July 1988

EUROPEAN ORGANIZATION FOR EXPERIMENTAL PHOTOGRAMMETRIC RESEARCH

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OEEPE

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	Direktor Univ. Prof. Dr.-Ing. H. SEEGER Institut für Angewandte Geodäsie Richard-Strauss-Allee 11 D-6000 Frankfurt a. M. 70	

Mr. M. JAAKKOLA National Board of Survey Box 84 SF-00521 Helsinki 52	Finland
Prof. Dr. E. KILPELÄ Institute of Photogrammetry Helsinki University of Technology SF-02150 Espoo 15	
Mr. J. DESUDDE Institut Géographique National Aérodrome de Creil F-60107 Creil	France
Prof. Dr. M. CUNIETTI Istituto di Topografia, Fotogrammetria e Geofisica Piazza Leonardo da Vinci 32 I-20133 Milano	Italy
Dr. Eng. L. SURACE Geographical Military Institute Via Cesare Battista 8—10 I-50122 Firence	
Prof. Dr. G. LIGTERINK Technical University Delft Thijsseweg 11 NL-2600 GA Delft	Netherlands
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Prof. K. TORLEGÅRD Royal Institute of Technology Dept. of Photogrammetry S-10044 Stockholm 70	Sweden
Mr. L. OTTOSON National Land Survey of Sweden S-80112 Gävle	
Prof. Dr. O. KÖLBL Institut de Photogrammétrie, EPFL GR-Ecublens CH-1015 Lausanne	Switzerland
Mr. R. KNÖPFLI Vize-Direktor Bundesamt für Landestopographie Seftigenstrasse 264 CH-3084 Wabern	

Director General P. Mc MASTER
Ordnance Survey
Romsey Road
Maybush
Southampton S09 4DH

United Kingdom

Dr. I. J. DOWMAN
Dept. of Photogrammetry and Surveying
University College London
Gower Street 6
London WC 1E BT

EXECUTIVE BUREAU

Mr. J. KURE
Secretary General of the OEEPE
International Institute for Aerospace Survey
and Earth Sciences (ITC)
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NL-7500 AA Enschede (Netherlands)

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International Institute for Aerospace Survey
and Earth Sciences (ITC)
350 Boulevard 1945, P. O. Box 6
NL-7500 AA Enschede (Netherlands)

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Bundesamt für Eich- und Vermessungswesen
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N-700 Trondheim

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Technische Hochschule Darmstadt
Petersenstrasse 13
D-6100 Darmstadt

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Proceedings of the
WORKSHOP ON CADASTRAL RENOVATION

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(with Figures, Tables and Appendices)

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PREFACE

On September 9-11, 1987, J. Krueger (Matrikeldirektoratet Copenhagen), in charge of OEPPE'S Application Commission II (cadastral mapping), and O. Kölbl (EPF-Lausanne), in charge of OEPPE'S Commission C (large-scale mapping), assembled and organized a Workshop on cadastral renovation at the Swiss Federal Institute of Technology in Lausanne (Ecole polytechnique fédérale de Lausanne). Its aim was to create a forum for a detailed analysis of the problem of cadastral renovation in the different European countries. Quite a few of the responsible managers of cadastral services of the concerned countries took part in the discussion. In total, 48 persons participated in this workshop, and no less than 35 papers were presented.

As an intergovernmental organization, OEPPE gathers the greater part of the responsible offices dealing with cadastral survey, topographic mapping, and the related topics. Therefore, OEEPE can be considered predestinated towards the above engagements. Furthermore, considering the present situation, there exists a genuine need to have a "platform" at disposal which allows a much deeper treatment of specific problems in this field of work than it is normally the case at the various international congresses or symposia. However this special form of manifestation also requires a very careful preparation and an adapted guiding.

The workshop was divided in three parts:

1) Conceptual and legal aspects
2) Technical aspects
3) Realizations in the different European countries.

One of the primary objectives of the surveying authorities is the development of reliable documents for planning; an important step forward came with the establishment of Land Informations Systems while large scale maps in general and cadastral surveys in particular still offer substantially the basic material for these objectives. The symposium showed that while cadastral survey undergoes deep modification, a great consistency can be observed between many European countries: as a characteristic example, Germany and Switzerland have the highest precision requirements concerning cadastral measurements. It also showed that, whereas a number of southern european countries were still engaged in the transformation of Napoleonic cadastre or «Franziszäischer Kataster» (introduced 1806 in the Austrian countries), Northern countries had made great progress in the establishment of Land Information Systems. In order to understand the various developments, it is also necessary to consider the specific conceptual and legal aspects in the different countries.

Finally, we hope the publication of these lectures, including a summary of the various discussions, might support a higher level of understanding for the diversity of the problems and might help the common efforts to create information systems which do meet the increasing requirements in a better way.

O. Kölbl J. Krueger

Lausanne & Copenhagen

June 1988

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LIST OF PARTICIPANTS

BREGENZER	Walter	Directeur Direction Féd. des Mens. Cadastr. Eigerstrasse 65 CH - 3003 Berne
BRINDÖPKE	Wolfgang	Dr.-Ing., Vermessungsdirektor Landesvermessung Niedersächsisches Landesverwalt. Warmbüchenkamp 2 D - 3000 Hannover 1
BRIOLI	Roberto Maria	Chief Eng. Ufficio Tecnico Erariale Viale Mameli 9 I - 61100 Pesaro
CANNAFOGLIA	Carlo	Ing. Largo Leopardi 5 I - 00185 Roma
CHEVALLIER	Jean-Jacques	Dr-Ing. EPFL - Géodésie et Mensuration GR-Ecublens CH - 1015 Lausanne
DALE	Peter	Professor Dept of Land Surveying North East London Polytechnic Longbridge Road GB - Dagenham, Essex RM8 2AS
DESCOINS	François	Assistant Faculté des Sciences de Toulouse Rue Dieulafoy Village Pompertuzat F - 31450 Montgiscard
DIERING	Horst	Adjoint Direction Fédérale des Mensurations Cadastrales CH - 3003 Berne

DÖRSCHEL	Ralf	Vermessungsdirektor Bayerisches Landesvermessungsamt Alexandrastrasse 4 Postfach D - 8000 München 22
EIDENBENZ	Christoph	Président de la Société Suisse de Photogrammétrie Chef de la photogrammétrie Office féd. de topographie CH - 3084 Wabern
ENEMARK	Stig	Institut for Samfundsudvikling og Planlaegning Aalborg Universitetscenter Fibigerstraede 11 DK - 9220 Aalborg Ø
FLOTRON	André	Ingenieurbüro A. Flotron AG Gmeindmattstrasse CH - 3860 Meiringen
HAWAWINI	Joseph	Dr-Ing. EPFL - Photogrammétrie GR-Ecublens CH - 1015 Lausanne
HEDNE	Olav	Chief Photogrammetry Section Land Consolidation Service of Norway Postboks 53 N - 1430 As
HEIERLE	Ursula	Etudiante DGRG EPFL - Photogrammétrie GR-Ecublens CH 1015 Lausanne
HVIDEGAARD	Jonna	Dr.-Ing. Matrikeldirektoratet Opmalingsafdelingen Titangade 13 DK - 2200 Copenhagen N
ITTERBEEK	Octave	Directeur général adjoint Administration du cadastre C.A.E. Tour finances Bte 38 Bld du Jardin Botanique 50 B - 1010 Bruxelles

JAAKKOLA	Matti	Director of the Photogrammetric Division National Board of Survey Opastinsilta 12 Box 84 SF - 00521 Helsinki 52
JERIE	H.G.	Professor Dr ITC P.O. Box 6 NL - 7500 AA Enschede
KOECHER	René	Directeur du Service de l'Arpentage Communauté urbaine de Strasbourg B.P. 1049 / 1050 F F - 67070 Strasbourg Cedex
KOEN	L.A.	Director Surveying & Mapping Cadastre & Public Registers Agency Waltersingel 1 NL - 7300 GH Apeldoorn
KÖLBL	Otto	Professor Dr EPFL - Photogrammétrie GR-Ecublens CH - 1015 Lausanne
KRÜGER	John	Inspector of Surveying Matrikeldirektoratet Opmalingsafdelingen Titangade 13 DK - 2200 Copenhagen N
LAURSEN	Vagn W.	Director SCANKORT I/S Kirkevejen 8 DK - 2630 Taastrup
LOCATELLI	Jean-Claude	Direction de l'Ecole Nationale du Cadastre 100, Ch. du Cdt Le Goff F - 31081 Toulouse Cedex
NUSSBAUM	René	Adjoint du géomètre cantonal Service cantonal des Mensurations cadastrales Case post. 620 CH - 2001 Neuchâtel

ONSRUD	Helge	Chief engineer Kart- og Datakontoret Det Kongelige Miljøverndepartement Postboks 8013 Dep. N - 0030 Oslo 1
PALOMBO	Jacques	Ing. géomètre Société ICOREM Route Léon Lachamp Luminy F - 13009 Marseille
PARSIC	Zvonko	Dipl.-Ing. Institut für Geodäsie und Photogrammetrie ETH - Hönggerberg CH - 8093 Zürich
PRADERVAND	Jean-Claude	Ing. géomètre EPFL - Photogrammétrie GR-Ecublens CH - 1015 Lausanne
ROCHE	Jean-François	Directeur divisionnaire Opérations fiscales et foncières Sous-Direct. III A Conservation cadastrale, Bât. E Rue de Bercy F - 75012 Paris
SCHOLL	Robert	Dipl.-Ing. Wild Heerbrugg AG GE Photogrammetrie-Systeme CH - 9435 Heerbrugg
SCHÜRER	Karl	Dr., Wiss. Direktor IFAG Richard-Strauss-Allee 11 D - 6000 Frankfurt a.M.
SCHUSTER	Günter	Dipl.-Ing. Hofrat Bundesamt für Eich- und Vermessungswesen Schiffamtsgasse 1-3 A - 1025 Wien

SUTTER	Aldo	M. Sc. Nucl. Dipl. Physiker ASCOP Ltd Kanalstrasse 17 CH - 8152 Glattbrugg
TEGELER	Wilhelm	Dr.-Ing., Vermessungsdirektor, Leiter des Dez. Neuvermessung Nieders. Landesverwaltungsamt Warmbüchenkamp 2 D - 3000 Hannover
TIMMERMAN	Jan	Ir., Dienst van het Kadaster en de Openbare Registers Waltersingel 1 NL - 7314 N.K. Apeldoorn
Van HEMELRIJCK	José	Contrôleur en chef Adm. du cadastre, CAE-Tour Finances Bld du Jardin Botanique 50 bte 38 B - 1010 Bruxelles
Van HEMERT	Jan	Vice Director, Ir. Dienst van het Kadaster en de Openbare Registers Directie Utrecht Postbus 85001 NL - 3508 AA Utrecht
Van VOORDEN	Antonie	Master of Science (ITC) T.U. Delft, Dept of Geodesy Thijsseweg 11 NL 2629 JA Delft
WALDBAUER	Gerhard	Dipl.-Ing. Regierungsvermessungsdirektor Landesamt für Flurbereinigung Baden-Württ., Luftbildstelle Buchnerstrasse 14 D - 7140 Ludwigsburg 11
WIDMER	Frédy	Dipl.-Ing. ETH/SIA Vermessungsamt Kanton Thurgau Promenade CH - 8500 Frauenfeld

Introduction

Reform of the Cadastral Survey in Switzerland

W. Bregenzer
Federal Directorate of Cadastral Survey
Bern

REFORM OF THE CADASTRAL SURVEY IN SWITZERLAND

W. Bregenzer
Federal Directorate of Cadastral Survey
Berne

Summary The actual cadastral survey is based on the Swiss Civil Code of 1912 and is conceived as legal cadastre. This survey covers about 2/3 of the surface of Switzerland; however it does no longer completely satisfy today's information requirements. A new concept was therefore developed which foresees a numerical survey with an enlarged information contents. It also foresees a transformation in phases of the existing survey measurements and the enlargement of the information contents. To carry out this reform, photogrammetric techniques should be applied increasingly.

Zusammenfassung Die heutige amtliche Vermessung (Grundbuchvermessung) basiert auf dem Zivilgesetzbuch von 1912 und ist als Rechtskataster konzipiert. Sie ist erst über ca. 2/3 der Flächen der Schweiz fertiggestellt und vermag die heutigen Informationsbedürfnisse nicht mehr voll zu befriedigen.

Die Neukonzeption sieht deshalb für die Zukunft eine numerische Vermessung mit einem erweiterten Informationsgehalt vor. Für die Umstellung bestehender Vermessungswerke auf Numerik und für die Erweiterung des Informationsgehaltes ist ein etappenweises Vorgehen geplant. Die Photogrammetrie wird bei der Realisierung der Reform vermehrt zur Anwendung gelangen.

1. The actual cadastral survey

Legal basis

The organization of the Swiss Survey Services of today was established at the beginning of this century and thus shows a strongly federalistic nature according to the historical development of the Swiss Federal State. The legal basis was given in 1912 by the Swiss Civil Law: it introduced the Federal Cadastral Register which shows comprehensively the private legal ownership rights on the ground and which provides up-to-date information on those rights. The plots of land must be entered and described in the Register. For this purpose a plan must be prepared showing the boundaries and the different uses of the land (e.g. houses, lakes and rivers, vegetation, etc.)

As a rule, the plan is produced through an official survey; it remains an integral part of the Register. Both plan and Register are continuously updated. Named ¨Cadastral Survey¨ ït was established mainly as a juridical cadastral survey.

Elements of cadastral survey

The geodetic basis is given by the triangulation of 1st to 4th order with 1 to 2 control points per km^2 (70'000 points on 41'000 km^2)
Required accuracy must satisfy the following limits:

	mean error position	mean error heigth
city areas	± 2 cm	± 2 cm
agriculture areas	± 3 cm	± 4 cm
sliding areas	± 4 cm	± 6 cm

The 1st to 3rd order triangulations are executed by the Federal Office of Topography, the 4th order triangulation is part of the cadastral survey and is carried out by the Cantons.

The general plan (or topographic plan) at 1:5'000 or 1:10'000 shows the situation, topography and vegetation; it is used for community-administration, regional planning, design of public works, etc.

The cadastral plan 1:200, 1:500, 1:1'000 and 1:2'000 is the most important element. It is the basis of the Cadastral Register and is used at the same time for any kind of geometric information on the land use above, on and below the ground.

2. Problems of the actual cadastral survey

Today the cadastral survey covers only about 2/3 of the country. New solutions must be found in order to terminate the survey over the whole country within the year 2000.

The actual survey consists of maps with distinct scales. However, more and more plans are needed in different scales with various information contents. The actual original plans furthermore suffer from physical ageing, and simply by wear and tear. Cultivable and building land is becoming scarce in our country, and thus asks for more information on its actual and legal conditions in order to ensure appropriate economic use and administration. This demand can no longer be satisfied by the actual cadastral survey.

3. The new concept

An important project committee has been established in order to solve these problems. This committee has delivered its final report in the spring of this year. This report has then been submitted to various interested parties for comments and on from 1988 it is planned to proceed to the adoption of the different laws and regulations. We hope to conclude this phase within 1990. The new conception must take the following precautions into account:

All existing and future surveys must be executed in a numerical way and the information contents should be extended to the following information levels:

1. control points
2. soil cover
3. single objects and line elements
4. local names

5. ground property
6. easements rights established by acts of men
7. legal rights established by law
8. utility services
9. altitudes
10. nature of use
11. administative boundaries

All these data must be continuously kept up to date. The data-output must be very flexible, that is to say that the scale, size, figures and contents of the plans have to be easily adaptable to the user's need.
The information levels can be combined in an arbitrary way. In this way levels 1 - 4 correspond to a general basemap, whereas levels 1 - 6 correspond to the cadastral survey, and all levels together will give a multipurpose cadastre.

The objective of the reform is to improve services for economic parties, administration and private persons. This means that the cadastral survey-system is to be keyed to a land information system, and that it has to serve as its basis. This is possible if the cadastral survey collects and controls these data, which secure the connection (co-ordinates) for all the other data inside and outside the cadastral survey. It goes without saying that modern electronic techiques are and will be used wherever possible (electronic distance measuring, data registration, data processing, computer-aided design).

The fields for which cadastral-survey might primarily be used would be:

- land Register
- community administration
- tax-administration
- fire-insurance
- regional planning, urban-planning

The information-system should allow an extension into all directions, in such a way that it can be used by any other field. The corresponding interfaces must be at disposal.

An experimental project will be started this year in which the cadastral register and municipalities will participate.

4. Realization

This new concept can be realized without major problems within a new survey. On the other side, considerable technical, economical and political problems might arise when existing surveys will have to be adapted. It is therefore planned to apply a phasewise realization for already existing surveys which will take into consideration the specific requirements and wishes of the municipalities.

For the transformation of existing numerical surveys it will be possible to foresee a cadastral renovation which is a subject of the present workshop.

And also, the survey of the still missing data will be in an appropriate way from the very beginning.

5. Aspects of Photogrammetry

The precision currently achieved by photogrammetric methods allows to consider these measurements equivalent to terrestrial measurements provided that the area does not show up major obstacles impairing the application of photogrammetry. Besides the new measurements, we foresee several possibilities to use photogrammetry fortherealization of that reform, as for example:

- revision of the information level soil-cover
- survey of the visible and signalized parts of the underground cadastre
- survey and revision of the digital terrain model
- control-point densification
- establishment of orthophotos (for different applications, but also for a simplified survey in extensively used mountainous areas)
- cadastral renovation (cf test Echallens of Prof. Kölbl)

Up to now, our experience showed that the increasing application of photogrammetry as a method for data-acquisition can lead to very interesting solutions as from an economical point of view. It was possible to deflate the costs of about 30% in a recent application of that technique for 50 municipalities in the mountain areas of the Graubünden Canton.

6. Perspectives

The last decades have shown that users-requirements in cadastral plans and registers have increased enormously. The use of land has become much more intensive and land has become more and more a scarce commodity. This fact leads to an increase of public laws reducing property-rights. Up to the present, there is no information-system about this kind of property-restrictions. Moreover, plans of different scales, different contents, different sizes are in increasing demand by all kinds of users.

We are convinced that the new cadastral survey will be able to fulfil the new requirements. In future the cadastral survey will increasingly assume a coordinative task as far as data of spatial references are concerned. We are convinced that the cadastral survey will fulfil in this way an economically important and useful task.

Discussion after the conference of Mr. Bregenzer

Waldbauer: Who will be responsible for the data bases : the authorities, the communities or the private companies ?

Bregenzer: The Confederation makes laws and prescriptions. Cantons are responsible for their application; they supervise the work and control its accuracy and completeness.
The surveying work is mainly executed by private surveyors. Cantons are free to decide whether they want to install a central data base or if they prefer a decentralization of the data.

Jerie: In other countries, the task of collecting data is partly distributed among those who need them.
A LIS is more than the mentioned 11 levels, it also contains socio-economic data.

Dale: Are the different levels kept in one data base ?
Or, do the different levels have different accuracies ?

Bregenzer: We consider the 11 levels as an ideal basis for a LIS; all data in the catalogue concern several users. Only data with juridical effects have to be collected by a surveyor.

level	collecting	processing	managing
control points	**G**	**G**	**G**
soil cover	S	S	**G**
single objects and line elements	S	S	**G**
local names	S	S	**G**
ground property	**G**	**G**	**G**
easements	**G**	**G**	**G**
legal rights	G	G	G
utility services	S	S	G
altitudes	S	S	G
nature of use	S	S	G
administrative boundaries	S	S	G

G surveyor
G surveyor, prescibed by the Confederation
S specialist

(drawn from "L'AVENIR DE NOTRE SOL" (The future of our soil) : Une contribution à l'amélioration de l'information sur le sol et de l'utilisation du sol; Réforme de la mensuration officielle. Département fédéral de justice et police; Direction fédérale des mensurations cadastrales, Berne 1987)

Chevallier: In Geneva, cantonal authorities have created a data base. Moreover, independent surveyors are building up a computer center. They are not supposed to manage all the data by themselves, but they can ask for a corresponding copy of the cantonal data base.

In Montreux 4-5 independant surveyors are working together on decentralized data bases.

Dale: Do you intend to sell the information - in that case do you have copyright on this information - and how will you ensure the continued reliability of the information once it becomes publicly available ?

Bregenzer: Our aim is that all data are accessible to the public. We are in the phase of conception, and have not yet determined how this ideal will be realized. We plan to make a difference between :

daily users (electricity, utility and telephone companies), who should contribute financially to the establishment of the database and will have the right to use the data, and

occasional users, who will have to pay a fee for the needed information.

Laursen: When you are collecting utility information, are you focusing only on information concerning the location or also on technical data such as material, diameter and age ?

Bregenzer: In the test project, we took only the parameters of location into consideration. We intend to survey only the geometric elements of the underground installations, that means the situation and eventually the height. The information relative to the canalisation network like diameter or age must be added by the owner of the installation.
A second question is the political realization of this concept. We know that there will be a lot of resistance and arguments against it and therefore we have decided to introduce this information level only as a so called "optional base". Nevertheless, if this level is adopted a number of conditions have to be fulfilled as for updating and norms for the representation. Furthermore these data have to be verified by the cantonal authorities of the cadastral survey.

Jerie: A decentralized but networked system where the utility companies collect and update their own information might be a good solution.
Orthophotos provide a quick method for renovation; can you give more details on the accuracy requirements for the DTM to produce these orthophotos ?

Bregenzer: The requirements for the photogrammetric methods are the same as for terrestrial surveys. We have defined 5 categories of accuracy depending on the value of the terrain. The choice of the method is free.

Diering: For the Graubünden project we obtained the following accuracies from photographs at the scale of 1:6'000 - 1:8'000 :
- point accuracy in planimetry ± 8 cm
- height accuracy ± 15 cm

The orthophotos were obtained from the same photographs that were used for photogrammetric point measurements.
The orthophotos served to check the point measurements and to derive the natural and the landuse boundaries.

Kölbl: In my opinion, the orthophotos are a tool to display information, but are not very suited for data acquisition.

1st Part

Conceptual and Legal Aspects of Cadastral Renovation

Chairman :

ir. L.A. Koen

CONCEPTUAL AND LEGAL ASPECTS OF CADASTRAL RENOVATION

ir.L.A.Koen
Cadastre and Public Registers Agency
Apeldoorn
The Netherlands

SUMMARY

Discussing conceptual and legal aspects of cadastral renovation requires a clear description of the meaning of the term cadastre and an analysis of the characteristics of cadastral systems.

The paper gives a general classification of cadastral systems and discusses the characteristics of the main West European cadastral systems. Historical and legal aspects are often preventing a quick development of the old cadastral system to a more modern and multi-purpose parcel- based land information system.

Renovation of the old cadastral systems within a reasonable time and at reasonable costs require the optimal use of photogrammetry.

The use of photogrammatry implies a more important role of topography in a cadastral system.

The more important role of topographic base mapping can have far-reaching consequences for the concept regarding the boundary-information and for the concept regarding the role of the geodetic reference framework as well.

Introduction

In this OEEPE workshop it is my intention to have a closer look at the cadastral renovation from the photogrammetric point of view.
It is my experience and my conviction that the renovation of a cadastral system and the building-up of a multi-functional cadastral system cannot be realized without the use of photogrammetry. Only with the help of photogrammetry cadastral renovation can be achieved within a reasonable time and at reasonable costs.

It is not always easy to use photogrammetry for cadastral renovation. Historical and legal aspects are often preventing a quick development of an old cadastral system to a modern and multi-purpose parcel-based land information system.
In most West-Europian countries there are renovation concepts. However in most of those countries there are no financial means to complete the cadastral renovation in the near future. In the circumstances one should opt for either the acceptance of a long period of renovation, or the acceptance of a new and more realistic concept. This is not an easy choice, because in the cadastral services there are often longstanding connections with the past. Cadastres conserve information and therefore they cannot be but slightly conservative.

The new tools are stimulating the discussion about the objectives. This is not wrong; tools and objectives are often interacting.
In a lot of countries, this is a time for change. The eighties are the years of disenchantment after the enormous economic boom in the decades after world war II, but they are also years of reflection, reconsideration and of new conceptions.

Cadastral systems, legal aspects.

Before discussing renovation concepts, let us try to have a quick look at the situation regarding the cadastral systems in the world.
Most of the industrialized and developed countries maintain a cadastre.
The concept is old and goes back about 5000 years.
The "modern" concept was introduced on a large scale in western Europe bij Napoleon. Those systems have to be adapted to the present requirements of quality and shape; structures depending on history will have to be pulled down and the legal and juridical facts adapted to the new requirements.
In most of the West-European countries the practice of cadastral survey and the practice of renovation as well are based upon a rather static, narrowly drawn property paradigm, based on a given legal and administrative framework.
A modern multi-purpose view of cadastral renovation, however, requires a thorough analysis of the existing situation and a reformulation of the existing institutional arrangements.
In numerous developing countries, and even in some developed countries a cadastral system does not exist. Many of those countries try to set up a modern cadastral system with the help of new technology. New technology has greatly improved methods of collecting, processing, storing and distributing of data. However, the new technology has not automatically resulted in better information. Today a problem in both developing and developed countries is not always a lack of information, but too much specialized, unrelated and incompatible information about land. Especially in Western Europe we are flooded with data. What we need is not more data, but consistency, standardization and a multi-purpose concept.

In our situation in Europe we are confronted with a great variety of cadastral systems. Social, technical, historical and economic differencies had an impact on the development of the systems.
However, all systems were developed, or are more or less still developing, along the line tax-cadastre, reference of ownership, planning-cadastre, multi purpose cadastre. Most of the systems are still strongly ownership oriented and parcel based.
Almost all European cadastres are part of the public administration and nearly all of them have a legal basis.
In the Western World roughly three different legal systems of registration can be distinguished, viz. private and public ones, the latter being devided into positive and negative systems.
I do not want to go into details of these legal aspects. For our discussion on cadastral renovation it is important to know that a positive system offers the best legal garantees for owners and for all who consult the public administration. However, it should be borne in mind that updating and renovation are expensive activities in such systems and take a very long term. On the other hand it is clear that the legal basis of such a positive system is a solid base for a long term renovation policy.

Before starting a discussion on renovation concepts I think it is essential to label and classify the various types of cadastral systems.

In literature we find a lot of different names for cadastral systems. Among a variety of classification schemes I came across a very usefull

one in a recent article "Parcel-Based Land Information Systems" by J.D. Mc.Laughlin and S.E. Nichols in "Surveying and Mapping, Vol 47, Nr. 1, March 1987".
In this taxonomy the cadastre is a subset of a Land Information System, defined as a record of interests in land encompassing both the nature and the extent of the interests. Further Mc.Laughlin identifies three categories of cadastres;
- fiscal cadastres, developed primarily for property valuation.
- juridical cadastres, which serve as a legally recognized record of land tenure.
- multi-purpose cadastres that can encompass both fiscal and juridical cadastres and can contain a variety of other parcel-related land information.

In this workshop on cadastral renovation the attention will be focussed on the use of photogrammetry for building up such a multi-purpose cadastre.

Renovation concepts.

There are many requirements to be considered implementing a modern cadastral system. Main requirements at the technical level concern the geodetic framework and the boundary information.

The most important function of the geodetic network is to support both the mapping activities and the updating activities. The usual concept is a densification from first order to a local level in order to improve and provide spatial references at parcel level.
In most countries this concept is neither effective nor efficient.
Main problems are:
- The density of control points is low, so that users often have to make local densifications. This is very expensive, especially for updating activities with a limited extent.

- It is hardly possible to control, administer and update the vast number of control points. In areas where control points are needed most, the risk of damage is very great.

- Not all users have the know how to handle the system properly. In a multi-purpose concept, however, the collection of data has to be done bij several authorities; this for practical reasons. These authorities are not always equipped for control survey activities on a high level.

What we need is an effective and efficient user-friendly concept of the geodetic framework.
In my view a good and large scale topographical base map can play an important role.
Especially in densely populated and built-up areas, where most of the survey activities are concentrated, we can find a large number of artificial topographical objects. A selection from those objects (e.g.corners of houses)) can be considered as the lowest order control points.
Large scale topographical base mapping provides a user friendly and visible system of control points. This is of special importance for updating activities. Modern survey equipment and modern computing techniques make it possible to operate in local systems in the field. The connection to the national network can be done afterwards by the computer.

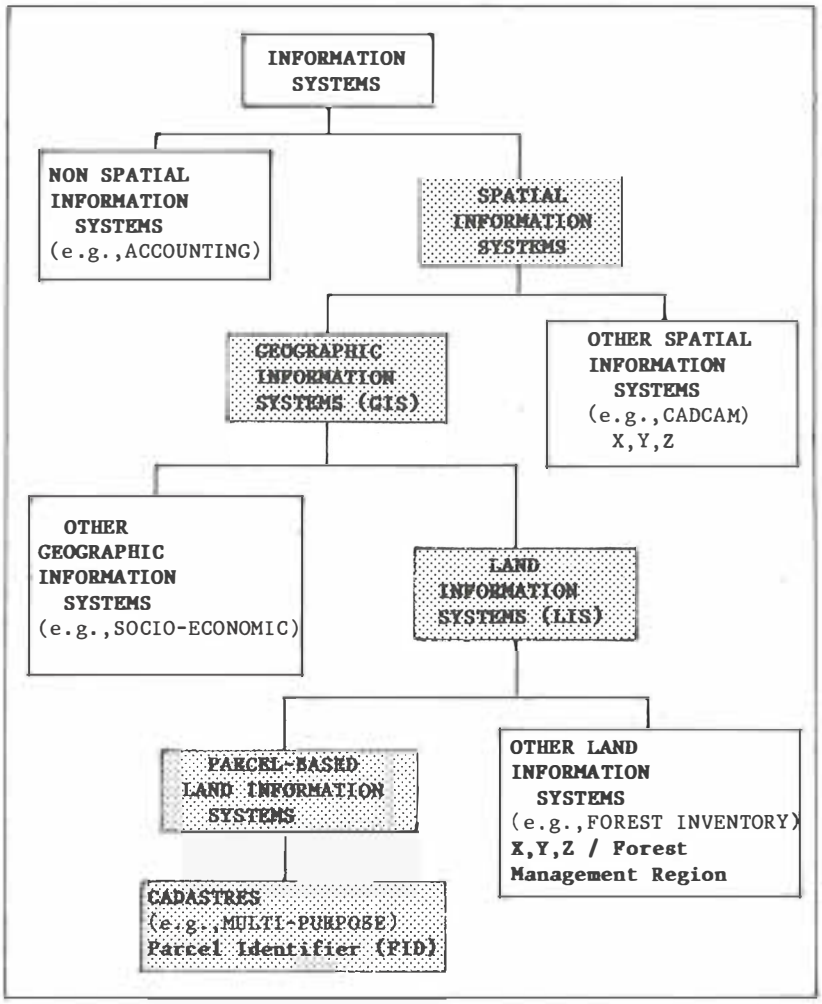
Topographical base mapping is also an important instrument for renovation of the boundary data.
In most of the developing countries the base mapping concept is generally accepted . And with that acceptance the use of photogrammetry is, in one way or another, a practical necessity.

In Western Europe the situation is more complex. The cadastral systems have a long history and often carry with them the burden of an old and inhomogenious archive of graphical and numerical information on boundaries.
Where the cadastre serves as a legally recignized record of land tenure, the numerical information is important for the function of the system for the individual citizen. For that reason in countries with a positive system of land registration the renovation concept is often a numerical one and terrestrially oriented. In my opinion the base-mapping concept can be used more in this situation.
Especially in areas with a lot of visible boundaries a base map can be used for identification procedures. In countries with a more public-oriented cadastral system with a more graphical concept of boundary information, or in countries without a long cadastral history, the use of photogrammetry is obvious.

An important and strategie choice should be made here.
If we choose the renovation of both numerical and graphical files of boundary information, we choose a very ambitious, long-term renovation concept. From a technical point of view this can be a perfect concept. However, the ambitious concept and the long period of renovation could lead to a situation in which the various demands cannot be met with at short notice. This might result in unrelated activities by services who cannot wait so long. The multi-purpose concept incurs a risk.

The alternative is to come to a combination of a short term graphical renovation of the maps and a longer term concept for the renovation of the numerical data. It might be clear that my personal view is that we have to choose this second concept. I am aware of the fact that this view is highly influenced by the situation in my country.

I am convinced that the choice we make now will be of the utmost importance for the future and the status of our profession.



SPATIAL INFORMATION SYSTEMS TAXONOMY

Discussion after the keynote of Mr. Koen

Tegeler: You will have 2 kinds of records for each boundary when you apply the concept of graphic renovation followed by numerical renovation.

Koen: You always have 2 types of technical records. The numerical data and the map information are not always consistent.
It is important to find a quick and perhaps cheap solution. The accuracy and the quality of the data will perhaps not be better after the first renovation, but you will obtain a visible concept of the ground control net which allows you to go on digitally in a rather short time.

Jerie: The crucial question is to find a reasonable conceptual model for accuracy requirements.
What kind of accuracy do we really need for an information system ? Accuracy costs money, especially in photogrammetry.

Koen: We often think in terms of what is technologically feasable with our instruments and not of what we really need; this leads to concepts based on instruments instead of concentrating on the goals.

Chevallier: There is often a confusion between accuracy and reliability. It is less important that you are within 1 cm, but you have to be sure that the cm you obtain is correct.
Probably we need different levels of accuracy for different objects (boundaries, utilities).

Laursen: A possible approach when dealing with accuracies in a LIS is to store the method the points have been measured together with the information. Thus, the users will be informed of what they can do with these data.
We will have to accept information of different accuracies although it covers the same subject.

Brindöpke: I think that the main point is not accuracy, but the fact that we still have old numerical records which have to be integrated in the new cadastre.

Koen: Photogrammetry can be used to reconcile the old numerical data and the new basis by "bringing the field into the office".
It should be pointed out how important it is the way you organize your ground control net. A good topographical basemap can be a great help, especially in built-up areas with many artificial objects such as houses which facilitate the identification.

Dale: In this context, one should keep in mind that most cadastral systems were producer driven, not user driven. Land Information Systems became user driven after their initial creation by producers; they are responsive to user demand.

One brought up an argument against photogrammetry is legal reliability and responsability. In the case of a licensed surveyor the case is clear, he should have an insurance for professional indemnity and legal liability.
Who is legally responsible in the case of an information system ?

Koen: In cadastral renovation, accuracy is less important than consistency.

STRUCTURAL ATTRIBUTES OF GERMAN CADASTRAL SYSTEMS AS CONDITIONS FOR THE APPLICATION OF PHOTOGRAMMETRIC SURVEYING

W. Brindöpke
Subdepartment of Photogrammetry
State Survey Department of Lower Saxony, Hannover

Summary Attributes, qualities and properties of German cadastral systems are discussed, which set conditions for the application of photogrammetry in cadastral surveying. Bottle-necks and advantages of the photogrammetric method are reviewed.

1. Structural attributes of German cadastral systems

1.1 Functions and purpose of the German "Real Estate Cadastre".
The German "Real Estate Cadastre" (Liegenschaftskataster) is not homogeneous. The strongly marked federalism in Germany during the 19 th century resulted in 50 and more different systems of Real Estate Cadastres due to different political systems at that time. And these facts have significant consequences even to-day. Nevertheless in each case the Real Estate Cadastre is everywhere the only complete and up-to-date register (Nachweis) of all real estate objects (Liegenschaften), that means: of all parcels and buildings.

Since about 150 years these registers serve for collecting land tax. Since 90 years these registers take part in the guarantee of land property. Since 50 years these registers include soil valuation. And after the last war these registers serve as multipurpose-cadastre too for planning, economy, environment control and for scientific purposes.
A particular importance has the Real Estate Cadastre in his function of the legal compound in respect to land property.

1.2 The legal and juridical compound of Real Estate Cadastre
The property of parcels, real estates and buildings is ensured and guaranteed by the official "Real Estate Register" (Grundbuch). This Register is regulated legally by the German "Grundbuchordnung" from 1897; it is valid uniformly for whole Germany. The "Real Estate Register" is a public register, a "public book". It is kept by the "Real Estate Offices" (Grundbuchämter), which belong to Inferior Courts in the Justice Administration. In this Real Estate Register each real estate "has its own place", "his own page" - the so-called "Real Estate Page" (Grundbuchblatt). Base for the naming and denomination of all real estates in this "real estate book" is another "official register" (§ 2.2 Grundbuchordnung); this "official register" is the "Real Estate Cadastre".
The official "Real Estate Register" possesses "public confidence" ("öffentlichen Glauben"), this means: its registration bears a reliability and a trustworthiness, a legal protection for all real estate properties and for the ownerships too! And now it is important, that the "Real Estate Cadastre" as the "official register" tates part too in this "public confidence".

The German Cadastral Survey Administrations belong to the federal competence of the 10 states of the Federal Republic of Germany. Each state has regulated and arranged cadastral organisation and surveying by "Surveying and Cadastral Laws". These laws order strictly how to set up "Real Estate Cadastres"; especially they prescribe the absolute correspondence between "Real Estate Register" and the "Real Estate Cadastre".

1.3 Components of the Real Estate Cadastre

1.3.1 Books, maps, records

The Real Estate Cadastre consists of 3 parts:
- the Real Estate Cadastre-Book, a verbal register and list,
- the Real Estate Cadastre Map, a graphical document,
- the survey data record, a digital data file (Vermessungszahlenwerk)

The first is of no interest within this lecture.

The map is the result, the output of the digital fundament, the digital survey data file, data record. And because the map is subject of "public confidence", therefore too the survey data records participate in the public confidence.

1.3.2 Content of maps and records

The graphical cadastral map contains - roughly spoken - only two important unconditional elements: boundaries of parcels and buildings. As further elements for a cadastral map belong boundaries of actual land use (Nutzungsartengrenzen) and essential topographic subjects, in particular topography in relation to boundaries of land property.
The digital survey data record is the collection of digital survey results, of numerical measurement values. In the present these digital results are collected and recorded on sheets and plans, which represent and figure orthogonal or polar survey datas, point numbers etc.
In future a digital data bank will play a new role.

1.3.3 Boundaries

Bondaries of parcels are based on an "official survey"; the authorization for this cadastral survey is given only for the several public cadastral offices and for Charged Surveyors. Today each cadastral survey has to fullfill hard conditions, for instance: each boundary point has to be marked; the survey has to guarantee a very hich accuracy (3-4 cm); the survey has to be integrated in a minor-control-point-network; the owner of the parcel has to acknowledge the survey very formally, a.s.o.. Thus the survey and the boundary become a subject of strong legal importance and significance.

1.4 The quality of cadastral maps

As mentioned the Real Estate Cadastre in Germany is of very different kind and quality. To give a general impression of quality and state of German cadastral maps, I give some rough figures:
- about 60 % of FRG is coverd by maps in grid-system with fixed margins; about 40 % are so called "Inselkarten" - "island maps" - which do not have grid-margins but topographical limitations.
- The scales vary totally between 1:500 and 1:5000, many cadastral maps have unround scales like 1:625 or 1:2133.
- The percentage of marked boundary-points is estimated by about 40 %.

- The most cadastral measurements do not fullfill modern requirements. There is in Germany the standard quality of "einwandfreier Vermessung", in english about:
  "incontestable or unobjectionable survey". The percentage of this quality is roughly 30 %.
- Cartographic and reprotechnical quality do not satisfy modern possibilities. There is to do a lot of work.

Résumé Renovation of many cadastral maps in Germany is necessary. With this subject Dr. Tegeler will deal in another lecture.

1.5 The significance of "old boundaries"
In respect to cadastral renovation, in particular if photogrammetry should be applied, the documentation of old boundaries has a very high importance, even if the geometric quality of the old survey is bad. In spite of a bad quality the documentation of an old boundary keeps legal validitiy as long as there is no definite argument against this. This involves, that each maintenance or revision or renovation has to start with the old boundaries. In each case at the beginning of any cadastral survey the documented boundary has to be determined in the field by its transferring, the so-called = Grenzfeststellung". This deals with comparing the documented boundary with the local boundary, and it includes expertise discretion too and hearing of the involved persons. Photogrammetric survey may not act without "official ascertainment" of all old boundaries.

2. Conditions for the application of photogrammetric surveying

But now I started already with chapter 2.

2.1 General types of cadastral activity
If we try to schematize types of cadastral survey activities, we could classify it as follows:

2.1.1 Maintenance and up-dating
The normal cadastral survey activity means: maintenance and up-dating; "revision" is not a suitable term, because there has to be treated a **change** in real estate subjects and not an error which should be revised.
Maintenance occupies more than 95 % of the cadastral survey capacity. In Germany (FRG) per year about 400 000 "small projects" of cadastral maintenance are carried out.
The photogrammetric method is not suitable for such duties, because those projects are not big enough.
Discussion about photogrammetry in this respect has no sense.

2.1.2 Renovation
Renovation of cadastre for lager areas is executed in Germany due to statistical informations for not more than 2000 km^2, inclusive surveys for land consolidation. That is less than 1 % of the republic's area. Only here an application of photogrammetry could be worthwhile to be discussed.

2.1.3 Digitizing
In the last years a renovation of cadastral maps is carried out more and more by digitizing the old maps. But we have to be conscious, that there is no renovation of the geodetic base or of the surveying datat. It's a renovation of maps only. Perhaps photogrammetry could make use of a good chance.

2.2 The actual surveying activity within a cadastral surveying project
Surveying in its proper and literal meaning amounts only a small part in a whole cadastral survey project. There are other activities which belong to a cadastral project:
Preparation of documents, registers, records and other materials; field preparation and reconnaissance; reconstruction of survey lines and networks; the already mentioned transferring of old boundaries into the field; hearing of involved persons; boundary ascertainment; marking of boundary-points; controlarrangements; procedures with land owners; computations; organisating the home work of all kind... a.s.o.. The actual survey activity itself does not share more than 10 - 20 % of the total project activity. Applying photogrammetry says actually, that it serves only for a small sector in a project. A cadastral survey project is not only surveying - but photogrammetry is o n l y surveying!
There may be another situation in "renovation cadastral maps only by digitizing". Which survey activities doe we have here?
First : Selection of reliable tie-points.
Second: geodetic determination of these tie-points.
Third : digitizing of the old map.
The photogrammetric method offers additional possibilities for technical concepts of renovating cadastral maps: the aerial photo itself and the method of blocktriangulation allow a more optimal procurement of tie-points for a qualified transformation of the old map into modern systems. Further: the aerial photo as the "very big information store" allows a very rich production and procurement of information for all actual and topographic boundaries in the field, which make checking and investigating old documented boundaries easier then by complicated terrestrical measurements.

2.3 Requirements of cadastral renovation
If we ask, which requirements should be fullfilled, if the application of photogrammetry in cadastral survey is discussed, we have to deal with the following criterions:

2.3.1 Amount
Surveying activity should amount a worthwhile volume and extent. We have to take in account, that in a cadastral survey project during field preparation a lot of terrestrical measurements are necessary anywhere. And photogrammetry is only suitable to execute a "final survey".

2.3.2 Accuracy
Photogrammetry has to fullfill the normal terrestrical requirements, for instance an accuracy of 3-4 cm. But this is not a bottle-neck of photogrammetry, which is able to adapt itself by choosing an adequate photo scale. Even an accuracy of 1-2 cm would be possible.

2.3.3 Reliability
A very severe requirement is the reliability of photogrammetric results! We have to be conscious that the aerial survey is a method of non-direct measurement. This involves a relative high expense for procuring reliable results. Often terrestrical control-measurements reduce and lessen the effectivity and economy of photogrammetric survey. We have to recognize that the measurements are participated in the "public confidence" of the cadastre. This is not a question of accuracy, it is a question of reliability.

2.3.4 Completeness

Another requirement is the completeness of survey results. A certain surveying procedure must deliver (nearly) all points in a project. That means for photogrammetry:

- no loss of signalized points by destroying or weather-influence,
- no loss due to perspective covering,
- no loss because of natural non-visibility by trees, roofes or others.

The method of indirect signalisation lesses the effectivity.

2.3.5 Flexibility

The method of photogrammetry has certain disadvantages for organising survey works. There is the bottle-neck of signalisation for "o n e unknown hour". We need more "phantastic immagination", how to make signalisation more undestroyable or how to carry out photo-flights more flexible.

Résumé Is photogrammetry able to fullfill the severe requirements of German cadastral surveying? My answere: I'am not very optimistic! But perhaps there are some chances.

2.4 Chances for photogrammetry in cadastral surveying

The actual and real advantages of the aerial survey method is, that the aerial photo contents an utmost quantity and amount of information from the earth surface. If cadastral survey shall procure coordinates of a limited number of points only, then a modern geodetic method seems to be the only adequate method for this job. But if an extent amount of information with different character is asked, the aerial photo with its areal character has a chance.

I would like to sketch these chances:

- the aerial photo-method furnishes and supplies economic results where terrestrical methods are handicapt, for instance: areas with heavy traffic or areas without horizontal vision a.s.o...
- if the aim of the project is not only the determination of single points but informations too, which are in relation to topography or local boundaries, the chances for photogrammetric application are not so bad
- there is a technology in developement, it is "coming", the "Videomap-technique". This method allows the very effectiv combination of digital information out of the "real estate cadastre" with the actual image of the landscape in an aerial photo. Renovation of cadastral maps perhaps may give a new chance for new attempts in applicating the aerial photo in cadastral surveying.

Discussion after the conference of Mr. Brindöpke

Dale: With the aid of photogrammetry you obtain homogeneous results overall, and it shows good quality. But for cadastral work you have to be sure that every single boundary falls within the specified standard. When you apply ground survey, you can check every single measurement.

How do you carry out quality control for photogrammetric work ?

Brindöpke: We check the coordinates we obtain either with old coordinates or with ground measurements.

Photogrammetric methods can achieve the required reliablity if the necessary precautions like security points and additional targets are observed.

LEGAL ASPECTS BY INTRODUCING A DYNAMIC DIGITAL CADASTRAL MAP IN DENMARK

Stig Enemark
Senior Lecturer, Surveyor
Institute of Development and Planning
Aalborg University, Denmark

Summary: To understand these problems, a short historical outline of the cadastral system in DK is necessary.

The basic function of the cadastral system is presented, and the derived demands for accuracy, graphical representation and identification of legal rights are described.

The dynamic digital cadastral map is defined, and the problems by establishment and operation are estimated in relation to the fundamental functions.

Examples will be given and discussed. Among these the use of the combination of the cadastral map and the ortophoto and the legal aspects for the guarantee of property ownership.

1. Introduction

Establishment and operation of a digital cadastral map is not only a matter of technical solutions. You must consider the users' needs, and you must take the fundamental functions of the cadastral system into account.

That means - do not put the technical possibilities into control, but consider the capability of various solutions in relation to the function of the system today and the needs in the future.

These problems should be general for cadastral renovation and well-known in many countries. But of course the problems are different in the various countries, as they are derived from the historical backgrounds of the cadastres, the organization of the systems and the future developments and requirements in the societies.

In Denmark the problems are very actual, as we have just started the process of converting the cadastral map to digital form. The process may last until the year of 2000, and we may find the solutions on the way.

In this paper I shall try to point out some of the problems, especially the legal ones. But in order to do so a short historical outline of the cadastral system in

Denmark is necessary, and the organization and basic functions of the system must be presented.

2. Short Historical Outline

The Danish cadastre goes about 200 years back. In fact, the first cadastre was established in 1688, of course for the purpose of collecting taxes from each single property. This first cadastre was made by a simple measurement, length and breadth, and a valuation of the yielding capacity of the soil. But no maps were made and there were no provisions for updating the cadastre.

The cadastre of today is based on a provision from 1804, as it was obvious that the old cadastre was no longer correct for calculation of taxes.
This new cadastre was made by a total mapping in the scale of 1:4000. In fact, most of the mapping was made in the years of 1780-1800, when the enclosure movement was carried through.

These maps were surveyed by plane table directly in the field and include a village and the belonging cultivated areas (island maps). The cadastral maps were then established by testing the original maps and complemented by a measurement of the village centre. The boundary turning points as established under the enclosure movement were not monumented, but the physical limits of each parcel were apparent on the ground from the cultivation. The procedure for making the cadastral maps therefore takes into account that no original measurements for the old property boundaries exist.
A new and total valuation of the yielding capacity of the soil was also made, to ensure a fair basis for calculation of taxes.

The properties were numbered for each village and recorded in registers - the cadastre, with indication of area and a number of "hartkorn" (the Danish unit for land evaluation). Each property may consist of a number of plots which means that the cadastral map will show the cadastral units, while the total peoperty (if more than one plot) is defined in the cadastral register.
Public and private roads running through a parcel were indicated on the cadastral maps, as they should not be taxed. Today most of the public roads are measured and subdevided from the parcel. The private roads are still shown and indicate a legal right as admission for another property. The private roads shown on the map may be different from the roads in the field.

From a provision in 1810 it was decided that the cadastre and the maps should be updated. And it has still been the duty for the single land owner to take care that changes of boundaries and parcelling out are registered in the cadastre with the co-operation of a private licensed surveyor.

The cadastre as described above was put into force in 1844 and is still in function. But the valuation of the yielding capacity was left in 1904 and replaced by the valuation of the peoperty for the market value.

An original and up-to-date cadastral map is shown in fig. 1 and 2.

To complete the historical outline it must be mentioned that the provincial towns were measured separately by a provision from 1863. The cadastre for these towns was put into force in 1885. The maps are in scale 1:800. Also the cadastre for the South of Jutland is specific. This cadastre was established in 1880 in the German model, as at that time the area was a part of Germany. At the reunion in 1920 the cadastre was taken over, and it is is still in force.

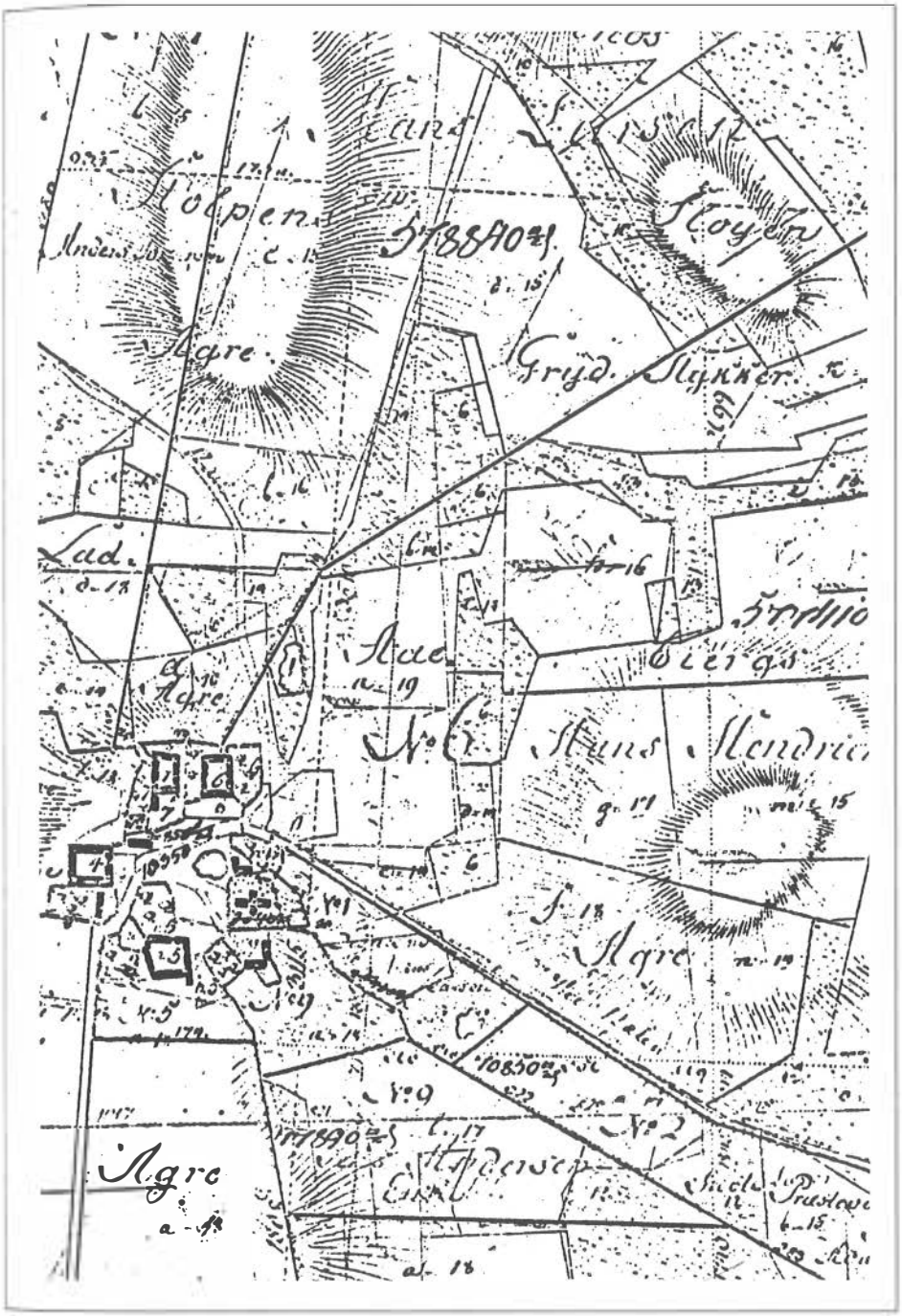


Fig. 1. The first cadastral map, scale 1:4000, established in 1806.

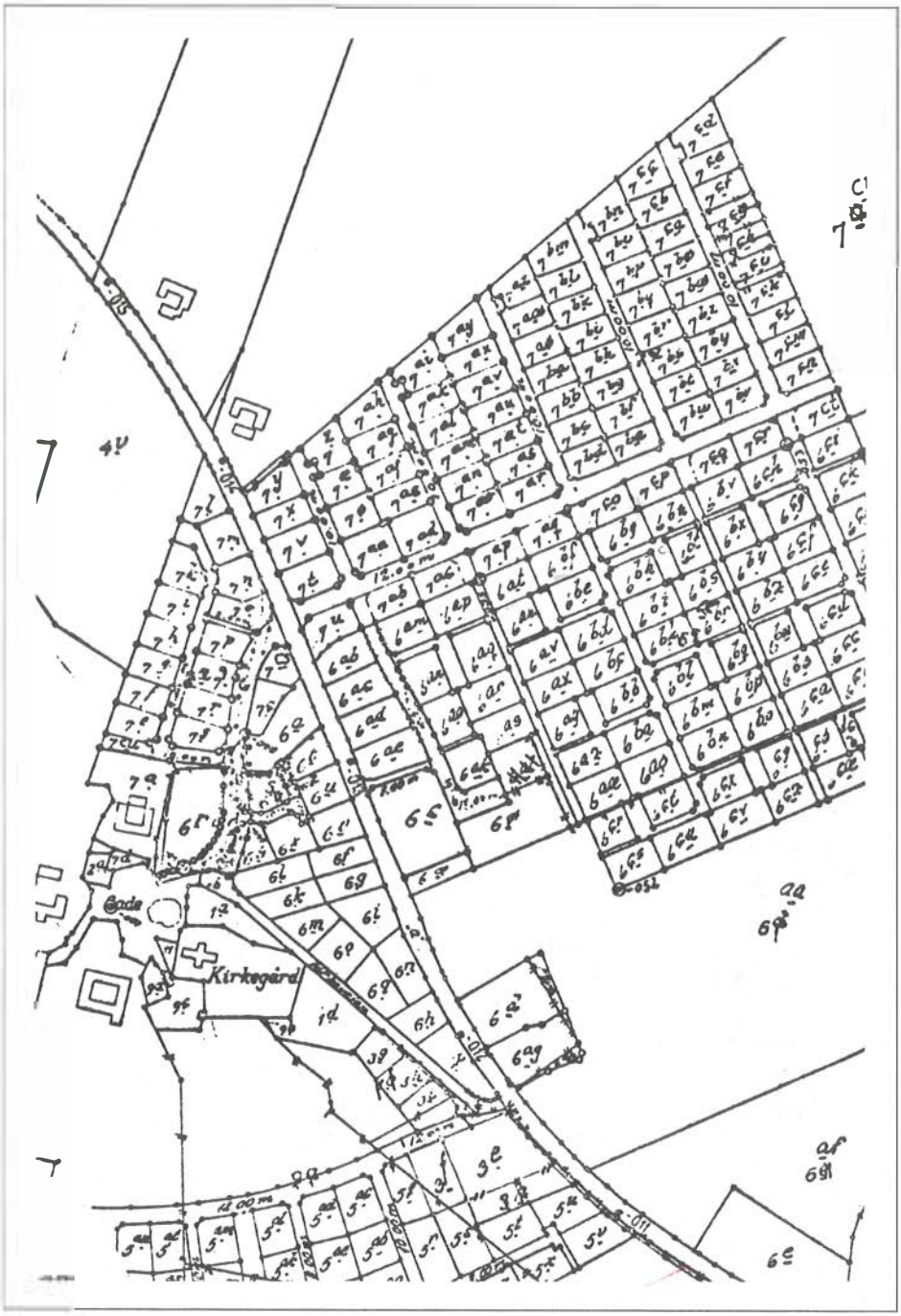


Fig. 2. Cadastral map of the same area as it appears in 1976.

3. Organization of the Cadastral System

As mentioned above, the cadastral measurement is taken care of by the private licensed surveyor. To qualify for a license you must have a university degree in surveying at Aalborg University and then work for three years as an assistant under a private licensed surveyor. There is about 300 private licensed surveyors and 100 assistants in Denmark.

The private land owner and even the central or local government must apply to a private licensed surveyor for the preparation of the documents, the revision survey and the submission of the application to the Matrikeldirektoratet for updating the cadastre. In the South of Jutland the application must be sent to the cadastral office for attention by a departmental surveyor.

The approvement from the Matrikeldirektoratet, showing the updated cadastre, is returned to the private surveyor and is also sent to the municipality for updating of the property tax register and to the land registry office for updating of the register of title deeds.

The application from the private licensed surveyor must contain a copy of the cadastral map showing the changes of boundaries, measurement sheets showing the new boundaries in relation to the existing, documentation for legal and private rights and documentation for approvement in relation to planning regulations and the land use laws.
In fact, the private licensed surveyor is placed in a task of great responsibility.

4. Defining the Boundaries

Provisions for marking and measurement of new boundaries have been into force since the early 1800. Of course the provisions have increased in accuracy through the years and appear in a very accurate form today.
The effect of these provisions is that measurement sheets for in principle all boundaries are hold in the Matrikeldirektoratet. Examples are shown in fig. 3. An exception must be made for the original boundaries established by the enclosure movement as mentioned above.

To define the property boundary the private licensed surveyor must compare the measurement information with the state of conditions in the field, placement of fences etc.
If discrepancies are found, the surveyor has to clear up the reason.

Maybe the land owners have agreed for another boundary without taken care for updating of the cadastre, or maybe the boundary in the field has been in existence for more than 20 years which may lead to the establishment of a prescriptive right.
In these situations the land owners must be involved, and if they cannot agree on the reason of discrepancy, the situation must be solved through a special legal procedure carried out by the surveyor.

As explained above the property boundary will not be fixed only by the cadastral map, and not even by the measurement sheets alone. You have to take the state of conditions in the field into account.

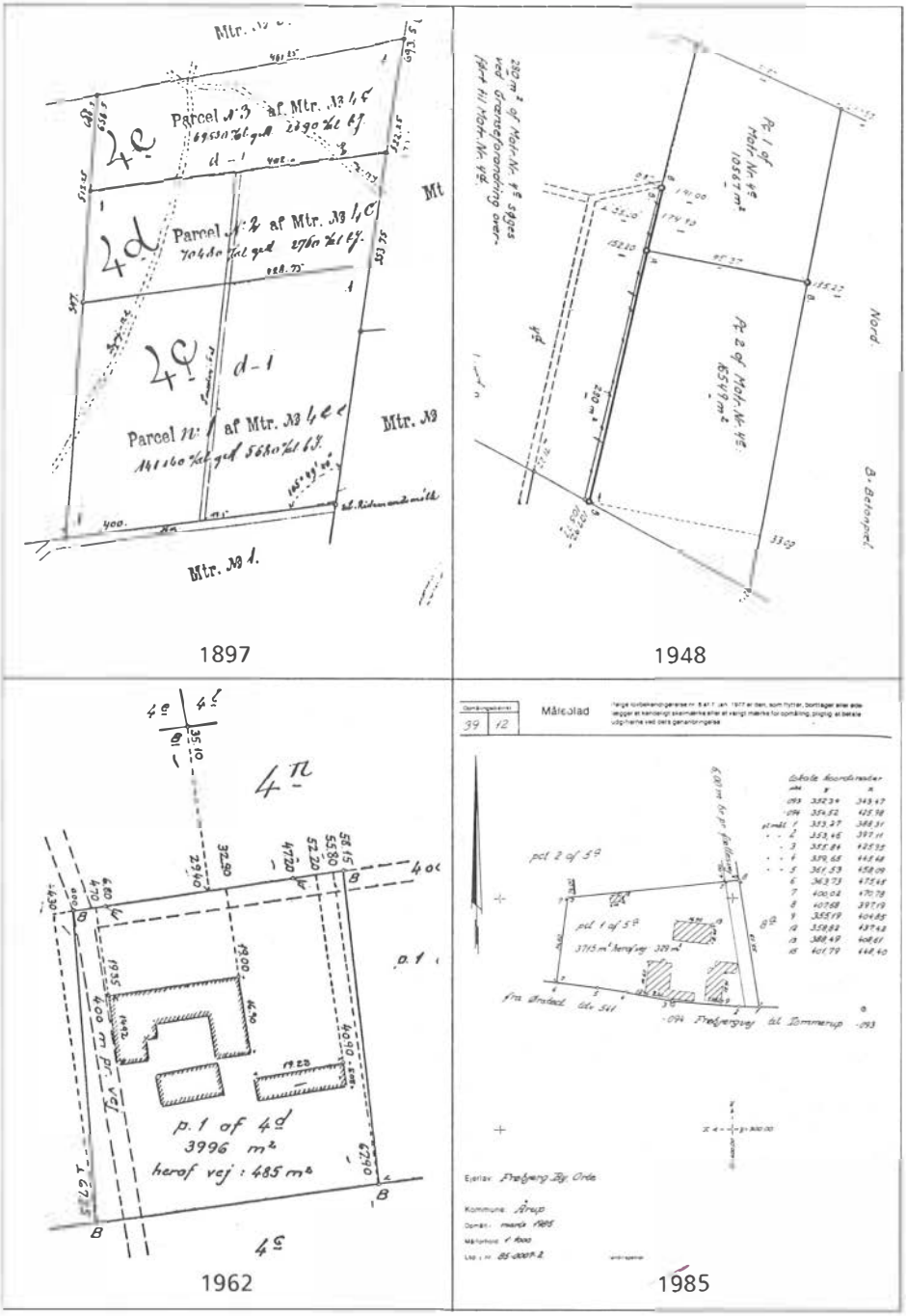


Fig. 3. Examples of measurement sheets through the years.

5. The Purpose of the Cadastral System

The basic function of the cadastral system is of course the identification of each property at all times, in agreement with the actual use.

Historical the purpose of this identification was the collection of taxes based on the yielding capacity of the soil.

Today the purpose is still to collect property taxes, but now based on the market value. But other purposes have shown up.
Especially the cadastre as basis for the founding of legal rights at the land registry office, deeds, mortgage and easements.
The cadastre is also the basis for the control of the property use in agreement with the land use laws.
And finally, the cadastre serves a purpose as basis for physical planning, constructing planning etc.

Of course these purposes would increase heavily if the cadastre register and especially the cadastre map could be connected with other registers and maps. This leads to the establishment of land information systems as you will hear from a later speaker.

If we look upon the basic purposes of the system the demands for accuracy, graphical representation and identification of legal rights are already fulfilled. We have no needs for changes except that the register procedure may seem old-fashioned, and the cadastral island maps in scale 1:4000 are not suitable for planning and administration purposes.

The possibility of using the landwide cadastral maps for other purposes by transferring them to digital form seems obvious. But still we must take care of the fundamental functions in the choice of solutions. Especially the function for identification of legal rights.
What are the problems then?

6. A Dynamic Digital Cadastral Map

To describe the problems we have to look upon the possibilities of making a digital cadastral map and the choice of solution in Denmark.

In principle you have the choice in a scale from just digitalizing the existing cadastral maps to making a total new measurement of the boundaries connected to the landwide reference system.

A low level of ambition means a quick and cheap solution but not a very suitable one for serving the challenges of the future, and you will leave a lot of problems behind for the running phase. A high level of ambition leads to the opposite situation.

In Denmark we have choosen a rather high level, but not a total new measurement.
The concept will be always to make the best possible use of the existing material (measurement sheets etc.) for establishment of the digital coordinates. Building up the maps will be complemented by a recoordination of every third control point by photogrammetry and by a total covering of ortophotos.

The process will be as follows:

1. Using the coordinates for the control points and the connected measurements for property boundaries directly, as they have the highest absolute accuracy. You have now established a socalled "skeleton map" or "framwork map";
2. Fitting in, transforming the measurement sheets in local construction, by using common points in the "framework map";
3. Fitting in, transforming the old boundaries without any measurements by digitalizing the existing cadastral map and using the ortophoto or other available maps, e.g. technical maps in a large scale.

You will make a register for the transforming result. It will now be possible to recalculate the coordinates in a given area, "transforming block", whenever you receive new coordinates for control points or new cadastral measurements for new and existing boundaries. That means that you will make a running improvement of the map, and that is why we call the map a dynamic one.

7. The Contents of the Map

The digital cadastral map will of course be more accurate and especially more useful than the analogue ones.

But it must be noticed that the fundamental functions of the system are still the same. That means that the property boundaries will still be defined by use of the measurement sheets compared to the state of conditions in the field. Not only by using the coordinates in the digital cadastral map.
The procedure for updating the cadastre may be improved, e.g. by on-line admission for the private licensed surveyor.

You may discuss the contents of the map. Especially if the costs of production are to be paid by users, e.g. the municipality and county councils, and private construction firms.

The contents of information in the cadastral map are rather low, and in some cases misleading, e.g. the private roads shown on the map may not fit to the actual conditions in the field, and especially the streams and the coast boarder may not be accurate.

In my opinion the solution for this problem is to use the cadastral map compared to the ortophoto, instead of "spoiling" the cadastral map with topographic elements. Still it has to be remembered that the cadastral registration identifies the legal rights as starting point. Furthermore, the digital media is perfect for combining several themes, but the contents and function of each theme must be clearly defined.

