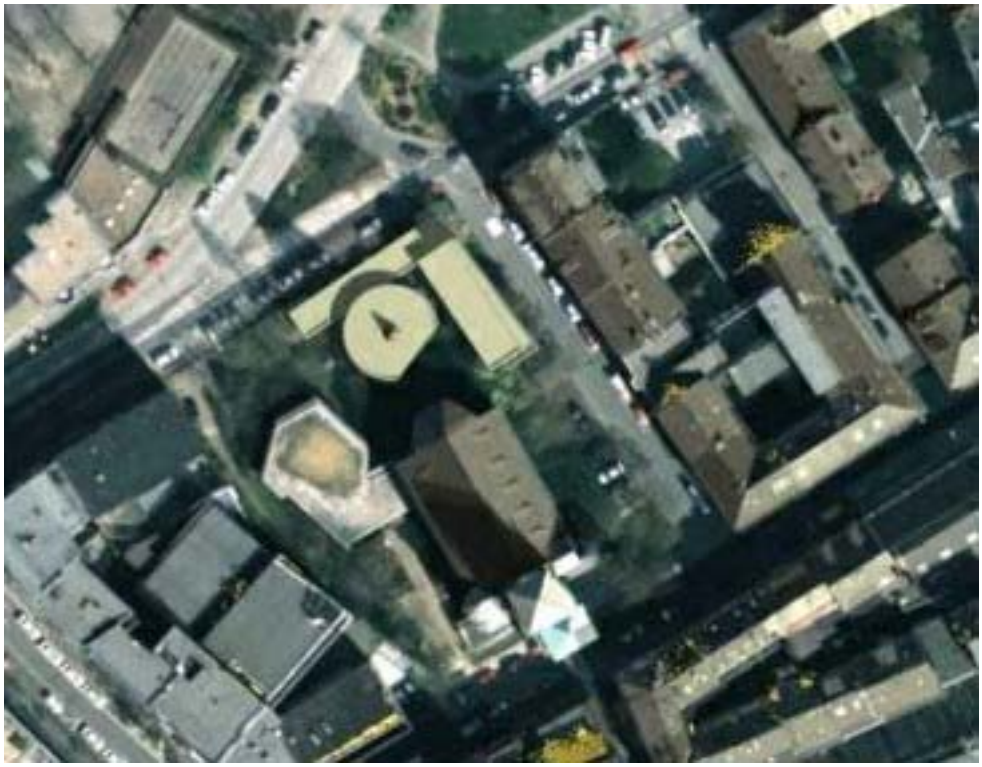

Figure 2: Orthophoto with the virtual object; even the shadow is calculated correctly

2.3 Background, Political Meaning

Many city councils have to look at the considerably growing demand of 3D data and thereby inevitably at the evolution in the field of 3D visualization. All the more considering since these developments are offering sustainable solutions, because of the considerably huge application potential.

In addition these applications help to solve, at least to moderate special (communal) local or municipal problems. There are to mention for example special analyses that need 3D data or at least spatial relations, or simulations that can make planning coming alive. Especially vividness helps to provide the citizens with high value information and strongly proves their facilities to participate in the planning process, particularly in the fields of traffic planning, building and environmental tasks. That way vividness can help citizens to improve living conditions. The use of this new technology leads as well to fundamental changes within the work of the municipal authorities. Within these, beside changes in the planning process, especially the facilities for rationalization and the improvement of competitiveness have to be mentioned.

The city councils are in demand as well as a data supplier for applications also outside the municipal authorities since they are positioned at the starting point of the value adding chain for three dimensional geobasis data. This was confirmed by a market study: according to it customers are looking for direct access to the data provider, if the offer is appropriate to their demand and if high quality data are available. Further on, the municipalities are in an outstanding position since only they ensure, by updating the cadastre, the high relevance of properties, buildings, land utilization and topography. If in addition new technology is used, those data can be accessed by mobile data systems. This step from GIS applications to mobile application, so called "location based services", facilitates a new and large application field, the limits are difficult to be foreseen now.

The facing projects within the field of urban planning require creative solutions, especially with regard to the actual financial situation. Because of budget problems only some few municipalities will be able to fund the creation of 3D city models autonomously. Possible solutions might be found in cooperation. And to build up a 3D city model partially only within a project or for only one special task might be one step towards the solution of the actual open questions, but the build up of a complete 3D city model should not be forgotten as the final goal, since only these models ensure the above mentioned value adding potential.
In addition attention must be paid to the fact that geobasis data without any revision or improvement are without any interest for most users. The cadastral offices are, as mentioned above, standing at the starting point of the value adding chain, and their data are the basis of all geodata applications. They alone do not fulfil the demands of the users, but the municipality can, on the other hand, take part in the improvement of the data.