8. Legal Aspects by Establishing the Digital Cadastral Map

As described above, the existing analogue cadastral maps go about 200 years back. Of course they contain all kind of problems, e.g. shrinkage, redrawing, and problems related to the fact that they were established by plane table measurement as island maps with no connection to a common reference system.
And you will have problems related to the fact that all new boundaries are fit into the map in the best possible relation to existing boundaries. By building a dynamic digital cadastre you use the quite opposite procedure.

I should like to point out two legal aspects for establishing the digital map.

Firstly, we may look upon how to fit in, to digitalize the boundaries without any cadastral measurement sheets connected.
You may use the ortophoto and then solve the problem, if the discrepancy is related to systematic errors, e.g. shrinkage etc.
But you may find discrepancies which are not easily explained. In this situation you have to transform the analogue cadastral map to the digital one, even if, by combination with the ortophoto, you can see that the cadastral boundary is not in agreement with the physical boarder in the field. The situation is shown in fig. 4.

The problem is related to the provisions for defining the boundaries as described above. You cannot encroach on the legal rights just by renovating the cadastre.

The problem is furthermore that it may be difficult to say whether you have a systematic error or a legal discrepancy, e.g. an established prescriptive right.

Secondly, we may look upon the statements for the property areas.
By establishing a digital cadastre you have the possibility of recalculating all property areas. Even if it is possible it may not be wise.

The cadastral statements of the property areas are empirically very important to the land owners, e.g. for buying and selling and for paying property taxes. And the statements of areas are used for the municipal property tax register and the register of title deeds.

In the cadastral register you will find three kinds of area statements. As calculated by measurement or by construction in a large scale or calculated on the cadastral map in scale 1:4000.

By building the digital cadastre you cannot be sure that areas calculated from the digital coordinates will be more specific than the existing ones. This is at least a fact for area statements calculated by measurement or construction.

A solution might be to recalculate all areas stated as "map areas". This will bring the system in harmony and remove some great errors in existing area statements. But of course it must be explained to the land owner and corrected in the tax and title registers.
As goes for the more specific calculated areas if you have a discrepancy between the statement in the cadastral register and the area, you may calculate from the digital map. You will have to live within that, even if it may be hard to explain.

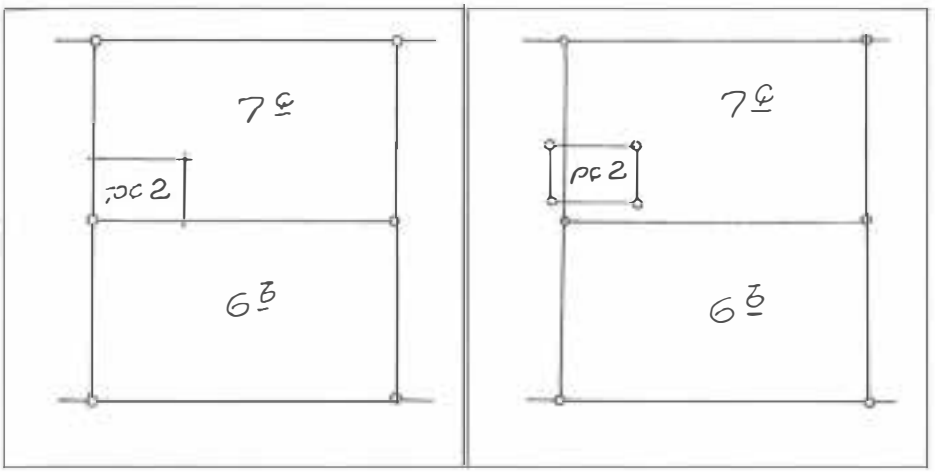
9. Legal Aspect by Running a Dynamic Digital Cadastral Map

Firstly, you have the problem how fo fit in the new boundaries by a dynamic method. In principle or in theory it may seem easy, but maybe not in practice.

As mentioned above, the dynamic digital cadastral system uses quite the opposite method of the existing analogue system for fitting in new boundaries.
By using the new cadastral measurements for correcting the old ones you may have a conflict for the graphical representation, not to mention the numeric representation.

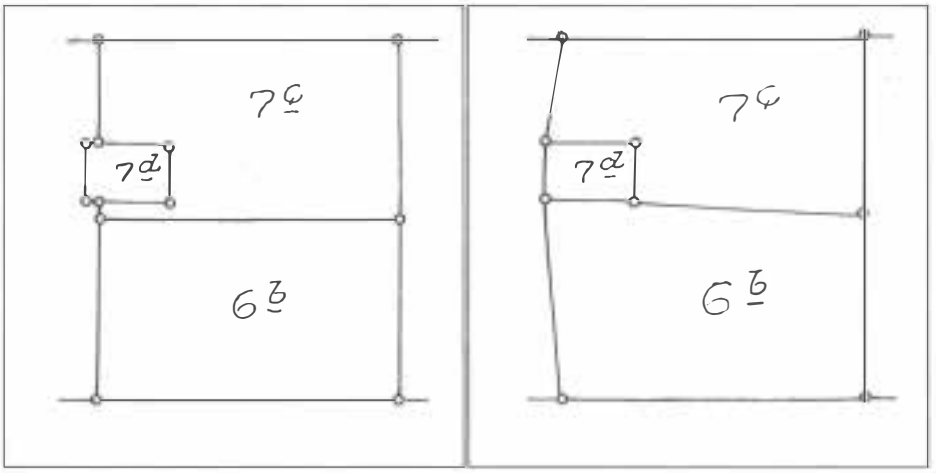
You will have to decide the size of correction for the existing boundaries, while you cannot just change the geometric and graphic representation. The problem is illustrated in fig. 5.
You may have situations where you have fo fit in the new boundary in relation to

Fig. 4. Cadastral map combined with ortophoto. A discrepancy is shown.



A. Existing dig. cadastral map. We want to parcel out pc. 2.

B. Fitting in pc. 2 by using the accurate coordinates.



C. The result is misleading to property ownership.

D. This solution is misleading too.

Fig. 5. Problems by fitting in new boundaries into the dynamic digital cadastre.

the existing and hide the accurate coordinates in a register for later use.

Also the statement of areas may be considered in the running dynamic system. Of course you cannot have a change of areas every time you make a recalculation for the boundary coordinates of a property.

Choosing the solution as mentioned above for establishing the digital cadastre, you may decide only to correct the area statements, if they are indicated as "map areas" and only if, by recalculation, the error goes beyond a fixed limit. Still you will have to accept that areas calculated from the digital map do not necessarily fit to the areas stated in the cadastral register.

Finally, you have the general problem of understanding and using the digital cadastre.
It is possible to calculate the length between the property corner marks, but is does not necessarily fit to the original cadastral measurement as shown on the measurement sheets.
And it is possible to combine the digital cadastre to digital technical maps and calculate e.g. the distance from a corner of a building to the property boundary. But this distance may not fit to the real distance in the field. Furthermore, the accuracy of various coordinates in the digital cadastre may be very unlike as explained by the procedure for establishing the cadastre.

These problems are common and call for a very full guidance for the users.

10. Closing Remarks

The connection between digital cadastral mapping, the fundamentals of the system and the legal aspects may appear from the description above.

Still the establishment of a digital cadastre in Denmark is in high time. The technological development is running fast, and you have to take part, even for a system with a history for over 200 years.

And there is a point for taking part right now. In Denmark the cadastre is the only landwide mapping in large scale. And you have in principle a precise definition for the boundaries of every property in the country.

Digital mapping for all purposes is increasing. By establishing the digital cadastral map you will get a perfect reference for all other kinds of digital mapping. And a perfect reference for building the land information systems of the future.

Discussion after the conference of Mr. Enemark

Tegeler: Does the law require that you inform the landowners of the changes that happen when you are fitting their parcels into the cadastral map ?

Enemark: Most of the time we do not inform them, even in the case of movements in the cadastral map; we are only correcting the map, but we do not move the boundaries. The cadastral map does not define the boundaries, it serves only for geometric identification. The definition is made by a private licensed surveyor when he compares the measurement sheets and the state of condition in the field.

PERSPECTIVES DE RÉNOVATION DE PLANS CADASTRAUX GRAPHIQUES BASÉES SUR L'EXEMPLE DE LA VILLE DE NEUCHÂTEL

R. Nussbaum
Service des mensurations cadastrales
du Canton de Neuchâtel

Résumé : Le Canton de Neuchâtel possède des plans cadastraux provisoires depuis une centaine d'années. Constatant une demande assez urgente de fonds de plans cadastraux numériques de la part de nombreux propriétaires de réseaux d'eaux, gaz, électricité, téléphone, etc, notre service étudie les moyens de produire de tels documents dans les zones urbaines. Un des procédés envisageables est le recours à la digitalisation des plans graphiques et à la photogrammétrie pour essayer d'améliorer leur précision et de mettre à jour leur contenu. En plus de la production, le résultat devrait être approuvé juridiquement par les autorités compétentes afin d'être considéré comme une mensuration officielle. Un test est en cours d'exécution pour vérifier la faisabilité de cette méthode. Son déroulement est décrit en détail. Les avantages et désavantages connus et supposés de l'utilisation de cette méthode, au niveau juridique, technique et financier, sont cités comme aide à la prochaine décision d'utiliser ou non cette méthode.

1. Introduction

La "Loi sur le cadastre" voté par le Grand-Conseil de la République et Canton de Neuchâtel est entré en vigueur le 1er novembre 1864 afin de dresser un cadastre général de tout le canton. La cadastration - terme utilisé à l'époque pour désigner la mensuration - de tout le territoire du canton, d'une surface de 800 km2, a été fixé à quinze ans. Et ce délai a été tenu.

Cette loi a prévu que :

- des arpenteurs-géomètres devraient effectuer le levé des plans;
- le bornage des propriétés serait déclaré obligatoire;
- les plans parcellaires seraient basés sur une triangulation exécutée 25 ans plus tôt;
- le contenu des plans serait identique dans tout le canton;
- le cadastre, appelé plus tard Registre foncier, serait

organisé;
- la mise à l'enquête publique des plans et du cadastre aurait lieu afin que les intéressés puissent les consulter et demander les rectifications nécessaires;
- les mutations seraient exécutées ensuite.

Le Règlement d'exécution de la Loi sur le cadastre, en deux parties, adopté les 20 mai 1865 et 8 août 1878, décrit avec précision les diverses opérations mentionnées dans la Loi. Il fixe en outre les tolérances entre distances prises sur le terrain et sur plan, et celles relatives aux différences entre deux déterminations de surfaces d'une parcelle.

Tous les plans cadastraux de la République et Canton de Neuchâtel ont ainsi été établis sur ces bases légales en quinze ans.

Plusieurs méthodes ont été utilisées pour confectionner ces documents : la planchette, la méthode polygonométrique avec théodolite partout ou la configuration du terrain le permettait, les mesures linéaires à l'aide de chaînes d'arpenteurs et, dans les endroits difficiles, la boussole.

Ces plans ont été continuellement mis à jour jusqu'à aujourd'hui par le service que je représente, et ils continueront à l'être à l'avenir, jusqu'à leur remplacement par des nouveaux plans cadastraux.

Les méthodes et instruments utilisés ont évolués dans le temps; on peut citer :

- l'utilisation des bases orthogonales sur le terrain, des equerres Müller et/ou du coordinatographe rectangulaire;
- l'emploi des théodolites auto-réducteurs, genre DK-RT de Kern, et du coordinatographe polaire;
- puis, toujours selon la même méthode sur le terrain, le calcul des coordonnées, leur report sur un film spécial et l'ajustage visuel sur le plan original;
- enfin, l'arrivée des instruments de mesures électroniques des distances, qui a permis d'améliorer le levé et d'augmenter le nombre des points d'ajustages; l'utilisation d'un digimètre assez précis de la firme Haag-Streit permet maintenant d'obtenir les coordonnées locales et, par des transformations mathématiques, comme Helmert, de déterminer numériquement la précision relative entre les plans et le terrain. Ce digimètre est aussi un coordinatographe rectangulaire et il donne ainsi la possibilité de reporter ensuite manuellement les coordonnées des nouveaux points.

2. Besoins des utilisateurs des plans cadastraux

Depuis 20 mois, notre service est confronté à la demande

bien précise de plans cadastraux numériques par les Services industriels (SI) de la Ville de Neuchâtel qui regroupent les distributeurs d'eau, de gaz et d'électricité. Cet utilisateur particulier n'est pas une exception et il préfigure les besoins de beaucoup d'autres.

Pour faire de la planification, de la gestion et de la construction de réseaux, les responsables des Services industriels ont besoin des plans de réseaux numériques afin de fournir en temps réel des informations utiles sur la topographie, le squelette des réseaux, les connexions pour alimenter un quartier, etc.

Sur la base des plans cadastraux numériques, qui constitueront un fond de plan, il faudra naturellement et nécessairement que les SI numérisent leurs cadastres des conduites et les reportent sur ce fond de plan pour constituer leurs plans de réseaux numériques. Je parle de cadastres au pluriel car chaque agent énergétique figure sur des plans cadastraux différents.
A terme, l'IENER, Institut d'économie et aménagements énergétiques de l'EPF-L, imagine qu'avec des plans de réseaux numériques et de l'électronique de contrôle, la télésurveillance avec comptage et analyse des flux du réseau, le télécontrôle localisant les pannes et anomalies et réduisant le temps de réaction en cas d'alarme, la télégestion, procédure automatique d'action à distance sur les vannes du réseau en fonction d'un modèle de demande et du contrôle de la demande réelle, que les distributeurs d'énergies pourraient étendre et développer des méthodes de gestion prévisionnelle, réduisant ainsi les coûts et optimisant le fonctionnement.

A titre d'exemple, notons que la gestion du réseau d'eau réglée par des dispositifs électromécaniques peut être améliorée par simulation fine de la demande prévisionnelle limitant les pompages ou les déversements et répartissant l'usage optimal de l'eau pour la consommation et la production d'électricité. Pour le gaz, les techniques actuelles rendent possibles des variations importantes de la pression de distribution permettant ainsi d'utiliser le réseau comme stock de régulation. Pour le chauffage à distance, les pertes sont proportionnelles à la quantité de tuyaux et à leur température. Par conséquent le fait de distribuer la chaleur à la température la plus basse possible limitera les pertes. Par ailleurs, il est possible de limiter la puissance installée de la centrale en utilisant le réseau comme stock ou en surchauffant le réseau avant les pointes de demande. Dans ce contexte, la gestion fine du réseau et la régulation centrale des flux d'eau dans chaque boucle d'utilisateurs permettent de réduire les coûts d'exploitation et les émissions dans l'environnement liées à la consommation d'énergie. En connaissant les caractéristiques du réseau et la demande, ces banques de données des réseaux constituent un outil puissant et

efficace d'optimisation et planification des réseaux.

3. Perspectives de fournitures de plans numériques

Les SI, ayant besoin de plans cadastraux numériques, ont donc constaté, malheureusement pour nous, ingénieurs géomètres, que ces documents n'existent pas encore et qu'il faudra une ou plusieurs décennies pour les constituer.

Il est incontestable que, pour les gens de réseaux de distribution de fluides, le plan est un moyen et, pour nous, un but pour lequel des directives imposent la méthode de travail et la qualité du résultat.

Ainsi, pour les SI, la production de plans est trop lente et également trop sectorielle.

En conséquence, l'institut de l'EPF-L déjà mentionné et les SI proposent de tester l'utilisation d'images non interprétés, comme l'orthophoto, afin de permettre un démarrage souple et rapide des méthodes numériques de gestion de réseaux.

En résumé, le projet "SYSURB", relatif à la gestion de systèmes énergétiques urbains assistée par ordinateur, financée par l'IENER, les villes de Martigny et Neuchâtel et la Commission pour l'Encouragement de la Recherche Scientifique (CERS), a pour objet de définir les concepts et méthodes de saisie de données, leur mise à jour rapide et de dialogue entre partenaires.

Procédé envisagé :

L'image sera lue par scanner et traitée de manière digitale comme une image vidéo. Le stockage sera fait sur disque optique; le squelette du réseau sera digitalisé et incorporé au contenu du disque optique. On aurait ainsi des images pictorielles et vectorielles.
Une grille hectométrique, l'hectare étant choisi comme unité de base, permettra un repèrage rapide et simple dans le tissus urbain. Une indication de la qualité des informations sera répertoriée afin d'affiner plus tard les données grâce à un cadastre numérique enfin disponible. La mise à jour par l'obtention de nouvelles orthophotos est envisagée.

D'autres méthodes sont possibles comme la digitalisation des plans contenant à la fois le cadastre et les réseaux. Certains propriétaires de réseaux l'envisagent très sérieusement.

Plusieurs réflexions se dégagent de cette publication SYSURB:

- absence de plans cadastraux numériques;

- a priori des années pour les constituer;
- les plans confectionnés par les SI seraient utilisés par beaucoup d'autres services :
  ponts et chaussées, protection civile, aménagement du territoire, PTT, etc, qui utilisent nos plans actuellement;
- les plans cadastraux ne deviendraient nécessaires que pour les besoins du registre foncier;
- les données géomètriques issues de leurs plans ne pourraient pas être reprises par des ingénieurs géomètres lors de la confection de nouveaux plans cadastraux;
- le besoin rapide de plans moins précis, de l'ordre de 30 cm, mais couvrant de grandes surfaces, existe réellement.

Après ces constatations, une action s'impose afin d'essayer de répondre au défi lancé.

4. Perspectives de fournitures rapides de plans cadastraux numériques

Partageant avec les responsables des SI et de l'IENER le vieil adage, qu'on devrait à Confucius, 500 ans av. J.-C., qui dit qu' "une image vaut mille mots", j'ai pris contact avec M. le Professeur O. Kölbl ainsi qu'avec la Direction fédérale des mensurations cadastrales à Berne pour essayer de produire assez rapidement les plans cadastraux numériques de la Ville de Neuchâtel à l'aide de la photogrammétrie.

L'idée d'utiliser la photogrammétrie vient, d'une part de l'utilisation possible d'orthophotos pour projeter de nouvelles canalisations tel que le suggère la publication SYSURB et, d'autre part, d'articles de M. Kölbl consacrés à la rénovation de mensuration par la photogrammétrie.
En ville de Neuchâtel, un réseau classique de polygonales a été déterminé il y a 10 ans. Entre vingt à trente points d'ajustage ont été choisis selon le critère qu'ils devaient être visibles et parfaitement identifiables aussi bien dans les plans d'origine que sur le terrain. Ces points ont été déterminés et contrôlés polairement à partir des points de polygones. Toutes les mises à jour, dès cette date, ont été effectuées à partir des points de polygones.

Le test de faisabilité de mensuration parcellaire par rénovation à l'aide de la photogrammétrie en zone urbaine pouvait ainsi commencer assez rapidement.

Avant de détailler la méthode, il faut rappeler que les plans cadastraux actuels sont graphiques et qu'ils ont été provisoirement approuvés par la Confédération lors de l'introduction du Code Civil Suisse en 1912.

La mensuration par rénovation consiste à digitaliser ces plans, à actualiser et à normaliser leur contenu. Elle est basée sur une recherche minimum de l'abornement et une utilisation rationnelle des éléments numériques (levés ou

coordonnées locales) issus de mutations effectuées précédemment.

4.1. Description de la méthode (fig. 1)

La digitalisation complète des plans cadastraux actuels a constitué la première opération par la saisie systématique de tous les points et de toutes les lignes les reliant : limites de propriété, de bâtiment, de différentes natures (bord de route); le centre de gravité de chaque unité cadastrale (parcelle, bâtiment, place, etc) et un point de son contour périmétrique ont été également digitalisé afin de pouvoir reconstituer la description de l'unité. Cette opération a été réalisée sur un coordinatographe rectangulaire à sortie numérique Haag-Streit ici-même à l'Institut de photogrammétrie de l'EPF-L.
La récupération des mesures effectuées antérieurement lors de mutations peut être exécutée ou non.
Cela dépend de l'importance et du type de la mutation, de son ancienneté, de la lisibilité des mesures et croquis, de sa validité actuelle, etc.
En cas de récupération, des points d'intercalations déterminés lors de la mutation et identifiables aujourd'hui sur le terrain seront signalés.
Lors de la reconnaissance du réseau de points de base nécessaires, d'une part, pour déterminer les points d'ajustage, utiles à l'orientation des clichés, ainsi qu'éventuellement les points d'intercalation demandés, et, d'autre part, pour les besoins de la mise à jour ultérieure des plans cadastraux, le toilettage du contenu des plans actuels est exécuté; cette opération consiste à signaler les objets nouveaux ou différents et à indiquer la représentation correcte par rapport aux normes actuelles.

La détermination des corrections (nouveau bâtiment) est supposée être effectuée lors de la restitution photogrammétrique. Pour les petits éléments (prolongation d'un mur existant), ou invisibles sur les clichés, à priori, les mesures devront être prises par levé terrestre habituel tout de suite ou lors de l'opération suivante.

Les déterminations des différents points mentionnés ci-dessus sont effectuées ensuite afin d'obtenir finalement des coordonnées.

Dans le cas du test de Neuchâtel, nous possédions donc déjà ces éléments, à l'exception de quelques points d'intercalation qu'il a fallu déterminer.

La signalisation de quelques points de base a été exécutée; vu la position de certains de ceux-ci, proches d'arbres ou de bâtiments, deux excentriques alignés ont été souvent indiqués par point.

Le vol, effectué par l'avion et avec la collaboration financière de la Direction fédérale des mensurations

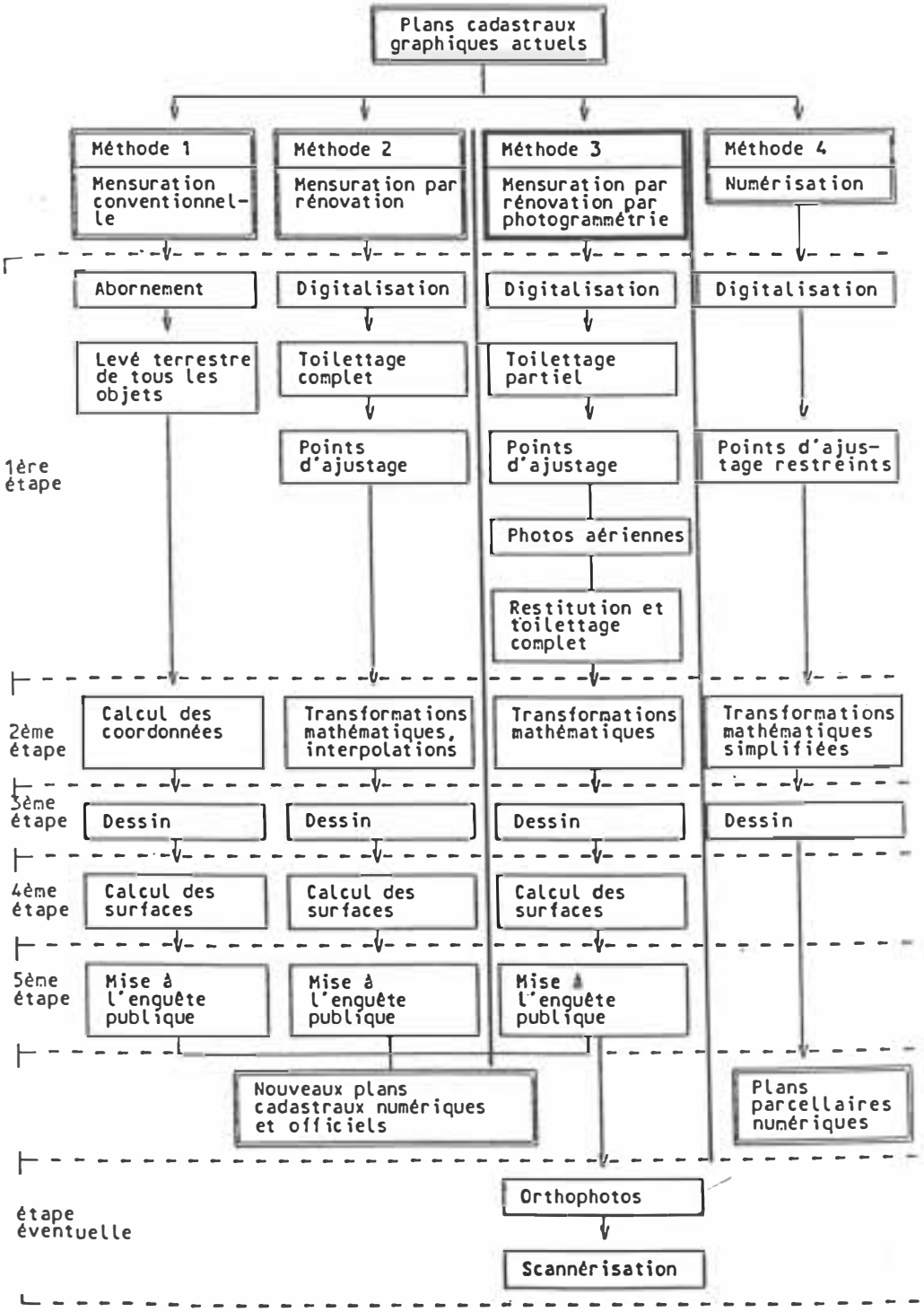


Fig. 1 Schéma d'exécution des mensurations parcellaires

cadastrales, a permis de prendre, à environ 900 m sur sol, des clichés à l'échelle 1:3000 selon un plan de vol défini par M. O. Kölbl.

Grâce aux coordonnées des points de base, d'ajustage et d'intercalation, des transformations mathématiques amènent les coordonnées locales issues de la digitalisation dans le système des coordonnées nationales. Toutefois ces coordonnées sont encore provisoires.

Un report et un dessin sont effectués pour contrôler le résultat de la digitalisation afin de la comparer au plan cadastral officiel.

En plaquant ce même dessin sur les photos agrandies à l'échelle de 1:500, il sera possible, parfois avec difficulté, de déterminer le forme et la grandeur des îlots homogènes dans lesquels tous les points subiront une transformation mathématique identique. Pour cela il faut trouver bien identifiable, sur la photo et le plan, quelques points d'ajustages dont les coordonnées seront déterminées lors de la restitution photogrammétrique.
La restitution permettra aussi de prendre l'altitude au sol de chaque point digitalisé et de compléter le contenu du plan selon les indications fournies lors du toilettage.

Des transformations mathématiques donneront enfin à chaque point ses coordonnées définitives X, Y et H.

Pour de plus amples et plus complètes explications, on se référera à l'exposé de M. J.-C. Pradervand consacré à "Rénovation of the cadastre with the help of photogrammetry. Application problems in urban area".

La suite des travaux correspond à une exécution classique et normale d'une mensuration :

- calcul des surfaces;
- dessin de contrôle des contours périmètriques;
- report automatique des points sur un support stable;
- dessin automatique ou manuel du nouveau plan cadastral;
- établissement du plan numéroté;
- confection automatique et presque complète de l'état des contenances donnant, par numéro de parcelle, la commune et le plan d'appartenance, les noms et adresses de son (ses) propriétaire(s), le(s) nom(s) et la (les) surface(s) de la (des) nature(s) la composant, sa surface totale, etc.

La mise à l'enquête publique du plan cadastral et de l'état des contenances clôturent l'exécution de la mensuration. L'approbation des autorités cantonales et fédérales rendent ces documents officiels.

4.2. Commentaires sur l'exécution partielle de ce test à ce jour.

Le toilettage doit se faire avant la digitalisation afin d'éviter la saisie d'objets disparus.
La digitalisation à l'aide de l'instrument décrit plus haut fut un travail long et fastidieux. Le recours à un système graphique interactif permettrait très certainement de faciliter la digitalisation de certains objets comme les murs, escaliers, en utilisant les menus de constructions interactifs. Par contre, la résolution de saisie des coordonnées locales sur le coordinatographe est supérieure, de l'ordre de 1/100e mm, à celle d'une tablette à digitaliser offerte sur le marché qui est de 2,5/100e mm.

La détermination des zones de transformation et des points d'ajustages par superposition d'une photo agrandie et du dessin de la digitalisation s'est revélée assez difficile pour mes collaborateurs et moi-même.
Il faut souhaiter que des logiciels de transformations mathématiques puissent prendre la relève de l'homme; une solution éventuelle pourrait consister à signaliser plus de points d'ajustage par plan et surtout des points de limite.

4.3. Avantages de cette méthode

Techniques :
- exécution a priori plus rapide;
- altitude de chaque point connue;
- contenu des plans totalement numérique;
- mise à disposition de photographies agrandies à moindre coût;
- possibilité aussi à moindre coût d'établir des orthophotos;
- injection de photos terrestres d'objets de réseaux (regards, etc) dans l'image stéréoscopique de la restitution photogrammétrique afin d'obtenir les coordonnées de ces points invisibles sur la photo aérienne; solution plus simple et plus économique que la signalisation avant le vol.

4.4. Désavantages

Juridiques :
- respect partiel des normes habituelles;
- approbation fédérale, par conséquent participation financière fédérale, plus difficile à obtenir.

Techniques :
- faisabilité de cette méthode en milieu urbain à prouver en tenant compte des difficultés dues à la végétation, au stationnement et à la circulation des véhicules, à l'ombre portée par les bâtiments;
- précision des coordonnées à connaître;
- différences entre les coordonnées des points issues des multiples transformations et les coordonnées des mêmes points résultant d'un

double levé terrestre supérieure à 10 cm (tolérance du degré de précision 2 pour Neuchâtel);
- obligation d'effectuer les vols de prises de vues au printemps dans une période assez courte;
- peu de façades de bâtiments visibles pour effectuer l'ajustage plan-photo;
- restitution des nouveaux bâtiments difficiles pour les raisons évoquées ci-dessus;
- toilettage par levé terrestre plus important que prévu;
- recours à plusieurs bureaux sous-traitants;
- recours nécessaire à un système graphique interactif pour digitaliser et décrire tous les objets;
- utilisation d'une méthode expérimentale;
- établissement d'un cahier des charges;
- difficulté à prévoir lors des travaux de mise à jour en présence de points de limite existants dont les coordonnées proviennent de la digitalisation (intégration des coordonnées "terrain" et "plan");

Financiers :
- coût actuellement difficile à estimer;
- aucun tarif paritaire n'existe; rétribution selon devis et/ou en régie.

5. Conclusions

La solution envisagée pour produire des nouveaux plans cadastraux numériques peut impliquer une limitation des exigences de précision.

S'il se révèle difficile ou impossible de lier les objectifs de précision, donc d'approbation fédérale, et de production, il serait alors préférable et souhaitable d'adopter une succession de techniques coordonnées et adaptées aux souhaits des différents utilisateurs. Par des améliorations successives, ces méthodes devraient permettre d'atteindre les objectifs de précision exigés par la Confédération, sans pénaliser les utilisateurs qui n'en ont pas ou moins besoin.

Les ingénieurs géomètres ne sont plus les rois des plans.

Et les plans ne doivent plus satisfaire que les besoins du registre foncier.

Les ingénieurs géomètres doivent cependant continuer à produire un outil merveilleux, le plan, afin de le mettre à disposition des utilisateurs potentiels.
Et ils vont s'engager dans cette voie, car le plan fait partie intégrante du système d'information du territoire et son importance ne fera qu'augmenter dès qu'il sera numérique.

Discussion after the conference of Mr. Nussbaum

Koecher: Why are you treating both boundaries and utilities at the same time with photogrammetric methods ? They do not have the same accuracy requirements.

Nussbaum: We treat them at the same time because the Confederation supports financially all cadastral operations that are undertaken in order to be officially approved once they are finished.

LE CADASTRE DANS LES BANQUES DE DONNEES URBAINES A SUPPORT CARTOGRAPHIQUE

Jacques Palombo
Société ICOREM
Marseille

Dès 1972, la Municipalité de MARSEILLE a pris la décision de concevoir avec la Société Informatique ICOREM un système d'informations urbaines à support cartographique. Ceci, dans le but de maîtriser parfaitement l'aménagement du territoire à gérer.

La première grande tâche à assurer a été l'informatisation des plans cadastraux au nombre de 1000 sur les 25000 hectares de la commune.

Cette tâche a été réalisée en 4 ans avec comme méthode : la digitalisation, point par point, des détails du plan, puis en différé la codification des liaisons jusqu'à obtention du dessin automatique. Y compris la codification des relations entre îlots, parcelles, bâtiments, voies, afin que l'utilisateur puisse accéder au niveau le plus fin, c'est-à-dire la parcelle.

En parallèle, les fichiers informatiques des données littérales cadastrales étaient chargés sur le même système.

L'ensemble de ces travaux ont été menés en étroite collaboration avec l'administration du cadastre qui a fourni toute la documentation nécessaire et mis en oeuvre un processus accéléré de mise à jour de tous les documents avant leur informatisation.

De surcroit, un levé topographique photogrammétrique a été effectué pour enrichir le plan cadastral avec des prises de vues au 1/4000°.

Les levés effectués consistaient à apporter des compléments importants sur le plan cadastral.

Ces compléments, nécessaires au travail quotidien des services gestionnaires du domaine public, étaient :

- le mobilier urbain
- la signalisation horizontale et verticale de la circulation
- les émergences des réseaux publics
- les plantations et espaces verts
- l'éclairage public
- les informations volumétriques :
  - Altimétrie terrain naturel et voiries (Profils en long et en travers)
  - Courbes de niveaux
  - Hauteur des bâtiments.

Tous ces renseignements superposés informatiquement aux renseignements cadastraux permettaient alors d'éditer toute sorte de plans personnalisés dont le support était le plan cadastral par simple combinaison d'informations.

La banque de données était enrichie de fichiers nationaux tels que les fichiers de la Direction Générale des Impôts, fichiers de l'Institut National de la Statistique (Population par îlots, démographie etc ...) ou des fichiers municipaux : Permis de construire, règlement d'urbanisme, fichiers des voies, fichiers circulation, éclairage public, propriétés appartenant à la collectivité etc ...

Les données cadastrales ont été largement utilisées et étendues au dela de leur vocation originelle, à savoir la fiscalité.

Cette informatisation a donné la possibilité à l'administration du cadastre de rééditer et donc de rajeunir les collections de plans en redessinant par voie automatique la totalité des plans cadastraux sur support stable polyester reproductible et d'éditer également le plan cadastral normalisé au 2000° en coupures pleines, tant apprécié par les aménageurs.

Une telle opération d'informatisation du plan cadastral, à usage des collectivités, exige une mise en place quasi immédiate de moyens de mise à jour.

Pour le cas particulier du cadastre, l'administration dont c'est la vocation première, s'est chargée de maintenir cette base de données graphique et de transmettre informatiquement les mises à jour aux utilisateurs.

Equipée au niveau national à Saint Germain en Laye d'un ordinateur de marque DIGITAL et de stations graphiques interactives et utilisant le logiciel CARINE développé pour Marseille, ces mises à jour graphiques ont pu se faire de façon continue.

La base de données cadastrale de Marseille a été alimentée mensuellement.

Les services de la documentation du cadastre à Saint-Germain en Laye ont beaucoup utilisé la méthode photogrammétrique pour la conservation des bâtis.

A l'heure actuelle, pour des raisons de décentralisation et d'utilisation des compétences locales, un poste de travail graphique installé dans les services départementaux situés à Marseille et connecté sur l'ordinateur de la Société ICOREM permet d'assurer la mise à jour de la base cadastrale.

Un accord de collaboration conclu entre cette Société et l'administration du cadastre permet à deux organismes dont la vocation est différente d'utiliser la même base de données et d'en assurer sa maintenance.

Après 1976, beaucoup d'informations sont venues grossir la base de données et notamment dans le domaine cadastral, on peut citer le cadastre de 1821 en centre ville, information utile au service de la conservation du patrimoine architectural et archéologique de la Municipalité.

Mais aussi grâce aux facultés de traitement de l'application CARINE, un grand nombre de sous produits issus des plans cadastraux ont pu être édités, représentations thématiques triées sur les caractéristiques des parcelles et des bâtiments.

Quinze années se sont écoulées depuis le début de cette initiative. La banque de données est beaucoup utilisée par les services de la collectivité, les concessionnaires de réseaux publics, les administrations.

Elle s'est beaucoup enrichie de données nouvelles permettant d'apporter aux décideurs de toute nature une aide précieuse dans leur travail.

L'expérience de Marseille n'est pas restée sans conséquences vis-à-vis des autres collectivités et l'on voit aujourd'hui que d'autres ont suivi cet exemple.

La Société ICOREM est intervenue auprès des municipalités avec lesquelles MARSEILLE a conclu des accords de collaboration. Nous trouvons ANTIBES, TOULOUSE, PALMA DE MAJORQUE et VALENCIA en Espagne pour lesquelles le thème du cadastre est important.

On peut citer, pour exemple, la ville de PALMA DE MAJORQUE pour laquelle la rénovation cadastrale était le mobile important pour la réalisation d'un tel projet.

Le cadastre, vieux et non maintenu depuis plus de 20 années, l'absence de plans fiables pour gérer la ville étaient devenus la préoccupation essentielle des services techniques.

La réalisation de cette banque de données s'est déroulée en 3 étapes :

- **1ère étape :**

Couverture totale de la ville d'un plan topographique détaillé au 1/500° des corps de rues avec tous les détails nécessaires à la gestion des services locaux et publics.

Ce levé effectué au sol a été réalisé avec des tachéomètres électro-optiques et codification sur le terrain. Les levés traités informatiquement ensuite venaient alimenter la banque de données.

- **2ème étape :**

Levé photogrammétrique des intérieurs d'îlots, limites apparentes des propriétés et bâtiments à l'échelle du 1000° sur la totalité de la zone urbanisée et chronologiquement dans les zones où le levé des corps de rues avait été réalisé.

Pour cela, un stéréorestituteur analytique MATRA TRASTER a été connecté à un ordinateur VAX 750 sur lequel réside l'application et la banque de données.

Les données photogrammétriques, appuyées sur les données terrestres, sont venues compléter la banque de données, au fur et à mesure de leur informatisation.

- **3ème étape :**

Le plan topographique de base ainsi constitué, déjà disponible pour les aménageurs, est utilisé pour la constitution du plan cadastral.

Les enquêtes terrain conduisent à la délimitation des propriétés, l'identification des propriétaires et la collecte des renseignements littéraux.

Informatiquement, par méthode interactive, on constitue le fichier des propriétés, on codifie également le plan cadastral sur des terminaux graphiques en utilisant les éléments informatisés du plan topographique.

Dans ces deux exemples : Marseille et Palma, le cadastre a été informatisé en 4 ans.

Marseille :	1000 plans	25.000 hectares	150.000 parcelles
Palma :	400 plans	8.000 hectares	60.000 parcelles

L'expérience présente : le Département de Vaucluse

Le projet consiste à mettre en place une banque de données départementale à support cartographique dans laquelle le plan cadastral et les données associées au plan jouent un rôle important.

Le programme du projet a été défini pour satisfaire à 3 exigences majeures :

- être un moyen d'information et d'aide à la décision à l'échelle du Département de Vaucluse pour les acteurs locaux de l'aménagement (élus, professionnels, agents de l'état et des collectivités locales ...),

- pouvoir se développer d'une manière intercommunale quelles que soient les typologies rencontrées (urbaine, péri-urbaine, rurale ...),

- avoir un caractère usuel permettant une information synthétique claire et rapide préalable à d'autres consultations éventuelles sur les systèmes d'informations plus spécifiques.

En ajout des informations cadastrales, il est prévu d'informatiser des éléments topographiques et les divers réseaux (EDF, PTT, eaux, assainissement ...)

- les documents d'urbanisme (Plan d'occupation des sols et règlement d'urbanisme),

le but étant de couvrir la totalité du territoire départemental, soit : 356.713 hectares, 700.000 parcelles cadastrales.

Une phase probatoire, actuellement en cours de terminaison, a consisté à établir une maquette de ce que pouvait être la base de données départementale.

Le choix d'une commune significative était fait fin 1986, les facteurs caractéristiques étant :

- effectif de population dans la moyenne Vauclusienne : 2100 habitants,

- superficie importante 4357 ha avec une topographie variée (Plaine et reliefs, cultures et forêts),

- présence des 3 typologies majeures (urbaine, péri-urbaine, rurale),

- situation économique et démographique semblable à la moyenne départementale.

Cette base de données test nous permettant également d'évaluer le coût global de l'opération, notamment pour le chargement des données cadastrales qui est le poste le plus important, mais aussi de trouver des méthodes de saisie performantes au moindre coût.

Deux méthodes de travail retiennent notre attention aujourd'hui et des tests probatoires ont lieu actuellement :

- Saisie massive du plan cadastral par digitalisation
- Saisie massive du plan cadastral avec un système à balayage.

La saisie par digitalisation et par balayage doit répondre à plusieurs critères essentiels :

- Performances
- Précision
- Economie.

Une méthode nouvelle de digitalisation assistée par ordinateur utilisée se décomposera en plusieurs étapes :

1) La partie saisie interactive par digitaliseur opérateur doit être simple et rapide. On saisit les lignes de parcelles, de bâtis et détails du plan une seule fois dans des classes différenciées sans codifier les contours par entités. Cette partie de travail peut se faire avec un programme simple et un micro-ordinateur.

2) Par programme et lors d'un traitement batch, on calcule les points à détermination multiples (extrémités de segments) et on calcule tous les alignements en projetant les points sur l'alignement.

On constitue automatiquement les éléments fermés par niveau de classe puis on effectue :

- le positionnement automatique des écritures élémentaires et des symboles (Boites postales, mitoyennetés, etc ...).

- la construction du fichier de dessin de contrôle.

3/ Edition d'un tracé de contrôle à la même échelle que le plan original et vérification de la digitalisation.

4/ Retour au système interactif avec écran graphique pour création des liens entre N° parcelle et son contour, adresse postale, N° parcelle. Contour îlot, N° îlot etc ... et corrections finales de la codification.

5/ Formatage final au format de la base de données.

Avec cette méthode de travail, le coût de digitalisation devrait être inférieur à la méthode de saisie totalement interactive car certaines phases se font sans intervention d'un opérateur et pendant des heures où l'ordinateur est peu utilisé.

La saisie massive des plans cadastraux avec un système à balayage scanner exige un matériel très sophistiqué et des programmes informatiques très élaborés.

Jusqu'à présent, ce type de mémorisation informatique a été utilisé pour des plans de l'industrie (CAO).

Le système avec lequel nous avons fait des essais se décompose en 3 parties :

- le scanner proprement dit où l'on dépose le plan à numériser et qui va l'analyser et générer un ensemble de petits vecteurs retraduisant l'image du plan qui devient alors visualisable sur écran,

- la station de travail graphique qui, faisant appel à un logiciel de restructuration, permet à l'opérateur de retraduire l'image scanner en informations point et liaisons logiques,

- la troisième partie consistant à formater les données dans le système base de données utilisé.

Ce travail a été fait sur quelques plans cadastraux en centre ville à l'échelle du 500°.

C'est le système 4991S1 de TEKTRONIX qui a été utilisé.

Les résultats obtenus ont été assez décevants car le plan cadastral est assez complexe et exige une grande fidélité de restitution.

Les hachures des bâtiments sont mal interprétées par le scanner et génèrent des contours dentelés. Les écritures ne sont quasiment plus lisibles. Un gros travail sur la station graphique est à réaliser.

De ce fait, la durée et le coût de l'opération se sont averés trop importants et n'ont pas apporté d'amélioration par rapport au système de digitalisation traditionnel.

Un nouvel essai doit être réalisé très prochainement avec un autre système réputé de haut de gamme. Les véritables conclusions sur la faisabilité de la reproduction des plans pourront être données ensuite.

Pour cette banque de données départementale, dès à présent, des accords entre le département et l'administration centrale du cadastre ont été conclus en vue de son élaboration et de sa mise à jour.

Le département constituera une entité de fonctionnement de la banque de données à laquelle pourront se connecter tous les utilisateurs partenaires (communes, gestionnaires de réseaux, administrations, service du cadastre).

Pour le cas particulier de la mise à jour cadastrale, c'est le département qui doit financer l'équipement matériel destiné au service départemental du cadastre qui disposera de deux postes de travail graphique et d'une machine à dessiner.

Ainsi, les utilisateurs de la banque de données et en particulier ceux dont le fond de plan cadastral est nécessaire à leur travail quotidient seront assurés de la fiabilité des informations mises à leur disposition.

Summary of the conference of Mr. Palombo by Mr. Chevallier

The Cadastre within Urban Databases Supported by Cartography

Mr Palombo presented 3 different projects, one in Marseille itself, one in Palma de Majorca and one in the department of Vaucluse (south of France).

The municipality of Marseille decided in 1972 to build up an urban information system supported by cartography. The first basic job was to digitize the existing cadastral maps. The 250 km² of the municipality are covered by 1'000 cadastral maps. Moreover a photogrammetric survey was carried out to enrich and update the contents of the cadastral maps. Simultaneously with the up-dating task by the CARINE software, the connections between the data base and national files - like statistical or tax-files and also the municipal files - were installed. During the whole project, there was close collaboration between local authorities, the ICOREM society and the national administration of the cadastre.

In Palma de Majorca the cadastre was old and have not been updated for some 20 years. The main goal of the project was cadastral renovation.

The operation was carried out in 3 steps:

1) A topographic basemap was established along the streets with electro-optic tacheometers.
2) A photogrammetric survey of the entire area was used to gather details that could not be observed by field survey.
3) The combination of both datasets was used to build up the new cadastral maps.
   It is important to notice that the maps for the management were ready before the cadastral maps, this is a great advantage for planners.

The third project concerns the departmental data base of the Vaucluse department. The goals are to produce a means of information and a help for decisions on the departmental level, but this data base should also be able to develop itself in each municipality without loosing the advantage of giving clear and synthetic information.
The goal is to cover the whole department, that means 3'567 km² containing ~ 700'000 cadastral parcels.
This information system is built up as a common and integrated project by the municipalities, the utility services and administrations, including the cadastre.

The last part of the conference concerned the methods of data capture for the digitizing of maps.
The scanning of the existing maps with a TEKTRONIX 4991S1 system yielded disappointing results. It is planned to make experiments with other systems.
The paper presents a new method of digitalization which seems to be successful. The first part is done manually by an operator and this phase is followed by an automated treatment of the data.

Discussion

Chevallier: Did you use a DTM in the Marseille project ?

Palombo: As a matter of fact, we did not.

CONCEPTUAL ASPECTS FOR PROBLEM SOLVING OF DUTCH CADASTRAL RENOVATION

L.A. Koen
Cadastre and Public Registers Agency
Apeldoorn
The Netherlands.

SUMMARY

The paper discusses the Dutch conception regarding the technical aspects for cadastral renovation in the graphical field.
The structure and the main characteristics of the Dutch Cadastre are reflecting the long history and the multi-functional character of the system.
The present situation is inhomogeneous; renovation is urgent to meet the demands of today.
Main principles of the Dutch renovation concept are:

- Graphical renovation of the cadastral map on the basis of large scale photogrammetric base mapping.

- Realisation of an integrated digital data base for both cadastral and topographical purposes and integration of updating procedures.

- Renovation within a reasonable time (project 2000).

- Return of investment.
  Optimalisation of the relation product - investment.

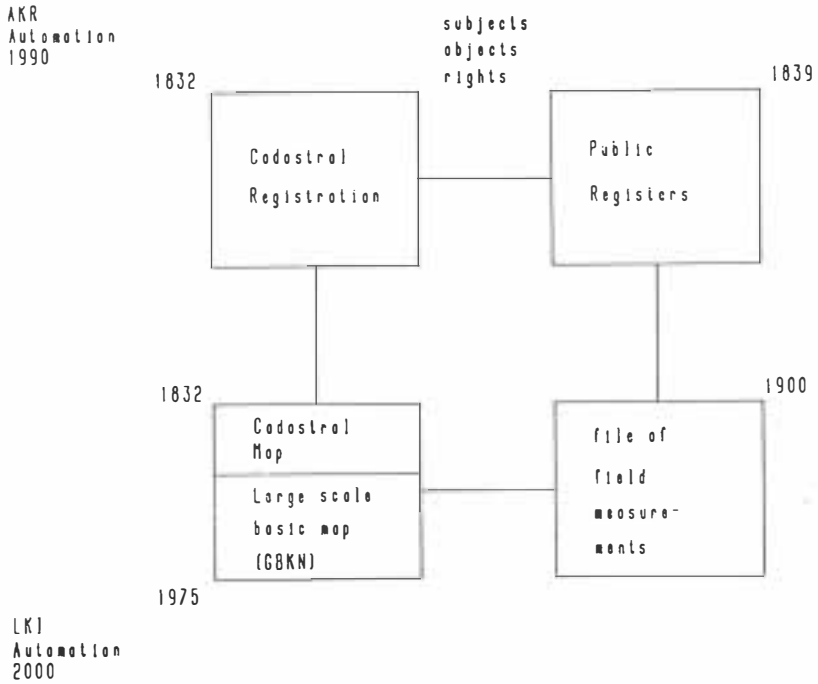
In the paper, attention is paid to the experiences of the last 10 years concerning technical, organizational and financial aspects of the Dutch cadastral renovation.

1. Introduction

The Dutch Cadastral system has a history of more than 150 years. Like many other european systems, the origin of the system goes back to the beginning of the 19th century, when cadastral systems were created for tax-levying purposes. The structure of the Dutch system still reflects this public origin. However, from the beginning private aspects played a role in the activities of the cadastral service. In the course of years these private aspect became more and more important. At the beginning of the 20th century the Dutch cadastral system was an important instrument for guaranteeing the legal status of real estate, in spite of the rather weak juridical bases at that moment.
During the 20th century, there was a continuous process of industrialisation and urbanisation in the Netherlands. The Netherlands became one of the most densely populated countries in Western-Europe. The developments mentioned asked a more intensive role of the government regarding physical planning, development and administration of real estate. Public information supply became more and more important, especially after the Second World War. However, the original parcel oriented cadastral system was not fully suited for the necessary mass information supply. Renovation and notably automation was necessary to fullfil this modern demands.
The relative high costs of renovation prevented a quick extension of automation in the technical field. Recent technical developments, however, made it possible to design a realistic concept for an automated multi-purpose cadastral system. The automation of the administrative part of the system will be completed in 1990. For the renovation and automation of the technical part there is a "plan 2000". In the following pages the attention is mainly paid to the renovation of this technical part.

2. The Dutch cadastral system

The main structure of the cadastral system can be described by the following scheme.



- Public Registers

  The public registers are the main source of the data in the cadastral system (subject, object, rights).
  According to the Dutch law, publication of deeds is a necessary condition for ownership. The public registers are performing the motor function in the system. For publication a fee is charged to the new owner. Thanks to the fact that the public registers are part of the organization, the Dutch cadastral service is financially self-supporting.

- Cadastral Registration

  Together with the cadastral map series the cadastral registration is the original information system for tax-levying-purposes. The cadastral registration is the systematic registration of subjects, objects and rights. Thanks to this systematic registration (and the automation of it) in practice the cadastral registration is also a main instrument for private en public information supply.

- Maps

  The cadastral map is the only large scale map covering the whole country. Its original function was mainly an administrative one; an instrument for acces, consistency and updating of the cadastral registration. In its original form the cadastral map is not quite suited for technical purposes.

  The large scale base map is a relatively young map series, produced by means of fotogrammetry. It is a topographical base map for technical purposes (planning, development and technical registration). At present the map covers some 30% of the Dutch area and has as main scale 1 : 1000.

  In the automated situation the cadastral map series and the large scale topographical base map are integrated.

  For the Cadastral Service the large scale base map is an important instrument for the renovation of the old cadastral map series.

- File of field measurements

  Up to the turn of the century the cadastral system had a pure graphical character. Systematic registration of field data started when the private use of cadastral data became more and more important.

  Field data play an important role in the updating process. The file of field measurements is not only a technical one, it is an official report of updating activities as well. Such an official report is necessary because in the Dutch systems official measurements can be carried out after the conveyance of the real estate. This may seem strange, but proves to be a very effective and efficient procedure. Combination and integration of several topographical and cadastral measurements become feasible. Moreover the work can be carried out at the moment that changes in the field have taken place, so that the cadastral model is a good representation of reality.

  The file of field data is frequently used for purposes of reconstruction.

The main parts of the cadastral system which are mentioned above, form a consistent and coherent whole. Common elements of all parts and linking-pin of the system is the cadastral parcel with its unique number.

3. Present situation and developments

- The present situation of the cadastral system reflects the long history and the development of its functions. In general the situation regarding the cadastral map series reflects the original function of the map for tax-levying; the file of field measurements reflects the development of the private functions, whereas the rather new large scale topographical base map series, being the main instrument for renovation and automation, reflects the multi-functional aspects of the modern, renovated cadastre.
  As a result of the long history there are a lot of differences in form and quality in the present situation. Consistency in quality and form, however, is a main condition for renovation and automation.

- The file of field measurements is not complete. After the year 1900 a beginning was made with the systematic recording of field data. For boundaries dating before 1900, information is only available in the graphical form of the map.
  Before 1928 maps and boundary data were represented in local systems. For reconstruction of boundaries in the field this is an acceptable situation. After 1928, when the national grid system was ready for use,an attempt was made for a systematic completion. In fact this was a recadastration-concept. This ambitious concept has been left since 1975. Since that time the renovation of field data has been integrated in the updating procedure. So there is no systematic approach for the renovation of field data.
  The moment of renovation of the registration of a certain boundary is the moment which is most appropriate for the private owner, viz. the moment of change of property.

- The cadastral map
  The cadastral map is the only large scale map covering the whole country. For more than 50%, the cadastral map series still has the original (1832!) form, quality and base.
  The scale of the original maps is 1:2500 for rural areas and 1:1250 for urban areas.
  For maps which were renovated by new field measurement after 1928, the national grid system was used. The new scales were 1:2000 for rural areas and 1:1000 for urban areas. (Sometimes 1:500).
  As indicated before, the original renovation concept was a terrestrial one. From a technical point of view this was a good concept, because total renewal of both map and file of boundaries was achieved. However, the concept was too ambtious and too expensive.
  The concept was left in 1975 when priority was given to a system of graphical renovation on the base of photogrammetric base mapping.

- Large scale base map (GBKN)

The initiative for the large scale base map of the Netherlands (GBKN in Dutch acronismes) was taken in 1975 after several years of research and development.

The GBKN is a map, mostly on a 1 : 1000 scale, with the most important topographical elements. Main users are the utility services (registration of underground utilities), the local authorities (physical planning, technical administration) and the cadastral service (renovation of the old cadastral maps, land consolidation).
It is a base map, so each user has to add his own specific information. (utility information, planning information, boundary information).
Making and updating of the map is done on a self-supporting bases. For most of the projects a contract between Cadastre, local government and utility-services is made. In a many cases there is an intensive cooperation in the technical field.
Main aims of the GBKN projects are:
- basis for renovation and automation;
- standardization for a better exchange of data
- greater economy.

At 1-1-1987 for approximately 35% of the Dutch area GBKN-maps were available or under construction (see fig. 2).
After a slow start in 1975 it can now be concluded that the topographic base-mapping concept is widely accepted.

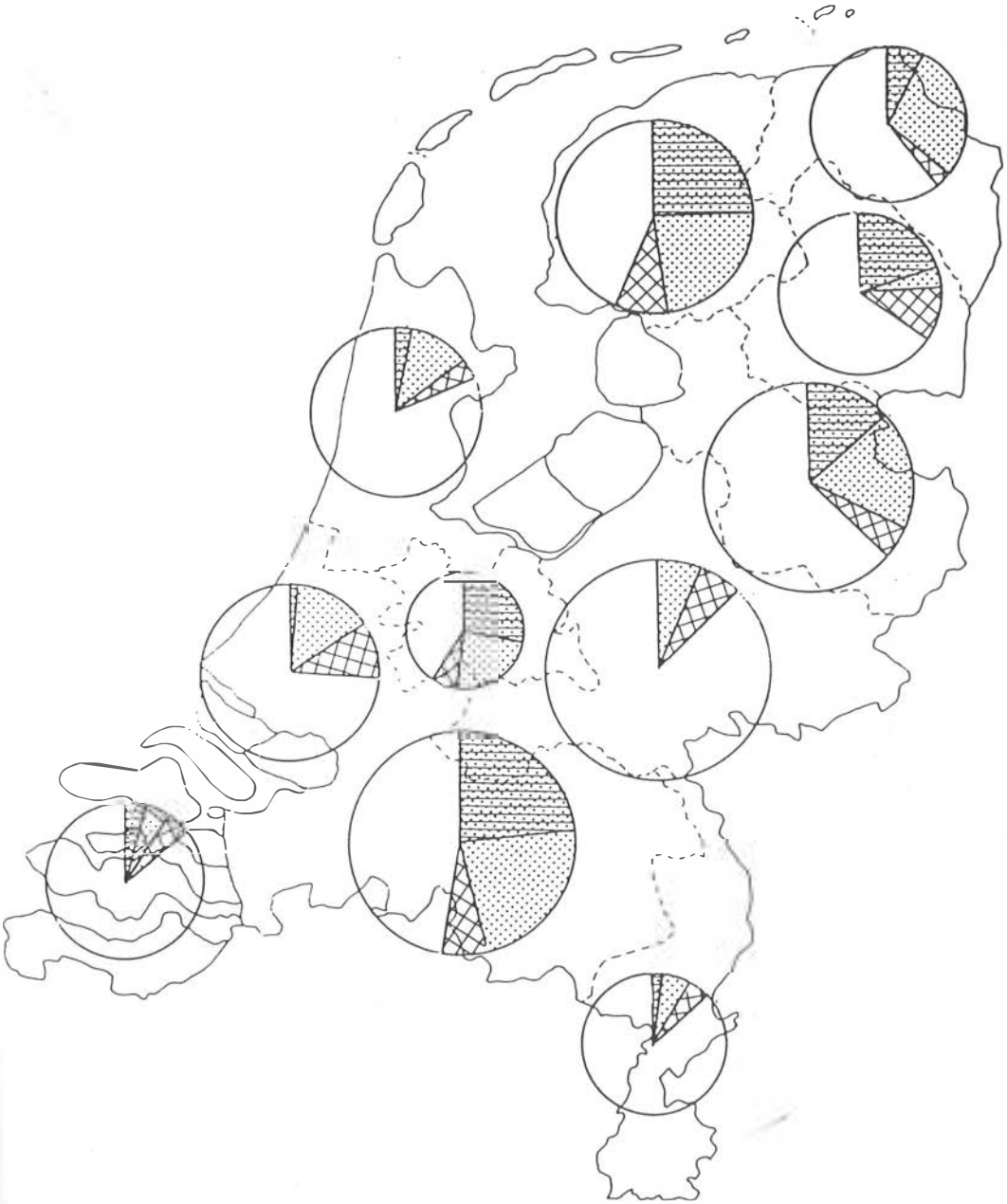
4. Principles for renovation

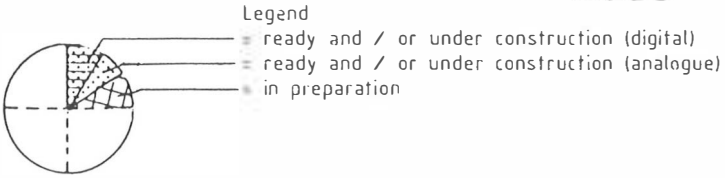
- General

Before 1975 the cadastral renovation concept was a terrestrial one and primarily focused on the renovation of the file of field data. It was an ambitious concept because it was more or less a recadastration concept with the emphasis on the private function of the system.
After 1975 the concept was changed because of the high costs and low spered of the terrestrial concept.
Main principles for the new renovation concept are:
- priority for the graphical conversion of the cadastral map series;
- integration of cadastral and topographical maps and of procedures of updating;
- renovation within a reasonable time (plan 2000);
- return of investment.

Large scale base mapping in the Netherlands

situation at 31-12-1986





- Priority for graphical conversion

Giving priority to the graphical conversion means in the first place graphical renovation of the cadastral map series.
In the old renovation policy priority was given to the renovation of the file of field data: a numerical concept. Only if we give priority to the renovation of the old cadastral maps and only if we restrict ourselves to a minimum quality concept it will be possible to bring the conversion to a favourable result within a reasonable time and at reasonable costs.
Graphical conversion does not mean a renovation of all old data at once.
Graphical conversion means conditioning for the next digital phase by placing all cadastral data on the same national datum, represented by a topographical base map.
After the graphical conversion cartographic data are more consistent, not necessarily more precise.
In the beginning there were internal objectives because graphical conversion was said to make too many concessions to quality. This opinion, however, is not correct. There are no fundamental changes in our quality concept. Only priorities are different.

- Integration of maps en procedures

This integration is necessary. It is impossible to maintain independently two large scale maps series, with strong relations and overlaps. However, there can be differences in the extent of the integration.
The most simple form of integration is the use of the base map for the graphical conversion and for the updating of topography (c.q. buildings on the cadastral map). This means integration of the coordinate systems.
A further integration can be obtained by choosing the same scales and formats.
The most consequent and consistent integration is the creation of a digital data base with boundary and topographical information.

From now on this will be our policy.
Integration of maps leads to integration of updating procedures and to the same price policy for the cadastral map and the base map.

- Renovation within a reasonable time

It is of the first importance for the Cadastral Service and for other map-users as well, to have a clear idea of the time still necessary for a complete renovation. What is a reasonable time? For a service that just celebrated its 150th anniversary time is a relative idea.
A too long renovation period affects credibility. On the other hand: the limited financial and personal means and the demand for return of investment as well make it necessary to spread the renovation over a longer period. This implies a period up to the magical year 2000 to complete the renovation for the whole country.

- Return of investment

In the Dutch cadastral service there is not a big tradition of thinking in terms of investment and return of investment. This situation is fully explainable from the historical role of the cadastral system.
The acceptance of the base map concept was an important step to a change of this situation. The base-map had to be self-supporting, so it was necessary to investigate costs and benefits of large scale mapping.
The enormous investments in cadastral renovation have to return by means of a more efficient updating procedure. Return of investment by the updating procedure can only be reached if the yearly expenses for renovation are limited to a certain percentage of the updating expenses.
Moreover priority has to be given to the areas with a high level of updating activitivies.

5. Automation, The LKI project

- General

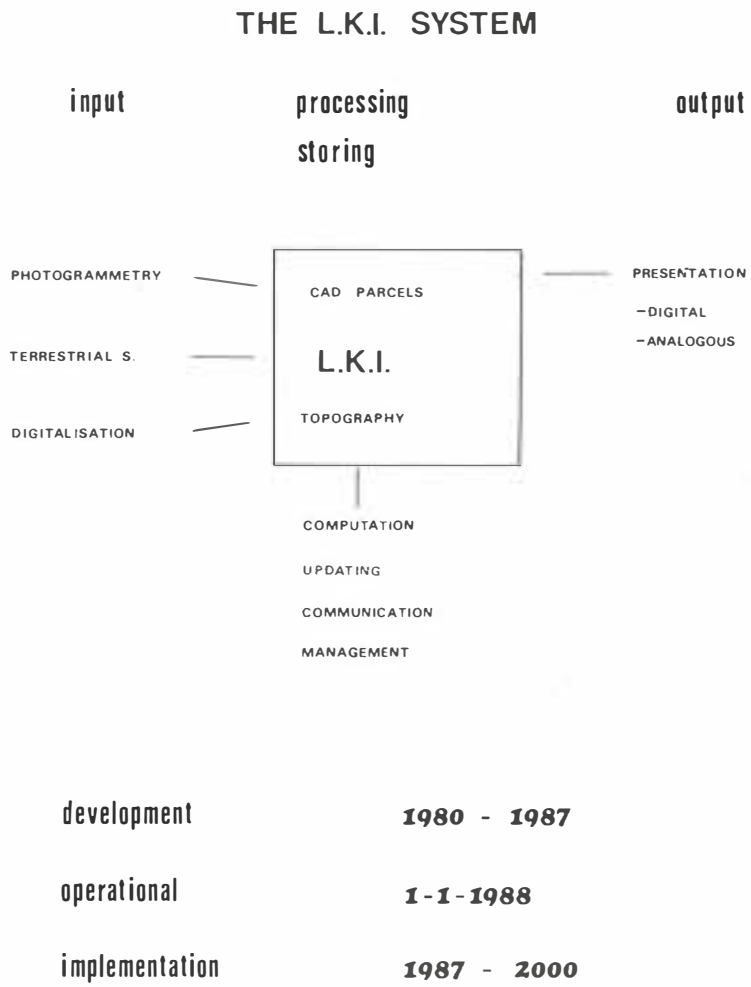
Development of automation in the technical field has already a long tradition. Since more than 25 years several systems have been developed for parts of the surveying and mapping procedure.
In 1978 a first step was made to a more integral conception. After a lot of research and several pilot studies a project proposal was accepted in 1984. It is the blueprint for the automation activities for the years 1985-1990.
In 1987 the functional and technical design was completed. We are now testing the system and will probably have the system fully operational by the end of 1987.
An extensive education and introduction programme is now being executed.

- Outline of the system

As a matter of course the principles mentioned in par. 4 are principles for the digital concept as well.
That means that the LKI system is an integrated system for both digital base mapping and updating and digital cadastral mapping and updating.
The system has a graphical base. For the time being the file of field data keeps its separate function, be it in a somewhat different form.
The general concept of the system is shown in fig. 3.

Fig. 3

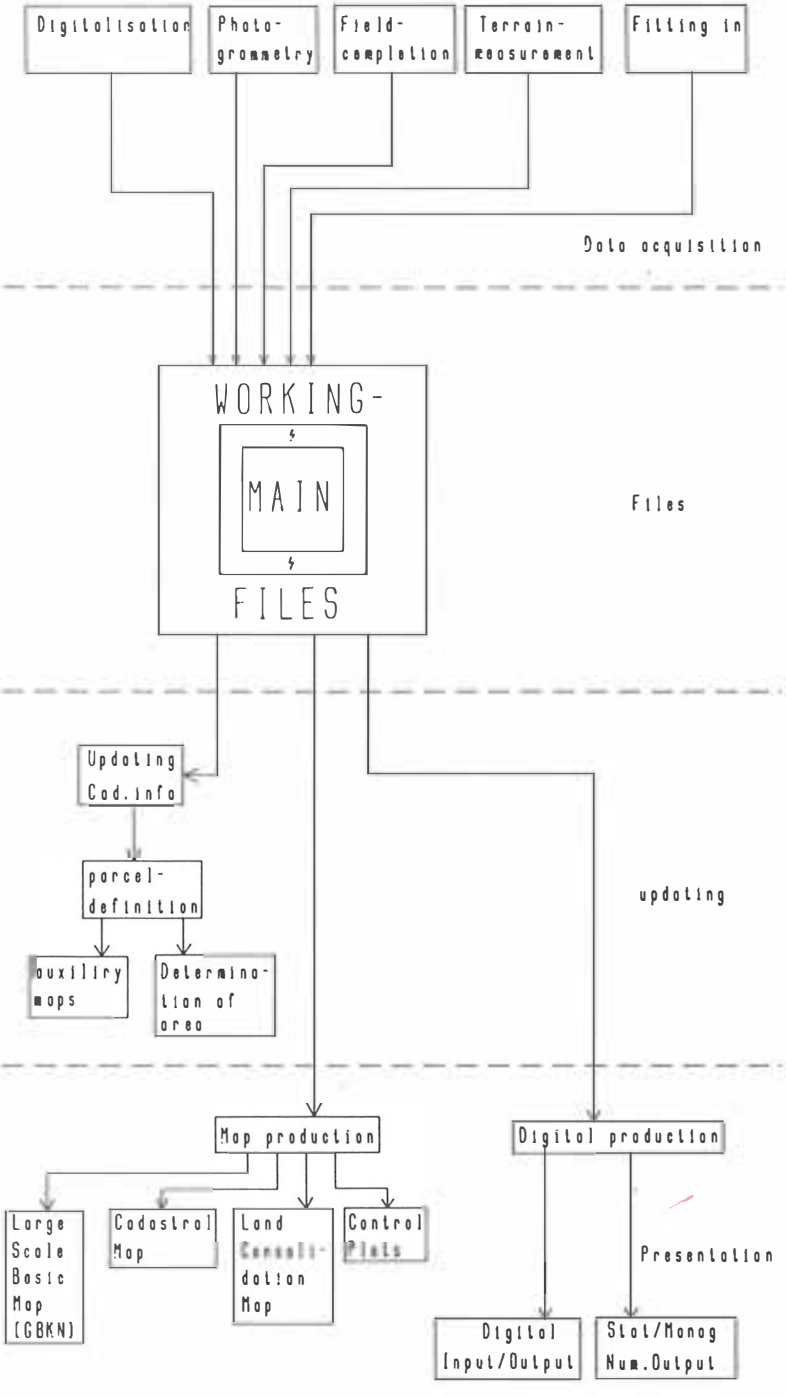
General concept of the LKI-system.



The software for the LKI system was developed in 1985-1987 and consists of the subsystems shown in fig. 4.

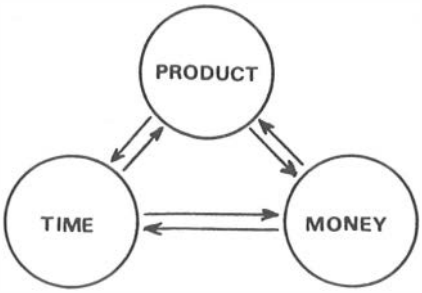
As a first step about 10% of the total activities will be done by digital procedures. In 1988 the system will be evaluated on effectiveness and efficiency.

LKI - SYSTEM


Digitalisation
Photo-grammetry
Field-completion
Terrain-measurement
Filling in
Data acquisition
WORKING-
MAIN
FILES
Files
Updating Cad.info
parcel-definition
auxiliry maps
Determination of area
updating
Map production
Digital production
Large Scale Basic Map (GBKN)
Cadastral Map
Land Consolidation Map
Control Plats
Presentation
Digital Input/Output
Stat/Manag Num.Output

6. Financial aspects, organization

The Dutch renovation concept can be seen as an attempt to optimalization. Main elements in this optimalization process are:



In view of the limited financial means, and a limited renovation period it was necessary to find out the minimal specifications for base mapping and graphical conversion.
In the years 1978-1983 a lot of investigations were made to find out the relation between map specification, characterization of the field and the costs of mapping. For more than 1000 maps the costs of mapmaking were registered systematically.
Analysis of the results gave us important information about the costs of field control, especially in built-up areas. Moreover we were able to develop algorithms for standard costs for different areas for base mapping and graphical conversion as well.

The whole base mapping programme still requires about Dfl. 400 million (= U.S. $ 200 million). This is an average of Dfl. 150 per hectare.
50% of the costs will be paid by utility services and municipalities.
The additional graphical conversion takes another Dfl. 250 million.
Roughly the whole cadastral renovation activity requires a cadastral investment of Dfl. 100,- per parcel.

Most of the work is done in large projects of 5000-10.000 ha.. The activities are carried out by the cadastral service or private contractors.
Previously to this a contract is being drawn up between cadastre, municipality and utility services, in which the financial aspects and other conditions (e.g. updating period) are laid down.
In several provinces long term arrangements for the whole area have been made.

7. Final remarks.

The Dutch renovation concept is an ambitious one. It is more than an internal cadastral mapping programme. The base mapping concept and the demand for 50% coverage of the costs requires a marketing approach.

The digital conception requires a lot of activities in the field of standardization.

The role of the surveyor is a changing one. Of course the old skills are still indispensible. But the new approach makes high demands to his ability for cooperation and communication.

Discussion after the conference of Mr Koen

Dale: You are building up a map production system, not an information system.

Koen: Before we can begin to build up a digital data base, we need a solid map-base.

Laursen: You are integrating the digital topographic map and the digital cadastral map in the same system. We split the production in Denmark.

Koen: The cadastral maps are still island maps and they are more or less administrative maps.
The topographic basemap is a more technical map and is also used by local authorities and utility companies.
We combine the two map series because they are more or less overlapping.

2nd Part

Technical Aspects

Chairman :

Prof. O. Kölbl

KEYNOTE ON TECHNICAL ASPECTS OF CADASTRAL RENOVATION

O.Kölbl
Institute of Photogrammetry
Ecole Polytechnique Fédérale de Lausanne

Summary Cadastral renovation can be subdivided in three working phases: the determination or renovation of the control point net, the renovation of the information contents of the maps and the integration of the map contents in appropriate information systems. Beside terrestrial measurements, the different photogrammetric procedures like aerotriangulation, stereoplotting and orthophotos have their importance for cadastral renovation; in nearer future also modern methods of image processing might be integrated.
The storage of the surveying information in appropriate information systems opens much greater flexibility than the use of graphical map documents as a renovation can be obtained in successive phases: in the first phase cadastral renovation could be limited to the digitalization of the old map documents controlled by simple means of photogrammetry which are later on successively improved.

1. Introduction

Cadastral renovation is currently of great actuality for many countries. Although the cadastral survey has lost to a great extent its original role as mean for equitable tax distribution, it has taken over other tasks such as the guarantee of the property in real estate and also as base map for planning purposes, and a multitude of other activities.

In this context it is interesting to realize that cadastral renovation is not only a problem of our time but similiar demands arose in much earlier times.
It is interesting to note that the construction of the railways in Europe was seldom considered as an action which would have required an integrated planning concept. Nevertheless, its impact on urbanisation was definitely as large as the impact of our modern highway net. But at that time the objectives for cadastral surveys were different.

In the past the main tool for cadastral survey, and also for topographic mapping, was the planetable. It was an efficient tool which allowed a good productivity and thorough but only graphical control. The surveys were conceived as a task in itself without planning a systematic approach for map revision. It appeared rather necessary to foresee from time to time a completely new survey. For example, it is mentioned that large parts of Western Switzerland were already surveyed at the beginning of the seventeenth century and resurveyed in the first half of the last century. Similar approaches are known from other countries.

At the beginning of this century, the planetable was gradually replaced by numerical methods. The advantages of numerical methods are the higher precision and the possibility to revise the maps without degradation in precision. The numerical methods are however much more time-consuming as numerous controls are necessary. The analyses of the data, the computation and the final plotting of the cadastral map are rather distinct working phases without any interaction. This is considerably slowing down the working progress and explains why many countries still stick to their surveys dating back to the last century.

The introduction of interactive graphic systems will change to a great extent the habits of map users and will also have influence on cadastral surveys. Up to now the graphical plan was the primary storage mean of the information and it presented the interface to all fields of application, a task which is taken over by the interactive graphic workstation. This new tool requires however technical modifications, not only for the information contents of the maps, but also for the control points and for the organization and management of the data. The technical aspects relevant for cadastral renovation can be subdivided in the following categories:

1 triangulation points and control points
2 data acquisition and renovation of the map contents
3 integration of the data in information systems, and interface with user's applications

For all these activities photogrammetric techniques can be used for data acquisition and it appeared useful to summarize the different techniques of photogrammetry in a special chapter and to treat their characteristics and their limitations.

2. Control points

A stable and permanent net of control points represents an absolute necessity for any cadastral renovation. Many of the older cadastral surveys could not be revised in an ordinary way due to the lack of proper reference points. In this context, it should be added that map revision was not foreseen in earlier times as already mentioned.

The importance of a reliable net of control points is best illustrated by the Austrian cadastre. For several years the renovation of the original survey was foreseen by successively remeasuring in case of modifications. The licensed surveyor was charged to link his measurements to a rather dense control net established in recent years. This obligation was only valid when the control points were not further away than about 100 to 300 meters. A connection over longer distances did not seem appropriate as it would require the establishment of a local control net implicating too important means for such rather modest measurements.

In this context it has to be pointed out that the absolute precision of a survey station is rather modest even with our modern tools for high precision measurements and efforts should be concentrated to guarantee a high relative precision. As an example, the new precision requirements of the Swiss Cadastral Survey can be cited. (cf table 1) This concept fixing the precision as a function of the point's distance corresponds to a great extent to the performance of modern surveying instruments, but also takes into consideration that only neighbouring points have to be reestablished with rather high precision. One has to admit that these requirements are rather severe

for photogrammetric methods but they are no real obstacle for their application.

	NT1	NT2	NT3	NT4	NT5
PFP1	7+10s	7+10s	7+10s	7+10s	7+10s
PFP2	7+20s	17+20s	17+20s	33+20s	33+20s
PFP3	$7+23\sqrt{s}$	$18+57\sqrt{s}$	$18+57\sqrt{s}$	$35+106\sqrt{s}$	$35+106\sqrt{s}$
PFT	100	200	300	400	500
PL(D)	18	35	71	141	354
PL(ND)	100	200	300	400	500
PSIT	100	200	300	400	500

(table 1)

Precision requirements (mean square error in mm for planimetry) for survey points in Switzerland according to the new concept of the reform of the official survey. (cf /1/) The precision is defined as neighbouring precision for PFP1 and PFP2 and refers to the next control point of higher order for the control points PFP3.
s is the distance in km between control points (PFP1, PFP2) or the distance to the next higher order control point for PFP3.

PFP1: triangulation points first to third order
(point fixe planimétrique catégorie 1)
PFP2: triangulation points first order
PFP3: control points determined by triangulation or polygons
PFT: topographic control points
PL(D): well defined property boundary
PL(ND): natural property boundary
PSIT: points describing the land use, isolated objects ...
NT1-5: tolerance level 1: center of large cities
2: towns, built-up area
3: agriculture terrain, high value
4: agriculture terrain, low value
5: alps, high mountain region

3. Renovation of the information contents of the maps

No doubt that the renovation of the information contents of the cadastral maps has to be considered as the central part of cadastral renovation. In this respect, it might be useful to distinguish between the geometric information of a map and its semantic information. The geometric precision is defined by the original survey method but not to forget the methods applied for map revision; in this respect, the precision of the control points and the stability of the information carrier have also to be taken into consideration. On the other side the semantic information is given by the legend of the map but also by the more or less consequent map revisions. As already mentioned

earlier, one should take into consideration that it is mainly the map revision that has contributed largely to the degradation of the map contents, not to say that much too often great parts of the map contents were not revised. Concerning these cases, the cadastral renovation will have to concentrate on an appropriate revision, or preferably, a completely new survey should be made when too many changes have occured meanwhile.

In the case of periodic revisions, it is feasible to foresee appropriate geometric transformations based on a reliable control net for renovation. In this case it is assumed that the inner precision of the original plans and the successive operations of revisions were performed with the required precision. The transformation into a numerical cadastre requires nevertheless a geometric transformation of the map contents. These geometric considerations are of particular importance in countries with a legal cadastre and high requirements for precision and reliability. In Switzerland for example, about only 30% of the area is covered by a semi-numeric or even graphic cadastral survey only provisionally recognized. These documents are regularly revised and the question is whether these documents can be the basis for a regular survey or whether completely new measurements have to be undertaken. The Photogrammetric Institute currently tests the possibility to use photogrammetric methods for cadastral renovation for the urban area of the town of Neuchâtel. In this particular case, the question to be answered is whether the actual precision requirements are met by the old map documents after appropriate transformations sustained by photogrammetric or terrestrial measurements. A more detailed report on this work will be given in a later conference. However, it appears that it is hardly possible to obtain the currently applied tolerances for boundary measurements. On the other hand, it seems appropriate to keep the descriptive elements as for example buildings and street borders. This information could be simply digitized and transformed into the new plan documents.

This short survey shows that the information contents of cadastral surveys has different aspects, and that it is impossible to give a unique answer to the question "how to renovate the information contents of cadastral maps?"

4. The challenge of land information systems

In the last years a considerable number of cities, districts and also whole countries have made great efforts in order to build up land information systems. One of the most important reasons for these efforts is primarily, besides planning tasks, the requirements concerning underground cadastre.

It is significant that the establishment of land information systems proceeds much quicker in countries without great tradition in cadastral services than in countries with a solid base for this type of measurements. At first glance, this appears paradoxical, but this phenomenom is closely related with the structure of the survey services. In countries with modest public services, the different map users - especially the industrial services - started very early to produce their own maps. In other countries such as Switzerland, these services normally use the documents of the cadastral service. The necessity to use modern information systems for planning and the exploitation of the infrastructure should not be underestimated. Therefore, it seems necessary that cadastral services also take into consideration these aspects and concentrate with high priority on the creation of information systems. Nevertheless, these requirements lead

to a certain dilemma as renovation or remeasurements might require years, even decennies whereas these services are requiring a quick establishment of appropriate information systems.

From this point of view, the cadastral renovation could be urged to look for intermediate solutions such as digitizing the cadastral maps and foresee - only in a second phase - a thorough renovation or remeasurement of the existing survey data. It is clear that such an intermediate solution could create a number of technical and political problems but might better satisfy the different requirements, compared to postponing the introduction of information systems and wait until the data can be supplied with the desired precision. In this context, it should not be forgotten that precision requirements of many map users are much lower than those necessary for the guarantee of the property, the predominant task of cadastral services in many countries.

From this point of view, the demand in information systems might be a real challenge for cadastral surveys and could widen up considerably the field of application. It is evident that the handling of an information system requires much more know-how and more training than it was necessary up to now when using the graphical plans. Consequently, many users will be more ready to collaborate with survey specialists provided that these instances be ready to create the necessary infrastructure. The introduction of information systems could therefore be a real challenge for our profession, should the tools be delivered in time.

5. Photogrammetric procedures for cadastral renovation

The previous chapters pointed out the different working phases for cadastral renovation, without trying to treat in a more systematic way the possible technical approaches. It is understood that a multitude of technical approaches for these different tasks should be analysed, but according to the objectives of the workshop, we preferably intend to treat the photogrammetric techniques. The different technical aspects of photogrammetry which might play a role for cadastral renovation could be summed up as follows:

1. aerotriangulation
2. stereoplotting supported by methods of superimposition and interaction with land information systems
3. orthophotos
4. image processing and landscape modelling

5.1. Aerotriangulation for cadastral surveys

The development of procedures for bundle adjustment with additional parameters, supplies a tool for high precision measurements that could satisfy most of the requirements needed for cadastral surveys. A number of speakers will report more in detail their experiences with this technique. The precision that can be obtained by this technique is of the order of ± 5 µm in the picture scale provided that the measuring process be severely controlled and that the control points supply an adequate precision.

The use of analytical plotters has considerably accelerated the measuring process and appropriate control operations during the measuring phase allow to reduce the number of cross errors. Nevertheless, it should be pointed out that the indicated precision

should only be considered as a reference value and it might be possible that different offices or survey organizations obtain considerably higher or lower precisions, depending on the technique applied. Limitations of precision might be due to the measuring instruments, the quality of point signalisation, care for film handling, and several other factors. Moreover, several organizations have not yet transfered their procedures from independent model triangulation to bundle adjustment.

Although photogrammetric control point densification and point determination might be very useful in open areas, it can be severely hampered in areas with a dense vegetation cover. The progress in terrestrial measurements, in automatic distance measurement and in automatic registration have considerably increased the productivity and a careful case to case analysis will be necessary whether photogrammetric or terrestrial point determination should be given preference. It is understood that this evaluation should not only concentrate on the operations for point determination but should also include all succeeding operations. Photogrammetric techniques require rather considerable initial investigations, such as signalisation and flight operations. As soon as the aerial photographs are available, all subsequent operations including plotting of details and eventually the derivation of a digital terrain model will need rather modest efforts.

In Switzerland, current instructions are worked out for fourth order triangulation and polygonation by photogrammetric means; from the technical point of view they are on the same level as the terrestrial methods: in this case, the one and only influence in the choice of a procedure remains the economical aspect.

5.2. Stereoplotting

The efficiency of stereoplotting for large and medium scale maps has never been questioned. Moreover the photogrammetric technique took advantage of the recent progresses in digital plotting. In earlier times, the operator produced a map manuscript on the stereoplotter which later on had to be redrawn, a phase which allowed to include the information from field verification and field completion. For digital plotting, the operator stores directly the graphical map information in a numerical way. A number of software facilities assist the operator in this working phase; the fair drawing will take place on a precision plotter but beforehand the map will be controlled and the data of field completion have to be incorporated in an interactive editing station.

The procedure as described before is mainly focused on new measurements. The superimposition of elements of map information onto the aerial photograph should largely facilitate the revision of the map information and the interaction with land information systems. The first instrument which allowed superimposition was the development of Intergraph. This company had used a high performance screen to show the map information available in digital form, and then introduced this image into the optical path of a stereoplotter. In its first version it used a black and white screen and the coincidences between photograph and drawing were rather rough due to considerable time delays and only approximate geometric transformations. Later on, Intergraph developed a new system including a special analytical plotter with a much better performance; the screen is now conceived to represent the map in colour.

At the 1984 Congress of Photogrammetry in Rio, Zeiss presented its new Videomap system which allows stereosuperimposition for the Planicomp family and the Zeiss plotters. In automn 1986 Wild presented its new interactive graphic station incorporated in an analytical plotter with stereosuperimposition (Wild S9-AP). The Institute of Photogrammetry of the Ecole Polytechnique Federale de Lausanne had developed the superimposition system in stereo; stereosuperimposition requires a much higher performance as far as image panning and image quality are concerned; it is however the only way to allow a thorough geometric control of the digital map information related to aerial photographs. It can be expected that these instruments will give a great challenge for the use of photogrammetry in cadastral renovation; it is however too early to evaluate their impact more in details. Most experiences with superimposition systems have been made in Denmark with very positive results, but it appears that development is still going on.

5.3 Orthophotos

To a certain extent, orthophotos play a double role. They can be used as a mean for data acquisition similar to that described for the superimposition, but they also present a final product which is easy to read and very illustrative. The possibilities for data acquisition with orthophotos are nevertheless rather limited as for their precision. Furthermore, it should not be forgotten that the precision of orthophotos depends on the precision of the digital terrain model and in any case the built-up area will not be orthogonalized. That means that houses are not erected and that the roof will be displaced with respect to the base of the house, in the same way as in enlargements of aerial photographs. It depends therefore to a great extent on the precision requirements, whether orthophotos should be used for primary data aquisition or if preference should be given to stereoplotting.

On the other hand, it seems that the illustrative character of the orthophotos cannot be overestimated. Whereas a linemap remains abstract, and will only give the information which the surveyor has decided to represent, the orthophoto gives many more details and allows the user to abstract the information he actually needs. It is therefore a very good document for various applications, which can also considerably reduce the map information which has to be surveyed. In Switzerland, it was possible to concentrate on the mapping of the border limits of real estate in a large project of cadastral survey whereas vegetation boundaries and street boundaries were only presented with the help of the orthophotos for cadastral renovation. A considerable number of countries make extensive use of orthophotos and the subject will be treated more in detail in other papers.

5.4 Landscape modelling

Although orthophotos are an efficient mean for the presentation of the landscape, it is very often wished to have more information and especially more flexibility for the presentation of the scene. Modern techniques of automatic image processing do allow to go much further than the elaboration of map documents. The various efforts in automatic image correlation allows to assume that this task will be completetly automatized in the nearer future. In that case, it would not be any more necessary to limit the process of digitisation to the ground, but houses and vegetation cover should also be included in the elevation model. This approach would then allow to include terrestrial

photographs into that process and finally one could arrive at a holographic presentation of the scene, including views of terrestrial standpoints.

Such an integrated approach would also allow to use terrestrial photographs of the boundary marks in order to identify and measure them on the corresponding aerial photographs; it could also help to reduce the efforts for signalisation. Presently, the Institute of Photogrammetry is studying this possibility for the determination of the underground cadastre. In this way, digital image processing should open completely new ways for the acquisition of information, and especially for the presentation of the information. From this point of view and in the context of cadastral survey, I would like to pretend that we are rather beginning to evaluate the use of photogrammetry than on the end of the development phase.

6. Conclusions

The requirements for a modern large scale cadastral survey have considerably changed in the last decade, also for the technical aspects. A few years ago, the graphical plan still represented the final product of survey measurements, whereas today many users turned over to numerical approaches, and want these data in an appropriate land information system. Therefore, in the near future, we will mainly deal with the appropriate management of the data in data banks or even in more refined management systems as they should come up with the fifth generation of computers and the progresses in expert systems. The graphical plan or map will still be necessary, but will be one of several output forms without requiring any more the high standart of many actual map products.

The role of the fifth generation of computers and the possible impact of artificial intelligence are not discussed in the different papers of that workshop. It seems that this subject is of more interest to various engineering enterprises and users of computer aided design. Nevertheless this development should not make obsolete the efforts presently undertaken in transforming the classical cadastre in a modern information system but should rather easen the management of our data. Most of the papers for this session demonstrate the recent efforts in cadastral renovation and it can be hoped that in one or two decades most of these projects will be completed.

Of course completion is always a great word in mapping activities and it is evident that also the revision of the information has to be taken into consideration in a modern survey system. But otherwise than in earlier time map revision is seen today as an integral part of routine survey activities. In Switzerland it is planned to use systematically photogrammetric flights for the revision of natural objects, and the digital terrain model whereas the control points and boundaries should be revised by terrestrial survey methods. It can be hoped that such a concept will avoid the problems of the existing system and guarantee that the map information remains up to date not only for the legal aspects, but also for the descriptive elements as vegetation limits, houses....

Literature

/1/ Réforme de la mensuration officielle REMO
Direction fédérale des mesurations cadastrales
Département fédéral de justice et police
mai 1987

A CONCEPT FOR THE RENOVATION OF THE DANISH CADASTRAL MAPS.

Jonna Hvidegaard, Ph.D.
Matrikeldirektoratet, Copenhagen

Summary In Denmark a project is started to renew the cadastral maps and convert them to digital form. Some of the problems, connected to the fact that the maps are up to 200 years old, are pointed out. The tools for the renovation are ortophotos in the scale 1:4000, measurements from the updating procedure, re-coordinated reference points and the existing maps. The actual conversion to digital form will be done on a CAD/CAM system. The role of the cadastral maps in a Land Information System is mentioned.

Introduction

When you work with renovation of the cadastre and conversion of the cadastral map to digital form the history of the existing maps and other cadastral documents are always of interest.

If the history is very short or non existing you may be able to start from scratch and build up an entirely new system. But if the history is long - which is very often the case when you look upon european countries, and most certainly in the case of Denmark - there are lots of things to take into consideration, and also a lot of materials to use in building up the new system.

I will not go into details about the history of the Danish cadastre as you have already heard about that from a previous speaker. I only want to point out that the Danish cadastral system has been in function for more than hundred years and is still serving its main purpose, which is to registrate land. In fact if you look at that one purpose only the need to change the system would not be very urgent.

The needs, which we most certainly feel, stems from the wishes to use the cadastre, and especially the cadastral maps, for other purposes as well. Here of course we move towards LIS, which I will return to later in this paper.

Content of the cadastre

Then what does the Danish cadastre consist of? And which materials and documents are of interest in this connection?

We have the register itself which has recently been convertet to EDP, and has been in full use for a year. The main content of the register is the parcel numbers and areas and some obligations mainly concerning farming. You will see that we do not file the name of the owner. The number of parcels in the register is 2,5 mill.

Beside the register we have the measurement sheets, where the surveyor has shown the measurements he has carried out to make a specific change of boundary. An example of a measurement sheet is shown in fig. 1.

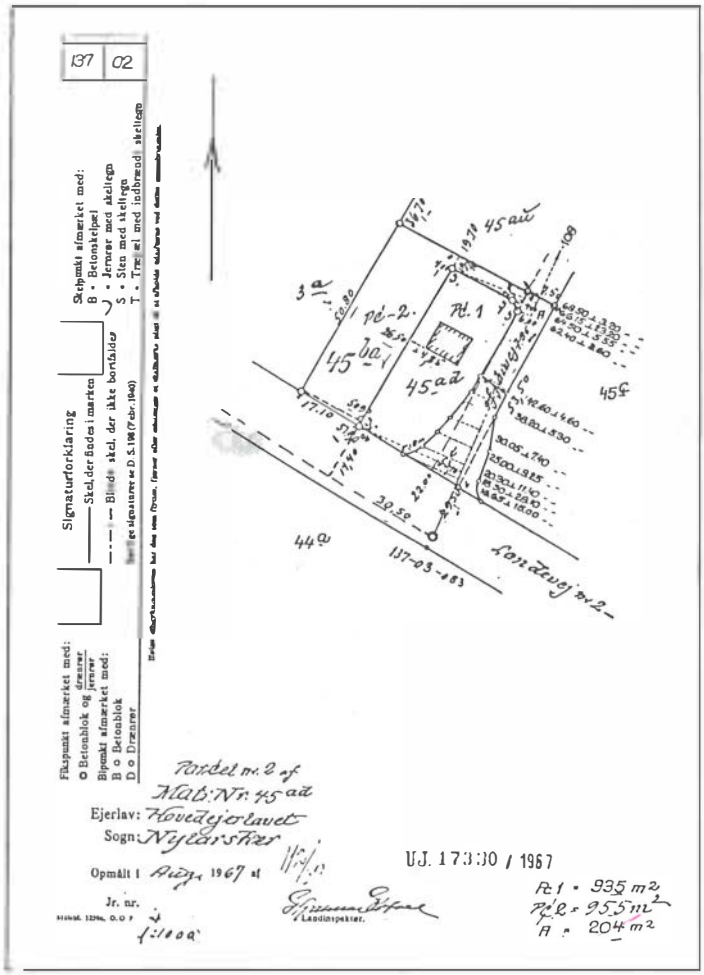


Fig. 1 Measurement - sheet

We do not know exactly how many measurement sheets we have in the archives but we estimate it to approx. 1 mill.

Finally the most important document in this connection: the cadastral map. The country is covered by approx. 15.000 map sheets.

The register and the maps cover the whole country and are updated currently every day with changes approved on.

The main part of the map sheets are in scale 1:4000, a smaller amount especially in urban areas are in larger scales, 1:2000, 1:1000 and 1:800.

The main part of the maps are so-called island-maps.

Island maps are well known also outside Denmark so I will only very shortly present them in order to point out some difficulties that arise when you want to use these maps as fundamental maps in LIS.

The maps have been measured and constructed in smaller parts on tables directly in the field.

The parts have been stuck together to form the map of a village or manor.

The problems arising from this are

1) The shrinkage of the maps is not uniform due to the smaller parts it consists of. A more uniform shrinkage adds on as the map, due to wear, are redrawn several times during the years. It has to be noticed that the oldest maps still in use were measured 200 years ago.

2) The edges of a map very often does not fit the edges of the neighbouring maps due to different definition of the border and also sometimes due to changes in the field in the time between the measurements of the two maps.

3) The maps are not connected to a common reference system, and the changes of the boundaries, with which the maps have been currently updated, have been fitted to the existing boundaries on the map and not to the reference system. In fact even the reference points have been fitted into the map via measurements to existing boundaries.

This was some of the basic problems that arise from the map alone. There are other problems which turn up when you start working on the map. There may be problems when you relate the maps to the measurements, you may get two measurements which do not give the same result and maybe the situation in the field does not fit the measurements and/or the maps.

Some of these problems have been mentioned by a previous speaker and some of them I will return to.

An other important faktor is the content of the maps. How many things do we register on the map?.

Fig 2. shows an example of a new cadastral map. The content has changed somewhat during the years always making the map more sparse. For instance no houses are shown on the map today.

Background for the plan to modernize the cadastral maps.

In the years since the cadastral maps were originally measured new maps have been measured and constructed. This has mainly been the case in the surburban areas of the larger towns. However essential these new maps were, they all together only cover a few percentages of the total area of the country, and they were quite expensive to produce.

As the need for maps related to the reference system grew, we started to search for other and cheaper ways to produce these maps.

Two projects, which we carried out, are of special interest in this connection

1) the Bornholm project and
2) the digitizing project.

The first, the Bornholm project, was to investigate the use of ortophotos for the rectification of the cadastral maps, and the second was to find out which use could be made of CAD/CAM for the production of cadastral maps.

To cut it short, both projects were a success, and gave the input to form a plan for modernizing the cadastral maps of the whole country.

How are the new cadastral maps produced?

The idea behind the production of the new maps is not only to create a digital map.

The problems mentioned earlier concerning the maps have to be solved. First of all the maps have to be related to the reference system. In order to do this first of all the reference points and the measurements related to the reference system are constructed to form the skeleton of the new map. Especially the measurement-sheets covering roads and larger subdivisions are interesting in this connection. The interior of the "skeleton", where there either are no measurements or where it will be too time consuming to use the measurements available, is digitized from the existing maps.

It is especially in the process of fitting these digitized parts, the ortophoto comes into use.

More generally the ortophoto is of course used to give information from the field whenever there is a problem to be solved.

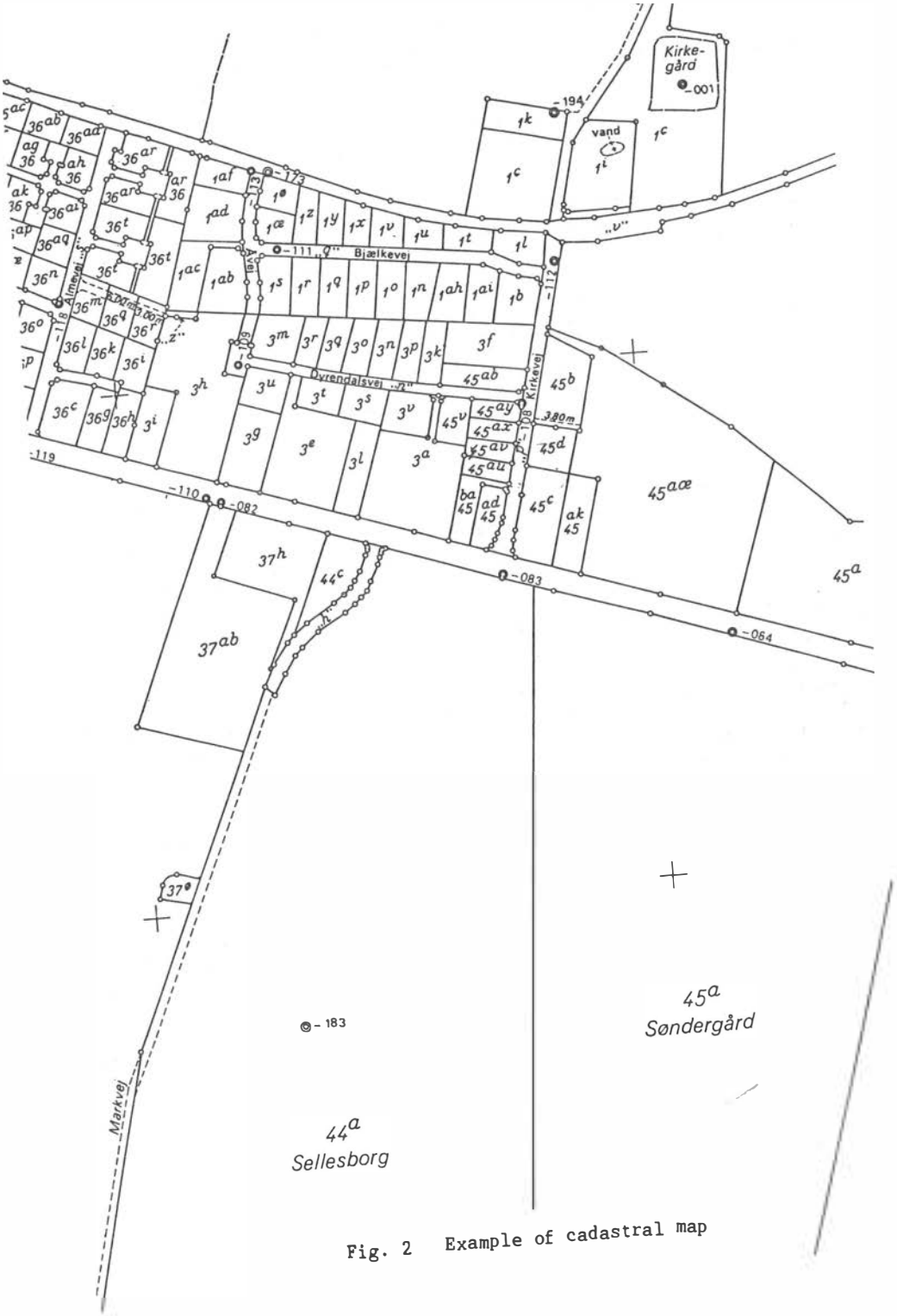


Fig. 2 Example of cadastral map

The building up of the digital map is illustrated in fig. 3a and 3b.

The updating procedure in the digital map will be different from the one used today.

In the current procedure new measurements are fitted into the map via the existing boundaries which may damage the accuracy af the new parcel.

In the new and rectified map it is the intension to keep the new measurements and fit the existing boundaries on the map to the new parcel. Here of course you will have to take care that the new measurement is the better one.

In this way the map will get more and more accurate, where the old procedure gradually spoils the accuracy.

Of course these are only the principal ideas. As mentioned by one of the previous speakers there are a lot of problems to be solved in this connection, especially concerning the legal aspects.

The maps have always been strongly related to the measurements and although many of the new customers will use the maps alone, the measurements are still very importent for cadastral and legal use.
Therefore the new maps are build up on the CAD/CAM - system in a way that keeps the relation to the measurements used in the process. In other words you can call the original measurements from the map on your work station.

Status for the modernizing project.

Just before christmas 1985 we got the financial possibility to start building up digital cadastral maps. We got a loan from the government which we will have to pay back via the income we expect to get from selling the digital maps and the ortophotos. As a first phase we will cover the island of Fyn (approx. 10% of Denmark) in 4 years. After that period we will ask for a loan for the rest of the country.

It is estimated that the whole project will cost approx. 700 mill Danish crowns.

For the first phase of 4 years the loan is 77 mill. crowns.

In the past 1 1/2 year we have started renewing the reference system on Fyn and we have covered half of the island with ortophotos. I will not go further into that subject, as someone else is covering it here in this work-shop.

Concerning the digital maps we have made specifications and have performed an evaluation of CAD/CAM systems available, to find the one which would in the best way fulfil our needs. One of the things we wanted from the system was that it would be possible to show the ortophoto on the screen as a raster background simultaneous with building up the digital map as vectors on top of it.

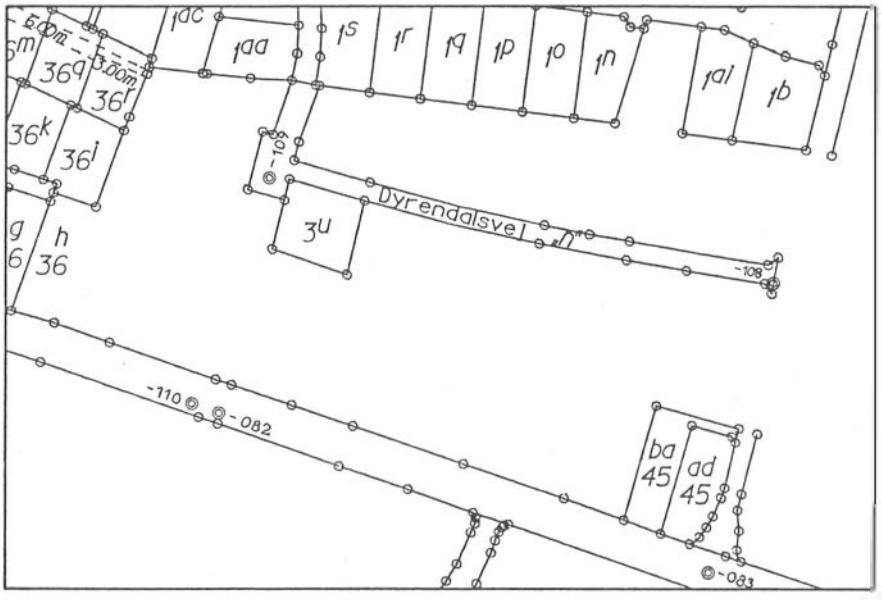


Fig. 3a Skeleton map

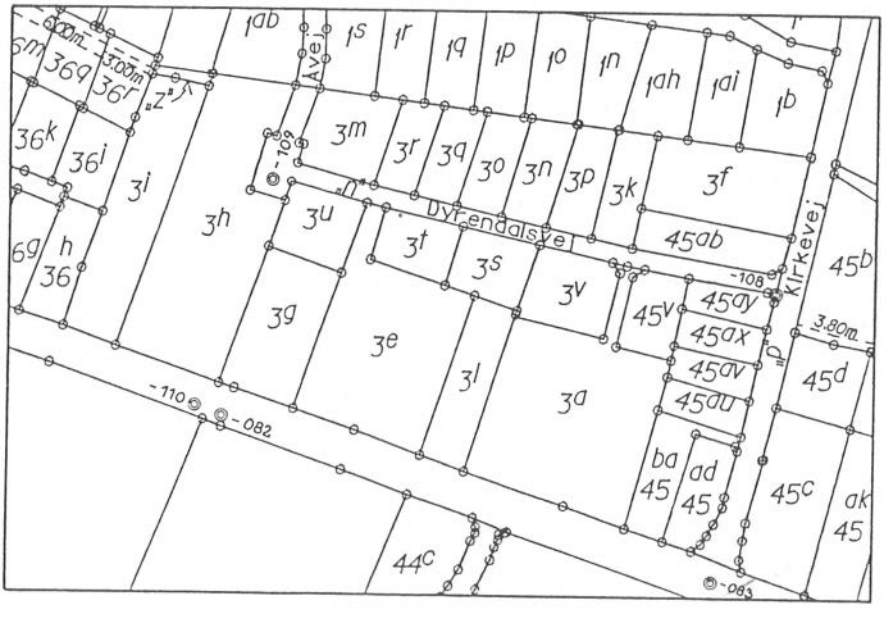


Fig. 3b The cadastral map after fitting in the digitized parts

That showed to be a rather sophisticated need, which only a few systems could fulfil.

Last month we signed a contract with the firm Intergraph, to buy hardware, standard software and special developed software for a total sum of 27 mill. Danish crowns. To this you have to add that we are programming 1/3 of the special developed software ourselves first of all to get sufficient influence on and knowledge of the system.

Fig. 4. shows the hardware of the system. It is based on a Vax 8530 cpu, 12 work-stations, a heigh performance scanner, discs, plotters etc.

The system is to be installed in november this year.

To work with the system we have a group of 5 persons to do the development, the programming and to run the system,
another group of 5 persons to currently user-test the programs as they are developed and to instruct and assist the persons who are doing the actual conversion of the maps,
and finally 4 groups of 5 persons each to do the conversion.

When a sufficient large area, for instance a municipality, has been converted the maps will be transferred to another department of the house for updating.

Connection to LIS

Of course we see the new cadastral map as part of a Land Information System.

The work, to relate the maps to the reference system, is essential in that connection as it gives the possibility to combine the cadastral map with other maps related to the same reference system.

The cadastral map is very sparse as shown earlier but it is a theme which is very interesting for municipalities, government offices, owners of pipes and cabels etc. for planning, registration and administrative work.

If you take a municipality as an example you will in most build-up areas of a reasonable size find what we call "technical maps" made for and paid by the municipality. They are, almost as a standard, produced by photogrammetry in the scale 1:1000 and show the houses, hedges and fences, roads, pavements etc. and technical installations for water, sewerage, electricity and so on to the extent it can be identified in the photos.

Already in the analogue world the cadastral theme is very much asked for to give information of the legal boundaries, which are not necessarily identical to the hedges and fences.

The "technical maps" are to a growing extent not only produced but also used in digital form, and therefore the municipalities want the cadastral map in digital form as well.

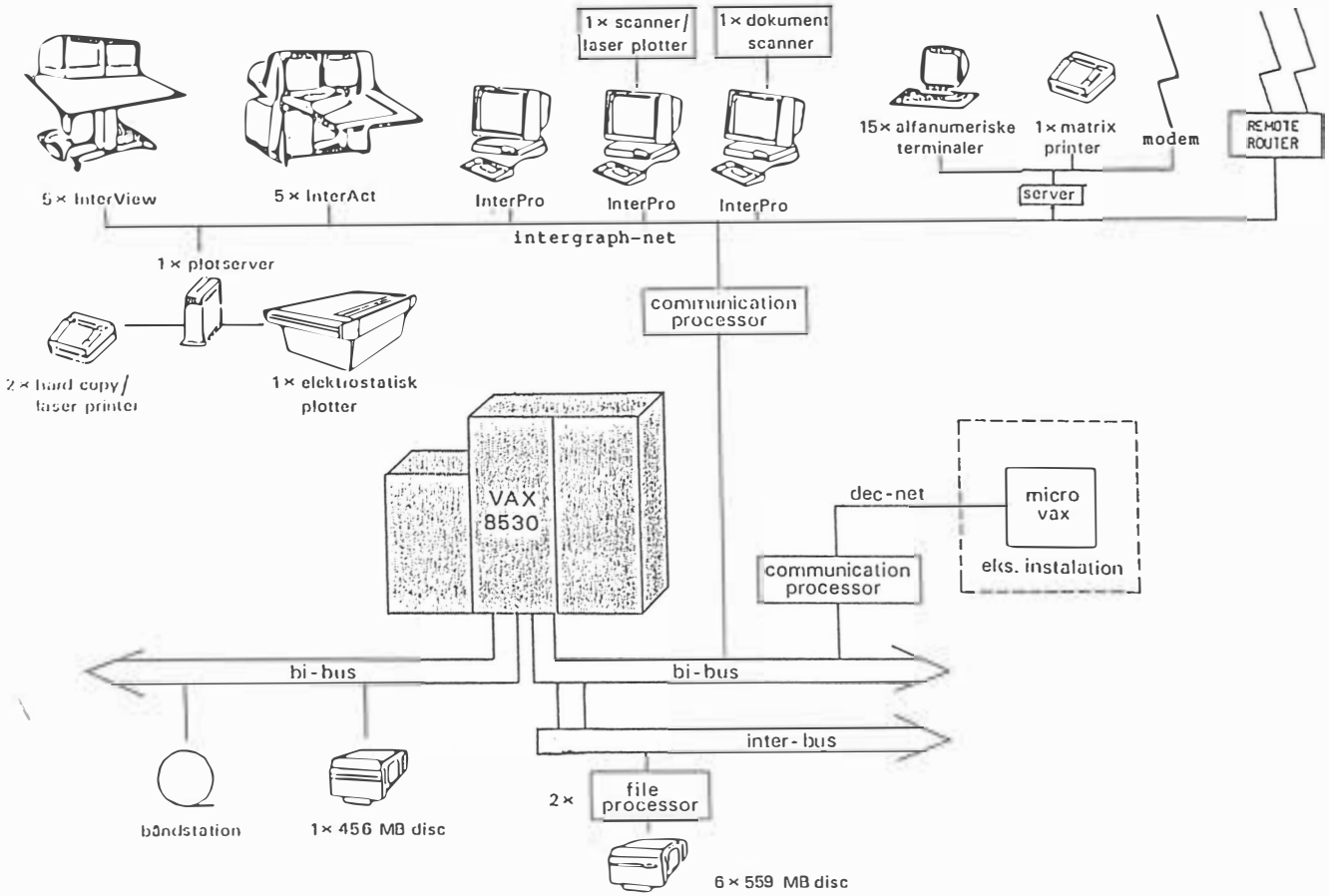


Fig. 4 Sketch of the system hardware

But of course it is not only a question of map themes. An even larger field opens when you look at registers. In Denmark we have several official registers on EDP today. We have registers concerning buildings, persons, taxes, firms and factories and others. Most of these registers, if not all, have the parcel numbers from the cadastre as a key. This means that you can show the contents of the registers on the cadastral map. To this you can add that the only one of the large official registers that has a map connected to it, is the cadastre, and that the cadastral map is the only map covering the whole country in large scale.

This gives the perspective and the possibilities for the cadastral map in digital form as illustrated in fig. 5.

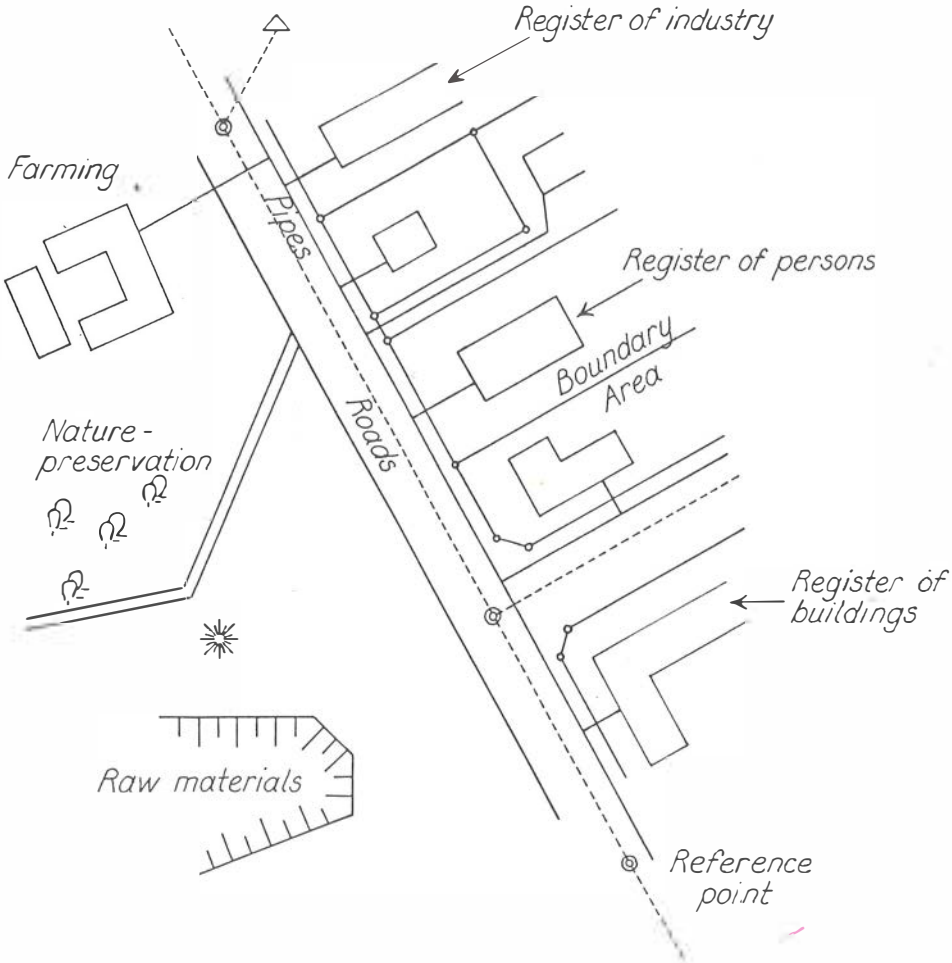


Fig. 5 Land Information System

This is also a reason why we are confident that we will be able to earn the money necessary to pay for the conversion of the maps to digital form - as I mentioned earlier our financial foundation is a loan from the government.

Copenhagen
august 1987

Discussion after the conference of Mrs. Hvidegaard

Jerie: Actually you have 3 sets of data; what is their legal status ?

Hvidegaard: We do not change the legal status, the boundaries are defined in the "old manner" with the help of a private licensed surveyor even if the base will be digital.

Jerie: Did anybody ever try to make a combined adjustment ?

Hvidegaard: We had the idea at the beginning, but it was too expensive.

Jerie: What kind of accuracy do you guarantee by your process ?

Hvidegaard: We do not guarantee any accuracy, not even for fix points. But after renovation of the fix points we have an idea of their accuracy. We think it is better to say this information was digitized and that one comes from a measurement, rather than giving a figure for the accuracy.

Chevallier: It is not clear that the costs for a completely new survey will be higher than what you spent on trying to fit and adjust the old measurements in a certain model.

Jerie: A new survey will not solve the problem. Cadastre has not only a technical aspect, it can also have a juridical aspect. An owner might ask the judge to go back to the original situation which constituted his right.

Dale: What happens to the old information ? Are you keeping it ?

Hvidegaard: We keep all material. Sometimes we have to look back at the boundary's history. We would like to put the measurement sheets in digital form to facilitate the search. The pictures will then be stored as raster-pictures.

Enemark: We are not changing any legal rights by doing a digital cadastre, so we have to keep all measurement sheets.

Tegeler: What is the use of those measurements if you have lost your reference points on the ground ?

Hvidegaard: This is the daily problem for the private surveyors. They have to take whatever they can to find out where the boundaries should be.
At the moment, it is difficult to produce good digital orthophotos with the available equipment. We decided to produce analogous orthophotos because we need them in the process but also because we can eventually sell them. We know that it is an intermediate solution to scan the orthophotos. In the future, we may get these scanned data in another way.

Koecher: In which form are you storing and consulting the scanned data ?

Hvidegaard: The measurement sheets will be scanned on a document scanner and stored on optical disks. The digital orthophotos will also be stored on optical disks in the future.

EXCHANGE OF INFORMATION ON DIGITAL CADASTRAL MAPS

Vagn W. Laursen

Scankort I/S, Denmark

Summary

Cadastral information is a key to combine information from a variety of public and private registers. Information from the parcel register and the cadastral map will be transferred between the Danish National Cadastre and these other registers and for that purpose an exchange format is needed. This paper describes the development in digital mapping which has lead to a commonly accepted standard for exchange of digital map information including cadastral information. Some special subjects concerning cadastral information are described and finally the future developments towards Land Information Systems are briefly mentioned.

Zusammenfassung

Katasterinformation ist eine Möglichkeit, Information von zahlreichen öffentlichen und privaten Registern zu verknüpfen. Information von dem Parzellenregister und der Katasterkarte wird zwischen dem Dänischen Nationalen Kataster und diesen anderen Registern übermittelt werden. Zu diesem Zweck ist ein Austauschformat erforderlich. Dieser Bericht beschreibt die Entwicklung der digitalen Kartierung, die sich zu einem allgemein anerkannten Standard für den Austausch von digitaler Karteninformation - den Katastersektor mit eingeschlossen entwickelt hat. Einige spezielle Themen bezüglich Katasterinformation werden behandelt und schliesslich werden noch die zukünftigen Entwicklungen in Richtung Land Informations Systeme kurz erwähnt.

1. INTRODUCTION

Cadastral information plays an important role in connection with planning and administration of our modern society being a key to combine information from a lot of different sources.

As a result of the fast development within the mapping branch, where a rapidly growing number of our maps are produced in digital form and the administration registers are or are going to be computerized, the demand for changing the cadastral system to digital form is strong. The parcel number, which is the identification of the smallest unit of land in the parcel register, is an important key to other registers.

In order to get all these registers to cooperate it will, for years to come, be necessary to be able to transfer information between these registers. The subject of this paper is exchange of digital information with special emphasis upon cadastral information.

To enlighten the background for the relevance of this subject, I will summarize the development in the mapping branch regarding digital mapping as this process has been going on for the last 5 to 6 zears. Among other things this development has lead to an exchange format for digital map information produced by the Danish Society for Photogrammetry and Landsurveying (Dansk Selskab for Fotogrammetri og Landmåling, DSFL).

The cadastral system and its interaction with private chartered surveyors and public and private registers is described with focus on the need for exchange of digital information.

This leads to the establishment of Land Information Systems (LIS). The opinion of the author is that these already exists as local, non-integrated registers built up by local goverments and utility authorities. The limitations in their use are mainly a result of the difficulties in exchanging information between them.

Exchange of digital cadastral information in a standardized way will be a big step towards realization of a more integrated LIS.

Allow me the freedom in this paper to mix the present day situation with a little bit of the plans for tomorrow. Sometimes changes happen so fast in this business that it is difficult to keep things apart.

2. THE DEVELOPMENT IN DIGITAL MAPPING IN DENMARK

Digital mapping was introduced in Denmark relatively early. The private mapping sector changed from analog to digital mapping as early as in 1981.

This development was a result of the natural gas companies requiring digital maps as the basis for their planning, design and administration of a new nationwide natural gas distribution network.

The existing large scale maps managed by the municipalities were examined at the beginning of the project. Most of them were outdated, of non-uniform standard and only covering the area of interest to a limited extent.

This took place in the beginning of 198o'-ties. At the same time the development of Interactive Graphic Systems had reached a point where they could be adapted to organizations like the natural gas companies. This especially interested the new organizations because they had no previous records of pipe information adapted to old analog maps. It was obvious to use the latest computerbased technology for the purpose of building up a basemap for planning, design and administration, relate all registration of the gas pipes to this basemap and mix it all in an Interactive Graphic System.

The decision made by the gas companies to go into digital mapping forced the private map producing firms into developing a completely new methodology for map production.

My firm - Scankort - bought the first analytical plotter in 1981. It was a Zeiss Planicomp C-100, a DZ-7 drawing table and an HP 1000 computer. Although it was an analytical instrument, the system was not prepared for digital mapping. We were therefore forced to develop a lot of programs and routines of operations ourselves. Among other things we had to do

- coding conventions for the topographical elements
- a program for registration and simultaneous control of all topographical details
- a program for editing the data files (it was not a data base at the time)
- a program for connecting features between models and flight lines to avoid later editing and
- provisional data exchange programs.

The demands for greater amounts of information from our customers and our own demands of increasing speed and volume of production emphazised the needs for more advanced systems to handle data.

As a result the firm purchased a Danish Interactive Graphical System (DanGraf) with workstations for editing, insertion of alphanummeric information, utility registration and for extraction of information in different data exchange formats.

Today we have 3 Planicomps in the firm and more than 95% of our map production is done in a digital form. All users require digital maps although most of them are not able to handle the information digitally at the moment. The fact that the maps are produced digitally enables them to switch to the new technology when time is ripe.

From 1981-87 the private photogrammetric firms have mapped approximately 50% of all urban areas and a large number of locations in rural areas in digital form.

3. EXCHANGE FORMAT DEVELOPED BY DSFL

The various users and producers of digital map information utilize different data processing equipment and organize their data bases in different ways, because it is very important that the whole system is specifically directed against the work being done in that particular organization.

This way of thinking makes the exchange of data bases in their original form impossible. We need a data exchange format for the transfer of map information from one data base to another.

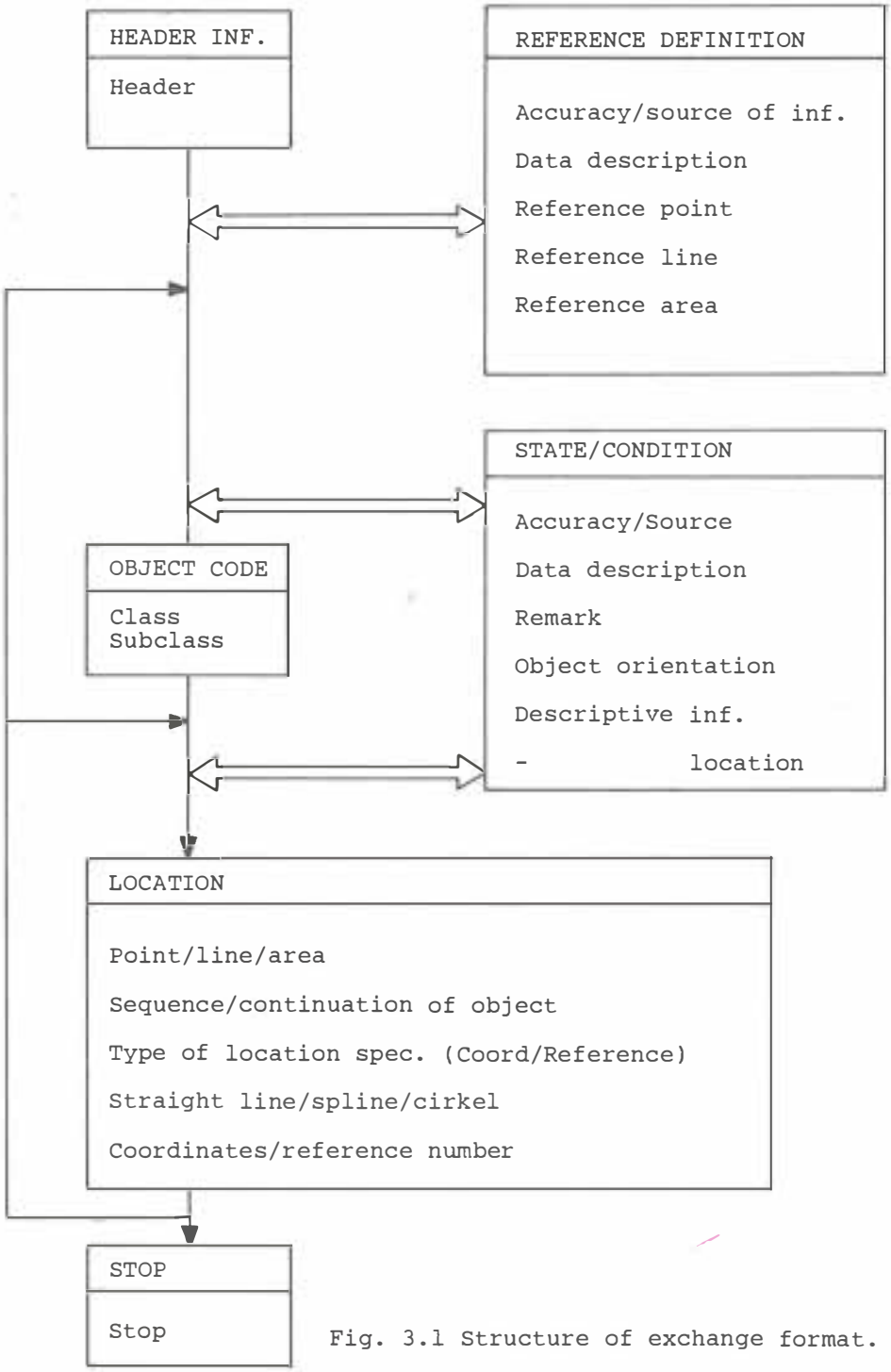


Fig. 3.1 Structure of exchange format.

The exchange format should include a description of data structure, code tables and possibly a graphical symbol standard to be used in order to get a similar graphical result in both ends of the transmission link. The graphical symbol standard is not a demand, because the transferred information need not be indeed should not be graphical. It is very important that the data exchanged represents the physical elements of the terrain as closely as possible. Otherwise definition problems will arise.

Furthermore, it is important to be able to include more than geographical information. The data exchange format must be able to handle all kinds of descriptive information. For a utility authority this will include component data and network information, relationships or links between these and location information of the geographical elements.

Besides the location the cadastre information must include administrative information as county, municipality, address code etc. and measurement information etc.

The Danish Society for Photogrammetry and Landsurveying (DSFL) initiated the development of an exchange format as early as 1982, and within a year the first prototype of the standard was finished.

This early presentation of the standard had an enormous impact on the mapping branch, because it happened before everybody had the need for the exchange format. Therefore the exchange format became a "de facto" standard and an important factor in the rapid introduction of digital mapping in Denmark. Today purchasers of digital maps include the standard in their conditions of delivery when entering into a contract with a map producer.

In fig. 3.1 on the previous page is shown the structure and basic elements of the DSFL data exchange format.

The DSFL exchange format includes at the moment:

- topographical/technical details and associated descriptive data
- cadastral information
- utility information (being completed).

The DSFL continues to maintain and expand this standard. Acceptable international standards concerning this subject are still lacking. One of the reasons is the local peculiarities and the enormous tradition that characterize the mapping branch in all countries.

4. THE CADASTRE

The cadastre is kept in the Danish National Cadastre (Matrikeldirektoratet). The principal function of the cadastre is the maintenance of an up-to-date register of all parcels of land in Denmark. The main elements of the cadastre are the parcel register, the cadastral maps and the measurements of boundaries.

The cadastre environment and the updating process is shown in fig. 4.1

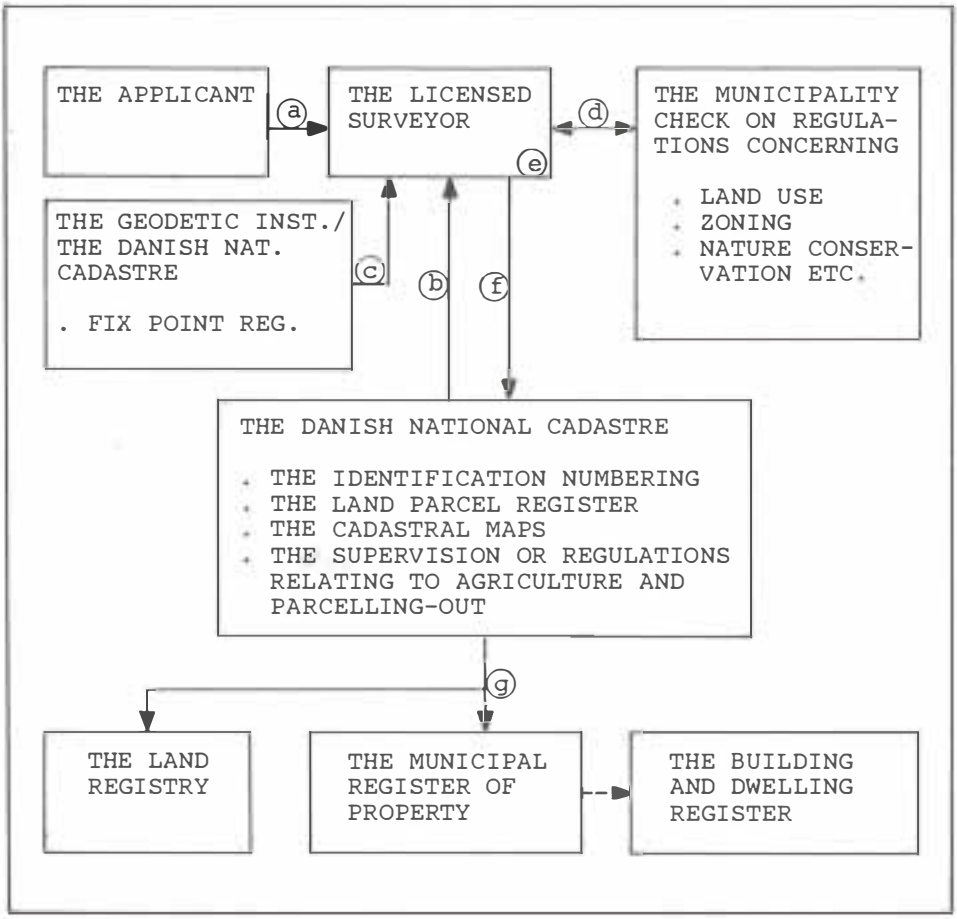


Fig. 4.1 The Cadastre and the flow of information

a. The applicant, a private landowner or a public organization, who whishes to have a change in a parcel boundary, must apply to a private licensed surveyor.

b. The surveyor collects the information from the parcel register, the cadastral map and the document showing the measurements of boundaries from the Danish National Cadastre.

c. In some cases he has to get information concerning the fixed points in the area so that new measurements can be related to these. Information is collected from either DNC og GI or from a common computerized register of all fixed points in the country. This register is being established at the moment.

d. The surveyor has to submit a special form to the municipality concerning different planning regulations.

e. After collecting all relevant information and doing necessary measurements for new boundaries the surveyor prepares the case. Often he will need to do some computation and plotting on his micro or minicomputer.

f. Having completed the preparations the surveyor sends an application to DNC followed by a cadastral plan, and measurements of parent plot and subdivisions.

g. In the National Cadastre all kinds of checks are carried out before the change is recorded in the parcel register and the cadastral map. The measurements are stored to document the changes.

h. The DNC informs the surveyor and the municipal register of property and the land registry. From the municipal register of property the building and dwelling register is updated.

The idea of describing this process in some detail is to show that the information collected in the field by the surveyor and processed in his local computer is channelled through a lot of information links more or less unaltered as original measurements or processed maps and alphanumeric information.

Today only a few of the channels of this information flow is computerized and works as a digital transfer of information, but tomorrow it will be quite different.

5. PUBLIC REGISTERS AND THEIR INTERRELATION

In the previous section the cadastre and its local environment have been described. The cadastre is a part of the public system of administrative and technical registers placed at the responsible organisations. In other words a complete decentralized land information system.

The variety of the registers is shown in fig. 5.1 on the next page together with the most important identification keys for cross-reference between the registers. The figure shows that the cadastre number occurs in many of the registers.

The cadastre is already described in the previous section. The land parcel register is computerized, but the cadastral maps are still manually operated.

The land register or title register contains information about all titles with their debts, easements and other limitations. The title register is manually operated by the local courts of justice. A pilot study for its computerization has been started.

LAND INFORMATION SUBSYSTEM	PERSON NUMBER	CADASTRE NUMBER	GEO-GRAPHIC COORD.	REAL PROPERTY NUMBER	ADDRESS CODE OF DWELLING	BUIL-DING NUMBER
THE CADASTRE		(X)	(X)	X		
THE LAND REGISTER		X				
THE MUNICIPAL PROPERTY REG.	X	X		(X)	X	
THE BUILDING AND DWELLING REG.		X		X	(X)	(X)
THE CENTRAL POPULATION REG.	(X)				X	
THE MUNICIPAL BASE MAP REG.		X	X		X	X
THE UTILITY AUTHORITY REG.		X	X		X	

(X) RESPONSIBLE SUBSYSTEM FOR DETERMINATION OF IDENTIFICATION

X THE IDENTIFICATION IS INTERGRATED IN A MULTI-IDENTIFICATION

Fig. 5.1 Cross-references between registers

The municipal property register is the basis for valuation and for calculation and collection of property and soil values and ownerships. This register is supplied from the building and dwelling register and the cadastre is computerized.

The Building and Dwelling Register contains data for general census, housing and construction statistics and act as the basis register for the public valuation of property. The register is operated by the municipalities and it is computerized.

The Central Population Register contains an identification for each citizen to be used in public administration and it is computerized.