3. LOOKING TO THE FUTURE: WHAT CAN BE DONE

For planning tasks and within projects there is, as mentioned above, a great demand for supplying the intermediate versions, latest and older ones, of a planning. Even within the municipality this supply will lead towards higher transparencies. But if the municipality wants to use all the potential, it should or even has to use the data for marketing and sales in addition. This is not only meant with regard to the classic tasks of the cadastral office but also to the marketing and to urban development. These new uses of geobasis data will be in interaction with other fields of activities. We can assume that these GIS applications will get a new impulse by the further development of the GIS systems. This especially concerns 3D applications, by the integration of data from different sources and the development of mobile and web based services. This interaction and the high, so far neglected potential of development gives hope on extensive development by the companies providing GIS systems.

3.1 The Further Strategy

In spite of all the difficulties, the original goal to initiate and to stimulate the developments necessary for 3D city models should not be given up.

Building up 3D city models is closely linked to ALKIS, the official cadastre information system in Germany. Although ALKIS is still in development, an integration of the 3D databases to ALKIS seems to be more than necessary. The strategy to achieve our aim is

therefore double-tracked: the further development of the ALKIS data model to a 3D database and 3D data modelling is pursued. Since 3D city models have to be built up already now, this will be done outside the ALKIS project and outside the ALKIS data structure. But the data structures that will be used have to guarantee that a later integration into ALKIS will be possible more or less automatically. To fulfil this demanding task further scientific support will be necessary.

3.2 Realization

In the meantime partial tasks have to be coordinated. Apart from the data capture, for certain, further research work in the field of databases and data model has to be followed. And finally for further 3D city models public private partnership has to be established. Presentations are necessary for the realization of the projects since they have shown, even within the little, not very successful project mentioned above, the high potential of 3D city models. On the other hand it was clearly shown that it is still a long way to the integration of databases and presentation, especially looking at the huge amount of work that had to be done for this short presentation and the great number of different software tools that were used.

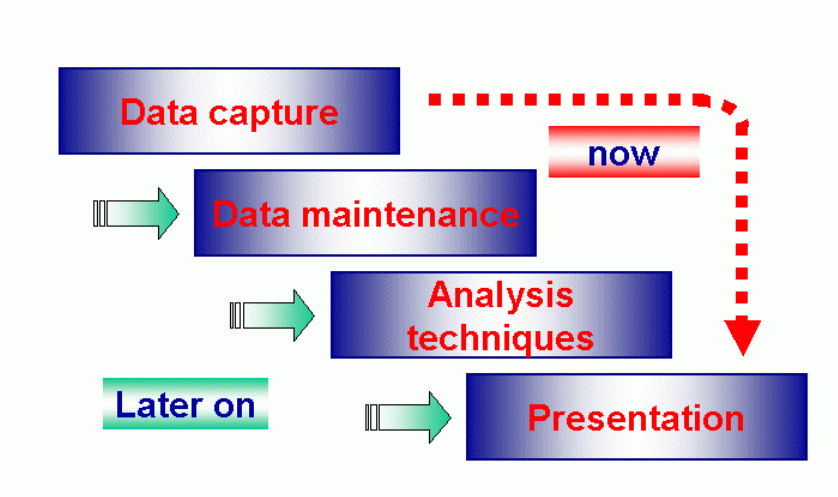

Figure 3: The strategy

3.2.1 Data Capture

Of course data capture causes no problem since the methods and the software needed have been used for a long time and therefore are well-engineered. Data can be captured or taken from aerial images, laser data, other databases, videos, images of the facades and so on. Possibly data can be transferred even directly from the cadastral database. From the existing information, city models, street or vegetation information and digital terrain models can be derived. As mentioned above, in our special case data capture is even already done.

3.2.2 Data Maintenance

Concerning data maintenance, only the demands of the users can be set up up to now. There is first the demand to build up hierarchical models. Multi-presentation must be possible, and that in two and three dimensions. Versions and variants have to be stored, and of course it must be possible to update the data. If in addition the storage of the data's history was

possible, most of the problems would seem to be solved! But certainly all these changes have to guarantee the integrity of the data. The user has demands regarding the safety of the database as high as to the efficiency of the algorithms used in the applications. It must be possible to define views (in a database sense). And, finally, there is the aim of distributed data storage.

3.2.3 Analysis Techniques

Regarding the analysis, the demands within the administrations are oriented towards the most frequent fields of application. With the help of the analysis, it must be possible to answer the various questions coming up from the planning process itself. But also the request of the citizens for transparency within the planning process and for consideration of their interests have to be fulfilled.

The derivation of sights and visibility is the most important application, but also the presentation of light and shadow in the course of a day or in the course of a year. As a consequence of the more complex impact, calculations for the derivation of the city climate and for the spreading of noise and waste gas will be more demanding since in this application field cycles have to be calculated not only for one day or one year but even for one week. And finally analysis has to be possible also for inquiries from mobile GIS.