The municipal base map registers. These registers are being constructed in a few of the municipalities. They contain primarily thopographical information for large scale mapping, but they are prepared for utility registration and for use in thematic mapping for different planning and administration purposes, e.g. through the transfer of data from the building and dwelling register. In this context the cadastre information is important and some of the municipalities have an up-to-date cadastral map.

The utility authorities in the private or semi-public sector are investing a lot of effort in creating utility registers for planning and administration of their pipe or cable networks. These days we see more and more often a cooperation between municipalities and utility authorities concerning establishment of a common base map. Through that cooperation only one master version is maintained at the municipality. The maps at the utility authorities are copies and regular updates will be transferred from the municipality.

Figure 5.1 and the above description of the different registers are intended to show that some of the information are contained in more than one register. There is a lot of communication between these registers and it needs specification in a data exchange format.

6. SPECIAL DEMANDS ON EXCHANGE OF CADASTRAL INFORMATION

Looking back at section 3 and figure 3.1, the flow of digital information starts at the local surveyor. His measuring is done on electronic theodolites and the data is processed in the computer creating the cadastral map and a drawing showing all the measurements.

In the Danish cadastral system, the measurements are more important than the final cadastral map, which is more or less an index map to the parcel register. Therefore the exchange format must contain facilities to handle both coordinates and observations. Until now the DSFL format only handles coordinates, so an extension is needed.

The information in the parcel register is connected to an area surrounded by a polygon. Handling of closed polygons with connected descriptive information must be possible.

When working with the cadastral map it is often the case that a point, a line or an area has more than one object code associated because the topographical element represents more than one feature. A wall might constitute a cadastral boundary at the same time. This double feature coding must be possible in the exchange format so that the different meaning of the element can be transferred to the new data base without losing the information that the two features are represented by the same coordinates. When drawing the map, the element should normally be drawn with a single symbol selecting the one with the highest priority.

The descriptive information is also coupled to the elements in a multiple way. In the structure of the exchange format described in fig. 3.1 the part named state/condition is used for specification of descriptive information that is valid until the information is changed or deliberately turned off. This is a very strong tool in setting up a set of parameters being valid for a lot of succeeding topographical elements.

In the cadastral system of the future, which is covered by another paper, another kind of information will occur. It is raster information from scanned ortho-photos or measurement sheets. This technic will be utilized in order to get rid of the vast amount of measurement drawings

in the archives thus making it possible to retrieve the information from the Interactive Graphical System. Therefore, the exchange format must be extended to handle raster images.

Until now exchange of information has been concentrated upon topographical elements with some connected descriptive information. The ties between the two types of information should be losened, so that it becomes possible to exchange information without a geographical reference at all.

Although this is a paper on cadastral information, I would like to make a parallel to the world of utilities, because the demands for separating topography from descriptive information has also been raised there.

In the ongoing work concerning extension of the DSFL format to cover utility information the basic needs have been described as seen in fig. 6.1.

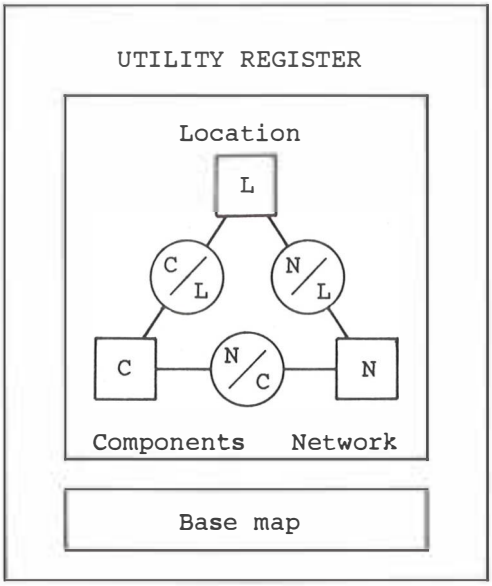


Fig. 6.1 Datastructure of utility register.

The structure of the exchange format must be able to handle both

- location information
- component information and
- network information

and the relations between these types of information which can be N:N - relations.

In the analysis of the basic structure of a utility network, a lot of similarities between utility and cadastral information has been found.

There is one basic function of the exchange format that I want to mention. When data are transferred from a producer to a customer the responsibility for the correctness of the data lies with the producer. But in a digital environment where data is transmitted by a telephone line or shipped on a magnetic tape it can be rather difficult to document the exact content and meaning of the data.

At the same time the two data bases very often differ which means that the producer cannot use his own data base to document the content of the delivery. Furthermore, the customer can easily though unintendedly destroy or even worse move data in his own data base.

To come to the point - data stored in a commonly accepted standard exchange format are the only proper way of documenting the content of a delivery of digital information. This leads to the conclusion that it is necessary to store all exchanged information in the exchange format, at least in the period where guaranties are valid.

7. FUTURE LAND INFORMATION SYSTEMS

The information society of the future is on its way. People are recognising the fact that geographical related information plays a crucial role in the planning and administration of our society. This is why we need to establish land information systems.

In the beginning these systems will be spred among different public and private organizations and data will be channelled between them by means of data exchange formats as described in this paper.

Later on the information will perhaps be concentrated in one computer and people can access the information through graphical workstations of unlimited capacity through connecting links of unknown length.

By then data exchange formats will be more or less superfluous. But it will take a long time and maybe it will never happen.

Whatever the case there is one point that must be emphasized. All information in a data base must be supplied with its current status, accuracy and origin. These parameters are necessary for all other users in order to assess the value of the information, so that its proper use can be assured.

This means that status, accuracy and origin must follow every single item of information whenever it is transferred from one place to another.

Discussion after the conference of Mr. Laursen

Mr Laursen asked the following questions at the end of his conference:

Does your country have a transfer format and is it generally accepted and used ?
Do you feel the need for an exchange format ?
Do we need international standards ?

Jerie: OEEPE has an application commission for the problems of data bases.
An international exchange format might be interesting on a geographic level for environmental questions but certainly not for cadastral applications.

Chevallier: Do your coding tables include an information dictionnary ? This is important if different partners are working together.
An international standard could be very useful mostly because there is no use to try to make the same project twice or ten times the same study.

Kölbl: Exchange formats were also a very "hot" topic at the Autocarto in Baltimore and there was also a number of publications on this subject.
Photogrammetric companies complain that they have a wonderful interactive graphic system which is completely adapted to their needs but they are almost compelled to buy another system because they have to deliver the data in conformity and integrated with the system of the users. Often the users are not prepared to accept any exchange format. Compatibility alone is not enough.

Dale: In the UK we had nearly 16 different exchange formats and that is the reason why we produced a national standard. We hope that people will use it. They will then only have to use an interface between their own data base and the national standard.
We encounter language and semantic problems when trying to establish an international dictionary. FIG has tried to constitute an international multilingual dictionary but for many expressions other languages do not have the corresponding terms; for example the different kinds of german bench marks cannot be translated into English and this makes the establishment of a standard very difficult.

Laursen: The availability of documentation concerning exchange formats could be a help in the analysis of the structure of our national standard. It might be interesting to see how alien fellow engineers deal with the same problems.
It is important a standard is generally accepted and used even if it has some lacks.

Kölbl: Is it possible to design now for the future ? Is it necessity to end up with higher order systems to have more information on topology - for example that a point knows to which area it belongs or that you have the possiblity to analyze if a road is passing near by another object ?

Laursen: At the moment we are not able to handle all of those specific situations. But the analysis we are doing on utility information brings us nearer to the solution of these questions.

L'ETABLISSEMENT DU PLAN CADASTRAL REMANIE PAR PHOTOGRAMMETRIE

J. CL. LOCATELLI
ECOLE NATIONALE DU CADASTRE
TOULOUSE - FRANCE

Résumé : Avant d'aborder la méthode d'établissement du plan cadastral remanié par photogrammétrie, il est apparu important de donner un aperçu sur les deux siècles d'histoire du cadastre Français. Ce cheminement nous conduira à la troisième génération du plan cadastral et à la mise en oeuvre du remaniement.

Le recours à la photogrammétrie pour l'établissement du nouveau plan remanié ne présente pas d'originalité particulière si ce n'est l'agencement et la synchrononisation d'une série complexe d'opérations successives tant au plan technique, administratif que fiscal.

Le support audio-visuel du diaporama se révèle comme le mieux adapté à la description d'un chantier de remaniement et le texte ci-après rassemble le commentaire des images qui seront projetées à l'occasion de sa présentation.

Summary : Before approaching the method which consists of working out the cadastral plan altered by photogrammetry, it appears to be important to give an outline concerning the two centuries of history relating to the French cadastre.
This will lead us to the third generation of the cadastral plan and to the implementation of the alteration.

The use of photogrammetry for the establishment of the new altered plan does not have any specific originality except the arrangement and synchronization of a complex series of successive operations in the technical and admintrative field as well as in the fiscal field.

The audio-visuel support of the overhead projector (diaporama) appears to be best suited to describing the alteration work and the following text contains the comment of the pictures which will be projected at its presentation.

1. Aperçu historique

Le plan cadastral remanié constitue la troisième génération du cadastre français et il est sans doute utile avant d'aborder les techniques relatives à son établissement de décrire brièvement ses antécédents afin de situer les principales phases de son évolution qui s'étend désormais sur une période de près de deux siècles.

Dès 1789, lors de la Révolution Française, les responsables politiques se posent le problème de l'établissement d'un cadastre pour l'ensemble du territoire national et de nombreux essais voient le jour sans qu'aucun d'eux n'aboutissent. Pour résoudre ce problème, NAPOLEON décide en 1807 de faire procéder au dénombrement général de toutes les terres de l'Empire, et pendant près d'un demi siècle, les géomètres arpenteurs Impériaux puis ceux de la Restauration établissent les planches parcellaires et rédigent les matrices cadastrales.

Ce cadastre napoléonien a été remarquablement exécuté compte tenu des moyens de l'époque, mais il souffre d'une tare rédhibitoire qui est l'immuabilité du plan. Seuls les documents littéraux, les matrices et les états de section, sont annotés des mutations survenues dans la propriété foncière. Cet inconvénient qui peut être considéré comme mineur à une époque où la structure foncière se modifiait à un rythme assez lent, s'est avéré rapidement un facteur important de dévalorisation du plan après que la révolution industrielle et le développement du chemin de fer aient bouleversé profondément le territoire. De 1850 à 1930, des textes législatifs incomplets, les incertitudes de la politique et les difficultés financières vont annihiler toute tentative de refonte du cadastre.

En 1930, le principe d'une revision exceptionnelle des évaluations des propriétés non bâties est acquis et cette opération à finalité fiscale s'appuie sur une rénovation préalable du cadastre. Ainsi est mise en oeuvre la deuxième génération du cadastre français qui, basée au départ sur une simple mise à jour du plan cadastral napoléonien, va s'orienter assez vite, du moins pour les zones bâties du territoire, vers l'établissement d'un plan entièrement nouveau issu d'un lever régulier.

De plus, la mission fiscale initiale, grâce à la mise à jour permanente du plan, est complétée d'une mission foncière et juridique suite à la mise en oeuvre de la réforme sur la publicité foncière en 1956. Enfin, le plan cadastral rénové devient un support technique très apprécié des communes.

Au cours des décennies 1960/1970, avec l'accentuation de l'exode rural et l'accroissement de la population, la maîtrise de l'espace urbain devient un souci permanent des collectivités. D'autre part l'importance des budgets communaux est en constante progression et l'assiette de la fiscalité directe locale doit être parfaitement maîtrisée.

Dans ces conditions et compte tenu d'une échelle parfois inadaptée du plan dans certaines zones en voie d'urbanisation, l'identification des biens et leur représentation topographique n'est pas toujours assurée de façon satisfaisante. Pour remédier à ces difficultés, la loi du 18 juillet 1974 permet à l'Administration de procéder dans ces zones au remaniement du cadastre. La troisième génération du cadastre français entre dans sa phase active dès 1981.

L'objectif essentiel du remaniement concerne l'amélioration de la qualité du plan. Dans cette perspective les attributions et le classement des parcelles restent dans la grande majorité des cas ceux du cadastre rénové et l'actualisation de la documentation littérale se limite à une simple correspondance entre anciennes et nouvelles références cadastrales complétée d'une actualisation des contenances parcellaires.

2. L'établissement du plan remanié par photogrammétrie

Au cours de la phase préparatoire des travaux, l'établissement du dossier de prospection permet au responsable de chantier de choisir les échelles du nouveau plan en fonction de la densité du parcellaire à représenter.

Quand la photogrammétrie est mise en oeuvre, et c'est systématiquement le cas pour les chantiers importants, supérieurs à 400 hectares, les échelles du plan définitif déterminent les conditions techniques de la prise de vues.

Les échelles couramment retenues pour l'établissement du plan cadastral remanié sont le 1/500è, le 1/1000è et le 1/2000è. Les échelles des clichés correspondant sont le 1/2500è, le 1/4000è et le 1/8000è. La focale de prise de vue la plus utilisée est celle de 150 mm mais on recourt également à celle de 210 mm pour les prises de vues à très grande échelle.

Un plan de signalisation est établi pour permettre au géomètre de positionner les points d'appui dont les coordonnées seront déterminées sur place pour les besoins de l'aérotriangulation. Un aérocanevas est en effet systématiquement mis en oeuvre pour le calcul des coordonnées trimensionnelles des points de calage qui seront nécessaires à la restitution de détails.

Les coordonnées de ces points d'appui sont observées et calculées à partir du réseau géodésique établi sur l'ensemble du territoire national par l'Institut Géographique National (I.G.N.).

L'utilisation des distancemètres électroniques conduit désormais à combiner les mesures d'angles et de distances pour la détermination des coordonnées planimétrique ; quant à l'altitude des points elle est obtenue par nivellement indirect et par visées réciproques. Dans le cas fréquent où des cheminements de précision à longs côtés sont réalisés, les têtes de cheminement sont nivelées directement à partir des points de Nivellement Général de la France (le N.G.F.) établi également par l'Institut Géographique National.

Les méthodes analytiques qui permettent de définir la position la plus probable des points d'appui sont utilisées pour le calcul des coordonnées grâce à l'utilisation d'ordinateurs puissants qui réalisent les calculs en bloc.

Lors de la signalisation préalable à la prise de vues le géomètre implante sur le chantier un certain nombre de panneaux dont les dimensions correspondent à la hauteur du vol. Les dimensions les plus courantes sont le 25 x 25 cm pour les prises de vues à l'échelle de 1/4000è, et, 40 x 40 cm pour le 1/8000è.

Outre les points d'appui des points auxiliaires de charpente sont également signalés et déterminés par aérotriangulation. Ces points permettront grâce à des levers complémentaires au sol de déterminer, à l'aide de simples mesurages la plupart du temps, des détails importants du plan cadastral qui ne sont pas visibles directement sur les photographies.

Ces points auxiliaires de charpente sont peu nombreux dans les zones bâties où la restitution photogrammétrique des détails topographiques permettra aisément la mise en place des limites de propriété. En revanche, leur densité est plus grande dans les zones rurales ou semi rurales où le parcellaire n'est pas toujours apparent et pour lequel la restitution perdrait une partie de son intérêt et de son efficacité si les opérations de post-complètement n'étaient largement facilitées par l'utilisation de ce canevas complémentaire. Il est courant pour un chantier de remaniement de 1 000 à 1 200 hectares que les géomètres soient amenés à baliser un millier de panneaux au sol immédiatement avant le passage de l'avion photographe. Toutes les précautions sont prises par ailleurs pour que ces signaux ne soient pas marqués par des ombres portées ou des masses boisées et leur positionnement est soigneusement repéré sur une photographie aérienne par exemple.

La prise de vues est réalisée après appel d'offre auprès des entreprises susceptibles de la réaliser, à une époque où la végétation ne masque pas trop les détails. Elle est effectuée aux alentours de midi solaire et la visibilité horizontale doit être au moins égale à 8 km.

La prise de vues fait l'objet d'une vérification immédiate portant aussi bien sur la précision du vol que sur la qualité des négatifs.

Les clichés-contacts sont ensuite annotés de la position des points à observer pour le calcul de l'aérotriangulation ainsi que des points situés à proximité des points de GRUBER qui permettront le calage du couple lors de la restitution de détails. Initialement la procédure consistait à choisir des contrastes sur les clichés. Cette méthode, longue et fastidieuse a été avantageusement remplacée par le "PUGAGE" qui permet de créer des points artificiels percés dans l'émulsion photographique. Cette manière de procéder élimine pratiquement les erreurs d'identification, assure une parfaite concordance des points images et améliore sensiblement le rythme d'équipement des clichés.

Les observations photogrammétriques sont réalisées sur les appareils analogiques ou analytiques de premier ordre de précision qui équipent les divers ateliers du Service du Cadastre. Saisies sous assistance informatique, les coordonnées locales des divers points observés sont transmises à un ordinateur central de grande capacité.

Le programme d'aérotriangulation installé à l'Ecole Nationale du Cadastre est le PAT M 43, il calcule par modèles indépendants à 4 inconnues planimétriques et 3 inconnues altimétriques et réalise une détermination en bloc par la méthode des moindres carrés. Ce programme performant, assure une précision parfaitement homogène dans le bloc photogrammétrique.

A titre d'exemple, la fiche statistique du chantier de la commune urbaine de VITROLLES dans les BOUCHES-DU-RHONE met en évidence la précision remarquable des résultats.

CHANTIER DE VITROLLES (Bouches-du-Rhône)
Echelle de prise de vues : 1/4000e

STATISTIQUES		PRECISIONS	XY	Z
Nombre de couples	109	E_{MQ}/points d'appui	4,5 cm	5 cm
Nombre points d'appui	20	E_{MQ}/points nouveaux	4,0 cm	6,1 cm
Nombre points nouveaux	1 081			

Un programme complémentaire permet le calcul des paramètres d'orientation à afficher sur les appareils de restitution.
L'opérateur est donc en mesure, dès la fin du calcul de l'aérocanevas de commencer la restitution des détails.

... La stéréo-minute qui en résulte est établie sur table traçante de haute précision, par digitalisation du modèle photogrammétrique. Le dessin est enrichi de tous les contrastes stables du terrain tels que les poteaux, les bouches d'égout ... qui ne figureront pas au plan cadastral définitif mais permettront, si nécessaire, de positionner les limites de propriété qui ne sont pas toujours visibles sur les photographies.

En dépit de la richesse de la stéréo-minute mais également de la très grande diversité de chaque document restitué, il est difficile de déterminer des temps moyens de restitution. A titre tout à fait indicatif on peut indiquer que quelques 24 heures de travail sont nécessaires pour établir le dessin d'une section de plan à l'échelle de 1/1000è, soit environ 35 hectares, dans une zone pavillonnaire dense de 250 parcelles environ.

... La fin des opérations techniques, dite de postcomplètement, est conduite sur place avec la participation des propriétaires qui précisent aux géomètres, de façon contradictoire, la position des limites de leur propriété. De simples chaînages permettent la plupart du temps de mettre en place les éléments du plan cadastral par rapport aux détails restitués. Il est exceptionnel que des levers complémentaires soient nécessaires, mais dans ce cas, le canevas des points déterminés par l'aérotriangulation facilite bien entendu la tâche du géomètre.

Il importe de préciser également que les plans d'arpentage ou de bornage établis par les géomètres experts agréés, antérieurement aux travaux de remaniement, sont retenus et appliqués sur le nouveau plan lorsqu'ils sont portés à la connaissance du géomètre remanieur.

En cas de désaccord entre les propriétaires sur la position d'une limite, une Commission communale de délimitation s'efforce de concilier les

opinions divergentes ou statue sur le litige à titre provisoire. En tout état de cause le géomètre de l'Administration ne prend pas position et seuls les tribunaux civils sont habilités à trancher les différents entre les propriétaires.

Le postcomplètement terminé, le plan est dessiné soit manuellement soit automatiquement. Dans ce cas, le dessin est d'abord digitalisé et fait ensuite l'objet d'une saisie informatique qui permettra un dessin sur table traçante assisté par ordinateur.

La contenance de chaque parcelle du nouveau plan est calculée par procédés automatiques et un document édité par informatique récapitule, par propriétaires, les nouvelles références des parcelles et leur superficie.

Le nouveau plan est ainsi présenté en commune ou chaque propriétaire a la possibilité de venir le consulter et demander, si nécessaire, sa mise au point. Le plan deviendra définitif après édition des différentes collections par le Service de la Documentation Nationale du Cadastre.

Parallèlement toutes les modifications apportées à la documentation littérale suite aux opérations de remaniement sont effectuées par l'intermédiaire du système interactif de Mise à Jour des Informations Cadastrales, dit MAJIC 2, qui est en cours de généralisation sur la totalité du territoire.

De même, la situation après remaniement est communiquée au Service des Hypothèques au moyen de tables de correspondance entre anciens et nouveaux numéros éditées par procédés informatiques.

... Le remaniement atteint actuellement son rythme de croisière. Chaque année 2 000 feuilles de plan intéressant environ 60 000 hectares, sont éditées par l'usine de reproduction du Service du Cadastre.

Il est prévu qu'en 1995 toutes les communes satellites des métropoles régionales représentant la majorité des zones urbaines sensibles seront équipées d'un plan fiable, à grande échelle, indispensable pour la constitution de banques de données urbaines vers lesquelles beaucoup de collectivités locales s'orientent actuellement.

De façon concomitante au remaniement, le service poursuit sur demande des collectivités locales la production du plan cadastral normalisé, le P.C.N., à l'échelle de 1/2000è. Son échelle uniforme, sa présentation en coupures pleines et orientées plein Nord en font un document utile à l'approche des problèmes fonciers pour de nombreux organismes privés et publics.

Discussion after the conference of Mr. Locatelli

Mr Locatelli added some information to the diashow :

The most important characteristic of our photogrammetric method is that we use surveying points which are marked by targets (~ 30 x 30 cm) and determined by aerotriangulation. Simple measurements in the field with reference to these targets allow us to complete the cadastral map with the non apparent property boundaries and the topographic details hidden by vegetation. Thus photogrammetric methods enable the terrestrial surveyor to do less completion work in the field.

Koen: Do you have a special law regulating your activities after the technical operations ?

Locatelli: We do not have a special law, but we have administrative procedures which oblige us to convene systematically all landowners to establish the boundaries in the field when we determine them for mapping. The delimitation is always organized in "a contradictory manner" which means that all landowners are listened in presence of a surveyor. In the case of a disagreement between the landowners, the cadastral office does not take part in the decision where the boundary has to be, but will wait for the judgement of the civil court.

Jerie: Do you store the map information in a digital form or is it only stored in a graphical manner ?

Locatelli: The actual production foresees only the graphic form, but for some communities we produce numerical maps after digitizing the final graphic cadastral map.

Kölbl: Are the photogrammetric data only processed in a graphical form ?

Locatelli: Actually the plans are graphic, but they will be digitized in order to allow digital plotting. We have drawing files which allow us to manipulate the map information. Nowadays a few municipalities are already treated in this way - you have heard of the approach for Marseille - but most of our maps are still graphic maps.

Jerie: When do you think you will finish your total program ?

Locatelli: We estimate that this renovation (remaniement) will take 7-8 years. By 1995 we should have finished most of the municipalities which are foreseen for renovation.

Chevallier: Do you have the means to update these new maps rigorously ?

Locatelli: Most of our documents are regularly updated, sometimes with some delay. We have 2 updating procedures:

The Updating of Property Boundaries
When a landowner divides a plot of land and sells a part of it, the bill of sale (l'acte de vente) is automatically transferred to the cadastral office and within 1-2 months the updating procedure is carried out with the help of a topographical document set up by a private licensed surveyor (géomètre expert agréé)

The Updating of Topographic Details
The location of buildings, new bridges or accesses to highways takes more time but we have never more than 1-1½ years of delay. Simplified photogrammetric methods are applied with high efficiency to update areas.

Itterbeek: What are the means used for this production in terms of manpower and machines ?

Locatelli: France has ~ 2'400 surveyors working for the cadastre and its territory is covered by ~ 5'500 mapsheets.
4 photogrammetric units (~ 30 plotters) are used for the renovation or the updating of cadastral maps. Private companies do also some of the updating.

Scholl: How do you treat the boundaries that are disputed when you make the map ?

Locatelli: We do not change the situation on the map and we wait for the judgement which will then be applied.

PHOTOGRAMMETRIE POUR LA REVISION DU CADASTRE

René Koecher
Directeur du Service de l'Arpentage
Communauté Urbaine de Strasbourg -France.

Summary The deficiency of accuracy of many cadastral plans which were made in the origine by hasty methods and the frequent and important backwardness of their up-to-dating with terrestrial means, allows the question of use of photogrammetry for their revision and their upholding.

This proposition brings various indications over the possibilities of the utilization of photogrammetry in connection with use of the soil and use of the maps. It is placed in vision of digital and polyvalent cartography and of land information system.

Résumé L'insuffisance de précision de beaucoup de plans cadastraux obtenus à l'origine par des méthodes sommaires et le retard fréquent et important de leur mise à jour par les moyens terrestres, permet de poser la question de l'utilisation de la photogrammétrie pour leur révision et leur maintenance.

La proposition nuance les possibilités d'utilisation de la photogrammétrie en fonction de l'utilisation des sols et des plans polyvalents et se situe dans une vision de plan numérique et de systèmes d'informations localisés

1. Introduction

Le thème proposé comporte la révision du Plan cadastral, et la mise à jour du plan cadastral.
Comme d'autres intervenants parleront aussi de révision et de remaniement du plan cadastral, en particulier en France, je vais alléger quelque peu cette partie et traiter plutôt la mise à jour.

1.1. La Révision du plan cadastral français

En cadastre Français, le mot révision a une définition bien précise. La révision cadastrale, n'existe que dans la loi locale du cadastre d'Alsace-Moselle. Il faut savoir que le cadastre se fait commune par commune. L'opération consiste à reprendre en considération le plan ancien de certaines parties du territoire d'une commune.
C'est le cas lorsque ces parties avaient été traitées sommairement au moment de la rénovation ou même n'avaient seulement été contrôlées quant à leur contenu, mais pas remesurées. Il s'agissait généralement des zones montagneuses, forestières, marécageuses ou rurales de peu de valeur. Ni l'Administration du cadastre, ni la Commune ou les propriétaires n'avaient tenu à faire de grands frais en levés terrestres pour améliorer ces fonds de plans. Il faut dire que le régime du cadastre français qui est à but

uniquement fiscal et même pas juridique , explique pourquoi cette modalité, insuffisante dans l'esprit de techniciens puristes, a pu être imaginée et executée. En principe la révision est donc une rénovation qui se contente de peu. Seules quelques zones complétement changées ou manifestement fausses sont remesurées. Les zones à peu près correctes graphiquement sont reprises avec des adaptations limitées.
La conséquence est qu'il existe dans la commune des zones entiérement mesurées à neuf, des zones corrigées et des zones à peine recadrées et seulement redessinées. Ces méthodes se font au moindre coût, et correspondent aux seuls besoins fiscaux et de définition de la propriété, sans aucune garantie, principes fixés il y a deux siécles déjà.
Beaucoup de communes ont donc intégré des données de l'ancien plan napoléonien. L'Administration a vue ces défauts et à mis en oeuvre le remaniement du plan cadastral, sujet dont vient de vous parler l'intervenant précédent.
Il est évident que la photogrammétrie, alliée avec le positionnement par satellites, semble particuliérement adapté à la révision des grandes zônes montagneuses et forestiéres. Les conditions d'une réussite restent cependant un bon canevas matérialisé, dense et précis et un abonnement systématique des propriétés.
Mais là nous sommes déjà dans un autre cadastre, celui de la 3e génération qui devrait prendre en compte des notions supplémentaires que celle de l'asiette fiscale.

2. La Mise à jour du plan cadastral - Principes

Faut-il rappeler que tout ouvrage plan qui se destine à étre permanent, doit avoir une organisation rigoureuse de mise à jour ?
La révision, décrite sommairement plus haut, est une opération unique dans le temps, pour une commune. Elle peut s'étaler entre plusieurs mois et quelques années, mais on ne devrait plus en refaire. De même le remaniement et la rénovation sont faits une fois pour plusieurs générations. La mise à jour par contre est une ardente obligation permanente et sans fin. C'est en quoi elle s'en différencie fondamentalement. Elle exige aussi les moyens en conséquence.
La mise à jour du plan cadastral se décompose en deux moyens essentiels : d'une part la modification du parcellaire, d'autre part la mise à jour du bâti et des natures de cultures.

2.1. Les modifications du parcellaire

Les modifications du parcellaire sont provoquées essentiellement par les arpentages effectués sur le terrain par les géométres-experts privés et les services publics. Les documents d'arpentage sont déposés au cadastre qui introduit leur image au plan cadastral de la circonscription aussitôt aprés avoir reçu l'information de la concrétisation juridique de la situation par un acte notarié, un acte administratif, un jugement etc. Cette mise à jour se fait en principe immédiatement dans le même mois. En pratique des retards considérables s'accumulent par manque de moyens humains dans les services.
D'autres modifications du parcellaire, peu fréquents, consistent à constater le changement important de certaines limites naturelles de propriétés comme les déplacements de rives de cours d'eau ou de bords de lacs ou de mers, des glissements de terrains, etc. Ces constats sont souvent faits d'office par les géométres du cadastre et introduits directement dans les plans. On doit avouer que trop peu de situations modifiées sont ainsi saisies et qu'il y aurait beaucoup de rattrapages à effectuer. Le défaut tient à un manque de motivation : les cours d'eaux n'apportent pas d'impôts. Il y a aussi un manque d'information : les propriétaires ne savent pas à qui s'adresser ou

s'en désintéressent. Enfin il y a toujours le manque de moyens.
Ici la photogrammétrie pourrait apporter une solution rapide, à condition bien sûr, que les conditions économiques soient remplies, ce qui est rarement le cas, car les chantiers sont très limités.
Cette mise à jour du parcellaire du plan cadastral se fait à la circonscription du Cadastre et se limite à des documents graphiques traditionnels : Plans au format AO normalisés sur films. Dans les communes est déposé un plan cadastral imprimé sur papier. Sa mise à jour consiste en le remplacement périodique de ce plan. Malheureusement cette périodicité est beaucoup trop longue, de sortie que ces plans perdent de leur valeur rapidement.

2.2. Les modifications du bâti et des natures de culture

Le bâti est une donnée relativement variable dans le temps et dans l'espace. Nouvelles constructions, agrandissements, édification d'annexes, terrasses, vérandas, piscines, garages, etc. et démolitions plus ou moins systématiques - par exemple en rénovation urbaine.
La mise à jour du plan cadastral est sensée être ponctuelle. Les permis de construire, autorisation de démolir et déclarations de travaux devraient théoriquement suffire pour avertir l'Administration du Cadastre où des levés modificatifs sont à opérer.
En pratique cela ne suffit pas du tout, certaines modifications ne sont pas à déclarer, d'autres constructions se font de façon occulte.
En outre, les moyens humains ne suffisent pas actuellement pour pouvoir parcourir le territoire de plusieurs dizaines de communes au fur et à mesure que les indications sont fournies par les mairies. Le phénomène de l'urbanisation accélérée a encore aggravé cette difficulté.
Il y a bien quelques relevés de constructions nouvelles qui arrivent au Cadastre à l'occasion d'arpentages parcellaires, mais les obligations sont souvent contournées par les géomètres. Il y a aussi des levés systématiques entrepris par certains services publics (Services techniques des Villes, distributeurs d'Electricité, de Gaz ou de Téléphone) en particulier dans les nouveaux lotissements, qui sont mis à disposition du Cadastre.
Cependant le gros du travail reste à faire. Il aboutit à un parcours systématique dans tout le territoire de chaque commune par les équipes de géomètres du Cadastre, malheureusement à une périodicité de plusieurs années seulement. Pour la préparation de ce type de travail des photos aériennes peuvent être très utiles. Sur le territoire de la Communauté Urbaine il existe des photos aériennes en couleurs, agrandies du 10.000 à l'échelle approximative 1/2000, qui permettent une excellente "reconnaissance au bureau".
L'idéal serait de pouvoir utiliser la restitution photogrammétrique pour mettre à jour les plans cadastraux, mais la limite de la précision graphique est vite franchie à moins de franchir encore plus gravement les limites de la rentabilité économique.
En effet, nous arrivons au coeur du sujet. Quant et comment utiliser la photogrammétrie au bénéfice du plan cadastral.

3. Utiliser la photogrammétrie pour la rénovation

3.1 Influence de l'échelle graphique du plan

En France le plan cadastral des zônes rurales est établi à l'échelle 1 : 2000. Cette échelle couvre donc la plus grande partie du Territoire. Les parties villages existent en général à l'échelle 1/1000, tandis que les parties urbanisées sont dessinées à l'échelle 1 : 500. Une rénovation ou un remaniement par voie photogrammétrique que de tout un territoire commu-

nal ou même de plusieurs communes adjacentes doit être une opération techniquement et économiquement possible. Techniquement la précision graphique (± 0,1 mm) peut être atteinte dans tous les cas, mais la différenciation des échelles sur une même commune, nécessite la multiplication des prises de vues aux échelles du 1 : 8000, 1 : 4000 et 1 : 2000 ou 1/2500.
On sera en pratique amené à faire une prise de vue totale au 1 : 8000, des prises de vue partielles au 1 : 2000 et quelques zones limitées au 1/2500. En pratique le coût de la mise à disposition de l'avion ne change pas, mais la prise de vue est à multiplier par trois.
La stéréopréparation devra aussi suivre cet échelonnement et nécessitera de préférence un plaquettage préalable adapté aux échelles. Pour l'échelle 1 : 500 la densité des points reçues est de 1 point de calage tous les 2 hectares, soit 6 points X,Y,Z par couple.
L"aérotriangulation sera plus compliquée, puisqu'il n'y aura pas de zone homogène et il faudrait passer par trois phases successives de compensation.
Enfin la restitution graphique devra traiter des données de plus en plus nombreuses plus on pénêtrera dans les zones urbaines. En réalité les zones urbaines posent beaucoup de problêmes et les zones denses nécessitent même des opérations de terrain pour éviter les multiplications des prises de vues. M. PRADERVAND de l'Ecole Polytechnique Fédérale de Lausanne nous en parlera en détail.

3.2. La rentabilité de la méthode

La rentabilité en cas de rénovation ou de remaniement malgré les nombreux préalables peut être intéressante dans le cas où il n' y a ni délimitation contradictoire, ni abornement systématique, et lorsque, comme en Cadastre français actuel, on se contente des limites apparentes et d'échelles relativement petites.
Cette rentabilité devrait être d'autant plus grande que le terrain est moins dense en bâti, et que les difficultés du relief rendraient des opérations de terrain plus chères. Un grand avantage : c'est une méthode rapide. En outre elle ne nécessite pas de présence lourde sur le terrain ce qui devient une facilité psychologique vis à vis des propriétaires. Mais voyons maintenant le problême posé dans le cas de la seule mise à jour.

4. Utiliser la photogrammétrie pour la mise à jour

Par rapport à une rénovation la mise à jour se caractérise par sa répétitivité et son exigence d'être beaucoup moins chère. Une mise à jour d'un plan doit se faire en principe le plus près possible de l'évènement modificatif. Comme certains éléments sont effectivement intégrés par des levés terrestres, chaque mise à jour doit devenir une révision générale. Il est convenu que la périodicité de ces révisions ne doit jamais dépasser 5 ans et qu'en pratique pour un plan cadastral 3 ans est déjà beaucoup en zone périurbaine.

4.1. Sélection des zones

La rentabilité devient beaucoup plus aléatoire lorsqu'il y a seulement mise à jour du plan. Dans ce cas la densité des informations à modifier est beaucoup plus petite sur un territoire donné.
On sera amené à bien sélectionner les zones où l'on veut intervenir, pour ne pas faire traiter des territoires où rien ne se fait, où les constats se font par la méthode terrestre (arpentages du parcellaire) et aussi celles où la photogrammétrie est inadaptée tel le bâti dense et de grande hauteur.
C'est ainsi que l'on a intérêt à éliminer les zones rurales dans le cas gé-

néral. Cependant il sera intéressant d'y faire restituer des grands équipements nouveaux qui se seraient mis en place depuis la dernière mise à jour (nouvelles routes, chemins, stades, ensembles immobiliers, etc).

4.1.1. Zones urbaines et Plans polyvalents

De même il y a lieu d'éliminer les parties centrales du bâti des grandes agglomérations.
Il faut d'ailleurs indiquer ici, que les grandes Villes ne se contentent plus du plan cadastral avec ses ruptures d'échelles et ses insuffisances thématiques. Pour leurs besoins de planification de détail et de gestion de la voirie et des réseaux souterrains, elles ont mis sur pied des plans urbains polyvalents, à très grande échelle (souvent le 1/200e) et ont commencé à les mettre en informatique. Ces plans VRD sont créés et tenus à jour par des méthodes de levés terrestres numérique, partie prenante d'une banque de données urbaines et d'un futur système d'informations du territoire sur l'ensemble de l'agglomération ou même d'une province ou d'un pays. De telles orientations préfigurent le cadastre polyvalent et digital de demain dont la création et la mise à jour sont assurés de façon collective par les utilisateurs principaux.
L'utilisation de la photogrammétrie dans un tel contexte est à considérer à nouveau sous un autre angle. D'une part la photogrammétrie a été exclue du Centre des agglomérations pour des simples raisons de faisabilité par rapport à l'échelle de restitution exigée qui est le 1/200. Il y a bien des Villes qui ont commencé par se contenter d'un plan à l'échelle 1 : 500, réalisés par voie photogrammétrique. Pour des besoins de planification et de gestion générale ceci a pu suffir un certain temps.
Mais l'exigence de la précision et de la grande échelle revient vite à l'ordre du jour, et plusieurs exemples sont connus de grandes Villes qui ont recommencé un plan numérique à l'échelle 1/1 par méthode terrestre.

4.1.2 Les zones périurbaines

Le rôle de la photogrammétrie n'est cependant pas supprimé dans ce contexte en particulier pour la mise à jour. Dans la phase d'urbanisation progressive du Centre vers la périphérie, de grandes zônes habitées, dont aussi les villages extérieurs disséminés, peuvent se contenter d'une expression graphique de leur territoire à l'échelle 1 : 500.
Les constructions y sont moins hautes et moins denses, la voirie et les réseaux sont logiquement aussi moins importants de sorte que l'échelle 1 : 200 ne se justifie pas encore. Comme cependant ces zônes font aussi partie du système d'information localisé, il importe que leur saisie initiale et leur mise à jour soit assurée sans défaillance.
L'intérêt de la photogrammétrie est accentué par le fait que les dépenses périodiques sont réparties entre plusieurs partenaires financiers qui sont d'accord sur les modalités techniques sous le leadership de la Ville.
Plusieurs thèmes sont saisis en même temps : bâti, voirie, topographie, affleurements des réseaux, lampadaires et mats, arbres, aménagements sportifs avec des détails tels hauteur des constructions, types de toitures revêtement des chaussées, espèces d'arbres, etc.
Il est bien entendu que dans l'esprit d'un cadastre juridique, tel que nous devons le promouvoir, les limites sont exclues du recours à la photogrammétrie. Celles-ci restent du seul demaine des mensurations terrestres actuellement.
Comme nous nous trouvons dans le contexte de base de données numériques, la juxtaposition correcte de toutes les informations dans la cartographie doit être garantie. Nous revenons donc à l'argument essentiel de la précision.

Celle-ci doit être compatible avec l'expression cartographique à l'échelle la plus grande demandée pour tous les éléments à intégrer à ce systéme de localisation numérique. Il faudra donc renoncer à apporter des données provenant de digitalisations de plans à petites échelles ou de photogrammétries issues de prises de vues plus petites que le 1/3000. Sinon les plans de synthése sur les zones traitées seraient des expériences d'illusionistes. Ce rôle les géométres-topographes sérieux refusent de le jouer.

4.1.3. La nécessité de la coordination

Le nombre des thémes à saisir, la diversité des partenaires, les différences des besoins de cartographie en échelles, urgences, détails, représentations graphiques, méne actuellement à un gaspillage de moyens humains et financiers qu'il est difficile de continuer à justifier.
Il y a déjà plusieurs pays dont les cadastres ont débordé leur rôle fiscal, et méme de définition juridique de la propriété fonciére. Ces cadastre fournissent un plan polyvalent qui prend en considération des besoins trés diversifiés de l'aménagement du territoire, de l'urbanisme, des transports, de la gesion des réseaux, de l'économie, de l'industrie, de l'agriculture, de l'hydrologie, de la géologie, de l'archéologie etc...
Une seule entité coordonne et met en oeuvre les méthodes de saisie et de mise à jour, méme s'il y a un conseil d'administration des utilisateurs qui oriente les programmes. Ce rôle est encore accentué par l'informatisation et la transformation en systéme d'informations localisées.
De méme dans une grande ville ou Province qui méne un projet de plan polyvalent il faut une coordination située en tête de l'Administration territoriale qui décide collectivement, qui met en oeuvre, qui arbitre entre les méthodes, qui attribue et contrôle les travaux, qui utilise les crédits et en justifie, qui diffuse les produits graphiques numériques et informatiques, qui étudie les possibilités nouvelles, etc.
Parmis ces possibilités nouvelles la photogrammétrie a souvent été oubliée : - volontairement ou par manque de compétences ? Maintenant que la restitution sous forme numérique est devenue courante, le recours à la photogrammétrie devrait favoriser l'essor des S.I.L.

5. Projet de Strasbourg

Avant de conclure, je voudrais indiquer sommairement un probléme tel qu'il a été analysé sur le territoire de la Communauté Urbiane de Strasbourg (FRANCE).
Doté d'un ouvrage plan traditionnel sur film, des échelles 1 : 200 jusqu'au 1.20.000, la Communauté Urbaine a commencé un projet de plan numérique où sont impliqués des partenaires extérieurs : Electricité, Gaz et Télécommunications. Avec le cadastre il y a seulement échange de levés de terrains.
Le probléme de la mise à jour est le principal souci pour rendre le systéme fiable.

1) Pour la zone centrale, 6 500 hectares représentés en plans exhausifs à l'échelle 1/200, la mise à jour se fait par méthode :
- terrestre exclusivement ;
- d'une part par une révision systématique tous les 5 ans ;
- d'autre part par des levés ponctuels dans des délais de moins de 2 mois à la demande de chacun des partenaires.

Les levés des géométres du Cadastre sont coordonnées également dans le temps et dans l'espace par la Communauté Urbaine.

2) La zone rurale 18.400 hectares, représentés en plans parcellaires des-

criptifs à l'échelle 1 :1000. Il faut peu de mise à jour. Il y a essentiellement mise à jour du foncier et quelques levés terrestres numériques.

3) Pour la zone périurbaine et 18 communes,types villages décentrées, seul le plan 1/500 topographique existe. La zone à traiter est de 6 100 hectares dont 2 200 bâtis. Notre préoccupation est cette derniére, le reste étant traité comme le plan 1/1000.
Il s'agirait d'enrichir des plans par les constructions nouvelles, les trottoirs, les affleurements et poteaux des réseaux, les talus et rails, les arbres, les aménagements publics. Les coûts estimés à ce jour se décomposent selon le tableau :

PHASES	F.F.	F.S.
Mise en place de l'avion	18 000	4 500
52 passes	77 000	19 500
411 clichés	30 000	7 500
Liaisonnement entre communes	18 000	4 500
Polygonation et rattachement de points de calage 2200 ha/5 points = 440 pts polygonation	2 200 000	550 000
Aérotriangulation 359 couples x 650 FF	233 000	58 500
Restitution env. 2200 ha x 100 FF	220 000	55 000
Récolement terrain et mesures complémentaires	160 000	40 000
Le formatage informatique est inclus	-	-
	2 956 000	799 500
Réparti sur 3 ans (programme triennal) surcoût de 30 000 FF à la prise de vue	30 000	7 500
TOTAL	2 986 000	747 000
Par an (arrondi)	1 000 000	250 000
Réparti entre 2 partenaires chacun	500 000	125 000

Il est à remarquer que le gros de la dépense est une mise unique : la polygonation et le ratachement des points de calage.
Pour les opérations ultérieures le coût total se monterait chaque année à environ 300 000 FF = 75 000 FS. Une telle opération est économiquement justifiée étant donné la rapidité de réalisation à l'entreprise et l'enrichissement simultané du Plan Numérique qui en résulterait sans curcoût.

Conclusion

Le présent exposé ne s'est pas limité au plan cadastral. En effet les systémes d'informations localisés des villes ou des provinces, préfigurent aussi les cadastres modernes polyvalents, précis et informatiques tels que certains pays les mettent en oeuvre.
Il y a de nombreux préalables à la mise en oeuvre d'un S.I.L. ou d'un cadastre polyvalent :

Un seul Service Central pilote, contrôleur et centralisateur des données
Une maintenance permanente des canevas, la mise en oeuvre de tous les moyens topographiques disponibles dans le pays, le partenariat des utilisateurs, des moyens humains performants.
La photogrammétrie peut certainement apporter une contribution substantielle à la contribution de tels cadastres et à leur mise à jour. Il s'agit de mettre l'accent sur le choix des zônes et de rechercher un bon équilibre qualité/prix et de choisir les méthodes de travail en fonction des besoins de chaque partenaire en informations et en précision dans le cadre d'une coordination dans un système d'informations localisées.
En ce qui concerne la photogrammétrie des préalables sont également existants : zônes favorables, buts recherchés adaptés aux possibilités, rôle de la précision , techniques, importance du nombre d'éléments modificatifs par rapport à la rentabilité, association financière de partenaires, délais de coût de la stéréopréparation au sol. La justification du recours à la photogrammétrie se situe dans sa rentabilité par rapport à d'autres méthodes et se retrouve surtout si l'on peut intégrer ses données directement dans un cadastre graphique informatisé ou système d'informations localisées.

PHOTOGRAMMETRY FOR THE REVISION OF THE CADASTRE

René Koecher
Directeur du Service de l'Arpentage
Communauté Urbaine de Strasbourg - France.

Summary The deficiency in accuracy of many cadastral plans which were made originally by hasty methods and the frequent and serious backwardness of their ut-to-dating by terrestrial means, permits the suggestion of the use of photogrammetry for their revision and their upholding.

The proposition brings various indications over the possibilities of photogrammetry in connection with the use of soil and the use of maps. It is placed in vision of digital and polyvalent cartography and of land information system.

Résumé L'insuffisance de précision de beaucoup de plans cadastraux obtenus à l'origine par des méthodes sommaires et le retard fréquent et important de leur mise à jour par les moyens terrestres, permet de poser la question de l'utilisation de la photogrammétrie pour leur révision et leur maintenance.

La proposition nuance les possibilités d'utilisation de la photogrammétrie en fonction de l'utilisation des sols et des plans polyvalents et se situe dans une vision de plan numérique et de systèmes d'informations localisés.

1. Introduction

The proposed subject contains the revision of cadastral plan and its up-to-dating.

As other contributions discuss revision and rehandling of a cadastral map, in particuliar in France, I will place less emphasis on this aspect and focus more on up-to-dating.

1.1. Revision of french cadastral plan

In french cadastral language, the word revision of map has a precise definition. It only exists in the local law of Cadastre in Alsace-Moselle. The operation consists of taking at new into consideration the maps of certain parts of the territory of a commune.

This happens when these parts were carried out hastily in a moment of cadastral renovation or when they were checked only in their contents, but not in their measurements.

This concerned most zones of mountains, of forests, of marshland or of rural zones of little worth. Neither the Government Service of Cadastre, nor the Communes, nor the owners were bent on making great expenditure in terrestrial surveying in order to improve these maps.

It is well known that the french cadastre, is conceived only with a fiscal object and has no juridical roll. This is the reason why such a modality, which is lacking in the spirit of purist techniciens, could be thought up and courried out.

Therefore, in principle the revision is a renovation satisfied by small means. Only certain zones which are completely changed or evidently wrong are measured again. Zones which are approximately correct in graphisme are kept with limited adaptations.

Consequently in the same commune some zones will exist with renovation based on complete new measurements, others zones will be corrected and others still will be lighter altered and then drawn as new.

These methods are used because of their lower cost which complies with the fiscal needs and also with the registration of the properties in conformity with principles established two centuries ago, but without any guarantee.

In this way, many communes have integrated indications from first "napoleonian cadastre". The Administration of Cadaster has seen this shortcoming and it began the "remaniement" of the cadastral maps, as the previous lecturer explained.

It is obvious that photogrammetry, allied with satellite Positionement (G.P.S.) is specialy adapted to revision of large zones of mountains and forest.

But the conditions of a successful result remain in a good, precise and dense network which is marked and is in a systematic marking of bounderies of properties. So we are already in an other cadastre system. It is that of the third generation and should register additional informations about other things than fiscal matter.

2. Up-to-dating of a cadastral plan - Principles

It is not necessary to remember that all maps which are destined to be permanent, have to have a strict organisation for up-to-dating.

Revision of cadastral plans, as explained before, is a unique operation of it's time for a commune. It may last some months, even some years, but after that, the operation is closed.

In the same way, remaniement and renovation are worked for several generations.
Up-to-dating of cadastral map is used to link two essential means : on one hand the modification of cadastral parcels, on the other hand the up-to-dating of buildings and Kinds of use of soil.

2.1. The modification of cadastral parcels

The modifications of parcels is mostly caused by boundery - surveying by private and public surveyers. The surveying acts are deposited at the cadastral office, which draws the new configuration into its cadastral map when the property situation becomes official by notary act and registration or by a judgement of Tribunal.
This up-to-dating is made theoretically in the same month as the act. But in pratice there is a considerable backlog because of lack of human resources in the public offices.

Other alterations of parcels, though not often, consist in surveying the important changes in some natural limites, such as the shifting of river sides seaside and the occurence of landslides. These statements are mostly done by geometers of Cadastral Office and introduced directely into the maps. In truth too few of these modified situations are surveyed and there is a lot of lost time to be made up for.
The fault is a lack of motivation because rivers, roads and streets return no taxes. There is also a lack of information , owners don't known where to enquire or they take no interest in these things. In the end there is always a lack of means.

Photogrammetry would be able to bring a quick solution, on condition that economic circumstances are fulfilled. However, this is rarely the case as most work sites are small.

This updating of parcels in Cadastre plans is done in the county Office and concerns only traditional graphic maps : normalised sheets in DIN AO on drawing film. In the municipal building there is a printed exemplar of this plan. Its up-dating is done by periodic substitution of the sheets. Unfortunately its periodicity is much too long, so that these maps loose there worth easily.

2.2. Changes in build and in kinds of growth

Building is a rather changeable parameter in time and space : new buildings, enlargements, the building of annexes, terraces, verandas, swimming-pools, garages... the demolishing systematically or not, for example in urban renewal.

Selective revision of Cadastral plan is supposed to be punctual. Theoretically, the building licences, the permits for pulling-down, and proceeding declarations ought to be sufficient, to advise cadastral administration where modifying surveys ought to be made.

In practice, it is not sufficient at all. Some modifications are declared and shouldn't be, whereas other buidings should be declared are not. Moreover, at the moment, human means are not sufficient enough to cover the territory formed by several tens of communes in proportion as indications are given by Municipalities. The great increase of urbanization has still worsened that difficulty.

Of course, some surveys of buildings made by hand during surveys of patches are given to the cadastre, but obligations are often twisted by surveyors. Systematic surveys made by administrations such as Technical Offices of Towns and distributors of electricity, gas or telecommunication, especially in the case of new divisions into allotments, are placed at the Cadastre's disposal.

Nevertheless most of the work is still to be done. For the teams of surveyors of the Cadastre, that work consists in walking over the whole territtory of each commune. Unfortunately, the periodicity of that work is still of several years. Aerial photographs can be very useful to prepare that work. For the territory of the "Urban Community of Strasbourg", colour aerial photographs at the scale of 1/10000, enlarged to the approximative scale of 1/2000, allow a first rate reconnaissance of the terrain, inside the office.

Ideally it would be best to can use photogrammetry to make the partial revision of Cadastral plans, but with that solution, a good graphic precison

often requires uneconomical means.

Then, the question is : how and when can photogrammetry be used for cadastral plan ?

3. Using photogrammetry in the remaking of Cadastre ?

3.1. The influence of the graphic scale of the plan

In France the scale of the Cadastral Plan in rural areas is the 1/2000. So the main part of french territroy is covered by that scale. The scale is usually the 1/1000 for the villages, whereas urban parts are drawn at the 1/500.

A photogrammetric revision or rehanding of a whole commune territory and even of some adjacent communes is technically and economically possible. Technically, drafting accuracy (∓ 0,1 mm), can be attained in all cases. But using several scales in the same commune will involve the multiplication of photographs at scales of 1/8000, 1/4000 and 1/2000 or 1/2500.

In practice, a global photograph at 1/8000, photographs at 1/4000 (over partial zones) and 1/2500 will have to be done. So that, the cost for the use of the plane will be approximately the same, but the number of photographs will be multiplied by three. The stereopreparation will have to be done in the same way and the preparation of adequate plates in ratio to the scales, will be necessary. For the scale 1/500, the density of points required is one for two hectares, that is to say six points (X,Y,Z) for a couple of photographs.

Because of a lack of homogeneous areas, the Aerotriangulation will be more complicated and three successive phases of compensation will be necessary. Finally, the graphic restitution will have to deal with an increasing number of parameters as penetration into urban areas increases.

It has to be said that urban areas are the source of many problems and the most dense parts need terrain operations to avoid the multiplication of photographs.
Mr PRADERVAND of the "Ecole-Polytechnique Federale de Lausanne" will talk about it in greater detail.

3.2. Profitability of the method

The profitability in the case of revision or rehandling, in spite of numerous preliminaries, may be interesting where there is neither done contradictory delimitation nor a systematic marking out, and when, such as in french cadastre nowadays, we content ourselves with apparent limits and rather small scales.

Profitability ought to be all the more important as the density in buildings lessens and as difficulties created by relief would comparatively increase the price of a terrain work.

A great advantage is the rapidity of the method. Moreover it doesn't require that many people be sent on the terrain and it's psychologically easier towards landowners.
But we are going to look at the problems arising in the case of a simple selective revision.

4. Using photogrammetry for selective revision

Compared with a renovation, the selective revision is characterised by its repetitive character and because it's execution is much cheaper.
The selective revision of a plan muste be done as soon as possible after the modification has taken place.

Some elements are effectively integrated by surveys, and so, each selective revision has to be a complete revision. It has been decided that the periodicity of those revisions shouldn't exceed five years, and in practice, three years is considered long enough for an area situated around a town, on a cadastral plan.

4.1. Selection of areas

Profitability becomes much more hazardous in the case of a simple selective revision of the plan. Then, the density of information to be modified is much more feeble on a precise territory.

We shall have to select the areas where we want to work, in order to avoid treating territories where nothing happens, where contracts are done by traditional surveys (surveys of parcels), and also, where photogrammetry can't be used because of a great building density or great heights.

So it may be interesting to exclude generally rural zones. But it will be economic to restitue the great new builded equipments which were made since the last up-dating (roads - motorways, sporting areas, new cities, etc).

4.1.1. Urban areas and multipurpose maps

Continuing with the same idea, central parts of builded zones in big cities must be removed.
It is necessary to mention here, that big cities cannot be sacrified any longer with the cadastral map with its scale discontinuity and thematical lacks. For the sake of detail planning such as street and underground (utilities) networks, the cities have drawn urban maps at very large scales (often at 1/200) which are multipurpose and which are more and more managed by computers. These "VRD" maps are created and updated by numerical fieldwork methods, as entrance to an urban data bank, and furthermore to a geographical information system of the whole agglomeration or even of a province or a land. Such orientations give the main characteristics of a future multipurpose and digital cadastral map whose creation and updating are collectively realized by the main users.

The use of photogrammetry in such a context has to be considered in a new light. First, photogrammetry is inadequate in citycentre mapping for the simple reason of feasibility with regard to the required scale of 1/200. Some cities began by using a 1/500 scale map realized by photogrammetry, that was sufficient for the needs of general planning. But the need of accuracy and large scale mapping has become more important and there are many examples of big cities that have now started a digital map at a 1|1 scale using "terrestrial" methods.

4.1.2. The suburban areas

The use of photogrammetry is not rejected in this context, particularly for up-to-dating.

With the constant increase in urbanization from the Centre towards the suburbs, big inhabited areas, within dissiminated villages, can satisfy their needs with a graphic image of their territory at a 1/500 scale. Buildings are less high and dense, streets and all the networks are consequently less important, so that a scale of 1/200 is not yet really necessary. But, since these areas are also intended to the land information system, it is subsequently important that their initial mapping and updating is done in the right way.

The advantage of photogrammetry is increased by the fact that regular costs are shared between several financial partners who agree on the technical specifications under the leadership of the City.

By the way several items are stored : buildings, streets, topography utility networks, lightmasts, trees, sports complexes, with details like the height of buildings, different types of roofs, or the different kind of trees, etc.
It is clear that in the optic of a juridical cadastre, such one as we have to promote, the definition of bounderies cannot be done by photogrammetric methods. They are still dependent on terrestrial measurements.

As is the case with "numerical data banks", the right juxtaposition of all information through "cartography" must be guaranteed. So we come back to the main argument of accuracy. It has to be compatible with the cartographic image at the largest required scale for all the elements to be integrated to the numerical localisation system. Therefore we have to reject data provided by the digitalisation of small scale maps or issued by photogrammetry which uses aerial pictures at a smaller scale than 1/3000. If not, the "general maps" of these areas would be unrealistic experiences, which is not the job of a good surveyor.

4.1.3. The need for "coordination"

The great number of uses of a map, the diversity of partners, the different needs in "cartography", scales, urgency, details to draw in many different graphic representations, actually leads to a waste in both human and financial resources, which is hardly justifiable.

There are already many countries whose cadasters have overwelmed their fiscal purpose, and even their rôle in the juridic definition of property of soil :these multipurpose cadastral maps take into consideration the very different needs of territorial planning, townplanning, transportation, network planning, economics. industry, agriculture, hydrology, geology, archeology, etc. Only one authority coordinates and practises the measurements, even if a council of the users gives the general orientation of the programmes. The necessity of this authority is increased by the use of computers in land information systems.

Where a big city or province has a project of multipurpose maps, it is necessarry to have a coordination ahead of the territorial administration, who decides collectively, who defines and arbitrates the methods, who gives out and arbitrates the methods, who gives out and checks the work, who uses the credits in regard of justifications, who diffuses the graphic and digital outputs, who studies among new possibilities, etc.

Among new possibilities photogrammetry has often been forgotten ; perhaps "voluntarily" or by lack of "knowhow" ?

Now that digital restitution has become common, the use of photogrammetry should make the development of land information systems easier.

5. The Strasbourg project

Before concluding, I would briefly like to demonstrate how the problem has been "analysed" on the territory of the Urban Community of Strasbourg (CUS).

Having already used traditional maps at scales from 1/200 to 1/20000, the CUS started a project of "digital maps" where outdoor partners like Electricity, Gas and Telecommunication participate. With cadastre administration, there are actually only field measurement exchanges.
The problem of updating is the main problem in making the system reliable.

1) For the central area, with 6 500 hectares mapped at a scale of 1/200, updating is exclusively done by terrestrial methods.
   - on one hand by a systematicl 5 year revision program ;
   - on the other hand by local measurements within two months at special request of one of the partners.

The measurements made by the surveyors of the Cadaster Administration are also coordinated in time and space by the "C.U.S."

2) For the "rural areas 18 400 hectares are mapped at a scale of 1/1000". There is little updating. It concerns mostly landed property informations and a few terrestrial measurements.

3) In the suburban territories there is only a topographic map at a scale of 1/500 of the 18 isolated villages surrounding the agglomeration Strasbourg. The total surface is 6 100 hectares, of which the 2 200 hectares which is built up, is our concern, the rest being mapped at the scale of 1/1000.

   These maps have to include the new buildings, kerbs of pavement, caps and masts of netwoorks, slopes and rails, trees and public equipements.

   At present time, the estimated costs are as shown in the following schedule

PHASES	F.F.	F.S.
Availability of the plane	18 000	4 500
52 orientated flights	77 000	19 500
411 Photographs	30 000	7 500
Junction between villages	18 000	4 500
Polygonation and measurement of predeterminated points 2200 ha/5 points = 440 polygonation points.	2 200 000	550 000
Aerotriangulation 359 sterogramms x 650 FF	233 000	58 500
Photogrammetry restitution around 2 200 ha x 100 FF	220 000	55 000
Complementary fieldwork	160 000	40 000
Numérical processing is included	-	-
	2 956 000	739 500

	F.F.	F.S.
The work being planned into a 3 year program gives an additional expenditure of about 30 000 F.F. for the photographic mission	30 000	7 500
Total	2 986 000	747 000
Costs per one year	1 000 000	250 000
Cost shared between two partners	500 000	125 000

It should be mentioned that the greatest part of the costs concerns polygonation and measurements of predeterminated points, which is an initial and unique "phase" in the whole work. For further operations, the total cost would be about 300 000 F.F. = 75 000 F.S. per year.
Such an operation is economicaly justified considering the short time in which the work can be done by private firms and the consequent enrichment of the "Numerical Plan" which it provides.

Conclusion

This present communication is not only concerned with the cadaster map. Infact, the geographic information systems of cities and provinces give the main lines of a multipurpose modern cadaster, accurate and managed by computers, such as have been started by a few countries.

Many things need to be done ahead the establishement of a geographic information system, or a multipurpose cadastre :

- a unique central service that pilotes, checks and centralises datas ;
- a permanent maintenance of both altmetric and planimetric networks ;
- the use of all topographic means available in the country ;
- a partnership of all the users of the system ;
- and the best in human resources.

Photogrammetry can certainly contribute subsequently to the constitution of such cadasters and to their updating.
Emphasis has to be placed, on the choice of areas, in order to obtain a good balance quality/cost and to choose the working methods in consideration of the needs in information and accuracy of every partner in a mind of coordinations within a geographic information system.

For the use of photogrammetry, there are also some essentials which are required in advance : the areas must be favorable, the aimes must be adapted to the possibilities, problem of accuracy must be solved, the density of updating elements must be in line with rentability, financial partnership of the users, delay and costs of ground measurements (stereopreparation).

The justification of the use of photogrammetry lies within its rentability, as compared to other methods and it is particularly recommended when the data can be stored directly in a geographic information system.

Discussion after the conference of Mr. Koecher

Jerie: Can you explain why your polygonation is so expensive ?

Koecher: We want to create a databank with maximum accuracy. In order to reach this goal all boundary points must be marked.
Many of the old triangulation or polygonation points have disappeared, but we do not want to lose all the old measurements, so we have to re-establish them with the original precision.
We are working in a local coordinate system (transverse Mercator) and we have to go into the National Lambert System which is a conical projection.
At first we make a triangulation, then we identify control points which are also used for transformations and terrestrial operations.

PHOTOGRAMMETRIC POINT DETERMINATION FOR CADASTRAL SURVEY WITHIN PROJECTS FOR LAND CONSOLIDATION (EXPERIENCES OF THE ADMINISTRATION FOR LAND CONSOLIDATION OF BADEN-WÜRTTEMBERG)

Gerhard Waldbauer
Landesamt für Flurbereinigung Baden-Württemberg
Buchnerstraße 14, D-7140 Ludwigsburg (FRG)

Summary

The new plot pattern resulting from the land redistribution must be ascertained by a new survey. Apart from the survey and border points (approx. 500 - 18 000 points per project), topographic objects frequently are to determined in this connection. For this task, photogrammetric point determination is used apart from surveying with electronic tacheometers. The photogrammetric method has proved to be particularly economical in cases where the portion of topographic objects (roads, slopes etc.) is high.
After initial work by use of the method of single model transformation, and intensive use of model block adjustment for approximately twelve years, bundle block adjustment with additional parameters (program PAT-B) has been the only method used since 1983.
Several tests to verify the achieved accuracy showed that errors of position of 1 to 2 cm were obtained in all cases.

Zusammenfassung

Die in der Flurbereinigung geschaffene neue Grundstückseinteilung muß im Rahmen einer Neuvermessung erfaßt werden. Neben den Vermessungs- und Grenzpunkten (ca. 500 - 18 000 Punkte je Projekt) sind hierbei häufig topographische Gegenstände aufzumessen. Für diese Aufgabe wird neben der Vermessung mit elektronischen Tachymetern die photogrammetrische Punktbestimmung eingesetzt. Dies hat sich besonders dann als wirtschafltich erwiesen, wenn der Anteil topographischer Gegenstände (Straßen, Böschungen usw.) einen größeren Umfang annimmt.
Nach ersten Arbeiten mit der Methode der Einzelmodelltransformation und etwa zwölf Jahren intensivem Einsatz der Modellblockausgleichung wird seit 1983 ausschließlich die Bündelblockausgleichung mit zusätzlichen Parametern (Programm PAT-B) eingesetzt.
Mehrere Tests der erreichten Genauigkeit haben ergeben, daß in allen Fällen Punktlagefehler von 1 bis 2 cm erreicht werden.

1. Description of the Task

When carrying out land consolidation projects, a new network of farm roads and ditches is constructed on the basis of a plan of the road and water system that is drawn up in consultation with the body of participants and in cooperation with a number of official authorities. Following this, the parcels of land which are to be newly formed are included in the new development system.

The task of the land consolidation authority is to perform cadastral surveys for this newly created situation and on completion of the procedure to submit the relevant information such as cadastral maps, coordinates and files with details on owners to the cadastral authorities. It should be noted that, in Baden-Württemberg, all new surveys are shown in the form of a coordinate cadaster with an accuracy of a few centimetres. The basis for this is a network of trigonometrical points with an accuracy in the order of approx. 1 cm, spaced approximately one kilometre from each other.

Land consolidation projects vary in size; when carrying out photogrammetric cadastral surveying in the past, projects involving the surveying of between 2,000 and 15,000 points have been dealt with. On average, point density per hectare is 20. Two types of points have to be distinguished: border points - which make up the vast majority - and survey points, from witch surveys can be done at a later date.

2. Choice of Survey Method

Basically, the administration for land consolidation has two methods at its disposal with which to carry out the survey. These are:

a. surveying with electronic tacheometers (Zeiss Elta 2) followed by calculation of the coordinates in the form of a traverse and polar survey calculation, or
b. photogrammetric cadastral surveying, described in the following in detail.

Today, most projects are surveyed using terrestrial methods, while in certain projects the use of photogrammetry is preferred for economic reasons.

Exhaustive profitabilty studies have shown that photogrammetry is cheaper than the terrestrial method if not only signalled border points but also a great number of topographic objects have to be surveyed. This is the case, for example, if there is consolidation for projects of public interest where the details of extensive road construction have to be recorded for the cadastral map or if, in the case of topographically highly-structured areas, a great number of borders between types of utilization, embankments, etc. have to be recorded.

In the case of the latter, Schubert (1985) has shown that the labour cost of photogrammetric cadastral surveying is between 20% and 30% less than when using electronic tacheometers.

3. Development of Photogrammetric Methods

Photogrammetric cadastral surveying for land consolidation projects in Baden-Württemberg can look back on more than thirty years of development. In 1955, Gotthardt reported on the Hengstfeld trial photogrammetric cadastral survey. In this case the photo scale 1 : 6000 was used and the models evaluated on the C 8 Stereoplanigraph of the Institute for Photogrammetry (as a matter of fact, the operator was cand. geod.F. Ackermann). Adaption to the state system of coordinates was performed by means of model transformation. The accuracy of the trial survey in the Hengstfeld land consolidation project was given with an error of position of the new points of ± 14,7 cm.The standard error when comparing surveyed and calculated distances was given as ± 7,9 cm; the difference between the two values was ascribed to systematic errors.

The system of single model transformation, where, for each model, four control points in the field had to be determined according to position and height, was practised by the administration for land consolidation in nineteen projects between 1964 and 1969, including an area of roughly 18,000 hectares and some 80,000 survey and border points. From 1966 onwards the Baden-Württemberg Office for Land Consolidation had its own Zeiss C 8 Stereoplanigraph at its disposal for this work.

The decisive breakthrough in aerial triangulation came at the end of the 1960s with the development of operable computing programmes to permit block adjustment with independent models.

In 1971, photogrammetry was officially licensed as a method of cadastral surveying by an edict of the Baden-Württemberg Ministry of the Interior. Apart from the course of procedure, these provisions (VVPhoto) give in particular a detailed description of the inclusion of terrestrial measurements in order to gurantee or increase the inner precision (accuracy of adjacent points) as well as the adjustment to the borders of the project area. The VVPhoto provisions have remained unaltered until today.

Between 1970 and 1983, in numerous projects following the land consolidation act, the Administration for Land Consolidation carried out photogrammetric cadastral surveys on the basis of the VVPhoto provisions according to the method of indepent models.

In total, 142 projects were processed, of which 80 were consolidations of vineyards. The area of the projects processed varied between approx. 10 and approx. 2,000 hectares, the number of points varied between approx. 500 and

18,000. During the above-mentioned period, the coordinates, consisting of some 300,000 survey and border points, were determined photogrammetrically. In terms of the total area surveyed by the Baden-Württemberg land consolidation administration, photogrammetry accounted for roughly 20 % of the work done.

In 1981, new research was published concerning the reliability of photogrammetric blocks. Reliability was introduced as a further criterion for judgement alongside accuracy. In 1982, as a result of these conclusions, the land consolidation administration modified the rules governing the photo flight so that, from 1982 onwards, larger-scale operations generally were overflown as so-called double blocks with a side lap of 60 %.

In 1980, a Zeiss Planicomp C 100 analytical plotting system was installed at the photogrammetric department of the "Landesamt für Flurbereinigung" and, from 1981 onwards, the first trials in photo-coordinates measurement and bundle block adjustment were carried out. While the coordinates of the survey an border points were determined according to bundle block adjustment in one single case in 1982, this method was used for the majority of cases in 1983. From 1984 onwards, work has been carried out exclusively according to this method, with the exception of small vineyard areas.

4. Presently-Used Procedures

4.1 Bundle Block Adjustment to Determine Points

4.1.1 Flight Planning and Aerial Photography

Today, the scale 1 : 4000 is used for all projects. It has proved to be a reasonable compromise between profitability and accuracy and, in addition, there is a favourable relationship between floating mark size and the size of the signal plates when using this scale.

To achieve a high degree of reliability in the blocks, the method of overflying double blocks with a 60 % side lap has continued to be practised (see also Ackermann, 1985, and Grün, 1986).

As a rule, the film used for aerial photography is Kodak MS 2448 colour diapositiv film. The possible slight disadvantage of this film against high-resolution black and white emulsions (OEEPE Publication No. 15, 1985) is cancelled out by the fact that, in the case of a colour diapositiv, the points signalled in white, and in particular topographic objects, can be interpreted more positively and more quickly than when using a black and withe film.

As signals, white 20 x 20 cm plastic signal squares are affixed with dowels to the plastic boundary markers. The survey points, where an even greater degree of accuracy is aimed for than in the case of the border points, and which are normally marked underground, are signalled by a 15 x 15 cm white square glued in the middle of a 50 x 50 cm black plastic plate. When using this pattern, series of measurements have provided the best accuracy of measurement.

It is always attempted to signal tie points, even those outside the actual project area. Only in exceptional cases are artificially marked points reverted to.

4.1.2 **Measurement of Photo-Coordinates**

Only the Planicomp C 100 plotter is used when measuring photo-coordinates. On behalf of the Landesamt, Prof.Dr. Ing. G. Hell of the Karlsruhe Polytechnic College developed a measurement programme (B 155) and integrated it into the existing Zeiss software. This allows an optimal measurement of photo-coordinates on the C 100.

A certain point is approached in stereo-mode, following which the two images are decoupled by foot switch and the photo-coordinates in the single images measured. After the measurement procedure the plotter switches back to "stereo" automatically. Seen from a practical viewpoint, approaching the points in stereo-mode has many advantages and reduces considerably the number of non-measurable points. It should be mentioned here that Grün (1986) came to the same conclusion.

The B 155 programme also performs transformations into fiducial marks, corrects distortion and, if necessary, earth curvature.

All points are maesured twice, that is, by two different operators in two separate procedures. The aim of this practice is less that of increasing accuracy than that of reducing the number of gross errors (especially numbering errors).

In one of the two semi-blocks with a 60 % side overlap, all signalled control points, tie points, survey points an border points are measured. In the strip offset 60 % to the side, which in the end only serves to stabilize the block, only the following are measured:

a. control points
b. survey points (for which more accuracy is desired)
c. some 20 points in the corners of the model for use as tie points
d. points that it was not possible to measure in the first semi-block.

4.1.3 Computation

In the first stage of calculation, the data gained from the stereo measurement in the form of "semi-images" are transformed, combining them into image-like data sets using the SORT-B programme (author: Dr. Stark, University of Stuttgart).

For bundle block adjustment, the land consolidation administration has bought the PAT-B programme from the "Forschungsinstitut für Luftbildtechnik GmbH" and installed it on the central IBM computer at the Ministry of Agriculture.

In the case of the two overlapping semi-blocks, separate adjustments are first calculated to facilitate the discovery of gross errors. Furthermore, at this stage the attempt is also made, through the use of additional parameters, to come to conclusions as regards systematic errors.

Once errors have been eliminated, the complete block is adjusted in one procedure.

To take systematic errors into account when doing so, the known set of 12 parameters (Prof. Ebner) is used and subdivided into three groups; i.e., two separate groups dependent of flight direction and one common group for all photographs.

Table 1 summarizes the results of practical point determination using the bundle method. All projects described were measured on the Planicomp, even if this was not done exactly according to the method described above. In the projects described, the photo-coordinates were registered directly on stereoscopic measurement of the point without decoupling the images and measuring them separately. This probably has a certain influence on the statistical information regarding block adjustment.

On looking through Table 1 it becomes apparent that the results are almost the same in spite of the very different conditions in the various land consolidation projects (form of the terrain, size, shape of the block). With the exception of the Allmendingen/Niederhofen project (first section), where the number of points per photograph was considerably less than usual, the standard error of unit weight is in the region of 1,2 cm. It can be assumed, then, that in standard cases a point accuracy of $\pm$ 2 cm can be achieved with certainty.

The column headed "mean difference of terrestrial distances" contains a confirmation of this statement of accuracy, where values between 2,0 und 2,6 cm are found as root mean square values of the differences between measured terrestrial distances and those calculated from bundle block coordinates. This takes account both of the accuracy of the coordinates and measurement errors in the terrestrial distances.

It is evident that the method of bundle block adjustment makes it possible to achieve absolute positional accuracy which surpasses the results of the previously usual method of block adjustment with independent models by a factor of at least 2 to 3.

Given the above, the demand for inclusions of terrestrially measured distances in the adjustment ought to be rethought, since these will hardly be suited to improving the result further.

4.1.4 **Verification of Accuracy**

In order to verify the accuracy of the results obtained from photogrammetric point determination, terrestrial control measurements were carried out in several projects.

The autor reported on two of these investigations in the 1985 "Mitteilungsblatt des Deutschen Vereins für Vermessungswesen - Landesverein Baden-Württemberg". In both cases the statement of accuracy of roughly 1,5 cm was confirmed.

A third, extremely extensive check of the Schnürpflingen project (second section) was undertaken in collaboration with the Institute for Photogrammetry at the University of Stuttgart.

In a geodetic network with observations of directions and distances, 120 check points were subsequently determined with a Zeiss Elta 2 electronic tacheometer. Net adjustment showed the accuracy of the terrestrial check points to have a mean point error of 0,9 cm; that is to say, a standard of accuracy which is slightly higher than that of photogrammetry.

A coordinate comparison between the results of the net adjustment and of photogrammetry revealed the following values:

mean deviation in x :	1,3 cm
mean deviation in y :	1,7 cm
maximum deviation in point position :	5,5 cm

These results, too, confirm in a very impressive way that, when using the methods of photogrammetric point determination, point accuracy of 1 to 2 cm can be achieved in standard cases.

Using the "Schnürpflingen" photographic material, the Institute for Photogrammetry at the University of Stuttgart is investigating to what extent the results could be improved by measurements on the mono-comparator. It is intended to publish a report on conclusion of the experiment.

4.2 Topographic Objects

As described above, photogrammetric methods are used to process those projects where a great number of topographic objects have to be surveyed. Up to the present, this has taken the following course. In a second, separate measurement procedure in the Planicomp, these objects are evaluated by means of computer-assisted mapping (Zeiss Planimap Programme) and engraved in scribing film at the DZ 7 plotter. Using copying techniques, this film is combined with the map of the property limits, texts and figures.

The following method is planned for the future:

a. digital mapping on the Planicomp together with the use of superimposition from a graphic monitor (Videomap system)

b. transfer of the data to an interactive graphic system (Siemens SICAD)

c. digital combination with the property limits, map texts, etc.

d. write-out of the complete map on a precision plotter.

4.3 Point Definition in the Stereo Model

As described above, point determination has up to the present been carried out for points indicated in the field by border markers an additionally signalled.

As new borders generally run along the line of new farmroads that are visible on the aerial photograph, it is theoretically also possible to define border points directly in the stereo plotter without any marking in the field. The basis for this is a boundary marking plan prepared by the engineer responsible for the land consolidation project.

In this field of points - which only exists in theory - all further calculations concerning the allocation of new parcels of land can be performed. Only when the owners are put in possession of the new parcels of land are transfer of the data to the site and boundary marking necessary.

The great advantage of this method is that certain border markers on the site do not hinder husbandry and that many of them are no longer destroyed by cultivation measures and have to be set up again at great cost.

Of course, this method is especially effective when the coordinated points in the field do not have to be made visible at all, as is the case according to the legal situation in Baden-Württemberg along certain strechtes of water, for example.

A series of experiments concerning point definition have already been carried out under the most varied conditions.

5. Prospects

Now that photogrammetric point determination has achieved a very high degree of accuracy and is, in certain circumstances, clearly the most economical type of cadastral surveying, the outlines of projects for the future are becoming clear, in which the techniques of

a. the coodinate determination of signalled points,
b. the registration of topographic objects by means of digital mapping and
c. point determination in the stereo model

can be combined with each other in a meaningful way.

References: Ackermann, F., Stark, E., Schubert, E., Waldbauer, G.,) Deutscher Verein für Vermessungswesen, Landesverein Baden-Württemberg e.V., Sonderheft Katasterphotogrammetrie, September 1985 (contains further bibliographical references)

Grün, A., Photogrammetrische Punktbestimmung mit der Bündelmethode, Institut für Geodäsie und Photogrammetrie der ETH Zürich Mitteilungen Nr. 40, März 1986

OEEPE: Optimal Emulsions for Large-Scale Mapping (by M. Jankola, W.Brindöpke, O.Kölbl, P.Noukka) Official Publication N° 15, August 1985

Table 1 : results of bundle block adjustments

Land consolidation project	year of photo flight	photo scale figure	number of photos	number of measured points	standard error of unit weight (sigma naught) (cm)	RMS values of residuals at image points in x (cm)	RMS values of residuals at image points in y (cm)	number of terrestrial distances	mean difference of terrestrial distances (cm)
Allmendingen-Niederhofen (first section)	1982	4 000	60	800	1,5	1,4	1,2	510	2,2
Allmendingen-Niederhofen (second section)	1983	4 000	120	3 500	1,2	0,9	0,7	3500	2,6
Waiblingen (B 14/29)	1984	4 000	25	3 500	1,1	0,9	0,6	4300	2,0
Schnürpflingen (first section)	1984	4 000	128	4 400	1,1	0,7	0,6	5300	2,0
Niederstetten I (second section)	1983	4 000	272	10 700	1,2	0,8	0,6	10100	2,6
Niederstetten I (third section)	1984	4 000	149	7 500	1,3	0,8	0,7	6300	2,4
Schnürpflingen (second section)	1985	4 000	85	2 500	1,1	0,8	0,6	2960	2,1
Bad Säckingen Wallbach	1985	4 500	37	1 700	1,2	0,8	0,7	1600	2,2

Discussion after the conference of Mr. Waldbauer

Kölbl: Do you have enough tie points in a scale as large as 1:4000 and do you use only signalized points or also artifically marked points as transfer points ?

Waldbauer: In Baden-Württemberg the common distance of trigonometric points is about 800 m. We try to use only signalized points as tiepoints but if we are not sucessful then we change to artifical points using the PM-1 of Zeiss.

Kölbl: Is it possible that these artifical points influence the precision of the aerotriangulation ?

Waldbauer: We did not make any research in this direction because we try to use only signalized tie points. If the flight is carried out as planned, we do not need any artifical points.

Brindöpke: What is the percentage of lost points ?

Waldbauer: Since we fly with 90% forward overlap and 60% side overlap therefore we lose only about 1-3% of the points. Only few of the targets of these points are lost (taken away); most of the targets are covered by obstacles.

Kölbl: In Denmark, mainly model adjustment is used. What is the reason that you do not use bundle adjustment ?

Krüger: Operators like very much the way they are helped with the program for model triangulation. We have also used bundle adjustment but only with monocomparators. The work was rather tedious.

Waldbauer: Past experiences have taught us that Zeiss utilities are not efficient for photocoordinate measurements in the Planicomps. We now use our own program, written by Professor Hell, Karlsruhe.

Kölbl: In Switzerland, model adjustment was used to a great extent. That was due to the equipment of the private photogrammetric companies with analogue instruments, but equipment has changed menawhile. I am convinced that the precision of bundle adjustment is about 2 times higher than for model adjustment.
Another problem arises from the picture scale; if we fly too high, much larger signals should be used, which is costly and causes considerable difficulties. Therefore one of the main problems might be the signalization.

Jerie: I think that the most significant difference is the 60% side overlap which costs more, but it also increases the value of bundle adjustment because it yields more information.

Kölbl: Can you give us figures on the increase of costs due to the 60% side overlap ?

Waldbauer: The flight costs increase by 40-60% and the overall costs for about 10%.

Timmermann: Why did you choose a 1:4'000 photoscale for rural areas instead of 1:6'000 for example ?

Waldbauer: In Baden-Württemberg the laws prescribe an accuracy of 2-3 cm for all points. The difference between two independant measurements of a border points should not exceed 8 cm.

Jerie: Is there any reason given for this law in rural areas ?

Brindöpke: One advantage of a photoscale as large as 1:4'000 is that the whitened stones can be seen. We do not have to use additional targets that can be destroyed and the result is a higher reliability.

Waldbauer: We did not use this solution. Our stones are already in the field for some years and might be dirty. It is cheaper to use targets than to clean the stones and paint them.

CADASTRAL RENOVATION WITH THE HELP OF PHOTOGRAMMETRY

APPLICATION PROBLEMS IN URBAN AREA

Jean-Claude Pradervand
Laboratoire de photogrammétrie
Ecole Polytechnique Fédérale de Lausanne

Summary The rapid change from a graphic cadastral plan to a digital cadastre is an actual problem for numerous cities wanting to equip them with modern means of urban planning. In default of a new survey, the digitizing of old graphic plans degraded by successive revisions risks to conduce to a bad result. The introduction of photogrammetry in the renovation process allows to control and to better these circumstancies. The proposed method is based upon a projection of the cadastral state on the plane of an aerial photograph. A thorough analysis of deviations between the cadastre and the photographical reality allows to determine correction parameters. Some problems inherent in the renovation of an urban cadastre are shown up.

Résumé Le passage rapide du plan cadastral graphique à un cadastre numérique est un problème d'actualité pour de nombreuses cités voulant se doter de moyens modernes de planification urbaine. A défaut d'une nouvelle mensuration, la digitalisation de plans graphiques anciens et dégradés par les mises à jour successives risque de conduire à un résultat médiocre. L'introduction de la photogrammétrie dans le processus de rénovation permet de contrôler et d'améliorer cette situation. La méthode proposée est basée sur une projection de l'état cadastral dans le plan d'une photographie aérienne. Une analyse minutieuse des écarts entre le cadastre et la réalité de la photo permet de déterminer des paramètres de correction. Quelques problèmes inhérents à la rénovation d'un cadastre urbain sont mis en évidence.

1. Introduction

Land information systems are becoming more and more in use and municipal services of some important localities are greatly interested by informatized management systems for underground utilities. It appears logical that cadastral survey, and especially cadastral maps, which give a representation of the land surface, are used as a basis for such systems. Unfortunately, the digital cadastre is still missing in many Swiss and European localities, where merely graphic plans, sometimes more than a century old, are still in force today. If an improvement of this situation does not seem urgent on the legal and fiscal standards, it is untrue for the persons in charge of the physical planning and urban services who are confronted with problems of development and management for underground utilities.

Considering a new survey as an expensive and long operation, an emergency solution is possible by digitizing the existing graphic documents and combining them with data bases of land information systems. But in the case of old documents, the usual digitizing is dangerous because these documents may include deviations arising from paper distortion, and especially

from a succession of numerous revisions. Photogrammetry can then be useful as a tool for control and correction of the existing cadastre.

The Institute of photogrammetry has already investigated this problem and suggested a renovation's method based on the superposition of a digitized cadastral plan with enlargements of aerial photographs [1]. The projective deformation of the cadastral state requires to know the altitudes of all points of the plan, as well as the orientation elements of the negatives. The comparison of the adjusted plan with the photograph permits to analyze deviations, to define zones with homogeneous deformations and to select adequate control points. A concrete test [2] was carried out and showed better results with local transformations than with least squares interpolation proceedings.

Presently, a test of cadastral renovation by photogrammetry is being carried out in a section of Neuchâtel city. Our Institute is collaborating with the Cadastral Survey of Neuchâtel canton. The test is covering a surface of about 20 ha large, distributed on approx. 10 graphic plans, to the scale of 1:500, established around 1870.

This work allowed us to adapt and develop new processing softwares for an environment comprising a VAX 11/750 computer, a Haag-Streit/Wild EK22 digitizer (coordinatograph with numerical output), a Wild BC1 analytical plotter plus a Wild TA2 precision plotting table. A Durst enlarger for large size negatives is used for large photographic reproductions.

Next paragraph will be giving the main phases of the proposed procedure for a cadastral renovation by the mean of photogrammetry. Some of these phases are described further in a more detailed manner together with solutions brought to precise problems encountered in urban zones.

2. Main phases of a cadastral renovation by photogrammetry

A cadastral renovation, checked by the superimposition of the digitized plans with enlarged aerial photographs, needs some additional works. All operations can be summed up as follows:

1. Signalization of geodetic fix points and of a certain number of boundary marks of property, and eventually of basis points for cadastral revision
2. Survey flight
3. Digitizing the original cadastral plans, making up lines-file and immediate drawing of the digitized plans for visual control
4. Aerotriangulation, then photogrammetric height determination of all points of the cadastral plan on the analytical plotter
5. Projective transformation of the cadastral plan and superimposition on enlarged aerial photographs
6. Analysis of the deviations between the deformed cadastral map and the aerial photograph. Field verification and determination of the transformation zones
7. Conversion by zonal transformation of the digitized map coordinate into the national coordinate system
8. Verification of the corrected map by superimposition on the enlarged aerial photographs
9. Calculation of areas and plotting of the final plan. Data integration into an eventual land information system.

3. Digitizing of the original cadastral plans and control plotting

The proposed renovation method is essentially based upon the comparison of the projectively deformed cadastral plan with the photograph: it is thus particularly judicious to be able to draw easily and automatically the digitized cadastral plan. For this reason, the data are recorded under a "Lines-file" code-name, which is very close to a plotting file containing simultaneously coordinates and data on the nature of the points and on the line type, as well as the sequence of the points to join. This order has to be defined during the digitizing phase, respecting as much as possible the hierarchy of the lines categories, for example :

1 Property boundaries
2 Buildings
3 Walls
4 Footways, sides of roads
5 Ways, accesses

To avoid engraving several times the same stroke, each line of the plan is digitized only once, even when belonging to several categories. A number is automatically assigned to each recorded point, though not necessary.

Line categories				Point number	Nature-code (- cancels the symbol)	Feature type (- ⟶ spring)	Abscissa	Ordinate	Altitude	Curve-code	Plan number	Automatic number	Altitude of the roof
1	3	0	0	0	5	1	561715.563	204934.183	436.709	0	214	191	0.000
1	3	0	0	109	5	1	561718.918	204936.652	437.031	0	214	192	0.000
1	3	0	0	0	1	1	561718.455	204937.180	436.832	0	214	193	0.000
1	3	0	0	108	5	1	561705.718	204954.691	439.619	0	214	194	0.000
1	0	0	0	0	1	1	561703.137	204958.104	440.113	0	214	195	0.000
1	0	0	0	0	-1	1	561685.947	204945.406	440.507	0	208	196	0.000
1	2	0	0	0	-5	-1	561722.368	204925.114	438.948	0	214	198	441.078
1	2	0	0	27	5	1	561709.611	204912.661	438.755	0	214	199	440.962
1	3	0	0	0	-5	1	561708.596	204911.661	436.747	0	208	200	0.000
1	3	0	0	0	-5	-1	561712.082	204991.797	446.479	0	214	202	0.000
1	2	0	0	0	5	1	561737.517	205011.914	447.433	0	214	203	448.532
1	2	0	0	0	5	1	561739.824	205013.741	447.460	0	214	204	448.532
1	3	0	0	0	5	1	561740.119	205013.933	447.460	0	214	205	0.000
1	3	0	0	0	5	1	561742.845	205009.468	445.262	0	214	206	0.000
1	3	0	0	0	5	1	561754.847	204989.664	441.635	0	214	207	0.000
1	0	0	0	0	1	1	561768.818	204966.539	437.761	0	214	208	0.000

Figure 3.1
Extract from a lines-file

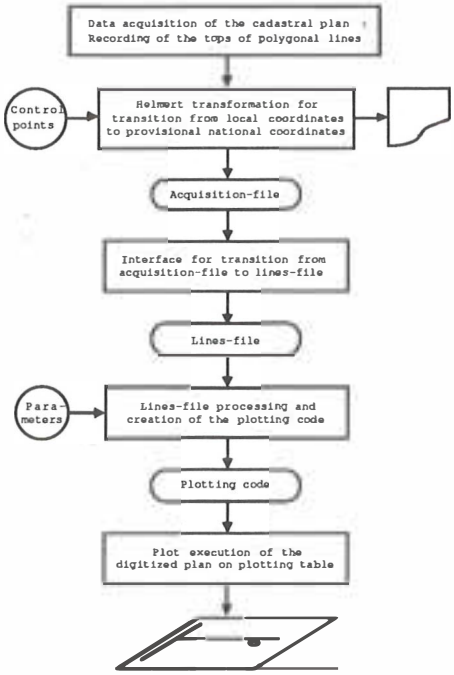


Figure 3.2
Digitizing and control plotting.
Diagram of the processing.

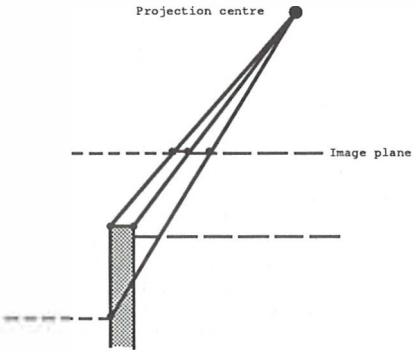


Figure 4.1
This figure shows that the wall limit at the ground level corresponds to nothing on the photograph.

To check up the digitizing work, it is recommended to plot the digitized plan on a transparent paper, thus permitting to make easier eventual corrections. Figure 3.2 shows the diagram of data processing from digitizing to control plotting.

4. Height determination of cadastral points

The projective transformation of the cadastral plan for the superimposition on the aerial photograph requires the altitudes of all digitized points. Determination of these altitudes can be made favourably by photogrammetric evaluation using the photographs foreseen for the superimposition. This operation should be made preferably with an analytical plotter, using the lines-file as a predefined file. The system drives then automatically the floating mark onto the points to be measured. As first height approximation for a new point, it is logical to keep the altitude of the last recorded point. The acquisition software is to be modified in this way.

In the case of a cadastral renovation in urban area, recording of the altitudes is not an easy operation as property boundaries are often mixed with those of the buildings and the walls. These boundaries are frequently hidden by vegetation and by buildings projection, or are lying in the shade of the latter. Consequently, a number of lines on the cadastral state do not show visible and well defined corresponding lines on the aerial photograph. In order to obtain a better display on the more visible level of the aerial photograph, it is useful to measure the altitudes of buildings corners on their roof too.
For the restitution of altitudes, the work of the operator is made easier by the consistent succession of the points to be recorded.

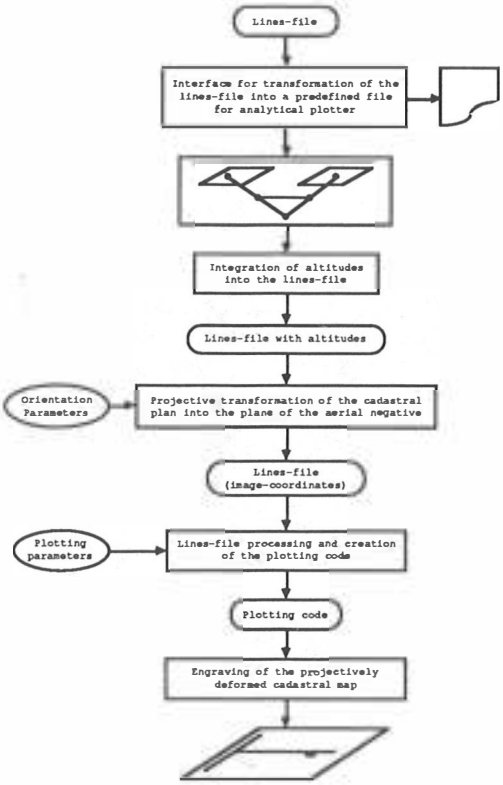


Figure 4.2
Height determination and projective transformation. Diagram of the processing.

That consistency is given by lines categories (boundaries, buildings, walls, ways, etc.) and by the sequence of points in a line (the objects must be described). Again, one remarks the importance and usefulness of the lines-file.

For numerous points, when dealing with an urban cadastre, it is often difficult to choose an altitude. It should then be remembered that comparison and analysis will be made with the help of the visible lines on the aerial photographs; in the case of walls, for example, the upper surface which appears on the photograph is the level to be restituted.

An accurate height restitution of all cadastral points is nearly impossible in urban area with only one model. However, a great accuracy is not required for points hidden by buildings projection if lines for comparision do not appear on the photograph.

Figure 4.2 shows the diagram of data processing from the height determination to the projective transformation and the engraving of the deformed map.

5. Projective transformation of the cadastral plan and superimposition with the enlarged aerial photograph

The projective transformation of the cadastral plan into the plane of a negative does no raise any problem. The transformation elements appear in the results of the block adjustment with the bundle method (coordinates of projection centres and spatial rotation matrix).

The projective transformation is applied to the lines-file "national coordinates" and we get a new lines-file "image coordinates" directly available for the engraving of the deformed cadastral state. This engraving will be executed on a plotting table, possibly with a scale neighbouring that of the cadastral map. It is important that the engraved lines be very thin to prevent hiding the photographic data during the superimposition (see figure).

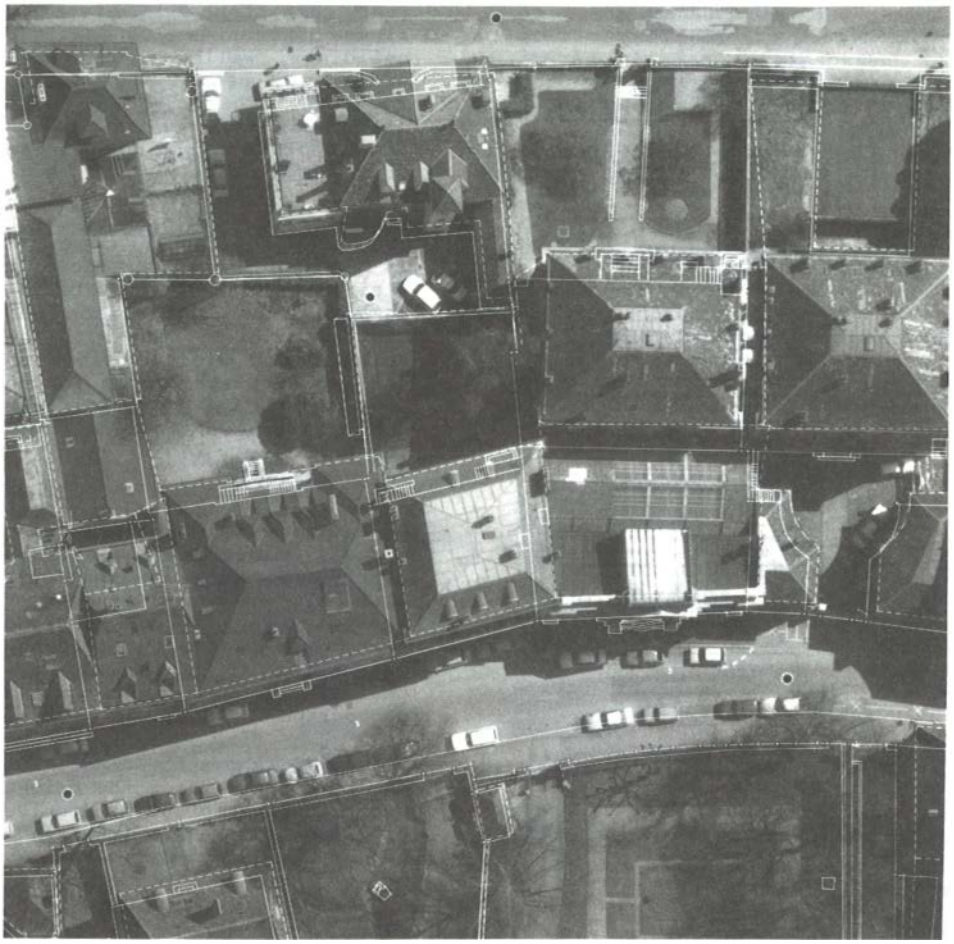


Figure 5.1
Superimposition of a projectively deformed cadastral plan with an enlarged aerial photograph. The buildings are plotted two times; the dashed line corresponds to their base at the level of the roof.
(Photograph reproduced by courtesy of the Federal Directorate for Cadastral Survey, Bern)

Three documents have been established for the superimposition and the deviation analysis of the digitized plan:

1) A positive film of the projectively deformed cadastral state

2) A simple photographic enlargement of the aerial negative at the same scale as the positive film

3) A photographic enlargement with superimposition of the deformed cadastral state.

Drawing up these documents requires of course high-precision equipment and stable supports. The plotting table should not introduce new deviations

into the cadastral state, and the enlarger must not distort the photographic image, which is the image of the reality. The realization of the superimposition is a rather delicate operation since it is executed in dark-room. The precise adjustment of the enlargement with the positive film is possible only by means of good points, well marked and easily identifiable. If necessary artificial points shall be set up before aerotriangulation measurements: they should be numerous and evenly distributed for a good control of the adjustment over all the enlarged surface.

It should be noted that this superimposition corresponds to the provisional transformation immediately introduced after the digitizing.

6. Analysis of deviations and determination of transformation zones

The photographic enlargement with superimposition will show the eventual deviations between the cadastral state and the image of reality. Divergences will be visible for signalized boundary marks, but especially for lines and surfaces of objects. The analysis should allow to define zones of homogeneous deformations which could be transformed individually. The essential tools for this visual analysis are the positive film of the deformed cadastral state and the corresponding enlargement, without superimposition. The protocoles of the successive revisions also give important information for the delimitation of zones. By shifting and adjusting the film lines locally on the photograph, the analyst is then able to define the transformation zones. However, one must be careful because this analysis is very subjective. The analyst should be very critical towards the homologous lines used as a basis for his adjustment. Finally, when doing this comparison, the analyst should also select the useful control points for the zonal transformations.

In urban area, few boundary points can be signalized; on the other hand, a number of boundaries are the same as those of the buildings or walls; this should make the comparison easier, provided they are well visible. Otherwise, the photogrammetric restitution of not signalized points, such as buildings and wall corners, does not offer a satisfying accuracy. The test of Vienna of OEEPE, for example, has shown an absolute accuracy of about ± 10 cm for this kind of points, which implies that deviations of 25 cm are quite possible. We were confronted with these problems in our Neuchâtel's renovation test, where no boundary points were previously marked. An adjustment's test with the help of wall and building corners was not probant. Among the reasons:

a) Difficulty to find enough control points

b) Bad distribution of these points

c) Too important residual errors when adjusting large zones

d) Doubtful quality of the original cadastral plan

Because of these difficulties, we had to elaborate a method to calculate the parameters of zonal transformation on the base of 4-5 vectors determined by manual adjustment. Practically, it comes down to measure the deviations for the points of the deformed map before and after the adjustment, and increase them with the provisional national coordinates to obtain the final coordinates. We can then deduct the transformation parameters. On the accuracy level, this visual adjustment is giving results difficult to estimate. However, with work documents to the scale of about 1:500, the deviations left should not be larger than 3-4/10 mm, which is

corresponding to 15-20 cm on the ground. This precision is also depending on the internal accuracy of the original cadastral plan and on the number of available elements for comparison (homologous lines).

The geometrical comparison of the cadastral state with the photograph is greatly aided by buildings display at roof level. However, great care must be taken with these elements: it is recommended to check on the ground if the base of the building is effectively centered under its roof. Besides, it is possible that a building is not situated correctly on its parcel.

This visual method of zonal adjustments is to be used cautiously, especially if few comparison elements are available, then risks are to introduce deviations on relatively short distances in limit zones. To check the reliability of the adjustments, a plotting of corrections, followed by some measurements checks on the ground, is recommended.

This method to determinate zonal transformation parameters avoids searching, identification and measurements of control points by photogrammetry. Finally, we see that the photogrammetric measurements only occur in the "aerotriangulation and height determination" phase.

7. Correction of the digitized coordinates by zonal transformation. Verification

In the above paragraph, we raised some problems bound to the choice of the transformation zones and to their parameters'computation. This is the renovation's most delicate part, for it will be strongly depending on the care brought to the analysis. The continuation is only a question of sorting and computation.

In order to make the sorting by zones, the perimeters are digitized and transformed into the national coordinates system. On the basis of these polygones, a selection software assigns a proper zone number to each point of the lines-file. Finally, the lines-file is corrected by applying to each point the transformation parameters corresponding to its zone number. The new cadastral state, as the original plan, can be deformed projectively, and then superimposed on the aerial photograph in order to verify the renovation. This procedure is exactly the same as described in paragraph 5.

8. Conclusion

Our tests have shown that photogrammetry allows to renovate appreciably degraded cadastre. Its application in urban zone is possible, even without signalized boundary marks.

The renovation method is based on a direct comparison of the plan with the aerial photograph, thanks to the outlines of homologous objects. That comparison requires a superimposition of the two data carriers, which are obtained by adapting the plan to the photograph's geometry. The photogrammetric measurements are limited to aerotriangulation and to height's determination of cadastral points, and eventually to an evaluation of natural control points.

Concerning the equipment, an analytical plotter and a photo laboratory fit with a high-grade enlarger for large size negatives are required. Analysis of the deviations and their corrections are particularly laborious.

Consequently, photogrammetric methods are justified only if a renovation by digitizing proves to be insufficient and if a correction of the coordinates is needed. It is yet still difficult to estimate the costs of pho-

togrammetry for a cadastral renovation. Nevertheless, the operation remains economic in urban area where, because of the great density of points, a new terrestrial survey is very expensive.

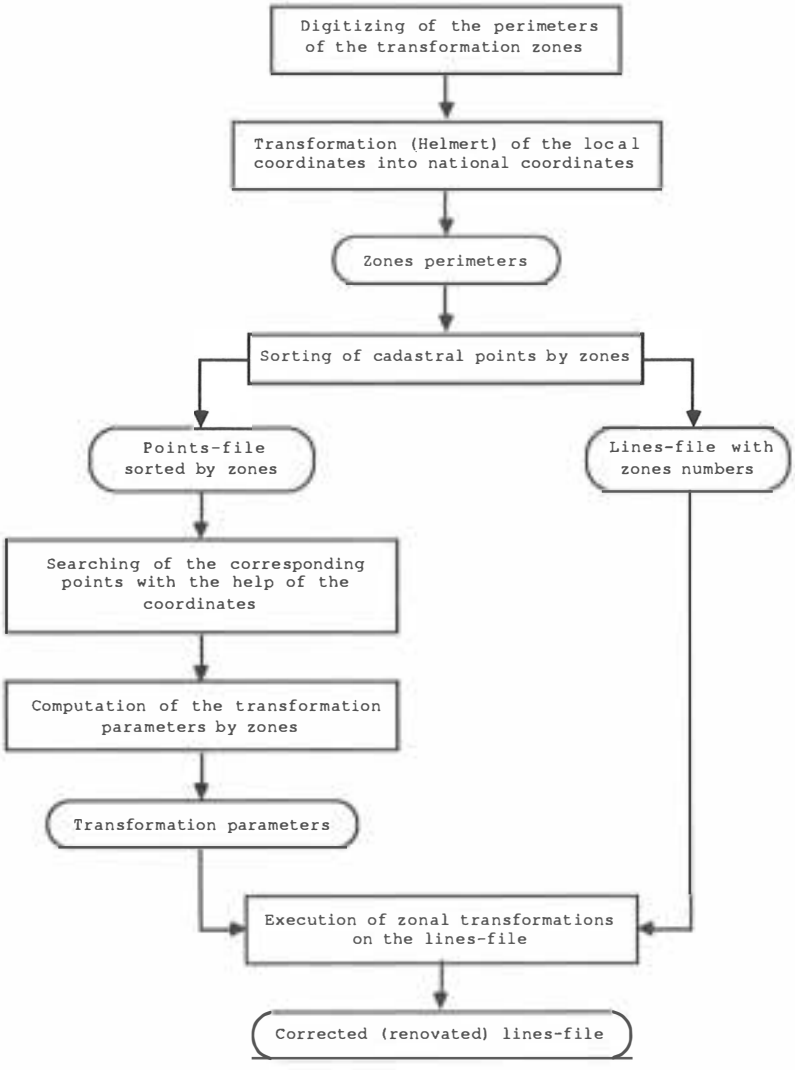


Figure 7.1
Correction of the digitized coordinates by zonal transformations. Diagram of the data processing.

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Travail de diplôme, EPFL-IPHOT 1980

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OEEPE, Official publication N° 16, Frankfurt a.M.
March 1986

Discussion after the conference of Mr. Pradervand

Waldbauer: Why do you deform the cadastral map instead of rectifying the aerial photograph and produce orthophotos ?

Kölbl: We are convinced that the aerial photograph is much more precise than orthophotos and that we have less measuring work to do. We are only measuring the points we are interested in and this easily up to a precision of 10 cm. If you make orthophotos in an area with great height differencies, the extrapolations lower the precision considerably.
In built up areas we use 2 levels : one is the base of the building at the level of the natural terrain and the other at roof's height. We measure and deform the drawing of the buildings for the roof level. This allows us to control symmetry aspects, which is generally not possible at the base of the building; in general, only two sides are visible at this level.

Scholl: The height differences must have an influence on the planimetric setting, especially at the edges of the models, even if you compute back the perspective deformation.

Kölbl: The height precision might be in the range of 10-15 cm, in a picture scale of 1:3'000. The focal length used was 30 cm, consequently their influence on planimetry is reduced by a factor 3.

Scholl: What magnitude of local displacement did you find with this method on old maps ?

Kölbl: Due to map revision we observed considerable local deformations which went up to 1 mm. In areas where a number of buildings were added we realize that the displacements are greater than in the center of the town which knows practically no changes concerning alterations and constructions.

With this method we can obtain a precision of :

mean square error ~ 10 - 15 cm
maximum error ~ 2 1/2 times as much => ~ 40 cm

Our method could be a quick approach. On a longer period I think that the limits should be measured again. But the natural features can always be derived from the old cadastral maps after a thorough revision.

CADASTRAL MAP DIGITIZING AND ITS COMPLETATION BY PHOTOGRAMMETRICAL REGIONAL MAP

R. M. Brioli
Direzione Generale del Catasto
Ufficio Tecnico Erariale, Pesaro, Italy

Summary For a low cost quality up-dating of old maps (that is with a lower metric content then original cadastral maps, albeit sufficient enough for other purposes) the integration may be used between cadastral maps on 1:2,000 and 1:1,000 scale - already or being digitized - and the most recent "Regional photogrammetric maps" on a 1:5,000 scale.

The procedure is the following: a preliminary plotting on the scale of the Regional photogrammetric map of the digitized cadastral map is carried out on polyester film and a preliminary comparison is then made, by simple overlapping.

By known algorithms (zone transformation) the geometric arrangement of the two supporting maps is made, if necessary.

As to all coincident elements after said arrangement, the coordinates of the original cadastral map are retained; for non coincident or even missing elements on the cadastral map, digitizing is made of the coordinates shown on the photogrammetric map.

It is thus possible to obtain a low - cost updated cadastral map (the Regional mapping is infact recent and it is revised or newly made quite frequently) though with updatings having a metric content peculiar to a smaller scale.

Moreover, every Fiscal Technical Provincial Department (about 100 in Italy) is equipped with a computer for the storage of all known available data, relating to surveys made by both its staff and indipendent consulting engineers, such data being supported by "reliable points". Processing of said data will allow to modify and correct the coordinates of reliable points, thus obtaining an even more dependable mapping.

Sommario Per un aggiornamento qualitativo (e cioè con contenuto metrico minore di quello della cartografia catastale, ma sufficiente per altre utilizzazioni) a basso costo delle vecchie mappe, si

può utilizzare l'integrazione tra la cartografia catastale a scala 1:2000 ed 1:1000, già numerizzata o in corso di numerizzazione, e la più recente cartografia fotogrammetrica regionale, alla scala 1:5000.

Il procedimento è il seguente: si effettua un primo plottaggio alla scala della carta fotogrammetrica della mappa catastale su supporto lucido, e si effettua un primo confronto per semplice sovrapposizione. Con algoritmi noti (trasformazioni zonali), si procede all'adattamento geometrico dei due supporti informativi. Per tutti gli elementi che, eseguito l'adattamento, possono ritenersi coincidenti, si conservano le coordinate della mappa catastale; per gli elementi per i quali non vi è coincidenza, o che sono addirittura mancanti sulla mappa catastale, si procede alla digitalizzazione delle coordinate rilevate dalla carta fotogrammetrica.

E' cosi possibile avere a basso costo una mappa catastale aggiornata (la cartografia regionale è infatti recente, e viene aggiornata o rifatta con sufficente frequenza), sia pure con aggiornamenti con contenuto metrico caratteristico di una scala più piccola.

Inoltre, ogni Ufficio Tecnico Erariale (a circoscrizione territoriale provinciale) dispone di un elaboratore in cui archiviare tutti i dati di cui viene a conoscenza, relativi a rilievi sia del proprio personale che di liberi professionisti, appoggiati a punti fiduciali.

La elaborazione di tali dati consentirà di modificare e correggere le coordinate dei punti fiduciali, ottenendo così un prodotto cartografico sempre più affidabile.

1. Introduction

The contents of a map are both qualitative and metric; firstly the map must allow to achieve such a knowledge of the territory as if it were seen from high above; secondly the map must allow to determine the coordinates of every point, according to the reference system.

It is well known that revision is one of major problems arising in a cadastral operation. The majority of cadastral surveys dates back to many years ago.

The present report refers to a revising experience for 1:1,000 scale maps for town centres and 1:2,000 scale maps for the territory of Emilia - Romagna Region (about 19,500 km^2), such maps having been mostly made by 1920 and being all available in the national system of coordinates (Gauss

- Boaga). Said maps are being digitized since this year.

The Region has up to date technical photogrammetric maps on a smaller scale (1:5,000, with photogrammetric shots at 1:13,000 scale having a 2,00 m planimetric allowance for well defined points), such maps being used for preliminary design of public utilities.

On the basis of digitized cadastral maps, or to be digitized soon, some public authorities undertaking public utilities in the Region have considered it advisable to carry out an experimentation for integrating the two mapping systems.

The above is due not only to the fact that public authorities often exact taxes for the services rendered, for wich both geometric and fiscal cadastral data are required, but as well for a quicker designing of the public works encumbent to same authorities.

This report illustrates the criterion adopted by the "Authority for the Reclamation of the Uso, Conca, river Valleys and the Riminese Agricultural Plain", together with the Municipality of Greater Rimini and the Emilia - Romagna Region, with the undersigned as a cadastral consultant on a territory covered by 74 cadastral map - sheets (about 150 km^2). The aim of said experimental program is to make available both the numerical cadastral system for the automation of the tax exaction service, and a valid support for designing on the basis of regional tecnical mapping and the contemporary drawing up of the particled expropriation plan on the basis of the cadastral map itself.

It is intended to extend such a system to all departments in charge of the design of large infrastructural works at regional level.

The system, moreover, allows, say as a by - product, an useful revision of the cadastral map, with a less precise content then the original map, but without the typical problem of precision loss by subsequent revisions.

The system is very economical too, because photogrammetric surveys already carried out for other purposes are used, and therefore it is useful for updating those areas of the regional territory, where an early actual revision of cadastral mapping is not foreseen.

2. Cadastral mapping

Italian cadastral maps are available on the following scales:
- 1:1,000 for town areas;
- 1:2,000 for rural areas.

In a minor quantity, moreover, 1:4,000 scale maps (for scarcely populated

and particled areas) and 1:500 scale maps (for some archeological areas or having particular interest) are available.

As a whole, the geometric features for some 70 million particles are included on over 310,000 sheets, the "mean age" of map sheets being 50 years.

About three fourths of the whole national territory have an acceptable mapping presentation; digitizing is therefore underway over such an extention.
Time foreseen for completing such process is 10 years approximately.

For the remaining part of national territory, the present drawing up of new maps is mostly made by aerial photogrammetry. The coordinates of vertexes of particled geometry and mapping references from stereoscopic model and integrating measurements on the ground are digitized and filed in a magnetic storage.

2.1. Digitizing of cadastral map

Digitizing of cadastral map, formation and use of the consequent data base are carried out through the following stages:
- input of geometric data;
- input of administrative data;
- operation of data bank (updating of geometric and administrative data);
- use of the data bank (issuing of certificates, tax levying, ...)

The input of geometric data will only be considered herein, which can be made by means of a digitizer or a scanner.

In a most synthetic way the following items have been studied and normalized:
- metodologies, requests of resolution and accuracy for wich a digitizer is used with at least 1/40 mm resolution and at least 1/10 mm accuracy through all working line;
- printing of checking lists to correct registration errors, if any;
- computing to transform instrumental coordinates into mapping coordinates, by the least squares method and utlizing not less than six orientation points;
- computing for checking particle areas, whose summing up must correspond to the total area as registered on cadastral books;
- computing for checking and compensation of sheet boundaries, because the vertexes of particles on such sheet boundaries must have mapping coordinates strictly even to those of corresponding vertexes of adjoining sheets;
- computing for compensation of the coordinates of particle vertexes, as each particle must have congruous coordinates of both common vertexes and adjoining particles;
- organization and system for data bank, to be achieved by hierarchical

levels.

With regard to the present work, the maximun error affecting the planimetric position of well defined points on the original maps at 1:2,000 scale resulted to be 40 cm after carrying out various checking measurements.

3. Regional photogrammetric map

The Regional technical map of the Emilia - Romagna Region is a 1:5,000 scale photogrammetric map, with 1:13,000 scale pictures. In the territory of Greater Rimini Municipality said map has been surveyed in 1986 (the previous photogrammetric survey of the Regional technical map dated back to ten years approximately).

The maximum admissible error affecting the planimetric position of well defined points is 2 m.

The grid for the geometric outlay of such a map is made out of the vertexes of the I.G.M.I., Istituto Geografico Militare Italiano, and also of the vertexes of the main grid, sub grid and detail vertexes of the Cadastral Dept.. In such a way, the geometric arrangement of the two maps is made easily.

4. Updating process

The first operation to be made is the drawing up of the cadastral map on the same scale as the 1:5,000 photogrammetric map on polyester film. The map drawn up in such a way is overlapped to the photogrammetric paper and then the geometric arrangement of the two maps is carried out.

It should be noted that the first experience, relevant at the moment to however only four out of seventyfour sheets planned for the experimental program, has stressed a substantial coincidence of the two maps, this being made easier by the fact that the two surveys have even reference systems and many coincident linking points, in spite of different timing and methodology.

Should the modification of routing for some water cuorses be excluded, the first area being checked has infact not undergone substantial modifications even with regard to crop dividing lines, wich still run along the ancient "Roman centuriation".

On the other hand many man - made works are obviously different, such as roads, canals and buildings expecially.

The area in reference has suffered many destructions durig the second World War (the so called Gothic line passed there) and the reconstruction

of buildings in slightly different position in respect of those on the cadastral map has been noticed.

Moreover, an always increasing discrepancy of buildings put into the map by successive revisions has been noticed, expecially for surveys carried out by independent consultants, enhanced by a suitable simbology.

In such case the cancellation of wrong cadastral coordinates is carried out, and new digitizing of coordinates is made with a less precision level, by using a photogrammetric map on lesser scale, but greater quality updating due to more recent photogrammetric pictures.

A suitable simbology is obviously allowing to put in evidence on the map the revisions introduced with such a process.

5. Future development

In each cadastral sheet, "reliable points" have been defined to which any surveys entailing map variations must be tied, both if such surveys are carried out by the Cadastral Dept. staff or qualified independent consultants. All surveyed data must be made known to the Cadastral Dept..

On every "reliable point" a hierarchical code is associated with its "reliability" which is from 1 (maximum, for trigonometric vertices of 1st order) to 12 (minimum, for border landmarks surveyed during revision and tested by the Cadastral Dept.).

Each cadastral technical office as been equipped with a computer exclusively used for the operation of "reliable points", storage filing and then computing of all main data made known to the Cadastral Dept..

In such a way, by means of subsequent updatings, it will be possible to modify the coordinates with those revising elements put in with coordinates originating from photogrammetric maps on a lesser scale.

N.B. The Italian cadastre is very similar to the French cadastre. It is a tax cadastre with no legal status. In large towns, cadastral offices are working together with private enterprises on the renovation of the cadastre for the needs of utility services. Photogrammetric and terrestrial methods are applied in these projects.

AUTOMATION OF ITALIAN CADASTRE

ACTUAL AND FUTURE DEVELOPMENTS

Dr.Ing. Carlo CANNAFOGLIA
Italian Department of Cadastre
R o m e

Summary Peculiar organizational problems of the traditional register of landed property will be overcome by the revolutionary help of information technology. The Cadastre is becoming an efficient instrument at the service of the community. The more significant requirements and some of the programs now being developed are described here.

Sommario I problemi organizzativi e gestionali degli atti catastali possono essere superati attraverso l'utilizzo delle tecnologie informatiche. In tal modo il Catasto può diventare un efficiente strumento conoscitivo del territorio al servizio della comunità. Nella presente memoria vengono illustrati i più significativi risultati e gli sviluppi in atto nel Catasto Italiano.

1. The Rural Cadastre

The Rural Cadastre was created between 1886 and 1956: surveys are carried out on a geometric-parcel basis, estimates made according to quality, class and rates. It is carried out for civilian purposes. It is a property census to enable the exact identification of land plots. But, it is also carried out for fiscal purposes by giving geometrical elements of the property (limits, extension and shape) and surveyance elements contributing to the formation of taxable earnings (harvest, production level and produce) thus allowing land rating.

The documents which concur to the formation of the Register for each censused Commune and for which conservation has to be carried out, are:

1) parcel map;
2) a listing or index of parcels;
3) a listing or file of their numerical references;
4) a listing or file of the owners.

As from 1968 storage procedures such as updating administrative census documents for land surveyance (list of plots, records of their numerical

references, list of owners) have been automated. Nowadays this automation has been progessively extended to all the Nation. The present Organization is of a centralized model and it is built around a DP Centre linked by teleprocessing to the peripheral cadastral departments.

The files belonging to the different Communes are kept at this Centre. Their updating starts with a phase in which the periphery gives data using interactive conversation by phone with the Central processing unit, which carries out formal and logical checks.

Data controls on the files are carried out by batch processing procedures and errors are detected and reported. Corrections are then made through teleprocessing. Changes are then evidenced (flagged) on listings of owners files, plot files. This data is then sent to the relative peripheral offices that update their own files.

This kind of organization has many drawbacks though: the great number of manual and repetitive jobs, the amount of library space at peripheral offices and finally the complexity of running teleprocessing networks.

All this has led to the idea of adopting a decentralized but controlled organization as opposed to the present central processing organization.

The following aims want to be attained by this organization:

1) Obtain a flexible information system - this would allow for modification and implementation of function and data distribution without having to revise implemented applications.

2) Pass the updating of cadastral files in real time on to the peripheral offices using appropriate computer applications thus freeing the Central EDP Centre of any peripheral applications.

3) Delegate validation of modifications introduced to the EDP Centre. This would then manage only national historical files and preparation of certificates when required by the periphery.

4) Allow the Centre to dedicate its own resources to manage and maintain application software; in addition to statistical processing, research and study processing for a national library.

5) Eliminate hard copy libraries at the periphery and produce visual and certified documentation for the public. This could be carried out using video-printers linked to local processing units. Furthermore peripheral units could be implemented with yet another back-up library (COM) to be used in case of system interruption.

Initial hardware for such a Centre comprises a system using OS/MVS operating systems with interactive programming; and an unattended computer for each local unit using a specific system for interactive data transmission. It should be able to cope with the data volume contained in local files and all modifications.

It is expected that such a system should be flexible enough to achieve

also automation of urban surveyance procedures. There is as described below a project now in the study phase that will foresee:

- updating to changing national socio-economic requirements;
- integration of the files of Landed property Register documents with automated cartography requirements and finally it will provide for linking with the Landed Property Registrars Offices ("Conservatorie").

These offices in fact have to ensure the publicity i.e. the appeal of third parties to judicial negotiations connected with property.

Both the Registrars Offices and the Registers of Landed Property (for both urban and rural property) have civil functions. The first have a probatory character (as they ensure certitude of rights in the property field) whereas the second ensure full knowledge of land, as far as identification of building and related owners are concerned.

The Register of landed property constitutes a full inventory of land ownership and will be enhanced by automated data acquisition of those elements needed to manage the various aspects it includes. It will then mainly have the job of guaranteeing the functionality of its numerous elements: the listing of property; systems for property identification; their identification of a map; the planimetries of urban property units; the definition and updating of their descriptive parameters.

2. The Urban Cadastre

The formation of the New Urban Cadastre was brought about in 1939 - its aim was multiple; it was to ascertain urban property ownership and determine its income; it was also to constitute a general building survey and include other urban land too.

General land certification as done on a property unit basis further to a written declaration and attached planimetry.

The documents that legally constitute the Urban Cadastre for each censused Commune on the national territory are the following: the file of numerical references, the ownership file, the numerical reference file pertaining to land maps and other subsidiary documents and necessary complements (maps; certification and classification indices) etc.

The planimetry for each individual urban property unit is not considered a legal document of the Register but is however filed and often required for indicative purposes.

In the present system the procedures for storage of files are very complex - they are still mainly manually updated on hard copy.

This is why it has been considered a must to carry out a study to revise the existing urban register system. This study is also aimed at defining

an automated system of parameters for the attribution of land income for single declared property units but have not yet been included in the census (assessed).

Furthermore the automation of the ownership files has been implemented (mod. 57) and so has that of the numerical listings in order to reach a local management of the above documents by computer.

3. Cartographical Land Surveyance

Cartographical production of the Italian Cadastre also in its function as a State Cartographic Administration is basically regulated by law n. 3682 of 1/3/1886. This law prescribes "that the extension and shape of each single property be drawn as well as the various cadastral plots and that they be represented by planimetric maps linked to trigonometrical points".

In practice maps are produced and updated in the following scales:

- 1:1000 for areas of intensive urban development
- 1:2000 for areas of reduced urban development (suburbs, for instance) and
- 1:4000 for agricultural areas.

The discovery of the utility of cadastral maps for civilian purposes and the possibility of making it even more functional has led the Administration to commence actions, that should be adequately legally supported, to obtain the following results: integrate surveyance maps with data such as altimetry and other information; recuperate metric precision of representational geometric information of small parcels of land in continuous and dynamic evolution; lastly to establish the geometrical characteristics of surveyance maps using coordinates.

This will be used with an automated cartographic surveyance management within the chosen computer environment.

Just as an example the various operative phases already established in the peripheral management of land surveyance are described below.

3.1. For Research - Viewing and Certification

The first phase will consist in the research within the existing library and by visualization on a screen of the area of map required. Access to the library can be carried out using blocks (keys) represented by surveyance codes (Commune - number of map page - numerical reference of parcel of land) or by topographical definition using limited coordinates.

The second phase will be a screen representation on hard-copy or plotter-printer with alpha-numeric data pertaining to the required parcels of land (Commune, map page, plot, coordinates for the vertices, surface,

etc.) as well as the stable reference points next to or within the required area (vertex monography, coordinates).

3.2. By surveing controls (surveings)

At the beginning videographic and numerical calculus functions will enable one to transform topographic measurements carried out according to the coordinates of old and new significative reference points.

In a second phase one will have an interactive control of these coordinates in comparison with the original ones on file and a flagging of the differences and of the incongruences.

3.3. By file updating

In the first phase a visualization of plots to be updated will take place; then: new dividers will be introduced and creation of derivative plots will be considered; following that, automated calculation of derivated plot surface and checking in comparison with the extension of the plot originallly on file will take place; finally: updating of the geometric library will be carried out.

A codification of the new elements introduced has been foreseen and the corresponding updating of information of an administrative kind will take place.

THE 1:1.000 MAPPING OF THE CITY OF MODENA OBTAINED BY PLANOALTIMETRIC INTEGRATION OF CADASTRAL MAPS

Dr.Ing. Giorgio BEZOARI
Institute of Topography, Photogrammetry and Geophysics
of the Polytechnic of Milan

and

Dr.Ing. Carlo CANNAFOGLIA
Italian Department of Cadastre
Rome

In the complex panorama regarding the production of large scale maps, the interesting experiment currently being carried out with the Local Administration of Modena is particularly worth noting, if we consider its originality.

The possible implications of this operation have an effect both on the sector of technical operations and on that more closely connected to the management of the cartographical and information instruments on loan to the Local Council and Cadastral Administration.

What we are seeing, then, is the process of formation of a large scale map edited by two Agencies of traditionally diverse operation and with definite differences with regard to cartographical problems, now united by circumstances in a technical, economic and organisational joint effort. The go-ahead for this experiment dates back to 1980, when the Modena's Local Administration communicated its need for a basic technical map, updated as necessary, to be used as a data-support for the setting up of a local Territorial Information System.

The inadequacy of the maps available at that time (reduced to 1:5.000 scale as used on Regional Technical Maps) and their impracticability for the purpose stated above put the Administration in the position of having to carry out a careful evaluation of the tools most suited for the job.

Both technical and economic observations directed the choice away from ex-novo mapping, toward the re-drawing of existing cadastral maps to 1:1.000 scale by means of an aerophotogrammetrical updating.

The choice adopted was determined on one hand by the availability of recently drawn (1962) cadastral maps of the area under investigation (urbanised areas), and on the other hand by the possibility of acceding to the information in possession of the General Land Office.

Consequently the cartographical choice of necessity that already adopted by the General Land Office, 1:1.000, for the representation of the relevant territories.

These areas, characterised by their urbanisation, cover a territorial extension of about 3,200 hectares and 133 cadastral maps.

The technical measures that constitute the technical background of this operation were drawn up by a specially formed committee consisting of members of the Cadastral Administration, with a view to guaranteeing the necessary connection with the cadastral mapping to be used as a basis and the convalidation of the standards to be followed by the Administration, aimed at the possible use of the redesigned maps. The approach which has been chosen refers to an updating carried out by using methods that are now customary in photogrammetry, starting from a traditional cartographical base of aerophotogrammetrical type, which is kept updated by the General Land Office mainly by means of manual interventions, outside generally accepted tolerances for such a scale of representation.

With this in mind, it becomes evident that previously drawn updatings make it necessary to obliterate, in a documented and careful manner, all integrations succeeding up to the period of the new drawing.

Also, the information traditionally contained in cadastral cartography needed an integration, both with regard to altimetrical data (inserting both land dimensions and the eaves of buildings) and to an enrichment of descriptive details.

The specifications that regulate the drawing up of the map in question do not generally differ from those adopted for large scale cartography. The specific details serve to regulate the areas where this initiative differs from the traditional methods.

With regard to sheet-format, no innovative elements were introduced and the cadastral findings were maintained (close perimeter maps).

In addition no previsions were made for topographical framing operations, considering the intrinsic characteristics of this initiative (the updating of already existing maps).

Differing from usual procedures - which includes the photogrammetrical shooting - the initial phase for the attainment of planoaltimetric integration foresees an absolutely accurate planimetrical orientation of the models, carried out through 8 support points, identifiable in the model in question and characterised by the edges of buildings or objects clearly visible on the photograms, with a checking of data to be rejected as they show up on the single support points.

Before passing to the restoration phase and therefore to the drawing up of the map, the support points of an altimetrical type are drawn out, their dimensions taken from the line of geometric levelling for the urban zone of Modena, adopting the usual tolerance values.

With regard to restoration, there is no need to dwell upon the procedures to be followed and the precision to be satisfied, as laid down in the specifications, as these also are as normal.

Finally, it should be noted that the indications relating to graphic representations are substantially similar to those normally in use by the General Land Office administration. The use of the cadastral maps supplied by the Local Office of Cadastre of Modena and used as support to the work of planoaltimetrical integration has brought about several problems.

In particular, the original maps on toughened paper that gave good results in the feasibility studies carried out by the contracting company, would have entailed if used the complete re-design of the updated maps, with related extra economic burdens.

Consequently the operating choice was for the use of copies of the original maps on translucent material.

This decision, however, did not have equally appreciable technical acceptability, in the sense that the translucent maps were not a faithful copy of those on toughened paper, which showed up in a lack of homogeneity in the altimetrical representation and even, from time to time, in the making of parameters.

In order to avoid such inconveniences, operating procedures were set up in a form partially modified from the initial technical standards of the specifications, with regard, among other things, to the possibility of following the orientation of each model in separate phases, map by map.

With regard to the cooperation between the Local Government of Modena and the General Land Office Administration for the drawing up of the above-described mapping, one of the objectives to be attained is that of designing the man in numerical form, therefore manageable through elaborative procedures, with a view to:

- allowing for a complete treatment of all cadastral information (geometrical and that relating to administrative censuses) in a computerized form within the local technical revenue office;
- using the map as an information base of direct relevance to the Local Council, as a general regulator, toponomy, and for zoning (subdivision of the territory into quarters, blocks, lots, etc.), thus defining a strict logical interconnection between communal and cadastral files by means of an one-to-one punctual correspondence on the territory.

On a purely cognitive level, we would recall the acts officially constituting the Italian General Land Office, upon which updating operations are carried out:

1) the particel map;
2) the list or file of the particles;
3) the register or file of items;
4) the list or file of owners.

Procedures inherent in conservation, that is, the updating of census administration by the General Land Office - the list of particles, register of items, list of owners - has been progressively computerized

since 1968 up to the point of covering all of the national territory. The cadastral map was put into numerical form, in its current state, only in limited pieces of territory.

Because of a strong tendency towards manual operations, the extension of the space devoted to files in non-central offices, together with the complexity of running centralized teleprocessing networks - this difficulty increasing as they expand - makes it now essential to pass from the level of an organisation centred on elaborative resources, as current, to that of a decentralised organisation run at the level of a provincial technical revenue office for cadastral files of territorial competence.

These considerations also conceal the need that large quantities of information be made available both to the General Land Office administration and to the local territorial agencies. It is currently very difficult to make use of these, and results are uncertain, and their full potential will only be reached if they are reconnected - homogeneously for rapid access, to the cartographical base.

We can identify a prime example in the cadastral field, where the diversity in updating times for the acts (extremely varied, for example, in the cases of the New Urban Building Land Office and the New Ground Office) has unfortunately made it necessary in some provinces to divide the cartographical representation, creating very serious obstacles and inconveniences to tracing and using file information.

Therefore a new evaluation of cadastral information will without doubt be brought about by the reordening and reorganisation of the files, especially by the prospect of their being run in a reunified and computerised manner.

In this light, we should call attention to the fact that cadastral cartography, supported by other data collected administratively and by means of censuses, may be read at various levels, a few examples of which are listed below.

- Administrative level
  Cadastral cartography, having the authority of official documentation, and due to its scale suitable to the finding of adequately precise metric information, is the basis for the determining of surfaces within the competence of territorial agencies (Municipalities, Provinces and Regions), and of the areas of public waters and streets. Thus, we can easily deduce its importance in administrative affairs.

- Geometric level
  A cadastral map graphically represents fixed properties with earning capacity, both spacially and reciprocally with the territory.

- Economic level
  A particle perimeter may be of physical or conventional origin, and in the latter case, we must underline the distinction put into effect

through the identification of earning capacity of a property coded according quality and class.

- Legal level
  The cadastral particle may originate simply from a different positioning of the property with regard to rights of ownership (differences among owners, other conditions being equal). The validity of this aspect, on an operational level, is exclusively limited to connections between property and user of the income in question, in other words the owner, as far as taxation is concerned.