3.2.4 Presentation

For the presentational part, again, demands and wishes are made for the moment only from the point of view of the users. This is first a most (photo)realistic presentation. The presentation should be possible in different forms, for example in single pictures, in films and videos, even interactively. Abstraction has to be possible, but on the other hand the details have to be presented as realistic as possible. Multimedia presentation has to be possible on different forms of output devices, even mobile ones, and of course in the internet, too. And for the future people is already talking of augmented virtual reality: the observer is in situ and special glasses are helping him to look at the existing and planned objects at the same time.

4 PROSPECTS: LOOKING TO THE FUTURE

4.1 The Actual Situation in Wuppertal

The above mentioned proposal how to use the existing photogrammetric data for a 3D city model has been finished now, the proposed data structure can be realised in any relational database and does not seem to be too difficult to transfer to future data bases. The next problem to solve will be a financial one again: how to finance the next tasks, e.g. programming of the interfaces and definition of the database.

4.2 The GDI initiative

To reach the aim of an integrated cadastral and 3D database, active participation in the GDI NRW has been taken up. GDI NRW stands for the initiative “Geodata Infrastructure NRW”. It is a reunion of actors within the field of geodata, more or less loosely organized since 1999 as a public-private-partnership, following the bottom-up principle. The partners are the state North Rhine - Westphalia, the local authority districts which are mainly represented by the planning or cadastral offices, IT-companies, universities and, most simply, users of geo-information. The aims of GDI NRW are the activation of the geodata market, improvement of the availability of geodata and elimination of technical, legislative and logistical problems or obstacles on the geodata market. Since the GDI NRW has grown extensively, now a professional organization structure is set up, and the partners have to become official members by signing a memorandum of understanding.

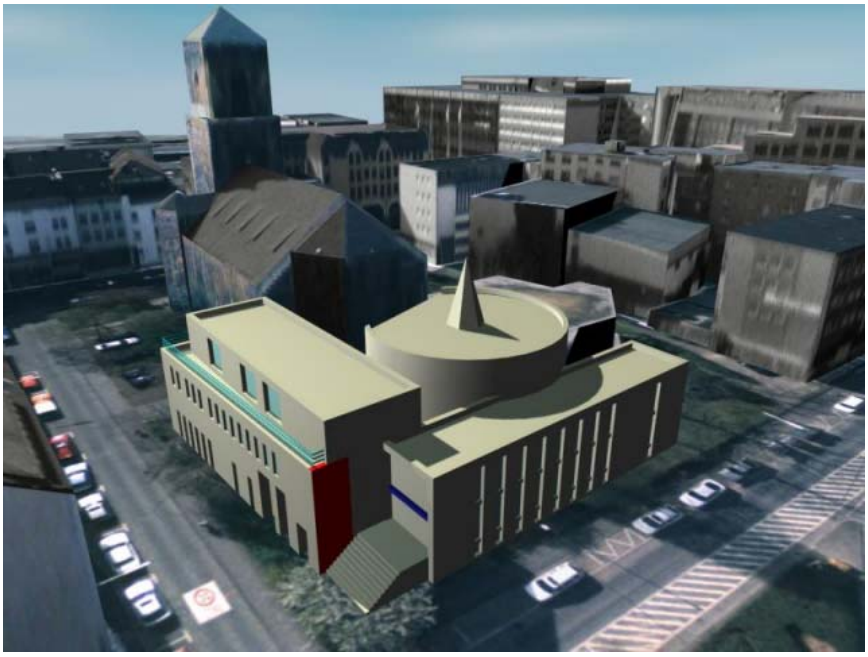

Figure 4: Model of the New Synagogue at the Beginning of the Planning Process

The GDI NRW work is done in special interest groups (SIG) that are founded by the plenum if there is enough interest in one special topic. Since May 2002 a SIG 3D exists. The number of members grows constantly. To support the organisation of work, the SIG is subdivided into working groups. Several cadastral offices take part in these working groups, driving the work towards the definition of quasi standards and an infrastructure they need. The cadastral office of Wuppertal is active within the working group on “application / target groups” trying to bring in the requirements of the municipalities as users. In the near future a testbed will be set up, concerning a first test of a suitable data structure.

We hope that this double tracked strategy (practical work and meanwhile forcing the definition of standards) will lead to a successful realization.

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BIOGRAPHICAL NOTES

1991 to 2000: Working at the Surveying an Mapping Agency of North Rhine-Westphalia in Bonn;
since 2000: Head of the division “Data processing and Cartography” of the office of cadaster in Wuppertal, Germany

CONTACTS

Bettina Petzold
Cadastral office of the City Council of Wuppertal, Germany
Große Flurstraße 10
D 42103 Wuppertal
GERMANY
Tel + 49 202 563 54 28
Fax + 49 202 563 81 58
Email: bettina.petzold@stadt.wuppertal.de
Web site: www.wuppertal.de