The importance of cadastral information therefore is clear in the setting up of anyone working on the territory, not only on the basis of abstract concepts, but with a view to a more complete vision, both on qualitative and quantitative levels, with regard to economic and social activities on the particular territory. The data that can be found have a determining role in the selection of expansion areas and in procedures for dispossession and the calculation of relevant compensation.

The cadastral map, precisely because of its rigorous geometrical characteristics and scale of representation, can also provide an irreplaceable support to the territorial localisation of services and activities.

The study of the urban framework of city centres worked on cadastral maps with a view to building recovery or to identifying on variations in fixed properties, connected to the carrying out of illegal construction, is only one recent example of the importance of cadastral data for the execution of the law (identification of the owners of properties for administrative purposes).

There is also a growing interest in the use of maps in the form of an exclusive technical elaboration. For example, municipal agencies are becoming more and more aware of the need for a more rational and more satisfactory running of technical workings in the cities, of the formation of appropriate filings of a cadastral type to aid the identification of works in the territory, and of an adequate inventoried description of these.

The lack of this type of information is heavily reflected in the costs of maintenance work, especially with regard to vertical expansion in urban centres (underground railways, underground distribution networks, etc.).

The use of cadastral maps in updated form as numerical cartography basis to the running of other municipal aspects finds a valid support in the fact that the Land Office administration has defined a geometric, cadastral data base organised according to a logically levelled structure, where each piece of information may be acquired and used autonomously.

To these levels of cadastral geometry (for example, the borders of map sheets, land particles, streets, waterways, etc.) we can add other levels

of information, representing knowledge of the territory, either on a qualitative or quantitative basic, not represented in cadastral cartography.

From the specific experience of the Local Administration of Modena, the possible added provisions are concerned with:

- altimetrical information expressed through level curves and stated points;
- morphological characteristics of the land in the form of escarpments, hills, etc.;
- architectural differences among different groups of buildings;
- identification of public green belts and representation of high-trunked plants.

The geometry that characterises the identified areas should be added to these cartographic points, with a view to the management of the territory from an administrative point of view, such as:

- area or district,
- census section;

or from a more purely technical, social or economic viewpoint, such as:

- blocks,
- lots,
- wings.

The identification and definition of such areas as a continuous unit of complete cadastral particles is of fundamental importance, in order to be able to assimilate these territorial agencies into the continuity of a cadastral map, thus making possible an unambiguous relationship between communal files and corresponding cadastral ones.

Finally, it should be underlined that the updating of basic mapping, a uniting of differing functions, must be demanded from the agencies which have, institutionally, the burden of managing single fractions, whose duty is to maintain each unit as far as data bank structure is concerned on an autonomous level, organised and made up according to the individual needs of the managing agencies.

RECONCILIATION OF GROUND AND AIR SURVEYS
A U.K. PERSPECTIVE

Peter F.Dale
Department of Land Surveying
North East London Polytechnic

Summary.

In most countries, cadastral surveying has traditionally been based on ground survey methods. Modern photogrammetric techniques are now capable of producing accuracies equivalent to, or at times better than the overall accuracies obtained by ground surveying. In the maintenance of a cadastral system, both ground and air survey techniques may be used. Ideally the standards of accuracy should be compatible. In practice, this is often not so. It is therefore necessary either to adjust the measurement data, or to store the raw data in a data base, along with an assessment of their quality. This paper examines the problem and outlines how a partial solution can be found.

1. Introduction

From the earliest times, cadastral surveying has been dependent on ground surveying to record the limits of each property. Early attempts to introduce photogrammetric methods failed because of their relatively high costs and lower accuracy in comparison with ground methods. Today techniques exist which compete favourably on both counts. Ground survey is most suited to small tasks, whilst photogrammetry comes into its own when the techniques of mass production are needed. The unit cost for fixing an individual property corner beacon is largely dependent on what in production terms is referred to as the economies of scale - the more the number of points which are coordinated, the more cost effective will be the use of photogrammetric techniques. In cadastral surveying, photogrammetry will never compete with ground methods when only a few points are to be recorded - for instance in subdivision work. Likewise it has no contribution to make when setting out new plots although it may be of help in the design stage. It can, however, be used to densify control as well as to survey individual boundary beacons. In terms of accuracy, ground survey, though capable of measuring with high precision, tends to produce results which are less homogeneous than photogrammetry. The latter, given air visible marks of the appropriate size, suitable photography, first order analytical plotters and modern computing facilities, can achieve precisions of the order of a few centimetres.

Whilst such accuracies are possible, there are many circumstances under which they are not in practice achieved. The precision of photogrammetric work depends upon many factors, the most important of which is the scale of the photography. Assuming that the size of the air visible ground marks is compatible with the scale of the photography, then the smaller the scale, the lower the precision of measurement but the cheaper the unit costs of production. Economic pressures force many organisations to work to the minimum standards of accuracy and precision necessary for the job in hand. In reality there is a difference between what is theoretically possible and what, certainly in the current United Kingdom economic climate, is justifiable within the resources available.

2. The Problem of Reconciliation

This paper is not concerned with the merits or otherwise of one method of survey as against another. It is taken as axiomatic that, given adequate resources, each technique is capable of producing accuracies that are adequate for cadastral purposes. The paper is also not concerned with whether existing standards meet the necessary and sufficient conditions for the sound operation of a cadastre, though it is concerned with how these standards are expressed. The prime focus of concern is the fact that new surveys are often to higher standards than previous surveys. As a result, new surveys must be down-graded to fit the old, or the old surveys must be up-graded, or some compromise between the two approaches must be found. Given the coordinates of two property beacons held in a data base to a precision of a decimetre and a measure of the ground distance between them to a centimetre, should the higher precision be ignored or the coordinates in the data base be revised? Should a cadastral plan show measured plot dimensions more precisely than can be computed from the coordinate values ?

At the recent Conference of Commonwealth Surveyors, Furmston referred to the changing concepts inherent in the new technologies, such as in the Global Positioning System, and wrote (**1**):-

"..the conventional wisdom, no doubt fuelled by historic limits to the parameters which could be measured, lays great stress on the accuracy of bearings and relative distances. Over cadastral distances these accuracies cannot be attained by absolute positioning methods, a factor which has also inhibited the use of photogrammetry in numerical cadastre."

The problem is of course neither new nor unique to Europe nor to the relationship between ground survey, photogrammetry and the cadastre. The need for reconciliation can arise specifically in the context of ground survey alone. Textbooks have been written dealing with such matters as "the Order of Importance of Conflicting Title Elements" and "Control of Conflicting Elements Within a Subdivision" (**2**). These have tended to produce rules whereby each problem can be solved on an individual basis without interfering with any adjoining land parcels. They do not solve the more general problem.

The need for reconciliation can stem from the poor quality of old surveys, some of which may have been undertaken more than a century ago; or from priority being given to the actual location of corner beacons in the ground in precedence to measurement information. In the English speaking world this is described as "Marks before Measurement, Pegs before Plans" and results from the acceptance of occupation rather than mathematics in the redetermination of boundaries.

More recently the problem has arisen with conventional ground control surveys. Under traditional land survey practice, the surveyor worked from the whole to the part, adjusting the secondary surveys to the primary, the tertiary to the secondary and fourth order to the tertiary. The quality of each stage of the survey used to be designed for consistency so that lower order surveys were undertaken to lower order accuracy. With modern electronic distance measurement, the quality of measurements is now often much higher than the quality of the control to which it is to be adjusted. Photogrammetrists recognised the problem a long time ago and simply adjusted their surveys as a best mean fit to the control. A field surveyor, running a traverse between two major control stations, will still attempt to adjust the work for consistency, holding the higher order control station coordinates as fixed. In so doing, good quality angle and distance measurements will be distorted to conform with a long established principle. For mapping purposes, the distinction between the observed and adjusted quantities may be no more than academic. For engineering and, more particularly for cadastral purposes, the distinction may be of vital significance.

The problem is also beginning to arise where graphic data are digitised and the resulting coordinates are held in a data base. In the United Kingdom, for instance, the declared intention of the Ordnance Survey is to work towards a scale free data base. Although there is some uncertainty as to what this means, one view is that the coordinates are as accurate as the values quoted. Thus if known to a centimetre, the values will be quoted to a centimetre but if known only to a decimetre they will be quoted to one decimal place of a metre. At present, when maps at 1/1250 scale are digitised, the coordinates are held to a ground equivalent of 5 cm; for the 1/2500 series the figure is 10 cm. Since the plottable accuracy is in each case less precise, there is a degree of unrealism. Be that as it may, a problem arises when ground survey measurements are linked into the data base for coordinates can then be produced with a nominal precision of 1 cm. How should the different standards be reconciled? In the long term it may be possible to resurvey the whole country and upgrade every coordinated point to a centimetre accuracy - which is an alternative meaning to the phrase "a scale free data base". No-one in their wildest dreams believes that this will happen so how should the data base be structured?

3. Land Title Surveys in the U.K.

The answer to such a question must be put into a context. In most countries, the greatest demands for precision come from engineering surveyors and from those concerned with the ownership of real estate. Cadastral surveying, as known in mainland Europe, does not exist in the United Kingdom. None the less, in the urban areas of England and Wales, State guaranteed titles are available to those whose property has been registered. A similar system is being introduced in Scotland where at present, unlike in England and Wales, there is a comprehensive register of deeds. Both systems of title registration use the Ordnance Survey large scale plans as a basis for their property descriptions. Boundaries are mapped to graphic standards only, except in very abnormal circumstances. Properties are currently subject to a tax known, as the rates, which has some parallels with the European fiscal cadastre. Ordnance Survey maps are used to locate the land parcels. The rating system is, however, being phased out and will be replaced by a poll tax.

The land title system in England and Wales works on what are known as general boundaries. The State does not normally guarantee whether the precise line of a boundary is one side of a fence or hedge, or the other, or down the middle. The reconciliation of numerical data therefore causes no legal problem. In the urban areas, the supporting plans are at a scale of 1/1250. There are about 50,000 map sheets at this scale and most were produced photogrammetrically. In the rural areas there are 150,000 sheets at a scale of 1/2500. These were originally drawn on the Cassini projection but as a result of the Davidson Committee Report in 1938 (**3**) it was decided to convert them to the national grid which uses the Transverse Mercator projection. This "overhaul" operation took some 50 years to complete using, in many cases, rectified aerial photographs. For both series, map revision is carried out on a continuous basis. Thus if a new property is built and the title to the land is to be registered for the first time, the Ordnance Survey will immediately carry out a survey of the plot for the Land Registry. In urban areas it is generally uneconomic to revise the maps using photogrammetric methods, and hence ground techniques are used. Fortunately the quality of the original surveys is, generally, good. In rural areas, the quality of the overhauled maps is, however, such that reconciliation of new surveys with the existing records is difficult and in due course new surveys will be needed.

Although graphic standards of accuracy meet most practical requirements, there is a move towards a numerical system through map digitising. In future all graphical map data will be held in digital form. These data will need to be revised using either field or photogrammetric methods. It is of course always possible to carry out a resurvey, plot the amendments and then to digitise the resulting graphic. Such an approach has the advantage of consistency in the data base. Given automatic methods of field survey data capture, with coordinate values available to higher precision, it is not a very efficient approach.

4. Land Information Systems

The need to reconcile data that have been captured to different standards is becoming more acute with the development of land information systems. Here there is a need to place a wide range of independent surveys on a unified spatial base. In many countries, surveys have been compiled separately, for instance cadastral records may not integrate with topographic, whilst the records of underground services such as buried gas, electricity, water and sewerage pipes are seriously deficient. In theory there is no need for this problem to arise since given good survey control and good basic mapping, all elements can fit together. If that had happened in the past, there would be little interest in land information systems today - they would simply be taken for granted. As it is, in many countries, land records do not form a coherent whole and limited resources are available for resurveying and remapping. The existing records, however deficient, will form the basis of most land information systems and will only be replaced by good quality new surveys bit by bit as money and manpower become available.

More significantly, cost benefit studies have yet to show the value of high precision, high quality mapping. In many countries, administrators and financiers are reluctant to allocate resources to an exercise where the up-front costs are high and the returns on investment are long term and possibly only marginal (4). In the United Kingdom, there has recently been an enquiry into the handling of geographic information. Known as the Chorley Report (5), it has made a series of recommendations to speed up the digitising of the Ordnance Survey maps but cautioned that "should a more rapid programme result in extra funding being required this should be found by the main users" (6). The dominant user group is that concerned with the utilities (such as the water, gas and electricity distributors) who are prepared to sacrifice precision for a speedy resolution to their digital mapping problems. From a geometrical point of view, inconsistencies in the data will be inevitable, at least for decades and possibly for centuries.

5. Standards for Data Quality

The reconciliation of surveys undertaken to differing standards must be seen in the context of how those standards are defined. In many countries, the accuracy of a cadastral survey has traditionally been expressed as a proportional error, for instance 1 part in 10 000. This relates to the accumulated bearings and distances of the boundary lines around a parcel of land and was adopted because surveys were often undertaken as a traverse around a plot. Such an expression has little meaning in photogrammetry where the the size of the error ellipse around any point is a more relevant measure. As a compromise, the accuracy of a ground survey may be expressed in terms of the agreement between coordinate values when a boundary beacon is fixed from two separate control stations.

In the National Transfer Format recently proposed for the exchange of digital map data in the United Kingdom, it is stated that (**7**):-

"Ideally, positional accuracy should be calculated on the basis of standard error, circular error or other established technique, and expressed in terms of metres on the ground to make it independent of scale.

Such an expression may only be valid at the database or section level, in which case it can often be related to a scale, such as 1/1250. The use of scale as a method of stating positional accuracy is acceptable provided that the accuracy implications are clear. It has advantages, in that the same statement of scale can also be used to convey information about generalisation and interpretation rules applied during data collection".

In the proposed format (**8**) the data record should include X_Coord, Y_Coord, QPLAN, (Z_Coord, QHT) where QPLAN is a single alphanumeric character showing the planimetric data quality by reference to the means of data capture and QHT (where heights are included in the record) contains the equivalent information for the height determination. This allows for every point to have an indication of its quality, but only in terms of the means by which it was surveyed. It does not resolve the problem of defining the accuracy of each individual point. The problem also exists in photogrammetry where standard errors may be used to define the overall quality of the work but the reliability of the distance between pairs of individual property corner beacons may in practice be inconsistent with ground measurements. A ground survey traverse is effectively self checking but the quality of any individual photogrammetric measurement is only partially related to adjoining points; in photogrammetry there is no independent check on whether the operator placed his floating mark correctly on every ground point. Hence quality controls over the accuracy of every individual measurement are difficult in photogrammetry.

6. Towards a Solution

In an ideal world, all data would be consistent and to a high standard of accuracy so that all users, even the most demanding in terms of accuracy and precision, could take advantage of them. The inconsistencies discussed above would be avoided by having high quality surveys to high precision. The scale free data base would be a reality. Some countries, such as Switzerland (**9**), appear to be in the enviable position of being able to justify resurvey to such standards. The United Kingdom is certainly not such a country. The upgrading of the basic survey fabric will be a slow and agonising process. There are many more urgent calls on the national resources. Thus the choice is either to lose the quality of good survey measurements to conform with the principle of consistency or else to store the raw data in an archive, flagged to indicate its quality, and to hope that one day advantage may be taken of it. The latter course has its own cost in terms of long term data storage. It is however the only solution at present on offer.

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1. Furmston B.E., 1987. Trends in Survey and Mapping Seen from Britain. Conference of Commonwealth Surveyors Paper A4

2. See for example Curtis M.Brown *et al*, 1957. Boundary Control and Legal Principles. 2nd Edition. Wiley. §4.12 & §5.15

3. For more details on Ordnance Survey Large Scale Map Series see Harvey J.B., 1975. Ordnance Survey Maps, a Descriptive Manual. Ordnance Survey, Southampton

4. The issue is discussed more fully in Dale P.F.& McLaughlin J.D., 1987. Land Information Management - An Introduction. Oxford University Press (in press)

5. Lord Chorley *et al*, 1987. Handling Geographic Information. Report to the Secretary of State for the Environment of the Committee of Enquiry into the Handling of Geographic Information. London, H.M.S.O. pp.208

6. Chorley Report *op cit*. Recommendation No.4

7. Working Party to Produce National Standards for the Transfer of Digital Map Data, (NTF), 1987. The Assessment and Transfer of Data Quality. Release 1.0 Ordnance Survey. p.2

8. N.T.F. *op cit* National Transfer Format pp. 6-51 & 6-76

9. Professor Otto Kölbl. Personal communication.

Discussion after the conference of Mr. Dale

Jerie: "Scalefree data base" is another word for digital data base because no scale reduction is applied.

Dale: So you would accept digitized data of 1 in 50'000 provided that you say it came from 1 in 50'000 ?

Jerie: You always have to attach a label to the accuracy. Earlier it was presented it in figures that meant that you should not reduce it to a shorter distance on paper.
The anglosaxon system is very different from ours with all these relative accuracies: one in 10'000, one in 50'000.
But I think it is not true, even in your own interpretation the higher order (first order) network has a higher accuracy as long as you talk about relative accuracies.
In terms of absolute accuracies, as we talk about coordinate accuracies, that is different. A lower order point does not have a higher absolute accuracy, it is only correlated with its neighbours and therefore distances are more accurate in absolute terms.

Dale: In some countries the specification for cadastral survey is one part in 10'000 for closing traverses. If you do not close on the first trip point, then you go on to the next one and provided you go on long enough you will find a point in the end where you can close with one part in 10'000. It is not a satisfactory way of expressing it.

Jerie: For all practical purposes only relative accuracies are required as long as we stay in one sytem.
Trouble comes up if we use photogrammetry because it is another type of measuring system with another internal geometry.
Or, if we want to join 2 cadastral systems we also need absolute accuracies.

Dale: But with modern technology we input data from all sort of sources.

Kölbl: The new tolerances of the Swiss cadastral survey define only a relative precision. It corresponds to the half axis of the error ellipse expressed as relative precision to the next point.
This is our only definition for precision; in earlier times, we did not have any for triangulation points, we had only tolerances for polygon points. The topographic service made the triangulation and nobody was allowed to interfere with the polygonation, so it was an internal question which precision should be achieved.

Dale: If this is true for adjacent points, would you accept that the next point was at the other side of the lake ?

Kölbl: For triangulation, yes.

Dale: Is it totally independent of distance ?
So it applies to points 10 m apart or maybe 10 km apart ?

Jerie: The error between these 2 points is more or less proportional to the distance. This comes almost down to 1 part in 10'000. The difficulty is that these prescriptions are a mixture and I think that it will be difficult to apply them to photogrammetric measurements.
Photogrammetry is a different measuring system, you obtain a very high relative accuracy in one model, but it will greatly lower if you go from one model to the next one. The discontinous accuracy properties make things complicated.
What do you do with the combination of "more accurate" and "less accurate" data ?
From the standpoint of adjustment theory, there is no problem. If you have independently measured points and suddenly you find a more accurate distance between them, you can shift them relative to each other. The trouble starts if you do that once again, because now the 2 points are correlated and eventually you will have to adjust the whole network. Now your system is getting correlated. This can be done on a computer but the question remains : is it worth doing it so ?

Kölbl: Can the methods we heard about be also applied in developing countries or should there be completely different solutions ?

Dale: The crucial question is ressources. Not only money, but also time, equipment and manpower.
The problems are very urgent and the populations in those cities are increasing rapidly. Partly this is provoked by an increasing birthrate, partly by the influx of people. These countries have no time for a complicated solution. Their problems are not far away from those of utility companies who want a quick and cheap solution. But if you go for that, you will need to produce a better solution in the future.

3rd Part

Realization in the Different European Countries

Chairman :

J. Krüger

REALIZATION OF CADASTRAL RENOVATION.

John Krüger
Matrikeldirektoratet, Copenhagen

Summary Cadastral renovation is a necessary, but very great task.
The European cadastres seem to move towards multi-purpose parcel based land information systems.
It is therefore found essential to speed up the process of converting analogue maps into digital map bases.
In the paper a brief comment is given to some of the problems which are going to be treated during the session.

Introduction.

The realization of cadastral renovation will of course follow the lines defined under the conceptual aspects.

The cadastral systems are by nature conservative and the legal aspects may be considered as a drag upon a quick development of the old systems.

It seems a fact that the greater tradition a country has in cadastral mapping, the greater are the problems in changing the system.

However most of the European cadastres seem to be moving towards multipurpose parcel based land information systems.
This is so because cadastral information is playing an increasingly important role in planning and administrating modern society, as it is a key to combining information from a lot of different sources, among which a great many have no graphical reference of their own.

Ways of cadastral renovation.

A mayor obstacle for most countries is to convert the map information from the plane-table measured island maps which have no relation to the national grid and which have only few or none measurements available.

The best way no doubt is to perform a terrestrial or photogrammetrical remeasurement, but that requires a lot of time for the field activities. It gives high quality maps, but the costs and the time consumption are considered too high.
Consequently the use of this method is decreasing.

As most of the European countries have no financial means to complete the transfer in the mentioned best way within a reasonable period of time, different cheap solutions to the problem of converting island maps into frame or digital maps have been performed.
Orthophotos and topographic base maps have been used successfully in tackling the problem.

Interactive graphic systems have made it possible for cable and pipeline companies to relate all registrations concerning the cables and the pipelines to their basemap and thereby perform the administration and the surveillance of the lines by means of the work stations.

In some countries this has put more pressure on the demand for the production of an official boundary element to the system.

However, the interactive graphic systems also imply possible means for speeding up the procedure for producing digital cadastral maps.

In this respect it is essential to remember that the precision requirements of many map users are lower than the ones necessary for the cadastral registrations.

A lack of quality in the latter may be met by introducing the concept of dynamic mapping.

There seems to be common agreement among the countries of Europe that concerning the realization of cadastral renovation it is essential to give priority to the control network.

The control network.

A stable and permanent net of control points represents an absolute necessity for any cadastral renovation and for the subsequent updating of the system as well.

The accuracy standards of the point determinations are varying from country to country, assumingly dependent on the kind of cadastral system and the class of land in question.

The standards are varying from +/- 2 cm to +/- 10 cm.
It is recognized as being essential to have only one reference system for all surveys.

The control points therefore have to be marked in a visual and secured way.

As regards the physical marking of control points the use of probes will probably be more common. A probe is a circuit with a certain frequency cast in a tube of polyethylene. If the probe is placed down to about one meter below the surface of the ground, it is possible by means of a special detector to seek out its vertical axis with an accuracy of about 1 cm.

The advantage of such probe marking is that it is not easily lost during road work and that it can furtheremore be seeked out even when snow, ice, mud or alike cover the ground.

In the multi-purpose cadastre the collection of data is likely to be done by several users of the system i.e. surveyors, municipal authorities, pipe-line companies etc.

It is therefore to be recommended that clusters of points in the reference system are visible and directly accessible or anyhow easily accessible, for example corners of houses, sewer lids (signalized) etc. In other words the system has to be made as user-friendly as possible.

The point determination is done either by means of an appropriate analytical-aerotriangulation with additional parameters or by means of terrestrial methods.

The situation today.

My main impression of the situation today is

- that cadastral renovation is regarded as a necessary but very great task

- that great effort have been and still is spent on converting the written records of the cadastre into edp and to build up systems to handle those data,

- that also great effort is spent on building up datafiles which can serve the purpose of automating the surveying and mapping data for example:

  Point data file consisting of:
  - general point data
  - position data
  - point remarks

  Planimetric data files

  Observation data files

Those data files are considered as needed for the running of a modern cadastral system and is a big step towards the digital cadastral map as part of a fully automated system.
Realization of cadastral renovation is carried out in all the countries. It will be interesting to learn more about it during this session.

Copenhagen september 1987.

THE CADASTRE
consists of

The register
2'500'000 parcel numbers

Maps
15'000 sheets

Measurements
1'000'000 measurement sheets

Main quality :

- Covers the whole country
- Covers all properties (2'000'000 units)
- Is kept up-to-date every day

TODAY :

- PARCEL REGISTER
  2'500'000 parcel numbers
- CADASTRAL MAPS
  15'000 sheets mostly 1:4'000
- MEASUREMENTS
  related to boundaries (2'000'000 files)
- THE REGISTER OF CONTROL POINTS
  approx. 360'000 pts increasing by 7'000 pts per year

CADASTRAL MAPS

- Since 1884 covering the country «Daily updated»
- Index-map for the system
  Key to the measurements

Scale 1 : 4'000 ?

1 : 1 ?

The use of the cadastral map

For cadastral purposes :

Maps combined with measurements
Best accuracy = accuracy of measurements

For non-cadastral purposes :

Maps without measurements
Best accuracy = accuracy of the map

Consequence :

NEED FOR BETTER MAPS

BUT :

SPECIAL PROBLEM

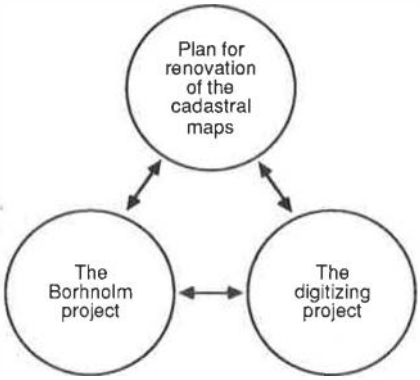
«Island maps» not related to national grid

Plane table survey

HOW

do we in the simplest possible way relate the «island maps» to the national grid

?



Begun in 1979, the Bornholm-project had its starting point in purely manual working methods, but these have been successively extended in the direction of digital methods along with the progress of the production.

In connection with a pilot-project concerning establishment of digital cadastral maps, the Bornholm-project forms the basis for the mapping policy of the cadastral department.

BORNHOLM

PILOT-PROJECT

- Draftsmen
- Technical maps
- Air photos
- Orthophotos

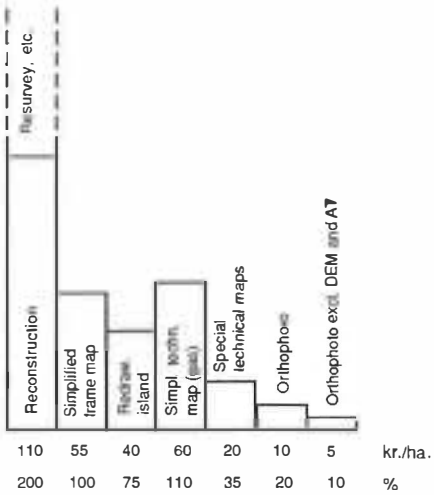
One of the aims was to investigate the use of orthophotos for the rectification of the cadastral maps.

In this process, the draftsmen normally use technical maps in combination with measurements from the archives. But they are very often forced to consult the aerial photographs in order to interpret the significance of the situation shown on the technical maps.

The introduction of orthophotos for the job improved their situation and was a great success.

BORNHOLM

Production-costs for different types of maps, October 1984.



The prices are only to be used in case of large coherent mapping jobs in open rural areas.

The first column solely represents the own expenses of the cadastral department making a proper cadastral re-mapping.

BORNHOLM - PROJECT

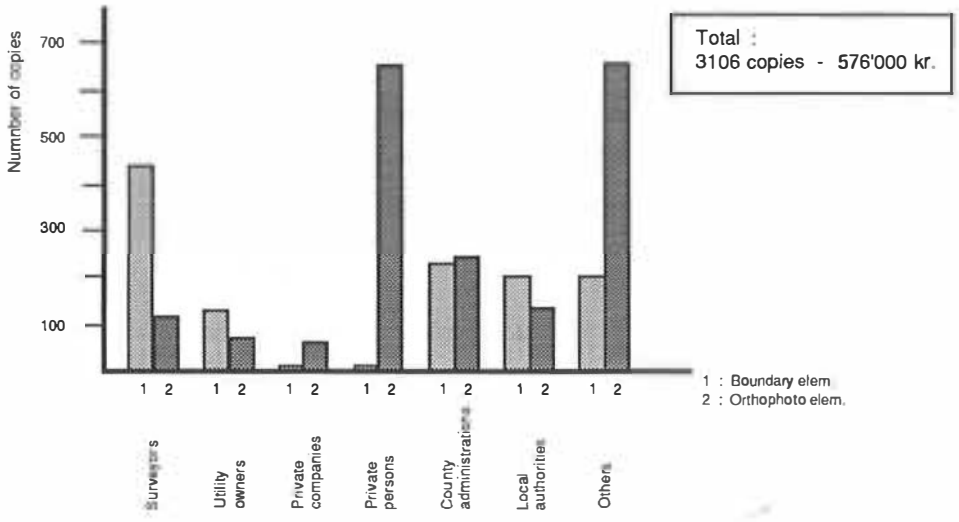
Formular example : Price pr. orthophoto (1984)

$$\frac{Md + Bd}{C \times D} \times (100 - S\%) + M + W$$

Md	=	Depreciation (in Danish kroner) on the basic **M**ain products (air photo-graphy, etc.)
Bd	=	Depreciation (in Dkr.) on **B**y-products (elevation data base etc.)
C	=	Number of sold **C**opies (per annum)
D	=	**D**epreciation period (per annum)
S%	=	Possible **S**tatesubsidy (%)
M	=	**M**aterial cost etc. (Dkr.) } reproduction per orthophoto (C)
W	=	**W**age cost } reproduction per orthophoto (C)

For coupled orthophoto maps (i.e. an orthophoto coupled with some additional theme) an extra fee is charged for the coupled theme e.g. cadastral maps, reference grid and/or contour lines.

BORNHOLM

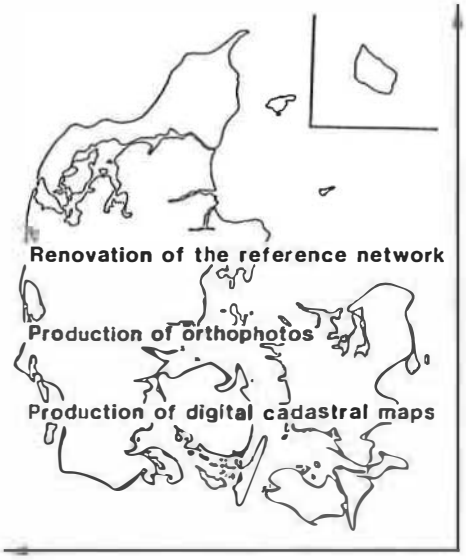


Bornholm is covered by approx. 120 sheets

Normally, 1-2 copies of each sheet are sold; on Bornholm, the number is 20-30 copies per sheet.

MD MATRIKELDIREKTORATET

Modernization of the Danish cadastral mapping system



Plans for RENOVATION OF THE CADASTRAL MAPS

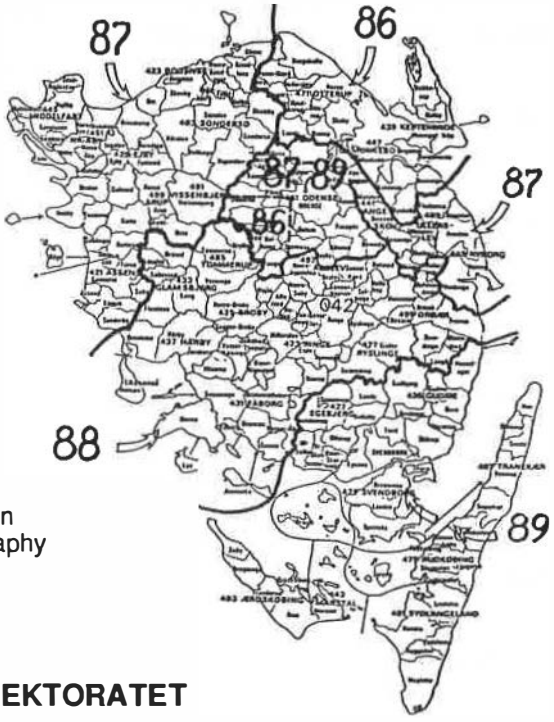
(10%) - renovation of the reference net
(10%) - orthophotos
(80%) - digital cadastral maps

approx. 700'000'000 kr. - 15 years

◆▮●▮◆

Decision from the government (10 Dec. 1985)

- approval of the plans
- a loan of 77'000'000 kr. - 4 years
- first phase on Fyn (10% of DK)



The county of Funen (Fyn)

Stages of the modernization plan
defined by the years of photography

MD **MATRIKELDIREKTORATET**

We are moving towards LIS

AIMS :

- make the cadastral map suitable for providing geographical reference to parcel based registers
- do it quickly
- do it sufficiently well

Open rural country ≈ 95%.
Cadastral map is the only large scale map covering those 95%.

RECOORDINATION OF MINOR CONTROL POINTS

Cadastral fixed points

WHY ?

- Primary geodetic net being re-coordinated by the Geodetic Institute (1970-1990)
- Cadastral minor control-net non homogeneous
- Quality of coordinates insufficient

HOW ?

- Analytical a.t.
- Every third point targeted the rest of the points : Recalculation.

  Natural points determined for later updating

AERIAL TRIANGULATION

- Photo scale 1:18'000 (c = 0.15)
- Panatomic, overlap : 80/30
- Ground control : 2 x b
- Tiepoints targeted : 1 x b

MSE : < 10 cm

FIELD CHECK

- Bundle adjustment (add. parameters)
- Pat B
- Pat M
- Bingo

Same photography used for orthophoto production 1:4'000

COLLABORATION WITH LOCAL AUTHORITIES

In urban areas

Photo scale 1:7'000

Mean square error < 5 cm

Targeting of all minor control points

The local authorities pay the extra expenses

COLLABORATION WITH OTHER AUTHORITIES

State railways

Telephone companies

Electricity companies

State road department

Gas distribution companies

Targeting of points for registration of pipelines

SCHEDULE

Stage	Local mun.	Area km2	%	Number	Negotiation	Photo	Orthophoto
1986	3 1/4	416	12	100	Feb. 86	May 86	May 87
1987	11 1/2	1103	32	250	June 86	May 87	Feb. 88
1988	9 1/4	1095	31	250	Feb. 87	May 88	Feb. 89
1989	8	870	25	200	Feb. 88	May 89	Feb. 90

FYN - PROJECT

Formular example : Price pr. orthophoto (1987)

$$\left(\frac{Dc + N}{D \times C} + M + W\right) \times (1 + O) + P$$

Dc = Direct Development Cost etc.

N = Production price for orthophoto Negatives, including «by-products»

D = Depreciation period

C = Number of sold Copies (per annum)

M = Material cost etc. (Dkr.) } reproduction per orthophoto (C)

W = Wage cost } reproduction per orthophoto (C)

O = General advance on Overhead

P = Profit

Discussion after the keynote of Mr. Krüger

Jerie: You said that you sold 3'000 sheets on the Island of Bornholm. How many copies per sheet did you approximatively sell ?

Krüger: The island is covered by 120 sheets, that makes an average of 20-30 copies per sheet. Normally we sell 1-2 copies per sheet.

Jerie: How did you obtain the price, and how does it relate with the costs ?

Krüger: We did the work ourselves as part-time jobs and we made a thorough study on the relation between cost and price. We used a rather simple formula for the calculation of the price :

Formular example : Price pr. orthophoto (1984)

$$\frac{Md + Bd}{C \times D} \times \left(\frac{100}{S\%}\right) + M + W$$

Md = Depreciation (in Danish kroner) on the basic **M**ain products (air photography, etc.)

Bd = Depreciation (in Dkr.) on **B**y-products (elevation data base etc.)

C = Number of sold **C**opies (per annum)

D = **D**epreciation period (per annum)

S% = Possible **S**tatesubsidy (%)

M = **M**aterial cost etc. (Dkr.)

W = **W**age cost

} reproduction per orthophoto (C)

For coupled orthophoto maps (i.e. an orthophoto coupled with some additional theme) an extra fee is charged for the coupled theme e.g. cadastral maps, reference grid and/or contour lines.

In order to make the users accustomed to the product we introduced it for a period of time for half the price.

Kölbl: The scale of 1:4'000 is rather small for a cadastral map, do you also use it in built up areas ?

Krüger: In built up areas we use scales in the range of 1:2'000-1:1'000, but this concerns a rather small part of the country. Furthermore, the municipalities have made good technical maps there. They are expected to provide a good support in improving our cadastral maps. Anyhow, the built up areas cover only ~ 5% of the country and our modernization plan is pointing at the resting 95% where the need is greater.

CADASTRAL RENOVATION BY PHOTOGRAMMETRY IN FINLAND

Matti Jaakkola
National Board of Survey
Finland

Summary At present the 1: 20,000 topographical maps cover the whole country and maps on a scale of 1: 500 - 2,000 the urban areas or about 10 % of the total area of the country. In order to meet the basic professional map needs especilally in the rural areas of southern and central Finland the National Board of Survey initiated orthophoto mapping on a scale of 1: 5000 in 1979. The photogrammetric co-ordinates for about 50% of all boundary marks will also be measured.

1. Introduction

For cadastral use, the mapping of Finland can be divided into three categories namely,

-The topographical basic maps on a scale of 1: 20,000 cover the whole country. They have been prepared and are maintained by the National Board of Survey. They include the real estate boundary element. The location of the boundary mark on the map is based on photo interprepation and a regrouping of the old cadastral parcel maps. As such, it is an index of real estates and boundaries, and was not meant for technical use.

-In towns and other densily populated areas, the scale of primary topographical maps varies between 1: 500 and 1: 2,000. The municipalities are responsible for these maps. They have been compiled mainly for town planning, and the map of these areas is usually complete. The boundary marks have been measured with an accuracy of a few centimeters. The 1: 500 - 1: 2,000 scale maps cover less than 10% of the total area of the country.

-Common standards have been followed in making the maps in the groups mentioned above. The third group consists of maps on scales varying between 1: 4000 - 1: 8000. They have been prepared by various agencies for special purposes without following any common principles of general mapping. Some of these surveys have extensive coverage, e.g. cadastral parcel maps and forestry taxation maps cover most of the country. Although, they have been maintained separately by two different organisations, their information contents are virtually the same.

In the first half of the 1970s, when the 1: 20 000 scale basic mapping of the country was nearing an end, one alternative which arose in planning the new mapping activities involved unifying and standardizing the unintegrated 1: 4,000 - 1: 8,000 scale surveys. An investigation of the need for and use of the maps was carried out by the National Board of Survey in 1976-77. Over 80% of all replies indicated that the boundaries were considered the most important element of the map when the 1: 20,000 scale topographic map of the country is ready.

2. Product

As a result of this investigation, the National Board of Survey held a test in 1977-78 which included complete 1: 5,000 scale topographical mapping of about 40 map sheets or an area of one rural municipality. An orthophoto base for each map sheet was also included in the test. Because the compilation of a complete topographical map was found to be far too expensive development of a map type on a scale of 1: 5,000 was started. It includes two elements:

- the orthophoto base map
- the boundary element

The boundary element is always presented in two ways: as a numerical boundary element, which is the primary result of the process, and as a graphical map. The first areas, covered by about 90 map sheets, were photographed in 1979.

3. Production method

The outlines of the production technique and some the technical details are presented in appendix I. However, some aspects may need closer inspection.

In order to achieve an accuracy for the boundary marks corresponding to the standards of boundary measurements, the co-ordinates of the boundary marks have to be determined using a geodetic or photogrammetric method. Photointerpretation or combining of the old cadastral parcel maps alone were not considered reliable enough. Photogrammetric triangulation was then selected as the primary method for collecting co-ordinate data.

The base of the aerial triangulation consists of the national horizontal control survey and of the signalized boundary marks. The premarking is carried out voluntarily by the landowners. In this way, we can have photogrammetric co-ordinates for only about 50%-60% of all boundary marks. The rest have been computed using old cadastral boundary measurements or have been placed on the map using photointerprepation . The photogrammetrically measured co-ordinates are intented for use as fixed values in carrying out new boundary surveys later on. We would also be able to check the co-ordinates of those boundary marks which have not been signalized and measured directly.

A fully computerized or automated system has been selected for prosessing data from the boundary element compilation. This has been done not only for economic reasons, but also, because of future needs in the use and revision of the boundary information. This also serves our land register reform, in which the manual register will be converted into a computer based real estate register. By using of the 1: 5,000 scale base map, we will try at approximately the same time to improve the quality of the register information, especially in the case of areas and other physical measures of real estate. So the 1: 5,000 scale base map is a start for the computer based co-ordinate cadastre. The first round of mapping will not of course provide us with the complete content of such a cadastre. The work will be completed along with the normal real estate surveys. The surveyors will be obliged to link their new measurements with the existing co-ordinates of the boundary monuments if they are sufficiently compatible.

That is why primary attention in the first round has been focused on obtaining photogrammetric co-ordinates for as many boundary marks as possible. This is a basic requirement. From the technical point of view, it is essential that the boundary lines of each parcel form a closed figure.

Some minor formal improvements have been planned in connection with the 1: 5,000 scale mapping. Homogeneous classification of existing boundary information is an example.

4. Production plan

Until now, the National Board of Survey has carried out this new mapping in about sixty municipalities . It includes 4,600 map sheets (size 0.5 x 0.5 m) on a scale of 1: 5,000. The statistics of this material show that on average there are between 8,000 and 15,000 boundary marks in each municipality . The average size of one municipality is 300 - 600 square kilometres , and with co-ordinates for about 50% of all boundary marks already determined the density of the measured boundary marks in our rural areas is about 10-15 points/square kilometer.

The experiences to date have been quite positive. The voluntary premarking of the boundary marks, which is the most critical part of the process, has been more successful than anticipated. In this type of mass production aerial triangulation has proved more suitable than the other possible methods.

According to our present production plan, we will cover about 50% of the country in 25 years with this new map. The coverage of the production in 1980-1987 and the production plan for 1980-2005 are shown in appendix II.

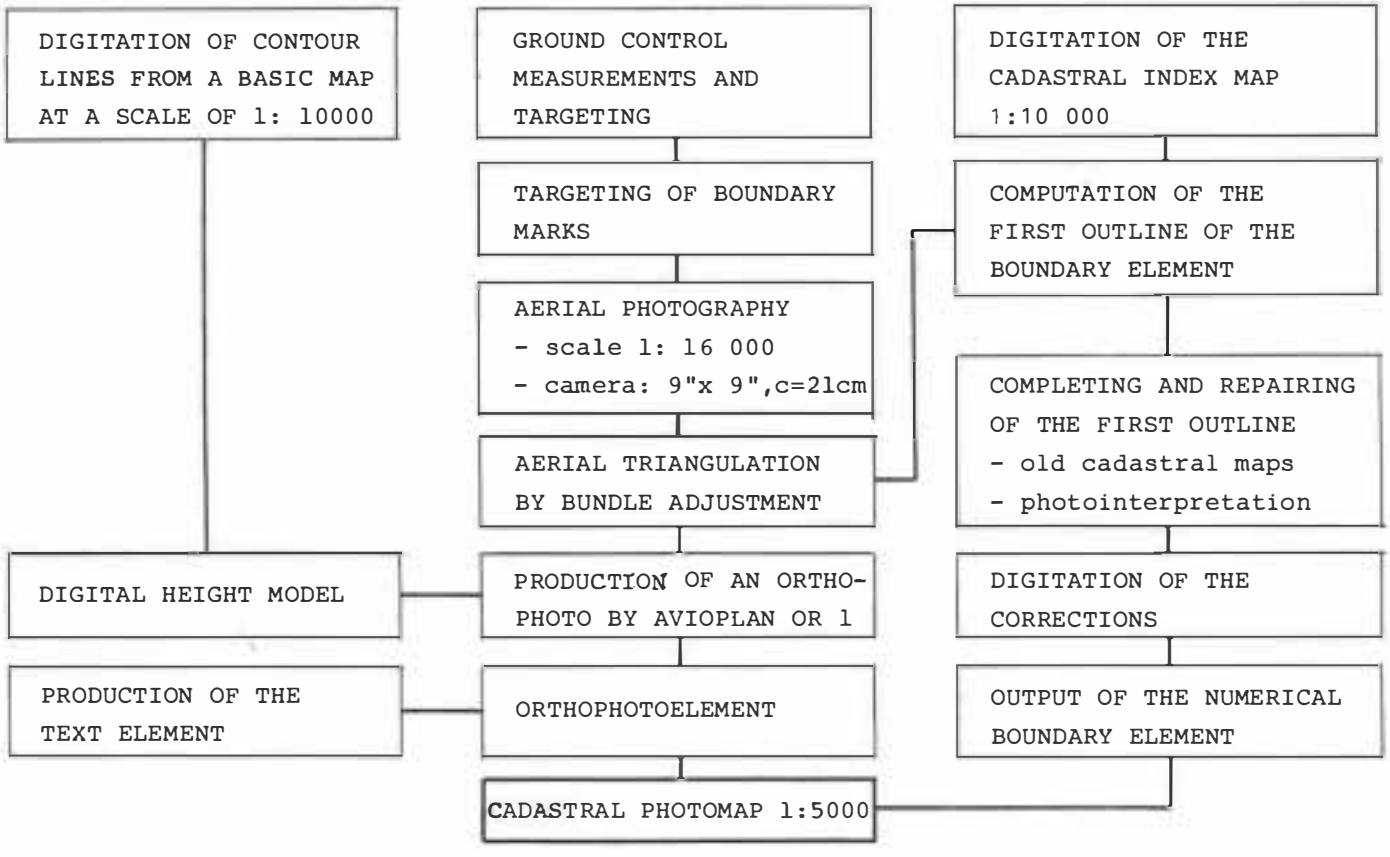
In addition to the legal boundary surveys, the map will serve other activities in rural areas such as planning, fiscal purposes, forestry, agriculture etc. For each specific purpose the user of the map has to prepare his own additional element, and bear the cost himself.

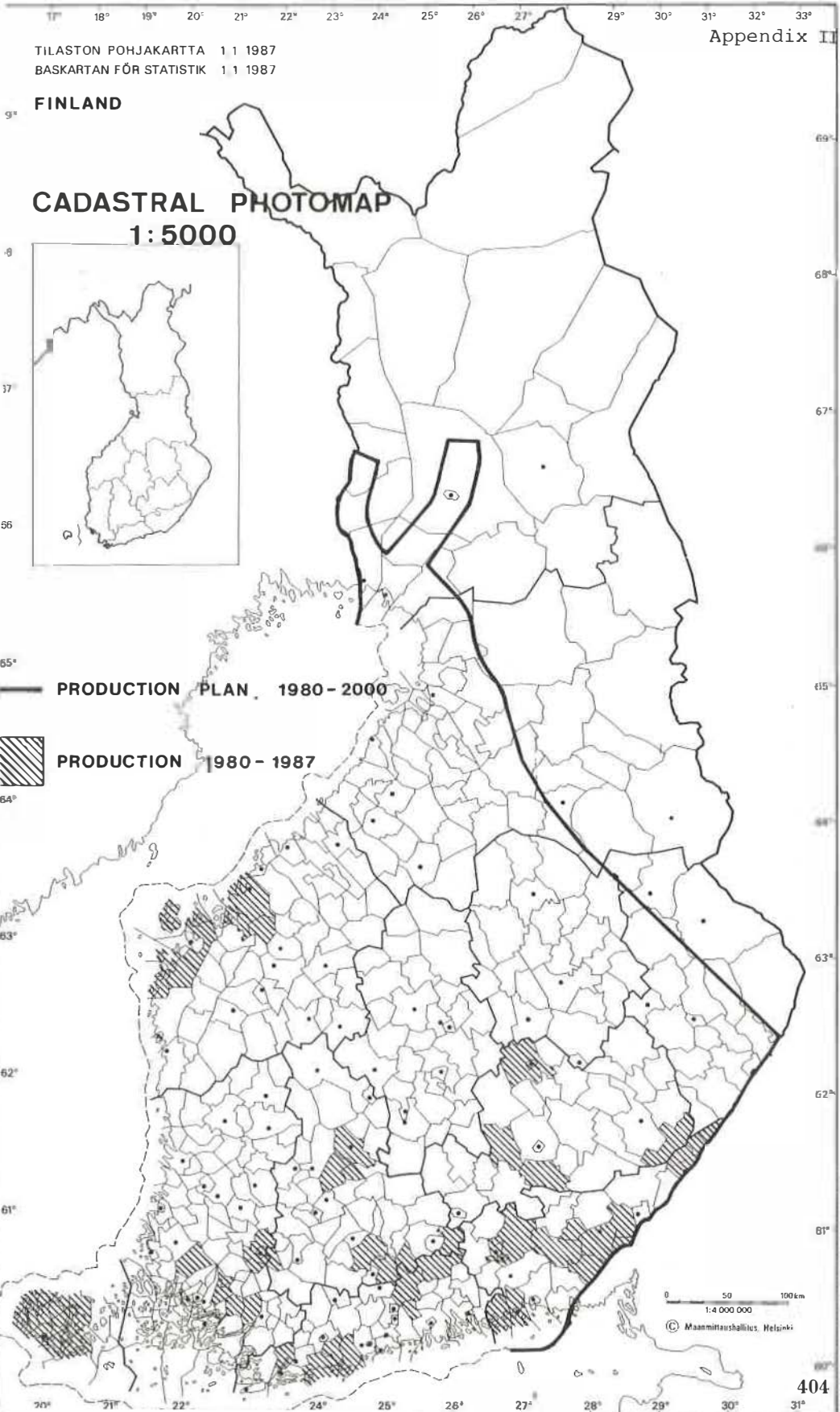
Our earlier experiments showed that the method mentioned above was sufficiently accurate and reliable for this type of multipurpose mapping and was the only reasonable selection from the economic point of view. The costs are presented in appendix III.

Reference

Jaakkola, M., Noukka P., 1984 Cadastral Photomap, a Base for 1: 5,000 Mapping in Finland. The Photogrammetric Journal of Finland, Vol.9 No.2 1984, Helsinki.

PRODUCTION OF THE CADASTRAL PHOTOMAP 1:5000




TILASTON POHJAKARTTA 1 1 1987
BASKARTAN FÖR STATISTIK 1 1 1987
FINLAND
CADASTRAL PHOTOMAP
1:5000
PRODUCTION PLAN 1980-2000
PRODUCTION 1980-1987
0 50 100 km
1:4 000 000
© Maanmittaushallitus, Helsinki

Appendix III

Cost and statistics of the work in rural areas, Southern Finland

	Cost (SFr/hectar)	
Densification of horizontal control, from 4 to 8 points/100 km	0.9	
Premarking, horizontal control	0.2	
" , vertical control	0.1	
" , boundary marks	1.1	
(" , by landowners	8.0)*	
		2.3
Aerial photography (1:16 000)	0.3	
Photogrammetric point densification	0.5	
Ortophoto work	0.7	
		1.5
Digitizing of parcel index map	0.1	
" manuscript	0.2	
" completions } Editing	1.1	
		1.4
Completion of manuscript } natural boundaries, register numbers, names, connections, field checking	1.8	
		1.8
Total SFr/hectar		7.0
SFr/map sheet(625 ha)		4375
In area of one map sheet:		
.total boundary marks		200
.from which are measured		100
.number of parcels		70

* voluntary work, not included in the total cost

Discussion after the conference of Mr. Jaakkola

Krüger: I was astonished to hear that farmers are putting the signals to their boundaries without quarreling. We could not ask that in Denmark.

Jaakkola: In Finland the boundary marks in the field, like monuments, are the strongest proof in boundary disputes rather than signals. In this regard the monuments also have preference compared to maps or other documents.
The legal matters are not the main problem in our cadastral system. Our main problem is the lack of uniform documentation of the system which is caused mainly by the age of the old surveys which in some places is over 200 years. We have several registers which deal with the land parcels like farm registers, forestry registers, fiscal registers, etc. and for example the area of a parcel may be different in each one.

Jerie: In Switzerland, landowners also marked their boundaries; is this system still in use ?
Do other countries also apply such a method ?
Signalization is an important aspect of cadastral renovation.

Kölbl: It is difficult to answer the question for Switzerland in a general way. In mountain regions, owners are involved in marking the boundaries. They receive instructions and a surveyor supervises the work.

Onsrud: In Norway we did the signalization for the so-called "economic map" in this way. It did not matter much if some boundaries were missing or appeared twice because the owners did not agree on the boundary line.

Tegeler: How much equipment do you use ?

Jaakkola: We rent a set of six equipements and we use it for 6 months a year.

Jerie: Are the logistics carried out by helicopters ?

Jaakkola: No, we use cars, because the stations can be put along the roads. Presently we have only an observation window of $5^1/_2$ hours. We measure one set, then we go to the next place. We have around $1-1^1/_2$ hours left to place the instruments and measure another set. The satellites themselves require one hour after placing the instruments to get the accuracy we need. We always put 2 instruments at existing stations to make the method safer. The results fit very well with the existing network. When there will be more satellites available, we will be able to extend the observation time from 5 to 8 hours.

Dale: Are the documents you are producing legal documents or simply an index diagram ?
If it is an index diagram, why do you want to locate all the beacons ? Could you not use the land use pattern in order to obtain all the parcels ?

Jaakkola: It is not a legal document at all. The important thing are the marks in the field. We have to go to the documents very seldom for positional purposes. We are improving the documentation of our cadastral information and of our parcels but time being we also try to combine the "legal" map and index diagram as one product. Today they are produced separately.
Another aim is of course the digitization, for which our old cadastral material can not be used, because it is not uniform and has been based on old parcel maps. We will try to improve the conditions for digital treatment in this way.

LE SYSTEME "MAJIC 2" - MISE A JOUR DES INFORMATIONS CADASTRALES

Jean-François Roche
Directeur divisionnaire
chargé de la conservation cadastrale à l'administration centrale, Paris

En France, l'établissement du cadastre a constitué une vaste entreprise. Au but fiscal poursuivi à l'origine s'est adjoint la mission foncière d'identification des biens-fonds, tandis que le rôle technique sous-tendait l'ensemble. La maintenance de ce cadastre représente une charge considérable compte tenu de la masse d'informations à gérer :

- 20 millions de propriétaires ;
- 90 millions de parcelles ;
- 35 millions de locaux.

Ces données, en perpétuelle évolution, sont affectées chaque année par près de 20 millions de modifications, indépendamment des changements d'ordre topographique. Un tel trafic appelle le recours à l'informatique de gestion.

*

LE RECOURS A L'INFORMATIQUE

Tandis que les données topographiques du cadastre ne sont que partiellement enregistrées les informations littérales ont toutes été prises en charge de la fin des années 1960 au milieu des années 1970.

L'informatique centralisée de l'époque était tout à fait adaptée à ces objectifs. Elle est encore temporairement utilisée au travers de la procédure de mise à jour des informations cadastrales - MAJIC 1 - qui est en cours de remplacement par un nouveau système dénommé MAJIC 2.

MAJIC 1

Le système MAJIC 1 vise à constituer et à tenir à jour une documentation cadastrale magnétique, et à produire des documents annuels, actualisés des changements constatés dans l'année civile écoulée.

C'est un système informatique centralisé : cinq centres régionaux d'informatique fonciers (C.R.I.) gèrent les informations sur support magnétique et assurent les différentes productions.

Chacun des 306 centres des impôts fonciers (C.D.I.F.) ou bureaux du Cadastre, transmet par voie postale les documents de saisie à son C.R.I. de rattachement, qui les exploite annuellement en vue de mettre à jour les fichiers magnétiques.

Les informations cadastrales sont en effet réparties dans quatre fichiers principaux : le fichier des propriétaires, le fichier des propriétés non bâties, le fichier des propriétés bâties et le répertoire informatisé des voies et lieux dits.

La production de masse assurée par MAJIC 1 a été optimisée depuis 1980 par la micromation des documents cadastraux (procédé C.O.M.).

Si MAJIC 1 a permis l'introduction bénéfique de l'informatique dans la gestion du cadastre, il n'en reste pas moins que ce système comporte des limites :

- fonctionnelles, car ses applications ne concernent que les missions fiscale et documentaire ;
- structurelles, étant donné l'organisation centralisée du système et les procédures informatiques nécessitant la rédaction de documents de saisie.

Dans sa forme actuelle MAJIC 1 a atteint ses limites de performance, d'où la conception d'un nouveau système, MAJIC 2.

MAJIC 2

Le nouveau système MAJIC 2, destiné à être implanté dans tous les bureaux du Cadastre avant 1990, élargit considérablement le champ d'application de l'informatique en prenant en compte, outre les fonctions de MAJIC 1,

- la mission d'identification des immeubles pour les besoins de la publicité foncière ;
- la délivrance et la comptabilité des extraits et reproductions de la documentation cadastrale ;
- la gestion des affaires contentieuses et les productions résultantes ;
- l'élaboration des statistiques et d'un tableau de bord de gestion.

La mission fiscale - exploitation des extraits d'acte (1), des déclarations de propriétés bâties et non bâties (2) - est, bien entendu, reprise dans MAJIC 2 selon le nouveau mode de gestion. La production annuelle des rôles, avis d'imposition et de la documentation reste assurée, comme dans MAJIC 1, par le centre régional d'informatique.

Hormis les travaux de recherche de l'information sur le terrain, la maintenance du plan cadastral, la surveillance de la souscription des déclarations et ses opérations connexes, toutes les activités cadastrales entrent donc dans le champ d'application de MAJIC 2.

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(1) Il s'agit des actes, administratifs ou notariés, qui entraînent un changement -de nature ou de titulaire- dans les droits de propriété.
(2) Les changements de consistance ou d'affectation des biens sont soumis à un régime déclaratif.

LES CARACTERISTIQUES GENERALES DE MAJIC 2

La gestion décentralisée

Bien que l'architecture informatique du système MAJIC 2 soit de type concentré (terminaux des C.D.I.F. reliés par réseau aux ordinateurs des C.R.I.), l'accès aux informations et leur mise à jour s'effectuent à partir des écrans-claviers du bureau du cadastre sans intervention fonctionnelle du C.R.I. Outre les productions annuelles de masse, ce dernier a un rôle essentiellement technique de pilotage de l'application et de maintenance des logiciels, des bases de données, du matériel et du réseau.

L'automatisation des tâches est, en outre, affirmée par l'implantation sur chaque site d'imprimantes permettant la production de toutes les éditions quotidiennes et périodiques.

Les transactions en mode conversationnel

La consultation de la documentation magnétique, son actualisation et le déclenchement des éditions s'opèrent à l'écran-clavier. Chaque transaction comporte une succession d'échanges d'informations entre l'agent et le système selon un scénario pré-établi, spécifique à chaque procédure cadastrale, et sous la forme d'un dialogue (mode conversationnel).

Le dialogue se déroule en langage naturel. L'emploi des codes est exceptionnel et, lorsque c'est le cas, l'agent a toujours la possibilité de consulter à l'écran la traduction des codes utilisés.

Le temps réel

La gestion MAJIC 2 s'effectue en temps réel. Toutes les données utiles au niveau local sont consultables et actualisables sans autre délai que celui nécessaire au système pour communiquer sa réponse ou effectuer la mise à jour.

L'interrogation de la base donne immédiatement la dernière situation des informations visées et une mise à jour se traduit par l'actualisation immédiate des données correspondantes. Les contrôles de saisie et de cohérence sont, eux aussi, mis en oeuvre en temps réel.

La distribution de l'information

L'application MAJIC 2 met à la disposition de l'agent, au poste écran-clavier, la totalité des informations foncières et fiscales utiles à la gestion.

La disponibilité permanente, au poste de travail, d'une documentation accessible directement selon plusieurs critères, est une caractéristique fondamentale du système MAJIC 2. Elle lève ainsi toutes les contraintes inhérentes à l'utilisation d'une documentation traditionnelle sur support papier ou sur microfiches et ouvre le champ à une réorganisation interne du service.

LES FONCTIONS ASSUREES PAR MAJIC 2

La fonction documentaire

Deux types de documentation sont mis à la disposition des agents :

- une documentation sur microfiches, similaire à l'actuelle, dont les informations sont figées en situation au 1er janvier de l'année de gestion ;
- une documentation magnétique, en constante actualité, dont les informations sont organisées en bases de données.

Etant la plus complète et la plus actuelle, la documentation magnétique est l'outil documentaire de base du service. Les microfiches deviennent ainsi une documentation à finalités particulières (renseignement sur la situation fiscale d'un propriétaire au titre d'une année considérée).

La fonction documentaire de MAJIC 2 comporte trois caractéristiques fondamentales :

- la disponibilité de l'information à partir de chaque écran-clavier ;
- l'accessibilité de l'information selon plusieurs critères même peu discriminants ;
- la possibilité de disposer de l'information sans connaître la structuration des données.

La fonction de mise à jour

C'est la fonction la plus novatrice en matière de procédures de travail.

Elle recouvre toute l'exploitation des documents porteurs de changements, soit l'essentiel des travaux de bureau du Cadastre.

La mise à jour s'opère par exploitation directe du document source à l'écran-clavier, après une simple analyse et sans rédaction préalable d'un document intermédiaire. De plus, l'opération impose rarement une consultation préliminaire de la documentation.

MAJIC 2 fait correspondre, à chaque procédure cadastrale classique, une ou plusieurs transactions spécifiques permettant l'exploitation complète d'un document.

Les transactions de mise à jour recouvrent :

- l'enregistrement du document source ;
- l'accès aux données concernées ;
- les mises à jour de données.

La fonction de mise à jour respecte donc la logique administrative. Elle n'est plus décomposée, comme dans MAJIC 1, selon une organisation des données en fichiers distincts.

L'organisation des données de MAJIC 2 est hiérarchisée, de telle sorte que les mises à jour induites sont effectuées automatiquement.

La fonction de production

Toutes les productions de volume important sont à la charge du système, qu'il s'agisse des éditions annuelles (rôles, avis d'imposition, documentation) effectuées dans le C.R.I., des productions quotidiennes (extraits cadastraux, lettres, notifications contentieuses...) ou périodiques (fiches d'évaluation, documents de travail, registres, états statistiques...) obtenues sur l'imprimante du C.D.I.F.

Cette utilisation optimum de l'outil informatique décharge les services d'un nombre important de tâches de copie ou de recopie en améliorant la présentation, voire le contenu des documents édités, notamment ceux destinés aux usagers externes.

Les fonctions de service

L'apport de MAJIC 2 sur des activités connexes à la gestion proprement dite des informations cadastrales est important :

- la comptabilité de la délivrance des extraits et reproductions de la documentation cadastrale est entièrement automatisée ;
- la gestion des affaires contentieuses s'effectue par la tenue d'un registre magnétique des réclamations, enrichi au fur et à mesure du traitement des demandes ;
- l'élaboration des statistiques de production s'effectue par comptage automatique ;
- un historique des mises à jour permet de connaître pour une information considérée, le motif des mises à jour précédentes en donnant la référence aux documents sources archivés ;
- des compteurs magnétiques attribuent les numéros d'enregistrement et d'archivage des documents et les immatriculations des nouvelles parcelles, supprimant ainsi la tenue de registres spécifiques.

Les fonctions de service de MAJIC 2 ont donc un double effet :
- elles simplifient les tâches ;
- elles fiabilisent la gestion.

L'ORGANISATION DE MAJIC 2

MAJIC 2 met en relation les 306 bureaux du Cadastre avec 4 centres régionaux d'informatique, par l'intermédiaire du réseau TRANSPAC

Toutes les données résident dans les C.R.I. Il n'existe aucun fichier dans les bureaux du cadastre. Chaque échange agent-système suppose un aller-retour d'informations entre le bureau du cadastre et le C.R.I. Le système de gestion de base de données I.M.S. et le réseau TRANSPAC permettent un temps de réponse moyen de 1,5 seconde, ce qui est correct pour l'agent utilisateur.

Cette architecture est telle qu'il n'est pas nécessaire de disposer d'informations enregistrées dans les bureaux du cadastre. Cependant des ressources en traitement local sont prévues, avec une capacité de mémoire utilisable avoisinant 500 K octets pour chacun des bureaux du cadastre. A l'avenir il sera possible d'utiliser ces ressources pour réaliser des calculs topographiques, effectuer des simulations, et des contrôles, etc...

Les bases de données

Pour chaque C.D.I.F., les informations enregistrées dans MAJIC 2 sont organisées sous forme de bases de données de deux sortes :

-une base de données principale qui renferme les informations cadastrales relatives aux entités parcelles, locaux, personnes, propriétés divisées en lots, lots, voies ou lieuxdits, etc...

-des bases de données annexes (base contentieux, base statistique, base comptable, base journal des mises à jour).

Pour l'ensemble du territoire, le volume total des informations contenues dans les bases est de 150 milliards d'octets dont 40 milliards d'octets de données cadastrales propres, contenues dans 2300 bases physiques (I.M.S.). Les logiciels comportent plus de 600.000 lignes de programmes. Cette base cadastrale reprend toutes les informations contenues dans les fichiers MAJIC 1, en les constituant en entités.

L'entité désigne un objet géré par MAJIC 2 : parcelle, local, personne, lot, voie, ... Les entités sont reliées entre elles par des liens qui peuvent être soit hiérarchiques (section - parcelle), soit fonctionnels (parcelle - personne). Dans ce dernier cas, le lien est à la fois constitué et qualifié par les droits qu'exerce la personne sur le bien. Une entité est caractérisée par un identifiant propre et un ensemble d'informations.

Une entité est liée hiérarchiquement à une autre, lorsque son existence dépend de cette autre entité. Le lien fonctionnel relie entre elles deux entités de même niveau. L'accès à une entité par son identifiant est direct. Une entité peut être atteinte indirectement par une entité qui lui est reliée (connaissance d'une parcelle par son adresse). Une entité peut aussi être recherchée à l'aide de mots directeurs figurant dans son libellé (recherche d'une personne par les quatre premières lettres de son nom et sa date de naissance).

La base comptable permet la réalisation des travaux de comptabilité matière et deniers, consécutifs à la délivrance des extraits cadastraux.

La base contentieux est destinée au suivi de l'instruction des réclamations et à l'édition de différents avis.

La base journal des mises à jour regroupe une série d'articles crées à la suite de l'exploitation de mises à jour. Elle sert à retrouver les informations ayant conduit aux mises à jour.

UTILISATION DE MAJIC 2

Les procédures administratives ont été décomposées successivement en familles d'activités, activités et tâches.

Les familles d'activités

1 - Consultation et délivrance des documents
2 - (en réserve, activités à développer ultérieurement)
3 - Mise à jour des informations
4 - Suivi du contentieux
5 - Gestion du service, comptabilité, éditions
7 - Gestion des transactions et des impressions
9 - Initialisation du système

Les activités

Le catalogue se présente sous forme de menu général (la codification de chaque activité reprend le numéro de la famille à laquelle elle appartient).

1A - Consultation de la documentation
3A - Changements fiscaux relatifs aux propriétés bâties
3B - Changements relatifs aux personnes et à l'attribution
3C - Changements relatifs aux fonctionnaires logés et aux syndics
3D - Changements fiscaux relatifs aux propriétés non bâties
3E - Changements collectifs
3F - Changements relatifs aux voies et à leur numérotage
3G - Exploitation des états descriptifs de division
3H - Changements relatifs au remembrement
3I - Changements de limite territoriale des communes
3J - Exploitation des documents d'arpentage
3K - Changements relatifs au remaniement
3M - Modification de données
3R - Rectification d'erreurs
4A - Suivi du contentieux
5A - Outils de gestion
5B - Comptabilité
5E - Edition de listes
5F - Traitements "Batch" périodiques
5G - Statistiques
7A - Gestion des abandons
7B - Editions et impressions
9I - Initialisation interactive
9J - Traitement des documents d'arpentage en cours

Les tâches

Au total, le système MAJIC 2 comporte 256 tâches qui font appel à plus de 400 écrans différents. A titre indicatif les tâches de l'activité "changements relatifs aux voies et à leur numérotage" sont les suivantes :

Tâche 1 : Création, modification, annulation du descriptif d'une voie
Tâche 2 : Renumérotage d'une voie avec correspondance anciens-nouveaux numéros
Tâche 3 : Renumérotage d'une voie par annulation-création
Tâche 4 : Numérotage d'une voie
Tâche 5 : Réunion de voies
Tâche 6 : Division de voies
Tâche 7 : Fin de document

Mode d'exécution des travaux

Généralement, il convient de préparer les documents d'entrée (par exemple, soulignement des informations utiles à relever dans un extrait d'acte).

Ensuite, l'agent choisit l'activité utile au moyen du menu général qui apparaît à l'écran et qui donne la liste de toutes les activités disponibles. Après avoir sélectionné l'activité, un sous-menu est proposé qui fournit la liste des tâches réalisables.

Certaines activités se déroulent à l'écran-clavier selon un scénario prédéterminé.

D'autres activités sont réalisées en effectuant des tâches unitaires de travail que l'agent peut choisir à son gré ou exécuter en se laissant guider par le système qui propose un enchaînement de processus. Ainsi, par exemple, dans l'activité "changements relatifs aux personnes et à l'attribution", la tâche "prise en compte des nouveaux titulaires de droits" est suivie de la "recherche d'un bien et de ses ayants-droits" et de la "mutation d'un bien".

La saisie des informations pour la réalisation des tâches est facilitée par l'apparition de questions, en clair à l'écran et par la gestion d'un curseur qui signale les données à préciser. Toutes les informations tapées au clavier par l'agent sont contrôlées dans leur structure et leur cohérence avant d'être utilisées par le système, en temps réel.

Les agents sont répartis en cellules de travail qui ont chacune accès aux données des bases relevant de leur compétence. Chaque cellule dispose d'un mot de passe pour accéder au système. Ce mot de passe peut être modifié à tout moment par le responsable du bureau du Cadastre, garantissant ainsi la sécurité du système.

LE MATERIEL INSTALLE DANS LES BUREAUX

Chacun des 306 C.D.I.F. comporte le matériel informatique suivant de marque E.S.D. (Electronique Serge Dassault).

Une unité de traitement local

L'unité de traitement local gère l'accès au réseau par l'intermédiaire d'un modem, les impressions dans le bureau du Cadastre et la gestion des versions logicielles locales.

Des écrans-claviers

Outil principal de l'agent, l'écran-clavier comporte trois caractéristiques essentielles.

. La disponibilité : ce terminal est disponible en permanence et distribué à raison d'un écran-clavier pour 2 agents (au total plus de 2.500 écrans-claviers pour l'ensemble du territoire).

. La potentialité : chaque écran-clavier assure un service permanent et autonome. Il permet d'opérer toutes les transactions et de piloter les imprimantes.

. Les spécifications ergonomiques : le système contient une fonction d'aide qui fournit à l'opérateur, à l'écran, le contexte de la tâche qu'il réalise (près de 1.500 pages-écrans d'explications). L'agent peut ainsi suspendre une transaction en cours en conservant l'acquis des saisies antérieures et la reprendre sans difficultés.

L'écran-clavier comporte enfin, des touches de fonction qui facilitent son utilisation : menu, sous-menu, aide-mémoire, page avant, suspension, accès au journal, vidage d'écran sur imprimante.

Les imprimantes

La fonction de production est très développée dans MAJIC 2. Deux imprimantes sont prévues pour chaque bureau du Cadastre. Elles éditent quotidiennement des extraits des différentes bases de données ainsi que des documents de position (comptabilité, statistiques).

Les éditions sont demandées lors des transactions correspondantes, après chargement de l'imprimante, à partir de n'importe quel écran-clavier qui retrouve son autonomie sitôt la commande lancée.

Les imprimantes fonctionnent avec du papier blanc ou des imprimés chargés en insertion frontale à partir de magasins. Aucune édition sur listing n'est prévue pour éviter tout travail de façonnage. Les impressions peuvent être réalisées immédiatement ou en temps différé. Il existe 86 sorties différentes de documents.

L'ORGANISATION DU TRAVAIL SOUS MAJIC 2

Au plan du fonctionnement du service, les objectifs suivants sont assignés :

- tirer parti de toutes les possibilités offertes par le nouveau système pour rationaliser les tâches et fiabiliser la gestion ;
- satisfaire à la contrainte ergonomique de limitation du temps de présence de chaque agent devant l'écran-clavier ;
- d'utiliser d'une manière optimale des matériels locaux ;
- de valoriser le travail en améliorant le contenu des tâches et leurs conditions d'exécution ;
- d'accroître la motivation et la responsabilisation des agents.

La nouvelle organisation repose sur la déparcellisation des procédures administratives, la polyvalence des agents et l'indépendance fonctionnelle des équipes de travail. Mais elle implique aussi une régulation des flux de documents sources pour éviter les pointes de charges. Au sein d'un bureau, les agents sont organisés en secteurs fonciers, correspondant chacun à une zone géographique de compétence.

LA MISE EN PLACE DE MAJIC 2

Sans parler de la phase d'étude du système et de l'installation des matériels, un plan précis d'insertion du système a été élaboré. Il doit permettre d'assurer une transition sans coupure entre les deux modes MAJIC 1 et MAJIC 2.

Ce plan comporte en particulier les étapes suivantes :
- préparation des fichiers MAJIC 1 ;
- recyclage des connaissances administratives des agents ;
- formation à MAJIC 2 par entraînement sur base de test ;
- basculement des informations MAJIC 1 dans les bases de données MAJIC 2 ;
- assistance au démarrage par des équipes spécialisées.

En 1985, deux bureaux prototypes ont été installés.
Le calendrier de généralisation du sytème est prévu entre 1986 et 1989 :
- 31 bureaux en 1986 ;
- 91 bureaux au cours de chacune des années 1987 à 1989.

*

MAJIC 2 place le Cadastre à la pointe de la technologie administrative. Alors que MAJIC 1 avait entraîné la subordination des procédures de gestion aux techniques informatiques de la première génération, le nouveau système rend la main à la logique cadastrale.

Déjà, MAJIC 2 apparaît comme une étape dans un processus de développement.

Des études sont en cours pour insérer MAJIC 2 dans un plus vaste projet qui vise une gestion intégrée des données cadastrales et des informations foncières de caractère juridique gérées en France dans les Conservations des Hypothèques.

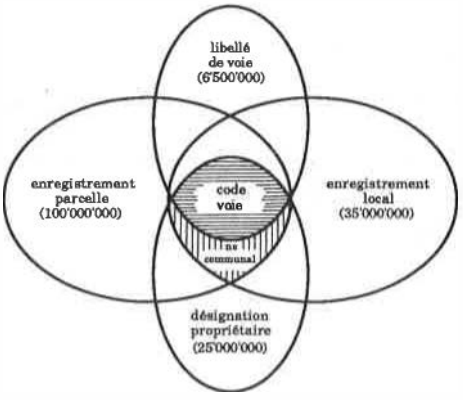
Parallèlement et pour compléter le tout, la Direction générale des Impôts s'attache à définir une politique d'informatisation du plan cadastral. Dans ce domaine, la problématique est particulière puisque les besoins prioritaires ne sont pas ceux de la D.G.I. Ils émanent des collectivités locales, pour lesquelles le Cadastre fournit l'architecture des systèmes d'informations localisées.

*

* *

FICHIERS MAGNETIQUES DU CADASTRE

MAJIC 1



Le fichier des propriétaires et le fichier RIVOLI donnent la possibilité de n'enregistrer que le n° communal et le code voie au niveau de chaque local ou parcelle sans prendre en charge la désignation du propriétaire ou le libellé de voie.

OBJECTIFS DE MAJIC 1

1. Constitution des fichiers
2. Mise en place d'un système évolué d'évaluation des biens
3. Edition des rôles d'impôt foncier
4. Edition de documents de position

❋

Il utilise les technologies des années 70

Il facilite la mise en place de MAJIC 2

◆

Ces objectifs sont actuellement atteints.

LES RAISONS DE MAJIC 2

Obsolescence de MAJIC 1

- Maintenance lourde (informatique - manuelle)
- Transferts d'informations trop importants
- Rigidité des calendriers
- Délais de réponse

En fait

LIMITES STRUCTURELLES et **FONCTIONNELLES**

Exemple

Nécessité de calendriers de relations Service - CRI (organisation centralisée)

Exemple

Seulement une partie de l'aspect fiscal réglé (sensibilité grandissante du contribuable - poids F.D.I.)

BESOINS DES SERVICES

Avoir une documentation :

- Actualisée en permanence
- Disponible à tout moment
- Intégrée
- Partagée

→ **MAJIC 2**

CHAMP D'APPLICATION DE MAJIC 2

Mission FISCALE (déjà assurée par MAJIC 1)

plus tard couplée avec ← **Mission FONCIERE**

FIDJI

(informatisation du fichier immobilier des conservations des hypothèques)

Mission DOCUMENTAIRE (en partie assurée par MAJIC 1 mais non encore télématisée pour les usagers)

~~Mission TECHNIQUE~~

?

INFORMATISATION DU PLAN → **MAJIC 3**

LES FONCTIONS DE MAJIC 2

MAJIC 2

FONCTION DE MISE A JOUR

- permanente
- intégrée
- autonome

FONCTION DOCUMENTAIRE

- base de données
- microfiches
- doc. sources

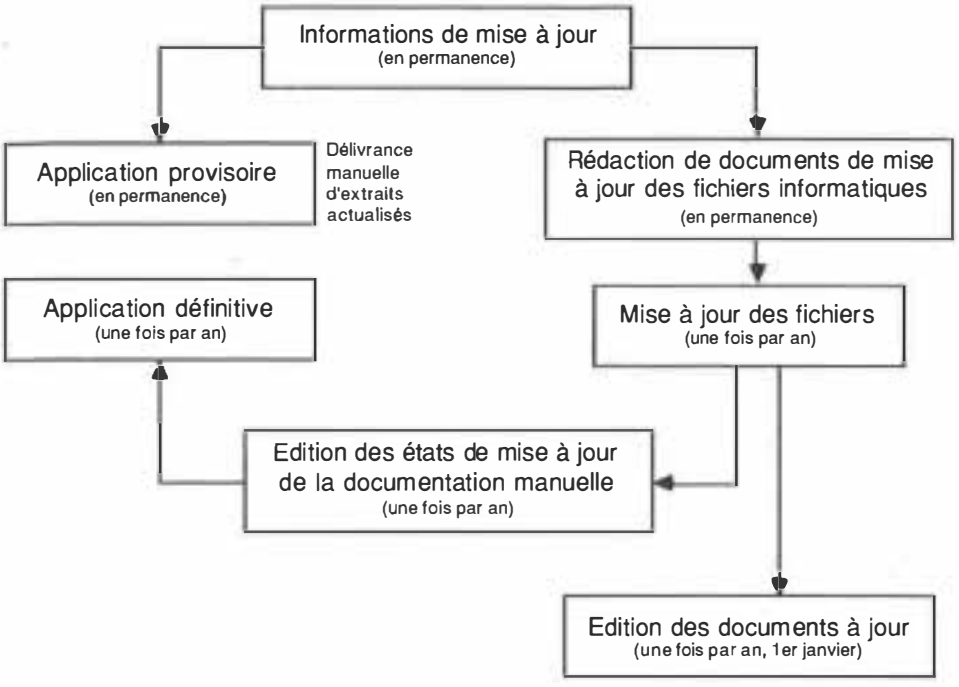
FONCTION DE SERVICE

- calcul : V.L. stat. comptab.
- gestion : content. clients histor.
- enregistr. : doc. sources nos parcel.

FONCTION DE PRODUCTION

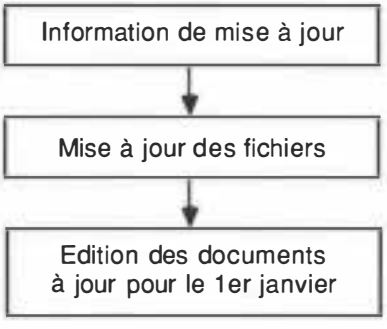
- central. : rôles microf. reman.
- quotidien : extraits doc. compt.
- périodique : listes fich. eval. regist. stat.

SCHEMA DE PRINCIPE DE LA CONSERVATION CADASTRALE (MAJIC 1)

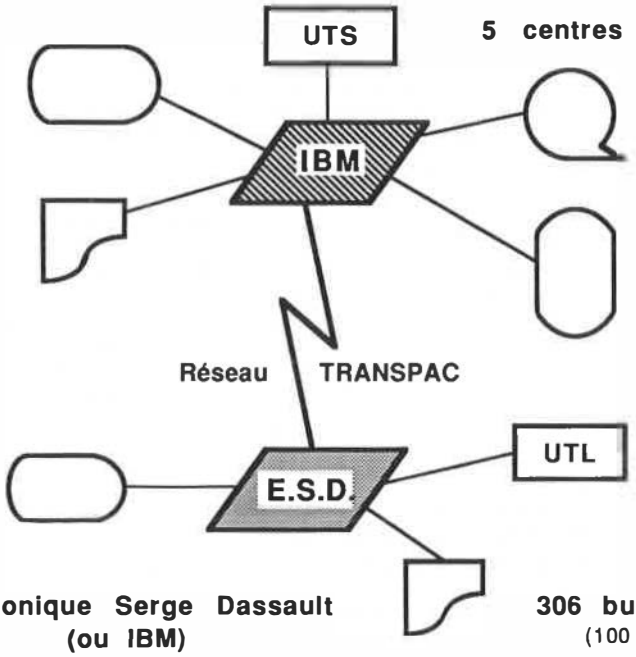


MAJIC 2 :

Documentation magnétique
à jour en permanence
Délivrance automatique des
extraits littéraux actualisés



ARCHITECTURE INFORMATIQUE



5 centres d'informatique
5 x 3090 - 200

Electronique Serge Dassault
(ou IBM)

306 bureaux (C.D.I.F.)
(100 en sept. 1987)
FIN EN 1990

Aucun fichier en local

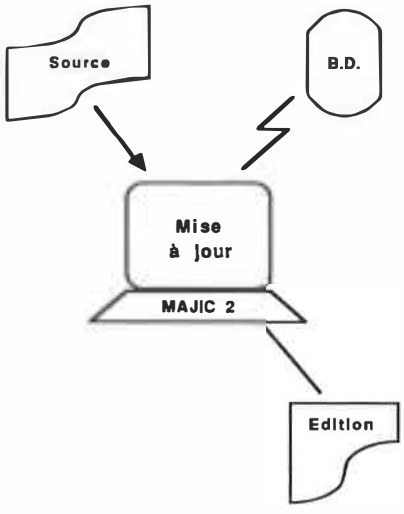
CONSEQUENCE DU CHOIX DE L'INFORMATIQUE REPARTIE

Gestion **DECENTRALISEE** =
- Autonomie du C.D.I.F. (pas d'informaticiens)

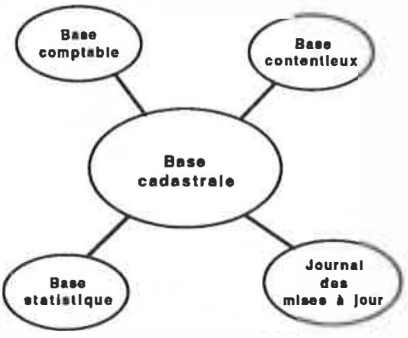
Gestion **TEMPS REEL** =
- ➖ tâches manuelles
- ➕ responsabilité de gestion
- ➕ souplesse du calendrier

Gestion en **CONVERSATIONNEL** =
- ~~Codification~~
- Contrôle ⇄ Correction
- Aide-mémoire

FONCTION MISE A JOUR



PRESENTATION DE LA BASE DE DONNEES



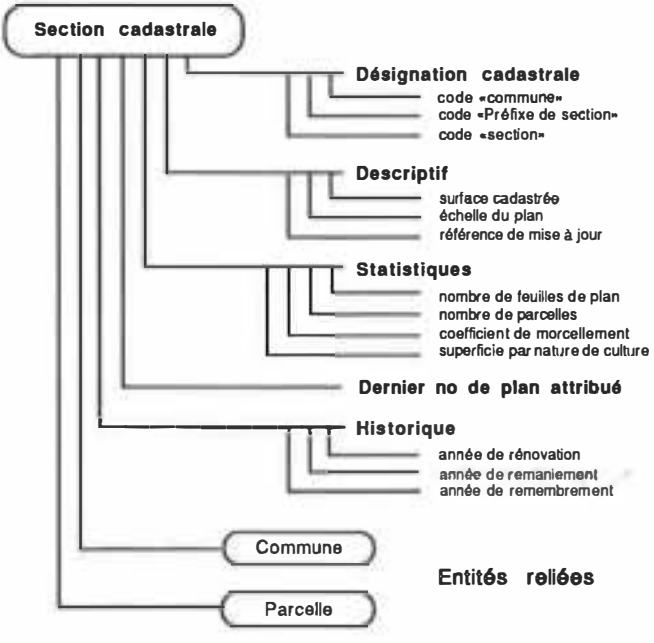
1 base logique

↓

23 bases physiques
/ département

NOTION D'ENTITE

Unité de gestion caractérisée par
- un identifiant
- un ensemble d'informations



MAJIC 2 : MODE D'EMPLOI

Les procédures cadastrales sont découpées en :

FAMILLES D'ACTIVITES	**(6)**
ACTIVITES	**(24)**
TACHES	**(256)**
(ECRANS)	**(~ 400)**

- On utilise le système de "MENU"
- Les transactions peuvent être réalisées unitairement ou de façon enchaînée
- Les questions posées sont en clair
- Les réponses données sont aussitôt contrôlées
- Un aide-mémoire est fourni, si besoin, à l'écran
- Le système est protégé par un mot de passe
- Un mot de passe donne droit à l'utilisation de toutes les activités ou de quelques-unes seulement. Ce mot de passe peut être changé à tout moment par le responsable

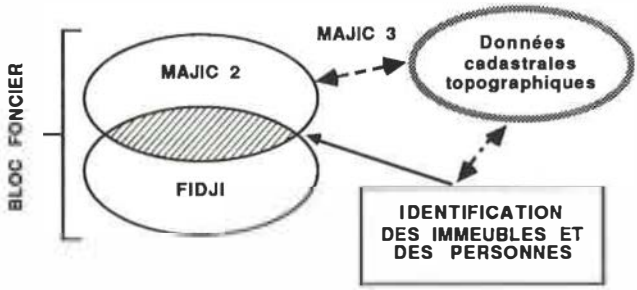
---

LES ACTIVITES DE MAJIC 2

1 A	=	Consultations
2 A	=	Changements relatifs aux P.B.
3 B	=	Changements relatifs aux personnes et à l'attribution
3 C	=	Changements / Gestionnaire - Syndic - Occupant -Exploitant
3 D	=	Changements fiscaux relatifs aux P.N.B.
3 E	=	Changements relatifs à l'évaluation
3 F	=	Changements relatifs aux voies et à leur numérotation
3 G	=	Traitement d'un E.D.D.
3 H	=	Changements relatifs au remembrement
3 I	=	Changements des limites territoriales d'une commune
3 J	=	Exploitation des D.A. et des C.C.
3 K	**=**	**Changements relatifs au remaniement**
3 M	=	Modification des caractéristiques d'une entité
3 R	=	Activité de correction
4 A	=	Suivi du Contentieux
5 A	=	Outils de Gestion
5 B	=	Comptabilité
5 E	=	Edition de listes
5 F	=	Traitement "batch"
5 G	=	Statistiques
7 A	=	Gestion des abandons
7 B	=	Editions et impressions
9 I	=	Initialisation interactive
9 J	=	Traitement des documents d'arpentage en cours

MAJIC 2 et FIDJI

Des études sont en cours pour intégrer MAJIC 2 avec le système FIDJI (**F**ichier **I**nformatique des **D**onnées **J**uridiques et **I**mmobilières) d'information des conservations des hypothèques.



Les données topographiques sont informatisées pour 50'000 ha.

REMANIEMENT CADASTRAL
(nouvelle rénovation)

NOUVEAU PLAN

CHANGEMENT DES Nos DE PARCELLES (+ certaines mises à jour)

MAJIC 2

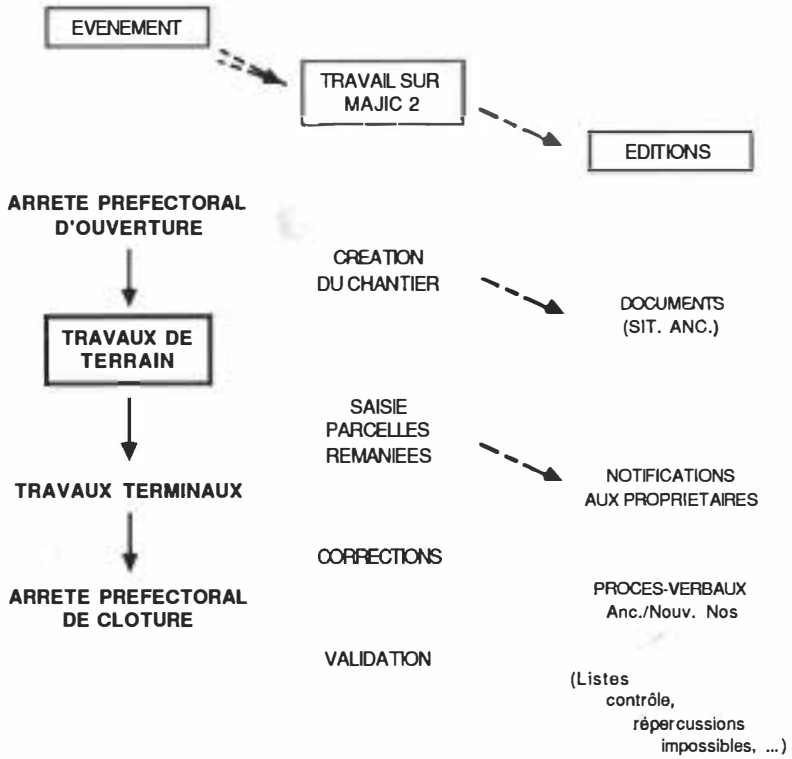
1. Edition documentation (situation ancienne)
2. Saisie des nouveaux nos
3. Edition notifications aux propriétaires
4. Gestion provisoire nos anciens / nouveaux
5. Edition P.V. pour la conservation hypothéq.

LISTE DES TACHES DE L'ACTIVITE REMANIEMENT

MAJIC 2 Sous-menu 3 K

T.1 Création du chantier
T.2 Description du périmètre
T.3 Demande d'édition de documents préalables
T.4 Retrait de parcelles du périmètre
T.5 Prise en compte de sections remaniées
T.6 Création de parcelles remaniées
T.7 Définition du territoire à incorporer
T.8 Demande d'édition de notification à un propriétaire
T.9 Annulation/modification de parcelles en cours de remaniement
T.10 Prise en charge de la date de dépôt du procès-verbal
T.11 Contrôles préalables à l'édition du procès-verbal
T.12 Demande d'édition du procès-verbal
T.13 Validation du remaniement

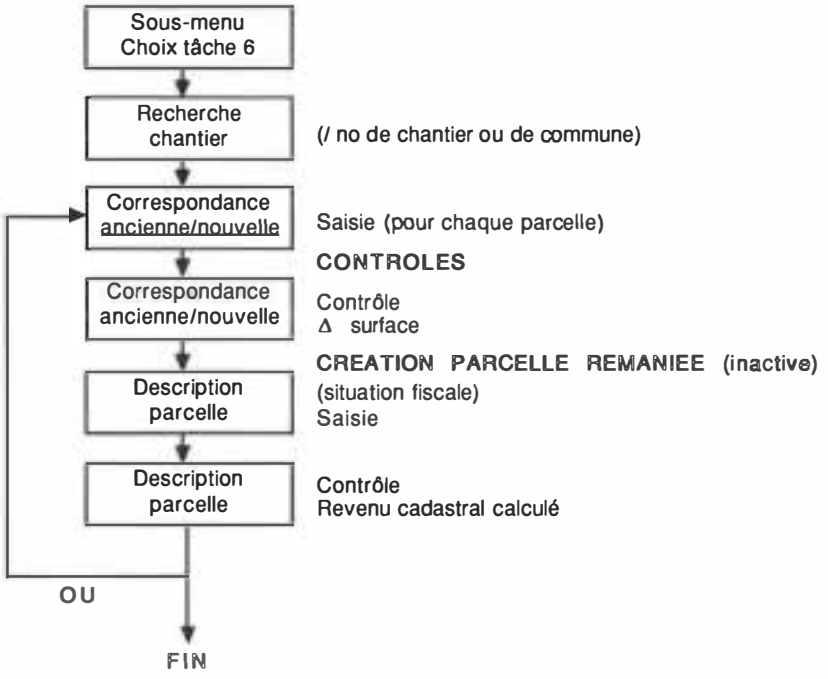
DEROULEMENT DU REMANIEMENT
/ MAJIC 2



CREATION DE PARCELLES REMANIEES

Tâche 6

ECRANS SUCCESSIFS



QUELQUES CHIFFRES

EQUIPEMENT BUREAUX CADASTRE MAJIC 2

par bureau	500'000 FF	(125'000 FS)
306 bureaux (5 ans)	150'000'000 FF	(37'500'000 FS)

(+ études + centres informatiques)

FONCTIONNEMENT

par an pour 306 bureaux	~ 1'000'000'000 FF	(250'000'000'000 FS)
rapport fiscalité "cadastre"	~ 50'000'000'000 FF	
budget France (hors collectivités locales)	~ 1'200'000'000'000 FF	

GAIN PRODUCTIVITE DE MAJIC 2

25 % = 1'000 agents de bureau	200'000'000 FF

Discussion after the conference of Mr Roche

The System "MAJIC2"
(UPDATING OF CADASTRAL INFORMATION)

Kölbl: Do you use simple alphanumerical terminals or interactive graphic working stations ?

Roche: We do not have graphic stations, we only have alphanumerical terminals. We deal only literal information (des informations littérales).

We have no graphical elements in the actual system, they are foreseen to come with MAJIC3 (~ 1990-2000).

Kölbl: What does editing of the situation's sketching mean in respect with MAJIC2 ?

Roche: The editing of maps is still done in the traditional way by making copies or photocopies of the maps. The system does not produce maps, it does the book-keeping of the map issues (délivrance des plans).

Itterbeck: You store the information in regional centers. Are they connected by a communication net ?

Roche: Yes, it is a starshaped connection.

AUTOMATISATION PROGRESSIVE DU CADASTRE BELGE

J. VAN HEMELRIJCK

Inspecteur à l'Administration centrale du Cadastre

Résumé Le Cadastre belge trouve son origine dans les décrets napoléoniens de 1807. Les plans et registres confectionnés à cette époque ont fait l'objet d'une mise à jour constante. Compte tenu de l'évolution de la documentation et de l'extension des tâches dévolues au Cadastre il s'est avéré nécessaire d'introduire l'automatisation dans le cycle des opérations cadastrales. Parmi les trois plus importantes documentations cadastrales, à savoir, les plans, les fiches d'expertises et les matrices cadastrales, l'administration a choisi d'automatiser en premier lieu les matrices cadastrales, qui, reprises sur supports magnétiques pour l'ensemble du royaume depuis juin 1975, constituent un vaste fichier "Propriétaires-parcelles" contenant 4.602.000 propriétaires et 9.208.000 parcelles. Conformément aux prescriptions légales ce fichier magnétique est mis à jour annuellement. Au départ de ce fichier sont réalisées électroniquement toutes les tâches nécessaires à la perception de l'impôt foncier. En outre d'autres possibilités ont vu le jour : l'établissement de cadastres partiels (ex. celui des biens appartenant au Domaine de l'Etat), la délivrance automatique d'extraits de la matrice cadastrale, etc...

Des tests sont actuellement en cours en vue d'actualiser les données cadastrales d'une part et de constituer un fichier topographique d'autre part.

Summary The Belgian Cadastre is derived from the Napoleonic decrees of 1807. The maps and registers compiled at that period have been constantly updated. Owing to the evolution of the documentation and to the development of the tasks entrusted to the land Registrary, it became necessary to introduce automation in the cycle of cadastral operations. Among the three main parts of the cadastral documentation i.e. the surveys, the valuation files and the land registers, the Administration had decided first to automate the registers, which, transferred to magnetic storage media for the whole of the Kingdom since june 1975, constitue a comprehensive "Landowners-plots" file data-bank containing 4.602.000 landowners and 9.208.000 plots. According to the legal prescriptions this data-bank is yearly updated.

On the basis of this magnetic file all the operations necessary for the collection of the land-tax are carried out electronically. Besides this application other possibilities appeared : the making up of partial cadastral Surveys (e.g. the Survey of real estates belonging to the Belgian State), the automatic issue of extracts of the land register, etc ...

Tests are now in progress in order to bring up to date the latest cadastral data, on the one and to set up a topographic file, on the other hand.

1. Définition du Cadastre.

Le Dictionnaire de l'Académie nous parle d'un Registre public dans lequel la quantité et la valeur des biens-fonds sont marquées en détail. Le Larousse, par contre, signale que l'Administration entend par le mot "CADASTRE" aussi bien le "Registre public sur lequel sont portés le relevé général, la mesure et l'évaluation des biens-fonds d'un pays" que "l'ensemble des opérations à l'aide desquelles on établit ce relevé pour arriver à l'assiette et à la répartition de l'impôt".

Il faut retenir de ces définitions qui diffèrent un peu quant à la forme, mais se rassemblent quant au fond, que le Cadastre est :

- une administration;
- un ensemble d'opérations et de documents qui ont pour buts :
  - l'établissement et la tenue à jour d'un relevé détaillé des propriétés foncières d'un territoire déterminé;
  - la localisation et l'identification de ces propriétés foncières;
  - la perception de l'impôt.

2. Bref historique.

L'institution cadastrale remonte aux temps les plus reculés, car la terre a toujours été une bonne base d'imposition et aussi parce qu'une telle institution est susceptible de créer l'ordre et la sécurité dans la possession des terres et des propriétés.

Quant au Cadastre belge, il trouve son origine dans les décrets des 23 novembre et 1er décembre 1790 qui instaurèrent en France et dans nos régions un impôt foncier général sur les revenus nets des biens immobiliers.

C'est en 1807 que Napoléon décréta un nouveau système, basé sur la division du territoire en parcelles, chaque parcelle étant mesurée, mise en carte et évaluée. Ce cadastre napoléonien fut instauré en même temps en France, en Belgique, aux Pays-Bas et en Rhénanie.

Cette lourde tâche fut confiée aux administrations locales. Dans nos régions les travaux débutèrent en 1815 pour se terminer en 1835, sauf en ce qui concerne les provinces du Limbourg et du Luxembourg où l'on mit un point final à la confection des plans et des registres en 1843.

3. Mise à jour.

Il est évident que l'efficacité d'une telle documentation dépend de sa mise à jour. Or en cette matière nous constatons que, dans notre pays, ce Cadastre napoléonien a fait l'objet d'une constante mise à jour annuelle depuis son origine.

Les mutations sont, dans l'état actuel des choses, reprises au Cadastre dans l'année qui suit la passation de l'acte ou la modification.

4. Caractéristiques.

De ce bref aperçu historique nous pouvons déduire, qu'avant l'introduction de l'informatique, le Cadastre belge était avant tout :

1° un cadastre communal;

2° un instrument fiscal.

5. Principaux documents.

Les documents cadastraux sont établis séparément par commune, éventuellement par division cadastrale de commune.

5.1. Le plan d'assemblage reproduit toute l'étendue de la commune et indique les sections, les rivières, les principales voies de communication, les bâtiments les plus marquants, etc...

5.2. Le plan parcellaire donne une représentation graphique des parcelles cadastrales. Il permet d'identifier le bien, de l'individualiser et d'en fournir le périmètre. Le plan parcellaire primitif reprend la situation à l'origine du Cadastre, tandis que le plan parcellaire supplémentaire (ou actuel) est une copie du précédent dûment mise à jour. De ce fait il reproduit la situation la plus récente.

5.3. La matrice cadastrale consiste en feuillets amovibles rassemblés dans un classeur. Ces feuillets numérotés, à raison d'un numéro par propriétaire (ou groupe de propriétaires détenant conjointement un droit de propriété) renseignent toutes les propriétés que possède ce propriétaire (ou groupe de propriétaires) sur le territoire de la commune ou de la division cadastrale de commune.

Elle se compose de :

- l'en-tête, qui contient les indications relatives au(x) propriétaire(s);
- le corps, qui donne un relevé des parcelles appartenant au(x) propriétaire(s);
- le total, qui est constitué par la somme des éléments comptabilisables, à savoir, la contenance et les revenus.

Signalons encore que pour faciliter l'accès à la matrice cadastrale, on a recours à des documents satellites qui sont :

a) l'indicateur alphabétique des propriétaires, qui est en fait un indicateur onomastique, c'est-à-dire un fichier dans lequel figurent les noms des propriétaires en même temps que le numéro de l'article sous lequel ils sont inscrits;

b) le tableau indicatif supplémentaire, établi par section de commune et qui renseigne toutes les parcelles du plan dans l'odre numérique, avec un renvoi à l'article de la matrice.

Depuis le 1.1.1979, la matrice cadastrale, l'indicateur alphabétique des propriétaires et le tableau indicatif supplémentaire sont délivrés sous la forme de microfiches (microfilms pour les services des extraits des directions régionales).

6. Missions.

Outre sa mission fiscale, l'administration du Cadastre s'est vu assigner avec le temps de multiples autres missions, notamment dans les domaines économique, scientifique et technique; les revenus cadastraux par exemple servent souvent de référence ou de critère pour l'application de nombreuses dispositions légales et réglementaires.

7. Pourquoi automatiser ?

Au vu de ce qui précède, il est indubitable que pour remplir valablement les missions qui lui sont confiées, le Cadastre se doit de posséder des inscriptions dynamiques exigeant une mise à jour permanente.

7.1. Evolution de la documentation cadastrale :

Depuis 1845 jusqu'à la veille de l'automatisation, la documentation cadastrale a subi une extension constante. C'est ainsi, par exemple, que le nombre de propriétaires était de :

914.000 en 1845
1.050.000 en 1860
2.008.000 en 1936
3.041.000 en 1968

Actuellement, nous en sommes à 4.602.000 propriétaires.

Il est évident que l'accroissement du nombre des parcelles accuse une évolution identique pour atteindre actuellement les 9.208.000 unités.

Cette évolution draine inévitablement un accroissement de travail considérable : mise à jour de la matrice et de ses documents satellites, modification du plan, maintenance de nombreux registres et de statistiques. La multiplicité des tâches qui n'existaient pas à l'origine rend l'organisation de plus en plus complexe et le fonctionnement beaucoup plus lourd.

De même la demande d'extraits de la documentation, que l'administration du Cadastre est tenue de délivrer, ne cesse également de croître, excédant actuellement la délivrance de 600.000 extraits par an.

7.2. D'autres facteurs imposaient également d'étudier de manière approfondie les possibilités de l'automatisation;

7.2.1. Conservés et mis à jour par commune ou par division cadastrale de commune, les documents cadastraux manuels empêchaient une exploitation rationnelle à l'échelle nationale.

Par l'automatisation et l'utilisation judicieuse de codifications, un Cadastre national peut être envisagé.

7.2.2. Le délai entre la survenance d'un fait nouveau (changement de propriétaire, modification à un immeuble) et son inscription matérielle dans les registres cadastraux est, d'une manière générale, trop long. L'automatisation doit permettre de réduire progressivement ce délai à un minimum.

7.2.3. Au long des opérations de mise à jour, depuis la prise d'information jusqu'à l'enrôlement du précompte immobilier, certaines données sont transcrites jusqu'à 7 fois (notamment les noms des propriétaires) ce qui constitue autant de sources d'erreurs ou de discordances.

Ici également l'automatisation peut pallier cet anachronisme.

8. Choix de la première application.

En résumé, le Cadastre belge possède trois grandes documentations susceptibles d'informatisation : le plan cadastral, la matrice cadastrale et la documentation d'expertise.

Parmi les divers aspects des activités cadastrales, la constitution d'un fichier général des propriétaires et des parcelles s'est rapidement imposée comme première application mécanographique.

Elle allait toucher, en effet, le document le plus complet et le plus consulté : la matrice cadastrale. Celle-ci occupe une fonction centralisatrice qui est le point de jonction du flux ascendant des informations concernant le morcellement administratif, juridique, topographique, territorial, fiscal des propriétés et du flux descendant concernant la levée de l'impôt, les contrôles fiscaux et territoriaux.

L'automatisation de ce fichier devait également permettre la confection de fichiers complémentaires, en l'occurrence :

- le registre des parcelles;
- le fichier alphabétique des propriétaires;
- la liste des redevables de l'impôt.

Elle offrait enfin la possibilité d'envisager une exploitation élargie des multiples renseignements contenus dans la matrice : statistiques d'ordre fiscal, social (en matière de logement), économique (sur la base des revenus cadastraux industriels ou afférents à l'outillage), la confection d'un Cadastre national, etc ...

9. Equipements.

Les études ont été entamées compte tenu des possibilités offertes par les ordinateurs de la seconde génération, c'est-à-dire la série I.B.M.1401. Or l'ordinateur qui nous fut livré en 1968 était de la 3ème génération : I.B.M. 360/40, ce qui nous obligea de repenser tout notre système, de changer nos procédures, de refaire de nouvelles analyses et d'écrire de nouveaux programmes.

En octobre 1973, l'I.B.M. 360/40 fut remplacé par un I.B.M. 370/modèle 145 d'une mémoire centrale de 256 K.

L'administration du Cadastre dispose depuis le mois de juin 1984, d'une configuration électronique de marque I.B.M. comportant :

- un ordinateur 4341/modèle L01, d'une mémoire centrale de 4000 K;
- une console n° 3278/modèle A02 + 2 écrans et imprimante (3278, 3279 et 3287);
- un lecteur de cartes n° 2501 et un lecteur + perforateur de cartes (3505 + 3525);
- 2 imprimantes n° 3203/modèle 005;
- 4 armoires à bandes + contrôle (4 x 3420/6 + 1 x 3803/2);
- 21 armoires à disques n° 3370 d'une capacité totale de ± 10 millards de bytes;
- 9 écrans + 1 imprimante en remote (3 x 3178 + 6 x 3278 + 1 x 3268).

Enfin, pour la fin de cette année nous disposerons probablement :

- d'un processeur IBM 4381 modèle P13 d'une mémoire interne de 16 méga-octets et d'une puissance de 4 Mips, soit une unité centrale 5 à 6 fois plus puissante qu'actuellement;

- du contrôleur de communication adéquat;
- de mémoires de masse présentant une capacité de stockage de 20 milliards de positions, soit près du double de maintenant;
- d'un système d'exploitation comportant VM/SP déjà installé et VSE/SP en remplacement de DOS/VSE;
- du moniteur de télétraitement CICS que nous possédons déjà;
- du gestionnaire de bases de données DL/I que nous possédons déjà;
- du logiciel VTAM de gestion de réseau en remplacement de BTAM.

Pour la saisie des informations, l'administration du Cadastre dispose d'un équipement de marque NIXDORF comportant :

- deux unités centrales n° 620/38, disposant d'une mémoire centrale de 64K;
- 40 écrans/claviers (encodeuses).

Pour l'assistance à l'actualisation des plans cadastraux, l'administration du Cadastre dispose de :

- un système interactif couplé à l'ordinateur I.B.M. 4341 (1 écran graphique TEKTRONIX + 1 écran I.B.M. n° 3277 + 1 table à digitaliser SUMMAGRAPHICS);
- une table traçante KONGSBERG;
- une table à digitaliser BENDIX.

10. La matrice cadastrale.

10.1. Reprise.

La matrice cadastrale est actuellement reprise entièrement sur support magnétique. Précisons que ce fichier qui ne porte que la situation active de la matrice cadastrale représente à lui seul 28.170.000 enregistrements de 150 positions.

Ce fichier qui concerne

4.602.000 propriétaires et
9.208.000 parcelles

constitue la banque de données "Propriétaires-Parcelles" en situation active, à laquelle il convient d'adjoindre un second fichier, en extension constante, reprenant la situation passive ou périmée destinée à pouvoir retracer l'historique du patrimoine immobilier.

10.2. Conservation de l'historique.

10.2.1. Aux exigences caractéristiques du Cadastre viennent s'ajouter d'autres difficultés spécifiques inhérentes au traitement par ordinateur. La mission du Cadastre ne se limite pas aux activités qui doivent permettre d'indiquer l'inventaire ou la situation actuelle de la propriété.

Il doit également pouvoir donner l'aspect historique de la propriété. Pour atteindre ce but, le Cadastre est obligé de conserver les situations actuellement périmées.

Il s'ensuit que le problème de la conservation concerne non seulement l'information contenue au cadastre, mais aussi sa mise à jour. Afin de pouvoir confier et la conservation et la mise à jour de la matrice cadastrale à l'ordinateur, il a fallu scinder la matrice manuelle en deux matrices partielles, à savoir :

- la matrice active, c'est-à-dire une matrice renseignant la situation valable au moment de la reprise;
- et la matrice passive mentionnant successivement les situations périmées résultant des mises à jour.

10.2.2. Evolution de la conservation de l'historique :

La situation périmée au moment de la reprise des matrices n'a pas fait l'objet d'une matrice magnétisée, mais demeure conservée dans la matrice cadastrale manuelle telle qu'elle existait au moment de la reprise.

Depuis la reprise jusqu'au moment de l'introduction de la microfiche en 1979, l'ordinateur imprimait, par commune cadastrale, chaque année, en raison du caractère annuel de l'impôt:

- de nouvelles matrices actives;
- de nouvelles matrices passives;
- une nouvelle liste des numéros parcellaires établie dans l'ordre croissant des parcelles;
- une nouvelle liste alphabétique des propriétaires.

Lors du passage de l'impression sur papier vers la microfiche un nouveau fichier a été créé, qui permet de suivre les parcelles, année par année, en indiquant la référence de la matrice cadastrale avant et après chaque mutation ou modification. Chaque année et par commune cadastrale ce fichier, ainsi que les matrices cadastrales actives, la nouvelle liste des numéros parcellaires et la nouvelle liste alphabétique des propriétaires sont édités sur microfiches. Les matrices passives, telles qu'elles existaient sur papier, ont été remplacées par les microfiches des matrices actives des années antérieures.

10.3. Mutations.

10.3.1. Chaque année le fichier de base "Propriétaires-Parcelles" est mis à jour compte tenu des modifications intervenues dans le chef des propriétaires, des parcelles ou des droits de propriété. Cette application couvre bon an mal an plus d'un million de modifications représentant 15 % de la totalité du fichier.

10.3.2. La mise à jour s'effectue actuellement en "batch" au départ d'un dossier de mutations par commune cadastrale dressé par les services locaux du cadastre. L'encodage de ces dossiers est centralisé au Centre de Traitement de l'Information (C.T.I.) et s'effectue sur notre équipement de saisie des informations de marque NIXDORF mentionné précédemment.

Après la mise à jour des fichiers en ordinateur les services utilisateurs reçoivent la nouvelle situation de la matrice cadastrale et des documents annexes sous forme de microfiches.

Pour leur part, les services régionaux sont mis en possession de statistiques détaillées portant sur les diverses contenances et les différentes sortes de revenus. Ces statistiques sont établies par commune cadastrale, par commune administrative, par province, par direction régionale, par région linguistique, etc ...

De même les livres-journaux sont transmis à l'administration des Contributions permettant l'enrôlement du précompte immobilier, compte tenu des modifications intervenues.

10.3.3. Modernisation des méthodes de mise à jour.

L'évolution des fichiers centraux vers une structure de base de données et le traitement direct et à distance de l'information récoltée et aménagée suivant les règles cadastrales avec mise à jour simultanée en temps réel sont à l'étude au niveau de la direction générale du cadastre.

Les buts poursuivis sont entre autres :

- la modernisation des méthodes de travail;
- l'accélération du rythme de mise à jour de la matrice cadastrale de manière à suivre le plus près possible la réalité;
- la constitution d'un cadastre national.

Ce nouveau mode de travail impliquera un certain nombre d'actions à réaliser dans différents domaines et induira un certain nombre de conséquences touchant à des nombreux aspects de l'organisation et du fonctionnement de l'administration. Il en résulte que l'application considérée ainsi globalement sera envisagée sous divers aspects :

- du point de vue des réglements, prescriptions et instructions administratives propre au cadastre;
- du point de vue de l'organisation et du fonctionnement de l'administration;
- du point de vue purement informatique.

Le réseau qui sera progressivement mis en place sera du type "réseau en étoile" et le nombre de postes de travail et d'imprimantes sera de l'ordre d'un bon millier au total pour l'ensemble du pays.

11. Le plan cadastral.

Le Cadastre belge est un Cadastre parcellaire; il est établi sur la base de la parcelle, considérée en principe comme une portion de territoire de même nature (de culture ou autre), située dans un même lieu-dit appartenant au même propriétaire et, par conséquent, désignée par un seul numéro au plan cadastral.

Cette définition, établie à l'origine du Cadastre belge, reste valable en ce qui concerne la plupart des parcelles bâties et non bâties, mais a été modifiée par l'arrêté royal du 12 avril 1966 à l'égard, en ordre principal, des maisons d'habitation, usines, établissements, avec lesquels on groupe, sous un même numéro parcellaire, sous certaines conditions, les dépendances bâties et non bâties contigües.

Le plan parcellaire est celui qui représente le territoire d'une commune dans ses plus petites subdivisions soit de cultures, soit de propriétés.

Etabli le plus fréquemment à l'une des échelles 1/2500, 1/2000, 1/1250 ou 1/1000 et exceptionnellement à l'une des échelles 1/5000 ou 1/500, il se compose d'un certain nombre de feuilles reproduisant chacune une section ou une partie de section.

Les parcelles y sont désignées, dans chaque section, par un numéro emprunté à la série continue des nombres entiers commençant à 1.

Il convient de souligner que, lors de la constitution du cadastre en Belgique, chaque commune a été triangulée séparément sans rattachement à une triangulation du pays, d'où la difficulté d'assembler les plans de communes limitrophes. Les agrandissements de plans, rendus nécessaires au cours des années par le morcellement du parcellaire dans les villes et localités importantes, en outre, par des procédés graphiques ont accentués les discordances.

En procédant par rattachement à la triangulation générale, comme on le fait actuellement dans les nouveaux levés cadastraux d'ensemble, on élimine ces inconvénients.

Ni les sommets des triangles, ni ceux des cheminements polygonaux, ne furent matérialisés sur le terrain : d'où l'impossibilité de reconstituer les bases d'opération après coup et de redresser les erreurs découvertes lors des rattachements ultérieurs de limites. Lors des nouveaux levés cadastraux d'ensemble réalisés actuellement, les bases d'opération sont matérialisées de façon durable sur le terrain.

Le Cadastre possède plus de 25.000 plans dont 4.000 environ sont rattachés à la triangulation générale du Royaume.

Cette documentation constitue l'unique plan parcellaire général du pays, annuellement mis à jour. En conséquence, elle entre en ligne de compte comme document de base pour la création d'une banque de données "SOL".

12. Le dessin automatique des plans.

12.1. Préambule.

Il importe tout d'abord de distinguer deux conceptions différentes selon qu'on considère la table traçante automatique soit comme une station indépendante dont le dessin est le produit final soit comme un périphérique de l'ordinateur permettant l'exploitation d'une banque de données.
Dans la première conception, l'application s'arrête à une statistique ou à un plan, tandis que dans la seconde, une réponse complète ou partielle peut être donnée à une question se situant dans le cadre de la banque de données (extraits, cartographie thématique, statistiques, ...) et un contrôle électronique peut être instauré lors de la reprise ou de la mise à jour de cette banque de données.

L'administration du Cadastre a opté pour la première conception, parce qu'elle répond mieux aux missions qui lui ont été confiées, de plus elle ne met pas en cause la réalisation d'une base de données "topographiques". Cette base de données pourra alors constituer le point de départ d'une banque de données "SOL" au moment où l'autorité supérieure en décidera la constitution.

12.2 Applications actuelles.

Avant de traiter les applications actuelles en matière de dessin automatique ou de dessin assisté par ordinateur, il faut distinguer les deux types de plans cadastraux c-à-d. les plans anciens, non rattachés à la triangulation générale du Royaume et les nouveaux plans établis par la Direction des grands levers et plans généraux (D.G.L.P.G.). Les plans anciens, datant en général de la création du Cadastre, ont subi, lors de leurs mises à jour successives, une certaine détérioration métrique, mais restent néanmoins des documents graphiques très valables. Les nouveaux plans, par contre, basés sur un réseau de points connus en coordonnées et dessinés sur un support stable sont pour leur part métriquement exacts.

Les méthodes de mise à jour des plans cadastraux concernant des travaux d'infrastructure importants comme les autoroutes, les remembrements ou les nouveaux lotissements p.ex., tiennent compte de cette différence de précision. Une mise à jour graphique des plans anciens est suffisante alors que les nouveaux plans exigent un traitement plus précis.

12.2.1. Mise à jour graphique à partir de photos aériennes.

Cette méthode a été mise au point pour permettre la mise à jour des plans anciens en ce qui concerne les grands travaux d'infrastructure comme les autoroutes.

Elle permet, à l'aide notamment de l'ordinateur et de la table traçante, d'obtenir les résultats suivants :

- intégrer les plans cadastraux dans une triangulation générale, les redresser si nécessaire et les pourvoir d'un quadrillage;
- rapporter les grands travaux d'infrastructure aux plans;
- apurer un certain nombre de cas non encore résolus à cause de non-délimitation et permettre ainsi de localiser les excédents de terrain, issus des expropriations, restant le long des autoroutes.

12.2.2. Les levés photogrammétriques.

Depuis les années '30', le Cadastre s'est intéressé à la photogrammétrie et exposait déjà en 1934 à Paris, lors du IVe Congrès International de Photogrammétrie, les plans issus de la première expérience photogrammétrique.

Pourtant la précision (assimilée à celle d'un bon croquis de terrain) et la rentabilité de la photogrammétrie furent jugées insuffisantes. Le Cadastre s'orienta vers la topographie classique et le service spécial des levers et plans généraux fut créé à cet effet en 1936.

En 1948 l'apparition d'un objectif photographique de haute précision permettait d'envisager de nouveaux essais en recherchant cette fois une précision analogue à celle obtenue par la topographie classique.

La précision était très proche de la limite de tolérance imposée (erreur moyenne en planimétrie de 0,2 mm). L'utilisation de la photogrammétrie paraissait cependant fort coûteuse et d'un rendement insuffisant. Trop d'interventions au sol restaient nécessaires pour compléter le plan obtenu par photogrammétrie.

En 1968 le Cadastre effectua des levés photogrammétriques sans autre marquage au sol que celui des points d'appui.

Depuis les premiers essais, le Cadastre s'est donc orienté, d'une méthode qui nécessitait de nombreux travaux préalables au sol, vers une méthode qui ne demandait que le relevé d'un nombre réduit de points de repère. La photogrammétrie a évidemment bénéficié en outre de l'énorme développement des moyens de calcul disponibles. Un programme d'ordinateur a été développé sur base d'une méthode de calcul conçue par le Cadastre. Les calculs sont effectués photo par photo afin de permettre un redressement numérique. Le film destiné au redressement est dessiné par la table traçante.

La méthode de levé photogrammétrique actuellement appliquée se prête fort bien à la restitution des régions bâties et se révèle très économique. La précision graphique est de 0,2 mm à l'échelle 1 : 1 000. Les photographies sont prises au moyen d'une chambre de prises de vue à angle normal à une altitude d'environ 1000 m (échelle ± 1 : 5000) compatible avec les nécessités de l'indication des détails repris sur les cartes cadastrales. Les stéréominutes sont établies au 1 : 1000 (territoires urbains) ou au 1 : 2000 (sites ruraux).

12.2.3. Les plans issus d'un remembrement.

Lors d'un remembrement des biens ruraux, la Société Nationale Terrienne (S.N.T.), qui a la charge des remembrements, appuie ses mensurations sur un canevas topographique réalisé par le Cadastre. Après avoir terminé ses travaux, la S.N.T. transmet une copie de ses plans à l'administration du Cadastre afin que cette dernière dresse les nouveaux plans cadastraux.

Les plans fournis par la S.N.T. ont un découpage qui ne correspond pas à celui des plans cadastraux et ne concernent évidemment que les parties remembrées de la ou des commune(s) impliquée(s) dans le remembrement. De ce fait, le Cadastre était obligé d'assembler manuellement des parties des plans fournis par la S.N.T. avec les mesurages des îlots exclus du remembrement, qu'elle avait effectués sur le terrain.

Depuis que la S.N.T. a introduit des procédés informatiques dans la confection de l'acte de remembrement et le dessin de ses plans, le Cadastre a des contacts suivis avec les responsables du service informatique de la S.N.T. Les contacts ont abouti d'une part à la préparation automatique des dossiers de mutations et d'autre part au dessin automatique des plans cadastraux issus d'un remembrement. L'échange d'informations entre les deux C.T.I. se fait à l'aide de bandes magnétiques.

En ce qui concerne plus particulièrement les plans, les informations - c-à-d. les coordonnées des points et les contours des parcelles - sont ventilées par plan cadastral avant d'être traitées. L'aboutissement de ce traitement est la gravure du plan sur la table traçante.

12.2.4. Les plans issus de mesurages au sol.

Grâce au développement des appareils d'arpentage, il s'avère actuellement possible d'effectuer les mesurages sur terrain de façon rapide et rationnelle. Le volume des travaux exécuté pendant la saison de terrain peut cependant avoir pour conséquence de rendre nécessaire une prolongation de la période consacrée aux travaux de bureau (calcul, semis de points, travaux de dessin, ...). Celle-ci provoquera automatiquement le raccourcissement de la saison de terrain suivante et annulera le gain de temps acquis lors des mesurages. L'emploi de l'ordinateur et du système de dessin automatique peut, dans la plupart des cas, entraîner une telle diminution des travaux de bureau que la période de travail sédentaire s'en trouve raccourcie.

Les données qui doivent être collectées pour permettre l'emploi du système de dessin automatique sont en fait les mêmes que celles qui doivent être mises à la disposition d'un dessinateur, c'est-à-dire des réseaux de points connus en coordonnées. Il est donc nécessaire de pouvoir disposer de deux sortes de données : des points connus en coordonnées et les types de lignes reliant ces points. Les programmes qui gèrent la table à dessin automatique puisent leurs informations principalement dans deux fichiers : d'une part un fichier "coordonnées" et d'autre part un fichier "lignes" ou fichier "parcelles".

La collecte des données et leur traitement sont de la compétence du "bureau central" de la direction des grands levers et des plans généraux (anciennement : service spécial) qui est relié à l'ordinateur central par voie de terminaux.

Dans un avenir assez proche tous les bureaux décentralisés de cette direction seront reliés au réseau de l'administration du cadastre et géreront les fichiers topographiques à distance et en temps réel.

13. La documentation d'expertise.

Il s'agit en fait de la constitution sur support magnétique d'un fichier général des propriétés bâties comportant les principaux éléments constitutifs des bâtiments intervenant dans l'établissement des revenus cadastraux et devant permettre, par voie informatique, un contrôle des traitements requis par la gestion "cadastre" dans ce domaine. Ce fichier répond également aux besoins des organismes directement intéressés (statistiques, logement, etc ...).

Les travaux de reprise de ce fichier "code de construction" ont été clôturés dans le courant de l'année 1985.

14. Applications diverses.

14.1. Domaine de l'Etat.

Grâce à l'automatisation de la matrice cadastrale on peut confectionner des Cadastres partiels ou thématiques, tel que celui des biens appartenant au Domaine de l'Etat.

Ce dernier comprend par commune les biens immeubles qui sont la propriété de l'Etat en précisant le département ou le service gestionnaire de ces biens. Il s'agit, en l'occurrence, d'un instrument de travail qui favorise une utilisation rationnelle du potentiel immobilier de l'Etat.

Depuis le début de 1987 ce fichier est consulté et géré par terminaux.

14.2. Extraits cadastraux.

Dans les derniers mois de 1975, une nouvelle application a vu le jour, elle concerne la délivrance automatique d'extraits cadastraux dont la procédure est réglée par divers arrêtés royaux. Appliquée au départ pour les demandes d'extraits émanant de deux provinces, elle a été étendue à l'ensemble du pays c'est-à-dire pour répondre aux 600.000 demandes annuelles. Les directions régionales disposent d'une station "lecteur-reproducteur de microfilms" équipée d'une recherche automatique de l'image. Les microfilms sont produits sur un appareillage COM relié à l'ordinateur.

Pour l'année 1988 les neuf directions régionales de mutations et expertises seront reliées à l'ordinateur central et délivreront les extraits sur imprimante électronique, tandis que la comptabilité de la délivrance des extraits sera gérée par l'ordinateur. L'objectif poursuivi consiste à réduire les délais de délivrance, à donner des renseignements corrects, de présentation irréprochable, et à rentabiliser davantage ce secteur de l'activité cadastrale.

14.3. La péréquation générale.

L'automatisation a joué un rôle prépondérant dans le cadre de la dernière péréquation générale des revenus cadastraux. Un grand nombre d'opérations manuelles fort assujettissantes ont été prises en charge par l'ordinateur.

Le flux des informations relatives à la péréquation vers le C.T.I., au moyen de listings, a été ordonné de telle façon que l'ordinateur a été régulièrement alimenté.

L'automatisation a assumé entre autres les opérations suivantes :

- l'expertise de la grande masse des parcelles non bâties;
- la confection sur microfiches des nouvelles matrices cadastrales n° 212 AM portant les revenus cadastraux après péréquation;
- l'établissement des livres-journaux pour l'administration des Contributions Directes sous forme de bandes magnétiques directement exploitables;
- l'établissement et l'envoi des bulletins de notification des revenus cadastraux.

Cette application a permis de résoudre de nombreux problèmes et d'en étudier d'autres. Il en résulte que le système s'est sensiblement amélioré et que l'expérience acquise en la matière servira dans l'avenir, que ce soit lors de la prochaine péréquation ou lors de révisions spéciales ou extraordinaires.

15. Rapports avec les administrations fiscales.

Dans un souci de parfaire la gestion administrative, il s'indique de poursuivre et de perfectionner l'harmonisation de nos rapports avec les administrations soeurs. En collaboration avec l'administration des Contributions Directes, il importe de mettre au point une intégration mécanographique complète des opérations réglant les relations entre les deux services pour la gestion du fichier du précompte immobilier. Cette intégration est actuellement en cours de réalisation.
En collaboration avec l'administration de l'Enregistrement, il s'agira de rechercher une intégration mécanographique des opérations réglant la fourniture des éléments nécessaires à la gestion des fichiers immobiliers.
Ce problème est lié dans une large mesure aux décisions qui sont attendues quant au fonctionnement du secteur immobilier et aux dispositions légales et administratives qui pourraient en résulter.
Enfin, il convient de renforcer la coordination et la collaboration entre les diverses administrations du Ministère des Finances par un apport constructif au sein de la Commission d'automatisation du Département.

Dans le cadre de la lutte contre la fraude fiscale, le Cadastre apporte déjà le soutien logistique de son service automatisation à l'administration de l'Inspection Spéciale des Impôts. Le Cadastre met également son fichier à la disposition des Contributions Directes à l'occasion de demandes ponctuelles.

18. Rapports avec les autres administrations et organismes publics.

Des contacts suivis existent avec les services publics utilisant la documentation cadastrale (Société nationale terrienne, Institut national des statistiques, ...) et avec ceux intéressés par les applications actuellement à l'étude (Institut national du Logement, Institut national des statistiques, Institut géographique national).

Des contacts analogues sont entretenus avec les organismes publics en rapport avec l'automatisation, soit directement, soit le plus souvent au sein des commissions instituées en vue de l'intégration dans un processus général d'automatisation de toutes les opérations administratives réalisées ou en voie de réalisation.

19. Conclusion.

En conclusion, on peut dire que la banque de données relatives aux immeubles, déjà détenue par le Cadastre et développée par les possibilités découlant de l'automatisation, constitue par sa mise à jour permanente une ressource nationale importante que peu de nations peuvent se flatter de posséder. Il est indispensable que notre pays, très morcelé du point de vue de la propriété et où celle-ci représente un patrimoine extrêmement important, soit à la pointe du progrès quant à la tenue d'un inventaire automatisé des biens-fonds, de leur consistance et de leurs propriétaires.

L'administration du Cadastre mettra tout en oeuvre pour que sa documentation automatisée réponde à ces impératifs.

Summary of the conference of Mr. Van Hemelrijck by Mr. Kölbl

The Progressive Automation of the Belgian Cadastre

The Belgian cadastre started early with automation. They now use third generation computers. The sequence of computerization is very important in order to retain the history of changes. The information is handled by a communication-net with terminals connections possibilities.

Mr. Van Hemelrijck insisted on the distinction :

- The automatic drawing table is considered as an independant working unit and the resulting drawing represents the final product or the output of the operations.
- The drawing table is a peripheral unit connected to a computer allowing the exploitation of a databank.

He showed us problems which arise during the revision of the cadastral maps and insisted that in Belgium, early photogrammetric tests and even applications date back to 1934 already. Photogrammetry is extensively used for revision, but also for new measurements.

The new system is similar to MAJIC2 in France, the computerization is based on a litteral file. The new measurements are treated by computer but the final output is a map. Up to now the updating is not done numerically.

There raises the question of how the enormous costs for the numerization and the numerical management of all the maps can be justified for a fiscal cadastre.

Discussion

Kölbl: Do you have your own equipment for photogrammetry or do you collaborate with private companies ?

Van Hemelrijck: All photogrammetric projects are treated in the office of the cadastral survey; nothing is granted to private enterprises. Since 1984 a law forbids that different governmental organizations do concurrence each other. The topographic service (IGN) is equipped with all the necessary instruments for photogrammetry; this service is in charge of the geodetic network and the triangulation of the country. As for plotting their activity is based on photographs on 1:20'000 and limited to the scale of 1:10'000 which is evidently too small for cadastral surveys; the average area of a parcel is ~ 30 a. According to our prescriptions the cadastral service should not do its own photogrammetric plotting, nevertheless the cadastral survey applies photogrammmetry but without really applying it. This means that we use very simple methods, mainly the rectification of the photographs to reconstruct the different plots by planimetric measurements.

Kölbl: Do you think that you can superimpose your cadastral maps and the orthophotos in colour at scale 1:10'000 ?

Van Hemelrijck: Private companies do produce these orthophotos. Actually we do not use them because the scale is not suited for our purposes.

DIE ERNEUERUNG DES KATASTERS IN ÖSTERREICH

Günter Schuster
Gruppe Kataster, Grundlagenvermessungen,
Staatsgrenzen
Bundesamt für Eich- und Vermessungswesen

Zusammenfassung

Die Wurzeln des Österreichischen Katasters gehen bis in die Anfänge des 19. Jahrhunderts zurück. Zielsetzung dieser Einrichtung war eine gerechte Besteuerung der Grundstücke, wobei die Grundsätze der Führung der Grundstücksinformationen bis in die Mitte der Siebzigerjahre des 20. Jahrhunderts Gültigkeit haben sollten. Die Entwicklung der Technologie und moderne Meßmethoden waren Anlaß, den Kataster an diese Entwicklungen jeweils anzupassen. Die Anforderungen, die heute von Seiten des Benützers an den Kataster gestellt werden, erfordern immer mehr eine Neuordnung des Katasters schlechthin. Der Kataster wird nur dann seine Gültigkeit behaupten, wenn die Aussagekraft des Katasters die Forderungen an ein boden- und grundstücksbezogenes Informationssystem, die von Seiten der verwaltenden, der planenden Stellen erhoben werden, erfüllen wird können. Wesentliche Bedeutung zur effizienten Darstellung des Katasters wird dabei der automationsunterstützten Datenverarbeitung zukommen.

Die Führung des schriftlichen Teiles des Katasters im Rahmen einer Grundstücksdatenbank ist in Österreich bundesweit verwirklicht worden. Derzeit werden alle Anstrengungen unternommen, den noch analog geführten Inhalt der Katastralmappe in digitaler Form anbieten zu können.

1. Einleitung

Der österreichische Grundkataster blickt nunmehr auf einen 170-jährigen Bestand zurück. Er wurde am 23. Dezember 1817 durch das von Kaiser Franz I. erlassene Patent als Grundsteuerkataster begründet. Die Erlassung des Grundsteuerpatentes verfolgte damals zwei Ziele. Erstens sollte eine gerechte Besteuerung eingeführt werden, die auf die persönliche Stellung des Grundbesitzers keine Rücksicht zu nehmen hatte und überdies lediglich vom Reinertrag des Bodens bei landesüblicher Bewirtschaftung ausgehen sollte, und zweitens sollte die flächenmäßige Erfassung der Grundstücke durch eine auf wissenschaftlicher Grundlage vorzunehmende Vermes-

sung und Darstellung in Plänen (Mappen) erfolgen. Dieses, im Jahre 1861 abgeschlossene wenn auch mit ungeheurem Weitblick geschaffene Werk war natürlich Änderungen insoferne unterworfen, als den jeweiligen Zeitverhältnissen - manchmal auch etwas schwerfällig - Rechnung getragen werden mußte. Damit hat aber der Grundsteuerkataster heute eine rechtliche und technische Höhe erreicht, die ihn vielen öffentlichen und privaten Ansprüchen gerecht werden lassen. Der Grundsteuerkataster hat damit auch jenen ursprünglichen Zweck, ein Instrument gerechter Besteuerung zu sein, weitgehend überflügelt.

2. Die gesetzliche Grundlage

Bis zum Jahre 1940 erfolgte die Bewertung des Grundbesitzes auf der Grundlage des Grundsteuerregelungsgesetzes, sodaß die darauf beruhenden Katastervorschriften voll anwendbar blieben. Durch die Einführung des Bewertungsgesetzes ist die Bewertung jedoch auf eine völlig neue Grundlage gestellt worden. Anstelle der bisher von den Vermessungsämtern ausgestellten Grundbesitzbogen sind die Einheitswertbescheide, die nunmehr von den Finanzämtern ausgestellt wurden, als Besteuerungsgrundlage getreten. Nicht mehr Katastralreinertrag und Bonität, sondern die Ergebnisse der Bodenschätzung sind für die Bewertung der Grundstücke herangezogen worden. Die Anpassung der für den Kataster geltenden Vorschriften ist jedoch unterblieben, sodaß diese zum Großteil als überholt, zum Teil als nicht mehr anwendbar bezeichnet werden mußten. Diese Gründe zwangen dringend zu einer Neuordnung der bisher geltenden Katastervorschriften. Aber auch andere Gründe gaben Anlaß, die Neuregelung des Rechtsgebietes als vornehmlichstes Ziel der Katastererneuerung zu sehen.

Die bisher in Geltung stehenden Vorschriften waren bis zu 150 Jahre alt und insbesondere auch durch die Entwicklung der Technik überholt worden. Neue Vermessungsgeräte und Meßmethoden ermöglichten es, mit dem gleichen Aufwand ungleich bessere Ergebnisse sowohl in qualitativer als auch in quantitativer Hinsicht zu erzielen. Dazu kam noch, daß die steigenden Bodenwerte immer mehr zu Schwierigkeiten führten, die nach einer Lösung verlangten. Nach der bisherigen Rechtslage nahmen nur die Grundstücksnummern am öffentlichen Glauben des Grundbuches teil, während die Katastralmappe lediglich zur Veranschaulichung der Lage der Liegenschaft bestimmt war. Welcher abgegrenzte Teil der Erdoberfläche von der Nummer umfaßt wird und damit den Gegenstand des eingetragenen Eigentumsrechtes bildete, war dem Vertrauenschutz zur Gänze entzogen. Im Hinblick auf die auch aus anderen Gründen notwendige Neugestaltung des Katasterrechtes schien es zweckmäßig, einen umfassenden Vertrauensschutz hinsichtlich der im Kataster eingetragenen Grenzen zu schaffen, ein Vorhaben, das noch durch die in der modernen Vermessungstechnik gebotenen Genauigkeit unterstützt wurde.

In Hinkunft sollten nun die Grenzen der Grundstücke im neuen Kataster mit den gleichen Rechtsfolgen geführt werden, wie dies bereits bei den Grundstücksnummern der Fall war. Die Folge davon ist, daß die Angaben des Katasters künftig die Grundlage für die Bestimmung des Grenzverlaufes der Grundstücke bilden werden.

Die Neuordnung der Landesvermessung wurde daher mit dem am 1. Jänner 1969 in Kraft getretenen Vermessungsgesetz nach folgenden Grundsätzen vorgenommen:

a) Aufgaben des Bundesvermessungsdienstes sollten im wesentlichen die Grundlagenvermessungen, die Anlegung und Führung des Katasters und die Herstellung der staatlichen Landkarten sein.

b) Der neue Kataster sollte neben seiner bisherigen Aufgabe, der Finanzverwaltung die Grundlagen der Einheitsbewertung zu liefern, auch der Sicherung der Grundstücksgrenzen dienen.
c) Der neue Kataster sollte nicht nur vom Bundesvermessungsdienst allein, sondern gemeinsam mit allen Vermessungsbefugten geschaffen werden.
d) Der neue Kataster sollte seinem Aufbau nach dem bisherigen soweit als möglich entsprechen, um einen reibungslosen Übergang zu ermöglichen.
e) Die Neuregelung sollte keine Mehrbelastung des Staatshaushaltes zur Folge haben.

Die in den Jahren nach dem Inkrafttreten des Vermessungsgesetzes gewonnenen Erfahrungen gaben im Jahre 1975 Anlaß zu einer Novellierung dieses Gesetzes. Bis zum 1. Jänner 1974 wurde in rund 1200 von insgesamt7834 Katastralgemeinden das Neuanlegungsverfahren für den Grenzkataster eingeleitet und damit die Möglichkeit geschaffen, Grundstücke in den Grenzkataster einzutragen. Im großen Ausmaß ist dies jedoch nur im Zusammenhang mit Agrarverfahren geschehen. Die neu eingefügten Bestimmungen sollten die Möglichkeit eröffnen, unter vereinfachten Verfahrensbestimmungen alle jene Grundstücke in den Grenzkataster überzuführen, die von Teilungen in Katastralgemeinden, in denen das Neuanlegungsverfahren bereits eingeleitet ist, betroffen sind. Davon war eine bedeutende Beschleunigung des Grenzkatasters zu erwarten.

Mit der weiteren Novellierung im Jahre 1980 sollte das Vermessungsgesetz an die technische Entwicklung im Bereich der automationsunterstützten Datenverarbeitung insoferne angepaßt werden, als nunmehr auf Grund der Einrichtung einer Grundstücksdatenbank die damit verbundenen Erfordernisse des Datenschutzes Berücksichtigung finden sollten. Das Bundesamt für Eich- und Vermessungswesen wendete die automationsunterstützte Datenverarbeitung schon seit dem Jahre 1956 an. Diese Anwendung bezog sich jedoch nur auf das Schriftoperat des Katasters. Die aus Rationalisierungsgründen erfolgende Erweiterung um Daten des technischen Operates und um Daten, die vom Grundbuch übernommen werden, erforderte die Anpassung des Vermessungsrechtes an diese Weiterentwicklung unter Einbeziehung entsprechender Datenschutzbestimmungen.

3. Die Grundstücksdatenbank

3,1 Organisatorische und technische Grundsätze

Das Katastraloperat wurde in den Jahren 1956 bis 1966 vom historisch überkommenen Foliantenprinzip vorerst auf eine Lochkartenorganisation und im weiteren entsprechend der Entwicklung der EDV auf eine Lochkarten-Magnetbandorganisation umgestellt. Obwohl dieses System bei seiner Einführung überaus fortschrittlich war, stellte es sich im Zuge der Weiterentwicklung der EDV als zweckmäßig heraus, für die Führung des Katastraloperates die Vorzüge einer Datenbank heranzuziehen, da die Lochkarten als Datenträger längst überholt und die Lochkarten-Magnetbandorganisation nicht weiter entwickelbar waren. Nicht zuletzt war jedoch die kurze Dauer der Datenerfassung dem Umstand zuzuschreiben, daß ein großer Teil der Katasterdaten aus dem Lochkartenoperat bereits maschinell lesbar vorlag. Im Sinne einer sparsamen und wirtschaftlichen Verwaltung sollte die Einrichtung einer Grundstücksdatenbank nicht nur für den Kataster, sondern auch für die Grundbücher erfolgen.

Die Grundstücksdatenbank stellt ein gemeinsames Projekt des Bundesministeriums für Bauten und Technik und des Bundesministeriums für Justiz dar. Ziel des Projektes ist die gemeinsame zentrale Speicherung aller Daten von Kataster und Grundbuch im Bundesrechenamt und deren dezentrale Führung in den Vermessungsämtern und Bezirksgerichten mittels Datenfernverarbeitung unter Wahrung der gesetzlichen Zuständigkeiten.

Kataster und Grundbuch führen boden- und grundstücksbezogene Daten. Die bestehenden gesetzlichen Verpflichtungen zur übereinstimmenden Führung beider Datenbestände erforderten auch die Führung von zum Teil identischen Daten. Interessenten an grundstücksbezogenen Daten mußten, um vollständige Informationen zu erhalten, jeweils Kataster und Grundbuch in Anspruch nehmen. Auf Grund des personalintensiven Systems der Führung von Kataster und Grundbuch bestanden Schwierigkeiten bei der Aktualisierung der Datenbestände und mitunter lange Wartefristen bei der Bestellung von Kopien und Auszügen.

Durch die Zusammenfassung der Daten von Kataster und Grundbuch in Form der Grundstücksdatenbank werden mit dem Wegfall der Führung identischer Daten innerbehördliche Rationalisierungseffekte erzielt und die boden- und grundstücksbezogenen Daten aktueller und benützerfreundlicher dargeboten. Die Speicherung der Datenbestände erfolgt im Interesse einer sparsamen und wirtschaftlichen Verwaltung im Bundesrechenamt. Die Verbindung vom Bundesrechenamt zu den einzelnen Vermessungsämtern wird durch Datenübertragungsleitungen sichergestellt, wobei diese Leitungen nicht nur den Vermessungsämtern und den Grundbuchsgerichten zur Verfügung stehen, sondern auch anderen Behörden zugänglich sein sollen. Zur Weitergabe der Informationen der Grundstücksdatenbank an die Benutzer und zur täglichen Aktualisierung der Datenbestände wurden bei den Vermessungsämtern Datenendstationen eingerichtet, die im wesentlichen aus einem Bildschirm und einem Drucker für den Ausdruck jener Informationen bestehen, die der Benutzer etwa zur Grundlagenbeschaffung für den Abschluß von Rechtsgeschäften benötigt. Für Benutzer, die Informationen aus der Grundstücksdatenbank häufiger und in größerem Umfang benötigen, wurde die Möglichkeit geschaffen, über eigene Datenendstationen zum Datenbestand zugreifen zu können.

3,2 Die Einrichtung der Grundstücksdatenbank

Der Umsetzung der Überlegungen hinsichtlich der Strukturierung der Datenbestände sowie deren Manipulation sollte ein Modellversuch dienen. Der Sprengel des Vermessungsamtes Wien war in Anbetracht der Heterogenität des Datenbestandes einer Großstadt als Versuchsgebiet ausgewählt worden und umfaßte bei den Grundstücken etwa 2,5 Prozent, bei den Grundbuchseinlagen etwa 5 Prozent des Gesamtdatenbestandes des Bundesgebietes. Der erfolgreiche Abschluß des Modellversuches Wien und die am 13. Juni 1978 erfolgte Zustimmung des Ministerrates legten den Grundstein für die schrittweise Umstellung des Grenzkatasters auf die Führung mit Hilfe der automationsunterstützten Datenverarbeitung in den übrigen Vermessungsämtern. Die Umstellung wurde nach folgenden Grundsätzen bestimmt:

- Die wichtigsten Vermessungsämter sind vordringlich zu versorgen;
- Die Vorbereitungsarbeiten für die Datenersterfassung sind in Ansehung der übrigen Aufgaben der Vermessungsämter möglichst gleichmäßig zu verteilen;
- Die Datenerfassungskapazität bei der EDV-Abteilung ist möglichst hoch und konstant zu halten.

Nach diesen Grundsätzen wurde die Einrichtung der Grundstücksdatenbank in 8 Ausbaustufen vorgenommen und planmäßig mit Ende November des Jahres 1984

abgeschlossen. Mit dem im April 1985 erfolgen Abschluß der noch erforderlichen Aktualisierungsarbeiten wird nunmehr der Kataster in allen Vermessungsämtern im Wege der Grundstücksdatenbank geführt. In der Grundstücksdatenbank werden damit für das gesamte Bundesgebiet 11,850.000 Grundstücke, die in 2,230.000 Grundbuchseinlagen eingetragen sind, verwaltet.

3,3 Die unmittelbare Einsichtnahme in die Grundstücksdatenbank

Das Vermessungsgesetz in der Fassung der Novelle 1980 hat die Frage der Öffentlichkeit des Grenzkatasters und damit auch die Einsichtnahme in den Grenzkataster neu geregelt. In Anpassung an die technische Entwicklung sollten benutzerfreundliche Wege den Zugang zu den Kataster- und Grundbuchsdaten eröffnen.

Mit Beginn des Jahres 1987 besteht für Vermessungsbefugte, Notare, Rechtsanwälte, aber auch für andere Personen oder Dienststellen, die Möglichkeit, den Datenbestand von Kataster und Grundbuch mit einer Datenendstation einzusehen. Die technischen Voraussetzungen für diese unmittelbare Einsichtnahme sind von Seiten des Bundesamtes für Eich- und Vermessungswesen in Zusammenarbeit mit der Postverwaltung vorbereitet worden. Die unmittelbare Einsichtnahme in die Grundstücksdatenbank erfolgt über das Medium Bildschirmtext (BTX), ein System, das sich durch hohe Verfügbarkeit und gutes Antwortzeitverhalten auszeichnet. Dem Teilnehmer selbst wird durch das System keine bestimmte Hardware-Konfiguration vorgeschrieben. Neben Bildschirm und Tastatur ist auch die Ausstattung mit externen Speichermedien sowie mit Druckern und Plottern möglich.

Bei der großen Anzahl von Benutzern ist die individuelle Einschulung nicht durchführbar. Daher werden sowohl herkömmliche Unterlagen als auch programmgesteuerte Informationshilfen bereitgestellt, die es dem Benutzer ermöglichen, das Angebot der Grundstücksdatenbank im Rahmen der erteilten Befugnis bestmöglich zu nutzen. Die Erteilung der Berechtigung zur unmittelbaren Einsichtnahme einschließlich des Umfanges der Befugnis erfolgt mittels Bescheid, dem auch eine Betriebsordnung angeschlossen ist. Diese Betriebsordnung regelt die ordnungsgemäße Verwendung des Systems durch den Berechtigten und enthält insbesondere die datenschutzrechtlichen Aspekte für die unmittelbare Einsichtnahme. Die Kosten für die unmittelbare Einsichtnahme sind für alle Benutzer im gesamten Bundesgebiet unabhängig von der Entfernung zum zentralen System der Grundstücksdatenbank gleich hoch.

4. Die Koordinatendatenbank der Grenzpunkte

Bereits zu Beginn des Projektes "Grundstücksdatenbank" war klargestellt, daß diese Datenbank als Basisdatenbank für ein umfassendes Informationssystem zu verstehen ist, somit ein flexibles Instrument zu sein hat, das es dem Kataster gestattet, später entsprechend dem Bedarf durch Hinzufügen weiterer Datenbestände den jeweils geltenden Anforderungen gerecht zu werden. Eines der für den Datenbestand des Katasters wesentlichen Folgeprojekte ist mit der im Frühjahr 1986 getroffenen Entscheidung zur Einrichtung der Koordinatendatenbank der Grenzpunkte eingeleitet worden. Entscheidungswesentliche Gründe waren insbesondere die Bedeutung des betroffenen Datenbestandes für alle Vermessungsbefugten, die Notwendigkeit, die rund 14,2 Millionen Grenzpunkte im Hinblick auf ihre Brauchbarkeit für einen aussagekräftigen Datenbestand zu überarbeiten sowie die Möglichkeit des Zugriffes zu diesem Datenbestand im Wege der Datenfernverarbeitung.

Ziel des Projektes ist die Einrichtung der Koordinatendatenbank in allen

bis zum Jahr 1988 entstehenden Grenzkatastergemeinden. In den nicht in das Projekt einbezogenen Katastralgemeinden wird in der Folge - nach 1988 - die Koordinatenbank der Grenzpunkte jeweils aus Anlaß des Neuanlegungsverfahrens eingerichtet werden. Die zu erfassenden Daten sollen darüberhinaus dem Fachmann eine Beurteilung der Grenzen der Grundstücke in Verbindung mit dem Festpunktfeld gestatten sowie eine brauchbare Grundlage für weitere Folgeprojekte - digitale Katastralmappe, Basiskarte 1:5 000 - sein. Wenn auch bei der Einrichtung der Koordinatendatenbank davon ausgegangen wird, die Vermessungsämter gleich zu belasten, wird den Gebieten mit starkem Grundverkehr höhere Priorität zukommen müssen.

Unter Mitarbeit der Vermessungsämter und der EDV-Abteilung des Bundesamtes für Eich- und Vermessungswesen wurde der Gesamtdatenbestand erhoben. Der Kataster führt demnach zur Zeit in unterschiedlicher Form (Koordinatenverzeichnisse, Koordinatendatei, Koordinatendatenbank) rund 14,2 Millionen Grenzpunkte, von denen rund 1,7 Millionen Punkte bereits in der Koordinatendatenbank enthalten sind. Für das Projekt verbleibt eine Menge von 12,5 Millionen durch die Vermessungsämter zu überarbeitenden Punkten. 1,5 Millionen dieser Punkte sind ausschließlich in handschriftlich geführten Verzeichnissen enthalten, der Rest ist in maschinlesbarer Form bereits in der Koordinatendatei gespeichert. Von den 12,5 Millionen zu überarbeitenden Punkten werden voraussichtlich 5 Millionen Punkte nicht in die Koordinatendatenbank aufzunehmen sein, da diese Punkte hinsichtlich des Anschlusses an das Festpunktfeld nicht den vorgegebenen Voraussetzungen entsprechen.

Durch entsprechende Steuerung der Erfassungskapazitäten der EDV-Abteilung wird jährlich eine Punktmenge von rund 1 Million Punkten erfaßt und in die Koordinatendatenbank eingespeichert werden. Aus dieser Sicht wird mit einem Projektsabschluß in voraussichtlich acht Jahren - bei Bereitstellung der notwendigen Budgetmittel - gerechnet.

5. Die Katastralmappe

Die älteste Katastralmappe Österreichs war das planliche Ergebnis der für die Anlegung des Grundsteuerkatasters durchgeführten Vermessungen, die durch das allerhöchste Patent vom 23. Dezember 1817 zum Zwecke einer gerechten Besteuerung angeordnet worden sind. Die Vermessungen waren in den Jahren 1818 bis 1861 nach der Meßtischaufnahme im Blattschnitt der damals vorliegenden Katastersysteme durchgeführt worden. Zur Evidenzhaltung beziehungsweise Erneuerung der Katastralmappe waren in der Folge Instruktionen erlassen worden, wonach die neue Katastralmappe zwar im metrischen System, jedoch immer noch in den verschiedenen Katastersystemen anzulegen war. Mit der Einführung des Systems der Landesvermessung (3-Grad-Streifen-System der Gauß-Krüger-Projektion mit den Bezugsmeridianen 28,31 und 34 Grad östlich von Ferro) im Jahre 1921 wurden auch für die Herstellung der Katastralmappe im Zuge von Neuvermessungen neue Vorschriften erlassen.

In den Jahren 1961 bis 1969 noch in Form des "Zahlenplanes" - neben dem Inhalt der Katastralmappe sollte auch der Inhalt der Feldskizzen in roter Farbe dargestellt werden - angelegt, wurde der Katastralmappe mit Inkrafttreten des Vermessungsgesetzes im Jahre 1969 eine dem Grenzkataster entsprechende Funktion zugewiesen. Die in der Katastralmappe eingetragenen Punktnummern der Grenzpunkte von Grundstücken des Grenzkatasters sollten in Hinkunft im Zusammenhang mit dem Koordinatenverzeichnis und den Planurkunden zum verbindlichen Nachweis der Grundstücksgrenzen dienen.

5,1 Die Umbildung der Katastralmappe

Neben der nur durch graphische Einpassung zu führenden Meßtischmappe (Fortführungsmappe) versuchte man eine den Vorschriften entsprechende Katastralmappe in Form der "Aufbaumappe" überall dort zu schaffen, wo als Ergebnis einer Vermessung Gauß-Krüger-Koordinaten für die Grenzpunkte vorlagen, in der Hoffnung, daß die Lücken sich allmählich schließen werden. Mit der notwendigen doppelten Führung der Fortführungs- und der Aufbaumappe war ein derartiger Arbeitsaufwand verbunden, sodaß das Konzept der Aufbaumappe nicht weiter verfolgt wurde und seit dem Jahre 1964 die Katastralmappe durch Umbildung neu angelegt wird. Eine Neuvermessung des gesamten Bundesgebietes war aus budgetären, personellen und kapazitären Gründen auszuschließen.

Die für die Umbildung der Katastralmappe erlassenen Vorschriften bestimmen, daß die Katastralmappe als Rahmenmappe im System der Landesvermessung anzulegen ist, wobei je nach wirtschaftlicher und technischer Notwendigkeit die Maßstäbe 1:1 000, 1:2 000 beziehungsweise 1:5 000 zu verwenden sind. Voraussetzung für die Anlegung der Katastralmappe ist jedoch das Vorhandensein von Festpunkten in ausreichender Dichte.

Zur Umbildung der Katastralmappe werden je nach Erfordernis die folgenden Grundlagen herangezogen:

a) Punktauftragungen auf Grund von Koordinaten im System der Landesvermessung;
b) Einpaßlinien, die durch photogrammetrische Auswertung gewonnen wurden;
c) Einpaßlinien, die durch Transformation aus der bisherigen Katastralmappe unter Verwendung identischer Punkte hervorgegangen sind;
d) Einpaßlinien, die durch Transformation aus der bisherigen Katastralmappe unter Verwendung der im System der Landesvermessung bestimmten Blatteckenwerte hervorgegangen sind;
e) Vergrößerungen oder Verkleinerungen der bisherigen Katastralmappe;
f) Maßstäbliche zeichnerische Darstellungen amtsfremder Stellen.

Der Grundgedanke der Umbildung besteht darin, die jeweils notwendigen Vergrößerungen oder Verkleinerungen des Inhaltes der Katastralmappe des Grundsteuerkatasters auf Grund von Auftragungen der im System der Landesvermessung bestimmten, unverändert gebliebenen Grenzpunkte sowie weiterer sorgfältig ausgewählter Einpaßhilfen in das System der Landesvermessung einzupassen. Dabei wird versucht, örtliche Verdrehungen und Verzerrungen des bisherigen Katasterinhaltes unter Einsatz der Photogrammetrie zu erkennen und gestützt auf die Katasterkenntnisse des erfahrenen Personals zu beseitigen.

Nach Abschluß der Umbildung werden für das Bundesgebiet rund 79000 Mappenblätter im Maßstab 1:1 000, 45 000 Mappenblätter im Maßstab 1:2 000 sowie 7 000 Mappenblätter im Maßstab 1:5 000 vorliegen. Mit Stand Ende 1986 liegen rund 64 800 Mappenblätter im Maßstab 1:1 000, 19 900 Mappenblätter im Maßstab 1:2 000 sowie 3 400 Mappenblätter im Maßstab 1:5 000 vor. Rund 28 400 Mappenblätter im Maßstab 1:2 880 sind noch umzubilden.

5,2 Die digitale Katastralmappe

Die digitale Führung des einen Datenbestandes - des bisherigen Schriftoperates - und die analoge Führung des anderen Datenbestandes - des bisherigen Mappenoperates - kann insbesondere im Hinblick auf die Methoden der Da-

tenverarbeitung im Interesse der Verwaltungsökonomie nur für jenen Zeitraum akzeptiert werden, der durch den Zeitaufwand für die Entwicklung der Modellvorstellung für die Umstellung des analogen auf den digitalen Datenbestand sowie durch die Umstellung selbst erzwungen wird.

Der Entwicklung des Modells für den Einsatz der automationsunterstützten Datenverarbeitung für die Anlegung und die Führung liegen vorerst folgende Zielvorstellungen zu Grunde:

a) Die Darbietung der Informationen soll in gewissen Grenzen unabhängig vom Maßstab und Blattschnitt mit verschiedenen Ausgabemöglichkeiten und zumindest langfrist gesehen im Wege der Datenfernverarbeitung erfolgen können;
b) Die Kombination und Sortierbarkeit der Informationen soll gewährleistet sein. Mit der digitalen Mappe sollen Teile des Informationsinhaltes aussortiert und für sich allein oder in verschiedenen Kombinationen dargestellt werden können;
c) Die Verknüpfung mit anderen Datenbeständen wie etwa topographisch relevanter Daten, Daten der Raumplanung und Bebauungsplanung, Daten der Bodenbewertung und Bodenschätzung, Angaben über unterirdische Einbauten soll möglich sein.

Den offensichtlichen Vorteilen einer digitalen Katastralmappe stehen allergings noch einige Probleme gegenüber. Im Gegensatz zu den bisherigen Datenersterfassungen für die Einrichtung der Grundstücksdatenbank kann diese Aufgabe nicht zentral durchgeführt werden. Wegen der oft nicht explizit erkennbaren Linientypen, die für ihre Identifizierung eine Verwendung der technischen Unterlagen notwendig machen, wird die Digitalisierung grundsätzlich im jeweils zuständigen Vermessungsamt erledigt werden müssen. Darüberhinaus erhebt sich auch die Frage, ob die Qualität der Katastralmappenblätter für den Aufbau der Datenbank ausreicht. Aus der Sicht der EDV sollte die erforderliche Verbesserung der Qualität einzelner Katastralmappen im analogen Bereich durchgeführt werden. Dabei wird auch zu prüfen sein, in welcher Form sich die Erhebung der Benützungsarten bei bereits umgebildeten Katastralmappen qualitätssteigernd auswirken könnte.

Insbesondere sollen jene Punkte hervorgehoben werden, die in Anbetracht einer grundsätzlichen Entscheidung für die Einführung der digitalen Katastralmappe kritisch erscheinen:

- Zum ersten ist dies die in Österreich sehr unterschiedliche Qualität der Katastralmappe hinsichtlich ihrer inneren Genauigkeit
- Zum zweiten erfordert die Organisationsform des BEV mit dezentraler Führung in den Vermessungsämtern und zentralisierter Datenverarbeitung auch bezüglich der Katastralmappe Organisationsmodelle, für die es in diesem Ausmaß bisher kaum Beispiele im Bereich der graphischen Datenverarbeitung gibt.

Diese Tatsache hat bisher mit Rücksicht auf die dadurch zu erwartende Leitungsbelastung und auch in Anbetracht des finanziellen Aufwandes für eine hiezu geeignete Software die Errichtung eines Datenverbundes für graphische Daten verzögert.

Die Einrichtung von graphischen Datenbanken war bisher unter Verwendung der technischen Voraussetzungen am Bundesrechenamt aufgrund eines aktuellen Bedarfes nur auf einige wenige Gebiete Österreichs beschränkt (Graz, Linz, Bruck an der Leitha). Hier wurden und werden Verfahren der Datenerfassung

und Führung einem Modellversuch unterzogen und die ersten Erfahrungen mit der digitalen Verwaltung von Katasterdaten gemacht. Mit der Entwicklung von kostengünstigen graphikfähigen Kleinsystemen ergibt sich jedoch in jüngster Zeit eine wesentliche Verbesserung der Voraussetzungen für die Einführung der digitalen Katastralmappe, gleichzeitig aber auch die Notwendigkeit der Abänderung des ursprünglichen Organisationskonzeptes. Die wesentliche Änderung gegenüber früheren Lösungen stellt sich als weitgehende Entlastung der Fernleitungen vom graphischen Dialog dar: Gegenwärtig steht die Adaptierung eines solchen Kleinsystems für Zwecke des Katasters unmittelbar vor dem Abschluß. Mit solchen Geräten soll in Zukunft in den Vermessungsämtern die digitale Führung der Katastralmappe auf lokaler Ebene ermöglicht werden. Für komplexe Auswertungen, für die Prüfung und Sicherung der Daten, eventuell sogar für die Darbietung im BTX-System ist der bedarfsgerechte Ausbau des Graphiksystems am Bundesrechenzentrum geplant. Der für die Aktualisierung notwendige Datentransfer zu den Vermessungsämtern kann hiebei kostengünstig über die vorhandenen Leitungen in der nicht vom GDB-Betrieb genützten Zeit in Form eines "Remote Job Entry" abgewickelt werden.

Bei den in die laufenden Versuche einbezogenen Katastralgemeinden sollen insbesondere

- die Substitution der graphisch ermittelten Daten durch gegebene Koordinaten im Landessystem,
- die interaktive Einfügung der Beschriftung,
- die Selektierung nach Datenkategorien und
- die Führung der Veränderungen in den Vermessungsämtern

untersucht werden. Des weiteren sollen die Versuche Aufschluß über den Umfang des Speicherplatzes, über den Zeitaufwand für die Vorbereitungs- und Digitalisierungsarbeiten sowie für die Führung des Datenbestandes geben.

Insgesamt wird nach Verfahren gesucht werden müssen, die in Ansehung der personellen und finanziellen Voraussetzungen des Bundesvermessungsdienstes und des zu erreichenden Zieles eine technisch und wirtschaftlich vertretbare Lösung ergeben. Konnte bei der Grundstücksdatenbank auf einen Grundstock von maschinell lesbaren Daten zurückgegriffen werden und in Kauf genommen werden, daß das angebotene Programmpaket erst im Zuge der Einrichtung Verbesserungen unterzogen wird, ist bei der Digitalisierung der Katastralmappe bereits vor der Schaffung des Datenbestandes nach Verfahren zu suchen, die zur Schaffung eines bestmöglichen Datenbestandes geeignet sind, und nach EDV-Modellen zu suchen, die der Qualität dieses Datenbestandes entsprechen.

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RENEWAL OF CADASTRE IN AUSTRIA

Günter Schuster

Gruppe Kataster, Grundlagenvermessungen,
Staatsgrenzen
Bundesamt für Eich- und Vermessungswesen

(Section of Cadastre, Basic Geodetic Surveys and
International Boundaries)
Federal Office of Metrology and Geodesy

Summary The roots of Austria's cadastre reach back to the beginning of the 19 th century. The objective of this institution was a fair taxation of landed property. The principles according to which information on real estate was kept were effective to the mid-seventies. Technological development and modern measuring methods were the cause to adapt the cadastre to these developments. The demands being made by today's user to the cadastre, increasingly reguire a downright reorganization of the cadastre. It will keep its validity only, if the evidence of the cadastre can fulfil the claims raised by administrative and planning authorities for a system of information on soil and landed property. Automatic data processing will be an essential resource for an efficient presentation of the cadastre.

For all of Austria there has been realized the management of the written part of the cadastre within the framework of a Grundstücksdatenbank. At the moment every effort is being made to be able to offer those contents of the cadastral plan in digital form that are still kept in analogue form.

1. Introduction

The Austrian Grundkataster is looking back now on an existence of 170 years. On the 23 rd. of Dec. 1817 it was founded as "Grundsteuerkataster" by a charter issued by Emperor Franz I. At that time, two objectives were aimed at by the issue of the "Grundsteuerpatent" (charter on land-tax). First of all, a fair taxation was to be introduced, regardless of the land-owner's personal position; further it was to be based on the net return of the soil, when cultivated in the common practice of the country. Secondly, the determination of the area of landed property was to be carried out on the basis of a survey relying on scientific methods and the delineation was to be depicted in plans (maps). This work was concluded in 1861 and, although carried out with great foresight, was of course subject to changes according to the necessity of paying its - sometimes cumbersome - due to the respective circumstances of the time. In that way the "Grund-

steuerkataster" has reached an excellence in legal and technical respects, which enables it to do justice to many public and private demands. Thus the "Grundsteuerkataster" to a great extent has surpassed its original aim of being a means of fair taxation.

2. The Legal Basis

Until 1940 the evaluation of landed property was carried out on the basis of the "Grundsteuerregelungsgesetz" (law regulating land-tax), thus the cadastre manuals, which were based on that law, were fully applicable. The introduction of the "Bewertungsgesetz" (law on evaluation of soil) put the evaluation on a completely new basis, however. The "Grundbesitzbogen" (compilation of information on landed property per owner per cadastral district), which had been issued by the cadastral offices and were the basis for the calculation of land-tax, were replaced by the "Einheitswert-bescheide" (ruling on soil evaluation) made out by the revenue offices. Cadastral net return and quality of soil no longer were drawn upon to evaluate landed property, but the results of land classification. The adaptation of instructions effective for the cadastre has been remained however, thus the bigger part of the instructions signified o tdatedness or could no longer be applied. These grounds proved forceful towards a reform of current cadastral instructions. There were also other reasons, which caused a reform of laws relating to that area to be the most important aim in respect to a renewal of the cadastre.

The instructions valid then were up to 150 years old and outdated, especially in view of the technological development. New surveying instruments and measuring methods made it possible to achieve uncomparably better results in quantity as well as in quality without increasing expenditure. In addition to this, the rising value of land lead to ever more difficulties for which a solution had to be found. According to the legal status until then, the legal force of the property register was effective only for the number of a plot of ground, whereas the cadastral plan only served to illustrate the location of a plot of ground. The exact demarcatet part of the surface of the earth represented by the number of a plot of ground, the latter being the subject of registered ownership, was excepted from the legal force. Considering the reform of cadastral law, which was necessary for other reasons aswell, it seemed appropriate to establish a comprehensive confidence in regard to the cadastral demarcations. This intention was supported by the precision necessary for modern surveying techniques.

Henceforth the demarcations of plots of ground were to be managed by the new cadastre with the same legal implications as was the case already with the numbers of plots of ground. As a consequence, cadastral data in the future will constitute the basis for the definition of the boundaries of a plot of ground.

The reform of national survey by way of "Vermessungsgesetz" (law on survey), which came into effect on Jan. 1 st, 1969, therefore was carried out according to the following principles:

a) The tasks of the federal authority of surveying were to be: basic geodetic surveys, cadastral foundation and keeping the cadastral records, and the production of national maps.

b) Besides its aim hitherto, to keep fiscal authorities supplied with basic information for land classification, cadastre was to legally secure the boundaries of plots of ground.

c) The new cadastre was not to be established solely by the federal authority of surveying, but jointly with professional surveyors.

d) The new cadastre should go conform with the old one as much as possible, so as to render the transition feasible.

e) The reorganization should not result in an additional strain to the national budget.

The experiences that were gained since the "Vermessungsgesetz" came into effect have been the incentive for an amendment of that law in 1975. Until Jan 1 st 1974 the proceedings for renewal of the cadastre have been started in about 1200 of a total of 7834 cadastral districts and thus set up the possibility to register plots of ground in the "Grenzkataster". This was done on a large scale only in connection with projects on land consolidation. The newly added provisions were to open up the possiblity to register under simplified proceedings all those plots of land which are affected by division in those cadastral districts where preceedings for renewal are already started. This promised a substantial acceleration of Grenzkataster.

A further amendment in 1980 was to adjust the "Vermessungsgesetz" to the technological development in automatic data processing in so far as now on account of the establishment of "Grundstücksdatenbank" the necessitis of protection of data against unauthorized inspection had to be included. Since the year 1956 already the Federal Office of Metrology and Surveying has been employing automatic data processing. This practice was limited, however, to the written records of the cadastre. With regard to rationalization technical records and data from the property register were to be included. This development necessitated the adaptation of the law in view of regulations for the protection of data against unauthorized inspection.

3 The "Grundstücksdatenbank"

3,1 Principles of Organization and Technology

During the years 1956 to 1966 the change from keeping the cadastral records in traditional folio volumes to a punch card system and, in view of the progress in automatic data processing, then to a punch card-magnetic tape organization took place. Though this system was very progressive at its introduction, in the course of further development of automatic data processing it proved advisable to use the advantages of a data bank for keeping the cadastral records, because punch cards were outdated as data carriers and the punch card-magnetic tape organization offered no further progress. Last, not least, the short period of time needed for data acquisition was to be attributed to the fact that a substantial part of the cadastral data from the punch card record was available in machine-readable form. In view of an efficient and economic administration the establishment of "Grundstücksdatenbank" was to be carried out not only for cadastre, but should include property register aswell.

"Grundstücksdatenbank" constitutes a joint project of the Federal Ministry of Technology and Construction and the Federal Ministry of Justice. The objective of the project is the joint centralized storage of all data from cadastre and property register at the "Bundesrechenamt" (Federal Computing Centre) and a decentralized manageing of the data via teleprocessing at property registries and cadastral offices respectively, with regard to their legal competences.

Cadastre and property register compile and administer data relating to soil and plots of ground. Existing legal obligations to keep both stocks of data in conformity resulted in manageing data, which to some extent were identical. Persons interested in those data had to consult both, cadastral office and property registry, to gather complete informations. The administration of cadastre and property register required a great number of staff, it was therefor difficult to maintain the stocks of data at an up-to-date level; now and again time of waiting for copies and excerpts was unavoidable.

Rationalization in administration has been effected by combining the data of cadastre and property register via "Grundstücksdatenbank", as identical data no longer need to be administered doubly. Besides, the data offered now are constantly beeing updated, which is an additional advantage for the client. With regard to an efficient and economic administration the data are stored at the "Bundesrechenamt". The connection between the "Bundesrechenamt" and each cadastral office is maintained by data-channels, which are not only used by cadastral offices and property registries, but other authorities aswell. At the cadastral offices terminals have been installed, whereby the information is passed on to the customers or the information is updated. Essentially the terminals consist of a screen and a printer to provide excerpts needed by clients for legal transactions. For those clients who frequently need "Grundstücksdatenbank"-information on a large scale there is the possibility to get their own terminal.

3,2 The Organization of "Grundstücksdatenbank"

A pilot scheme was carried out to contribute towards realizing the considerations and plans as to the structuring and management of the data. Regarding the heterogenity of its data, the district of the cadastral office of the city of Vienna was chosen to be test area, comprising about 2,5% of real estate and about 5% of property registration of Austria. The foundation for a step-by-step transfer to administer "Grenzkataster" via automatic data processing at the other cadastral offices was laid by the succesful conclusion of the pilot schema "Vienna" and governmental agreement on Jun 13th, 1978.
The transfer was determined by the following principles:
- cadastral offices of great importance must be given priority
- preparation work for data acqisition has to be shared equally with regard to the remaining work
- the capacity for data acquisition at the department of automatic data processing has to be maintained on as high and constant a level as possible.

The installment of "Grundstücksdatenbank" was organized in line with these principles, according to plan it was divided into eight phases and completed by the end of November 1984. In April 1985 the necessary updating was finished, so that now the cadastral records of all the cadastral offices are administered by way of "Grundstücksdatenbank". Thus via "Grundstücksdatenbank" on a nation-wide level the management of 11,850 000 plots of land, registered by way of 2,230 000 property register files, is maintained.

3,3 Direct consultation of "Grundstücksdatenbank"

The 1980 amendment of the "Vermessungsgesetz" has newly defined the question of public accessability and thus of direct consultation of the "Grenzkataster". Corresponding to technological development access to cadastral and property register data should be granted more easily.

Since the beginning of 1987 for professional surveyors, lawyers, notaries, but also for other persons and government offices, there has been set up the possibility to gain direct access to the data stocks of cadastre and property register via terminal. The technological provisions preceding the direct consultation have been planned by "Bundesamt für Eich- und Vermessungswesen" in cooperation with the postal administration. Direct consultation of "Grundstücksdatenbank" is effected via the medium "BTX" (text on screen), a system boasting great availability and short times for response. The participant is not tied to a special configuration of hardware. Besides screen and keyboard the use of external memory, plotters and printers is feasible.

In view of the great number of users an individual training cannot be offered. Therefore, programme controlled information as well as the usual papers are offered to enable the client, to use the information stored at "Grundstücksdatenbank" to his best advantage within the framework of his legal authorization. A ruling must be obtained by the user to get a permit for direct consultation and specifying the extent of it, regulations governing the conditions of work are added on to the ruling. These regulations govern the use of the system according to the law and especially aspects of protection of the data against unauthorized inspection. The charges for direct consultation are the same for all users in the country, regardless of their distance to the central system of "Grundstücksdatenbank".

4. Data Bank of Coordinates of Boundary Marks

Already at the start of the project "Grundstücksdatenbank" it was made clear that this data bank was to be the basis for a comprehensive system of information and therefore be a flexible instrument permitting cadastre later on to meet such demands as may be made by adding further stocks of data. One of the ensuing projects is the data bank of coordinates of boundary marks, which was decided upon in the spring of 1986 and which is essential to the stock of data of the cadastre. The motives relevant for this decision were especially the importance of the stock of data in question for every professional surveyor, the necessity of revising a total of about 14,2 mill points in respect to their usefulness for an expressive stock of data and also the possibility of access to the data via teleprocessing.

The objective of the project is to establish the data bank of coordinates in every "Grenzkataster" - district that will be organized by 1988. Subsequently those cadastral districts not yet included into that project will get the data bank of coordinates established after 1988 on the occasion of the proceedings for renewal. Beyond that, the acquired data shall enable experts to pass judgement on the boundaries in connection with the net of control stations as well as constitute a useful base for further projects, i.e. digital cadastral plan, "Basiskarte" 1:5 000.
Establishing the data bank of coordinates will proceed from the presupposition of equally sharing this additional work among the cadastral offices, those districts subjected to frequent land transactions must get top priority. The total stock of data was collected in cooperation between the cadastral offices and the department of electronic data processing of "Bundesamt für Eich- und Vermessungswesen". Thus at the moment about 14,2 mill boundary marks are compiled and managed by cadastre, in different forms (i.e. register of coordinates, file of coordinates, data bank of coordinates), about 1,7 mill of which are already included in the data bank of coordinates. There remains an amount of 12,5 mill points for revision by

the cadastral offices to complete the project. 1,5 mill of these points are available only in handwritten registries, the rest is already stored in machine-readable form in the file of coordinates. Of the 12,5 mill points about 5 mill probably will not be included into the data bank of coordinates, because they do not comply with the settled demands in regard to the net of control stations.

By an appropriate regulation of the capacity of data collection of the department of electronic data processing an amount of 1 mill points will be put in per year and stored at the data bank of coordinates. Within that view completion of the project can be expected in 8 years, provided the fiscal means are available.

5. The Cadastral Plan

The eldest cadastral plan of Austria was the one resulting from the survey carried out to stablish "Grundsteuerkataster" according to the imperial charter issued on Dec. 23, 1817 to the purpose of imposing a fair tax. The survey carried out during the years from 1818 to 1861 was a plane table survey using the sheet lines of the cadastral system then existing. Subsequently instructions for the revision respectively renewal of the cadastral plan were issued. Accordingly the new cadastral plan had to be drawn up in the metric system, but still differing cadastral systems were applied. The introduction of the national survey system (3-degree-zone-system of Gauß-Krüger-projection with the reference meridians 28, 31, 34 degres east of Ferro) in 1921 initiated new instructions for the production of the cadastral plan in the course of cadastral resurvey.

From 1961 to 1969 drawn up in the form of "Zahlenplan" - besides the contents of the cadastral plan the contents of the field sketch were to be presented in red colour - the cadastral plan in 1969 assumed a function appropriate to "Grenzkataster" after "Vermessungsgesetz" became effective. In the future the numbers of the boundary marks of plots of land of "Grenzkataster" should serve - connection with the register of coordinates and graphic documents - as a binding proof of boundaries.

5,1 Transformation of the Cadastral Plan

Side by side with plane table sheets (Fortführungsmappe), which were kept up to date only through graphic fitting in, it was attempted to draw up a cadastral plan according to instructions, in the form of "Aufbaumappe" for those districts, where Gauß-Krüger-coordinates were available as a result from a survey. It was hoped to fill in the holes by and by. But the necessary parallel keeping of two plans, i.e. Fortführungs- and Aufbaumappe, caused such an enormous expenditure of work that the concept of the "Aufbaumappe" was dropped and new cadastral plans have been made via transformation since the year 1964. For reasons of budget, staff and capacity, a cadastral resurvey was out of the question.

The instructions issued with regard to the transformation of cadastral plans determine that it must be drawn up as a "Rahmenmappe" in the national survey system. In accordance with economic and technical necessities the scales 1:1 000, 1:2 000 respectively 1:5 000 must be used. The existence of survey points in sufficient density is a precondition to compile a cadastral plan.

To meet varying demands the following fundamentals are drawn upon in order to transform cadastral plans:

a) plotting of points based on coordinates in the national survey system;
b) Fitting in of lines obtained by photogrammetric evaluation;
c) Fitting in of lines obtained by transformation from the preceding cadastral plan, using identical points;
d) Fitting in of lines obtained by transformation from the preceding cadastral plan, using sheet corner values defined in the national survey system;
e) Scaling up or down the previous cadastral plan;
f) Graphic delineations, true to scale, by non-official institutions.

The basic idea of transformation consists of fitting the contents (scaled up or down, whichever ist necessary) of the "Grundsteuerkataster" plan into the national survey system, based on plottings of constant points wich are defined in the national survey system and with additional, carefally selected supportive adjustments. At the same time it is attempted to eliminate spatial distortions and deformations from the previous cadastral contents with the help of photogrammetry and of staff experienced in cadastral matters.

After completion of transformation there will be about 79000 sheets of cadastral plan on scale 1:1000, 45000 sheets on scale 1:2000 and 7000 sheets on scale 1:5000 available, covering the national territory. By the end of 1986 there were about 64800 sheets on scale 1:1000, 19900 sheets on scale 1:2000 and 3400 sheets on scale 1:5000 available. About 28400 sheets on scale 1:2880 are left to transform.

5,2 The Digital Cadastral Plan

To manage one stock of data - the previous written records - in digital form, and another stock of data - the previous graphic and technical records - in analogue form, can especially in regard to the methods of data processing in consideration of an economic administration be accepted only for that period, which is necessitated by the time spent on the development of the scheme for transformation of an analogue to a digital stock of data as well as by the transformation proper.

For the time being, the following objectives for the development of a model for the use of automatic data processing in construction and management are at the root:

a) Within limits, the presentation of information is to be effected independent of scala and sheet lines, in different variants of data output and in the long range, via teleprocessing
b) Combination and sorting of information should be ensured. By means of the digital plan it will possible to sort out parts of the contents and present them separately or in varying combinations
c) Connection with other stocks of data, i.e. topographically relevant data, data on regional planning and on expansion schemes, data on land evaluation and land classification, particulars about underground installations, should be possible.

The obvious advantages of a digital cadastral plan are faced, however, by some problems. Opposite to previous data acquisition for the compilation of "Grundstücksdatenbank", this work cannot be carried out centralized.

Digitalizing must on principle be carried out at the cadastral offices, as identification of frequently ambiguous typs of lines necessitates the use of the graphic and technical records. Moreover, the question whether the quality of the cadastral plans is sufficient for the establishment of a data bank must be faced. From the point of view of electronic data processing the required improvement of the quality of some sheets should be carried out within the analogue sector. Along with that it will have to be examined in which form the inclusion of agricultural land-use could raise the quality of sheets that were transformed already.

Those points, which seem to be critical with view to the basic decision of instituting a digital cadastral plan, will be emphasized in particular:

- First of all, the rather varied quality of cadastral plans in Austria in relation to their internal accuracy
- Secondly, "Bundesamt für Eich- und Vermessungswesen" presently is organized in a form of decentralized management at the cadastral offices and centralized data processing. Regarding cadastral plan, a scheme of organization will be needed for which to this extent hardly any precedents in the sphere of graphic data processing are existing.

In consideration of the heavy demands which will be laid on the lines, but also with regard to the expense for qualified software, the facts mentioned above have so far delayed the organization of a computer network for graphic data.

Instituting graphic data banks making use of the technical provisions of "Bundesrechenamt", has so far been limited to a few areas in Austria, (Graz, Linz, Bruck/Leitha) in response to current demand. Methods of data acquisition and management have been tested there in a working model and the first experiences relating to digital administration of cadastral data have been made. Recently the development of low-price small units capable of graphic processes has essentially improved the conditions to institute a digital cadastral plan; at the same time this has necessitated a modification of the original concept of organization. Compared with previous concepts, the substantial change consists in relieving teleprocessing lines of graphic dialogue: at the moment such a small unit is being adapted for cadastral purposes. In the future, the digital management of cadastral plans at the cadastral offices will be carried out via these units. An extension of the graphic system at "Bundesrechenamt" is planned, so as to cover requirements such as complex interpretation, securing and checking of data and possibly the presentation via "BTX" system. The transfer of data to the cadastral offices, which is necessary for updating, can be effected at low costs via existing lines by using remote job entry at times not needed by "Grundstücksdatenbank".

- Substitution of graphically determined data by given coordinates of the national system
- the interactive insertion of lettering
- selection according to categories of data
- management of alterations by the cadastral offices

are to be tested at those cadastral districts which are included in current working models. Moreover, these working models are to elucidate the measure of storage capacity, the time needed for preparation and digitalizing and for the management of the data.

By and large, in view of the staff and budget conditions at "Bundesamt für Eich- und Vermessungswesen" and the objetive to be realized, procedures will

have to be found which will produce a solution that is technically and economically acceptable. Whereas prior to "Grundstücksdatenbank" a stock of machine-readable data was existing and it could be accepted that the programme pachage was improved during the process of establishing "Grundstücksdatenbank", for the process of digitalizing cadastral plans procedures must be worked out before the stock of data is established, suited to establish the very best stock of data. Models for electronic data processing must be found which are equal to the quality of the stock of data.

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Discussion after the conference of Mr Schuster

Kölbl: For processing you have only alphanumeric and no graphic information passing. Is it possible to have a central computer with 70 terminals connected to it and to get a sufficiently quick response time ?

Schuster: Actually, we do not have a connection between literal and graphical information; this should be established in a later phase.
Data are obtained in the offices and the cadastral maps will be digitized there, but managing, checking and updating are centrally done (maps are also given out to users in this central part). Information of less extent can be handed out through the decentralized graphic stations at each cadastral office. The data transfer is executed by (durchgeschaltete Standleitungen). The transfer of graphic information will not be done during daytime when we need direct and quick information but during the night as batch job. The data will be treated in the central unit and then transmitted to the cadastral office afterwards.

Tegeler: But it will not be possible to work there interactively and manipulate the map-information ?

Schuster: It will be possible because we use an AUTOCAD-system which we judge suited not only for data-acquisition but also for updating the cadastral maps. The reason why we did not begin earlier with digitizing was that the working stations were too expensive for us. Now we are using a PC-system which allows us to equip all our offices.

Brindöpke: You said that you will not use some 5 mill. points in your databank.
Do their coordinates have bad accuracy or are those points not integrated in the framework ?

Schuster: These points could have coordinates in the national framework and are integrable, but we do not want to introduce them in the databank because their accuracy does not satisfy the prescriptions.

Brindöpke: In all European countries we have old points with bad quality. What shall we do with those points in a databank ?
A databank should cover an area including the bad points.

Kölbl: We have the same problem with weak points. We foresee the need to give more information beside the coordinates : precision and validity of the point; codes of course which should be able to describe the quality of points in an adequate manner. Simply leaving them out would change the context.

Schuster: We cannot organize the mass of our data in this way. We do not have enough space to store an indicator of the precision of a point.

Chevallier: What is the connection between the data bank of boundary points by coordinates and the renovated cadastral map ?

Schuster: The connection will be established when we digitize the cadastral maps. Later, we substitute the numerical values when they are at our disposal, otherwise we use the digitized graphical elements.

Chevallier: Is the updating done numerically ?

Schuster: 5% of the cadastral maps are numerical, the remaining part is of graphic origin.

Kölbl: You use an AUTOCAD-system for cadastral surveying. It uses a CAD-CAM system without database structures and without topology. Is there not a danger that without topology you will not have enough coding possibilities and that relations will not be recognized ? If you have only a computer-aided design system you will soon be limited.

Schuster: This is mainly a financial problem. We are working decentralized in several offices, which must all have to be equipped. But the amount of data is lower there and we accepted some limitations in the system.

Diering: You have made the transmission to a boundary cadastre. What is the legal status of those digitized cadastral maps?

Schuster: In the boundary cadastre, there are only points that are technically in order; furthermore we have to make a delimitation procedure with the landowners. If we have numerical values, the surfaces have to be calculated with the coordinates, but these values do not have a legal significance.

REALISATION OF THE CADASTRAL RENOVATION IN THE NETHERLANDS

Jan van Hemert
Ministry of Housing, Physical Planning and Environment
Agency of the Cadastre and the Public Registers.

Summary In 1975 a big mapping project started in the Netherlands, named G.B.K.N. (large scale base map of the entire country).
At this moment, after twelve years, a significant part of the project is realized.
According to the plans the project should be completed in approximately twenty years from now.
Immediately after the realization of the large scale base map the realization of the renovation of cadastral map will be started.
Both map series are related to the same uniform coordinate-system for the entire country.
The quality of the old cadastral map varies.
A large amount (about 40%) of the old cadastral map is based on the original surveying that took place in the beginning of the nineteenth century. Some of the renovated parts are dated between 1900 and the beginning of world war II.
Consequently after the production of the G.B.K.N. all the cadastral maps will be renovated including the maps wich have already been renovated before the realization of the G.B.K.N.
This method is based on a philosofy which implies that optimal updating of both map series is only possible by a full technical integration of both map series.
Since 1982 the manufacturing of the G.B.K.N. aimes at the creation of an entirely digital product.
Experiments are carried out in order to establish a renovated cadastral map as a digital product.
In Utrecht (one of the twelve provinces) quite a lot of experience has been acquired in this production technique.
This presentation will discuss the production of the G.B.K.N. the renovation of the cadastral maps and the integrated updating of both map series.

In this process photogrammetry plays a very important role. The technical methods of G.B.K.N.-production, the renovation of the cadastral maps, the integrated updating of both products as well as the financial consequences will be discussed.

1. Introduction

This contribution will elaborate the subject of the renovation of the cadastral map as it is at present executed in the Netherlands, and especially in the province Utrecht.
Utrecht is one of the twelve provinces. It is situated in the centre of the country with the city of Utrecht as the provincial capital.
The province has an area of approximately 150.000 hectares, nearly one million inhabitants and there are 300.000 cadastral parcels.

The renovation of the cadastral map is an activity, which actually started already in the beginning of this century.
The terrestrial remeasurement methods used in the past were so labour intensive and expensive that a renovation of the complete map series was never finished.

This situation changed in 1975.
In that year, by a Royal Decision, the "G.B.K.N." was introduced. The G.B.K.N. is a large scale topographic map (mostly 1:1000) with limited contents.
The Cadastral Agency was placed in charge of the production, updating and publication of the G.B.K.N.
This map is used as a base map by several authorities like municipalities, public utility companies and the Cadastral Agency. The costs are divided among the participants.
The G.B.K.N.-map offer an excellent base for the renovation of the cadastral maps and the introduction of the G.B.K.N. stimulated the renovation of the cadastral maps enormously.
Immediately after the realization of the first large scale topografic maps experiments were started in order to find an optimal procedure for cadastral map renovation based on the G.B.K.N. Soon it became clear that it was necessary to integrate the G.B.K.N. and the cadastral map as much as possible in order to reduce the costs of both production and updating of both map series.

At this moment for more than 50% of the provincial area a G.B.K.N. is completed or in production and for more than 30% of the area the cadastral map is renovated.

Regarding the current progress of the production it is expected that in het year 2000 the whole province is covered by G.B.K.N.-maps and renovated cadastral maps.

2. The G.B.K.N.

As mentioned in the introduction the G.B.K.N. is a large scale topographic base map series.
The fact that it is a base map means that not all the possible topographical elements are depicted, but only the elements with a more or less permanent nature having importance for the users.
The G.B.K.N.-map contains buildings, limitations of roads and pavement, canals and ditches, dams, under and upper sides of dikes and bridges, gates, hedges etcetera.
For the readability semantic information is added, like streetnames, housenumbers, names of waterways, name or function of public buildings and names of cemeteries.

The G.B.K.N. is a frame map. One sheet has a size of 50 x 100 cm corresponding to 50 hectares of land for a 1:1000 map.
The analagous presentation of the map is still the most usual for the majority of the users.
Nevertheless since 1982 the G.B.K.N. map is produced in a digital way. This means that delivery of the graphic information on magnetic tape is possible.
The precision of the identification of the objects is 0.2 mm on map scale.

The production is executed in project-wise. One project normally consists of one or more municipalities and covers an area of 5000 to 10000 hectares.

Aerial photographs are made of the whole project on a scale of about 1:6200.
From the built up areas also photographs on a larger scale (1:3000 to 1:3500) are made.
Along the photogrammetric block ground control points are measured and related to the dutch triangulation network. The 1:3000/3500 scale models are fitted in the 1:6200 models.

Afterwards the (digital) photogrammetrical mapping is performed.
The topography, as far as it is of importance for the G.B.K.N., is measured in stereo-models and a classification code is added.
Momentarily about 80 classification codes are distinguished.

After the photogrammetric mapping the field completion takes place. The topography, which is not visible from the air, and the walls of buildings are measured.
Important is that the whole field completion is related to the photogrammetrically measured elements. For the mapping of the buildings using the ridgeline is prefered to the use of rooflines, because of the better precision of the photogrammettrically mapping of ridgelines.
The mapping of the field measurements is executed by using an interactive graphic system (CAD/CAM-system).

3. The renovation of the cadastral map

The cadastral map in the Netherlands dates from the beginning of the last century.
The renovation of the cadastral map started in the beginning of this century, but it was never finished.
The quintessence of the renovation of the cadastral map as it took place until the middle of the seventies was actually total remapping.
In the terrain the reconstruction of the existing cadastral delimitations and contact between the cadastral surveyer and the owners took place.
After this boundaries were measured within the Dutch triangulation network.
After the measurements were completed a new cadastral map was made of them.
This process implied that the new cadastral map was a result of the field measurements.
This process was done everywhere in the country. Only in areas with large parcels or where the precision of the mapping of the boundaries was less important, photogrammetry was applied. This technology was especially applied in rural areas in the middle and the west of the country (the typical Dutch polder landscape).

The method of renovation of the cadastral map, which requires a lot of time for the field activities, but which also gives a map with high quality was dead ended because the costs were too high.
This way there was no perspective to renovate the complete cadastral map of the Netherlands.
The introduction of the G.B.K.N. changed this situation completely.

After a few years of experiments a process was developed for the production of a new cadastral map based on the G.B.K.N. and nearly without visiting the field. Only in exceptional cases field measurements are executed. That means also that the most important cause of the high costs was reduced to nearly zero.
At the same time the G.B.K.N. and, with this, the photogrammetry became the most important technology for cadastral renovation.

If necessary the existing old cadastral map is enlarged up to the scale of the G.B.K.N. and connected with the G.B.K.N.

After this process the cadastral boundaries are compared with the corresponding topographical elements. This process is done for each individual boundary mostly after local fitting in.
In this process of comparison generally there are three possibilities:

- the cadastral boundary coincides with a topographical element;
- the cadastral boundary nearly coincides with a topographical element;
- a clear difference exists between the topographical element and the cadastral boundary.

There is no technical problem if the cadastral boundary and a topographical element coincide. Both elements are declared identical and the topographical element is accepted as a cadastral boundary and depicted on the new cadastral map.

In case of near coincidence of the cadastral boundary and the topographical element a process of testing takes place. In this procedure it is tested whether the difference can be found within the tolerances. Several decision criteria have been developed for the several kinds of areas. Important in this procedure is also whether there exist cadastral field measurements and the age of these field measurements.
On the field sheets there are mostly indications of the nature of the cadastral boundaries. In some cases there also exist direct measurements of the cadastral boundary to a clear, topographical element (buildings). All this information mostly makes it possible to make good decisions about the coincidence or no coincidence of the cadastral boundary and the topographical element.

If there is a clear difference between a cadastral boundary and a topographical element then it is not possible to integrate them into one line. In this cases mostly the boundary is copied from the old cadastral map and the difference between the cadastral boundary and the topographical element will still exist. In some cases a visit to the terrain can clear up the situation, but this is only done in exceptional cases.

The premises in this process is the condition that only in cases in which can be clearly assumed that the cadastral boundary and the topografical element are really different there must be two different lines. In all other cases the lines are declared identical.

This production process for a new cadastral map implies also a separation between the cartographic part of the cadastre and the reconstruction data (field measurements).

In former times the cadastral map was a result of the terrestrial measurements. In the new procedure the GBKN and with the GBKN the photogrammetrical map is the base of the cadastral map.
Actually the cadastral map is in the new filosofy nothing more than an added theme of the topographic base map (GBKN). The field measurements are only used for reconstruction purposes in case of unclear situations or if there are questions from the public.

The renovated cadastral map is after completion of the proces of boundary identification completely adjusted to the GBKN.
The form of the new cadastral map is just like the GBKN a frame map. The scale of the new cadastral map and the GBKN is the same.
Topographic elements which can be found on both map series (buildings) are identical. The numbers of the cadastral parcels are written on the map on which the largest part of the parcel is represented.

Both map series which will exist both at the same time can easily be integrated into one product by using a system of cut out holes.

Of course the coming technical automation will change a lot of things.
At this moment the production of the G.B.K.N. takes place in a digital way.
At present experiments are carried out to add the renovated cadastral map to the G.B.K.N. as a digital overlay.

In the province Utrecht we are trying to scan the new cadastral map. This technology is still in a developing phase.
We expect in the coming years the change to real digital production methods as well for the G.B.K.N. production and the new cadastral map as for the integrated maintenance of both map series.

4. The integrated updating of both map series

Of old one of the main tasks of the Dutch Cadastral Agency is the updating of the cadastral map.
After the introduction of the G.B.K.N. a new task started, namely the updating of topographical information.
Of course this gave and still gives some problems.
The first problem which appeared was the information that mutations took place. While for cadastral mutations a closed information system existed, an information system for topographical mutations had to be developed.
It is obvious that the map user, who is closest to the origin is charged with the collection of the information of the mutations. In the Netherlands this is the municipality, which is also a participant itself.
In the current situation the municipalities deliver information about the mutations to the Cadastral Agency.

The information about the topographical mutations is added to the information about the cadastral mutations, after which in a municipality a mutationproject can be executed.
In practise updating takes place with a frequency of about 2 years. The updating of both map series is carried out completely integrated.
Fot this reason it is important that both map series have the same format, scale and coordinate system.
This simplifies the field measurement and the mapping.
In the same way as during the GBKN production the field measurements are fitted in the map using the coordinates of well identified topographical elements with a sufficient accuracy of identification, usually buildings.

The updating field measurements can be carried out by measuring some distances to original buildings, followed by an interactive mapping by a graphic system, as far as digital maps are concerned or by mapping in the classical way in an analog map.
In case of mass mutations use is made more and more of selfrecording tachymetric equipment in the field. After this the data processing and the fitting of the data measurement in the cartographic datafile is executed by a batch process.
This implies that after adding the field measurements the cartographic datafile still keeps its graphic absolute accurancy based on the original photogrammetric product.

5. The costs

The control of the costs in the production and updating of the GBKN and the cadastral map is of course of vital importance.
The fact that in the last decades the cadastral renovation by means of a remeasurement method did not succeed, was mainly a financial problem.
The costs were so high that a perspective of a completion of this task in a reasonable number of years was absent.
The GBKN and with it the switch over to the photogrammetry followed by a graphic renovation of the cadastral map has changed that situation.
In this process an important role is played by the fact that the costs of the GBKN production and up-dating are not only carried by the Cadastral Agency but also for a large part (50% or more) by the other participants (municipalities and public utility companies).
The participation of the other financers is voluntary.
This implies that the GBKN is subject of a market mechanism. It became necessary to find a good balance between the contents and quality of the GBKN on the one side and the costs on the other side.

In the province Utrecht we succeeded!
The Cadastral Agency had made principle agreements on the GBKN-management with all the public utility companies and the representing organisation of municipalities.
These agreements concern contents, qualities, costs, planning of production and aspects of the updating like frequency and sharing of costs.
The necessity of controlling the costs strictly has resulted in a rather accurate determination of the costs.

To determine the costs for an individual project or for the whole province some years ago the area was divided into 6 classes (appendix 1).
Afterwards for each class a price per hectare was calculated for the whole production process starting from a project of average size.
The price for a project, calculated by this system, is used as an estimated price for the offer to the participants.
Then parts of the production activities are put out to contract to private companies.
The experience until now tells that the final realisation costs are usually within a margin of 10% from the calculated estimated price.
Depending on the market situation the price can even be somewhat lower.
The costs per class vary from about Dfl. 110,- per hectare for the cheapest class (open rural area) until about Dfl 3200,- per hectare for the most expensive class (old city centres).
In appendix 2 the total costs per class and the costs per activity are shown.
The total costs for the whole province will amount to about Dfl 48.000.000,-.

From the diagram in appendix 2 it appears that the costs of photogrammetry amount to one third of the total costs.
The field completion on the other hand is rather expensive.
Therefore a reduction of costs can best be found by reducing this activity. Within the field completion especially the measurement of buildings (the correction of the rooflines) is the largest cost factor.

The costs for the renovation of the cadastral map are of course strongly depending on the used working methods and on the used base material.
Important in the working methods is the frequency of terrain visiting. As mentioned earlier only incidentally terrain visits take place to solve bottle-necks.
One tends strongly to solving the indistinctnesses in the terrain, so that there is a task for the managers to prevent this. In Utrecht the costs for terrain visits have been limited to 10% of the total costs of cadastral map renovation.
Also the remapping of old field measurements must be reduced.
The costs for cadastral map renovation amount to Dfl. 40,- to Dfl. 80,- per hectare.

It is expected that the total costs for the renovation of the cadastral map will amount between Dfl 10.000.000,- and Dfl 14.000.000,- for the whole province.

The costs for the updating of the GBKN and the renovated cadastral map are for the future even more important than the production costs of both map series, for the production will be finished within a measurable time, while the updating will continue.
In the classical situation only the cadastral map was updated. In the province Utrecht there are 6000 mutations in the cadastral map annually. The mutations in the GBKN are extra.
The number of topographical mutations is 2 or 3 times the number of the cadastral mutations, but often topographical and cadastral mutations coincide.
This means that in the year 2000 the Cadastral Agency is confronted with approximately 20.000 mutations.
In order to keep such an increase in the workvolume under control some measures have to be taken off course.
One of them is the integration of both map series and the measurement and mapping of mutations into one process.
The introduction of automated technologies and the placing of the cartographic data of both map series in one datafile, but on different levels, will mean a further improvement of efficiency.
A second aspect, which economizes is the fitting in of field measurements in the map elements.
The fact that all the photogrammetically depicted buildings are considered as graphic ground control points gives the possibility to the surveyor to measure quickly relations between old and new map elements.
The aspect of updating will be a remaining and even growing point of concern in the future.
Because of the fact that the updating of the GBKN is co-financed by other map users there will remain an external pressure to limit the costs of updating.

6. Final remarks

The introduction of the GBKN in the Netherlands has started a lot of new developments in geodesy, photogrammetry and in the cadastre.
The introduction of the new product also made the geodesists more critical about the relation between product quality and costs.
The GBKN plays an important role in the coordination between the different map users. The Cadastral Agency has got a realistic perspective to renovate the cadastral map.

The geodesist of today is not only technology oriented, he is also a manager who stands in the middle between a good product and a costlevel as low as possible.
The future will bring a lot of changes.

The switching of the momentarily still fragmentary and experimental character of the digital map to a real well managed working system for digital production and updating will take a lot of energy, but the starting point has been passed and the possibilities are realistic.

appendix 1

Classification of areas for the GBKN

Class 1

Complete open, rural areas without buildings

Class 2

Rural areas with few buildings or woods

Class 3

Built-up areas. Mostly built after 1940, regular forms of houses and industrial areas.

Class 4

Built-up areas. Mostly built in the period 1900 - 1940 irregular forms of houses.

Class 5

Built-up areas in the cities. Mostly built in the period 1850 - 1900. Very irregular forms of houses.

Class 6

Inner parts of a town, built before 1850.

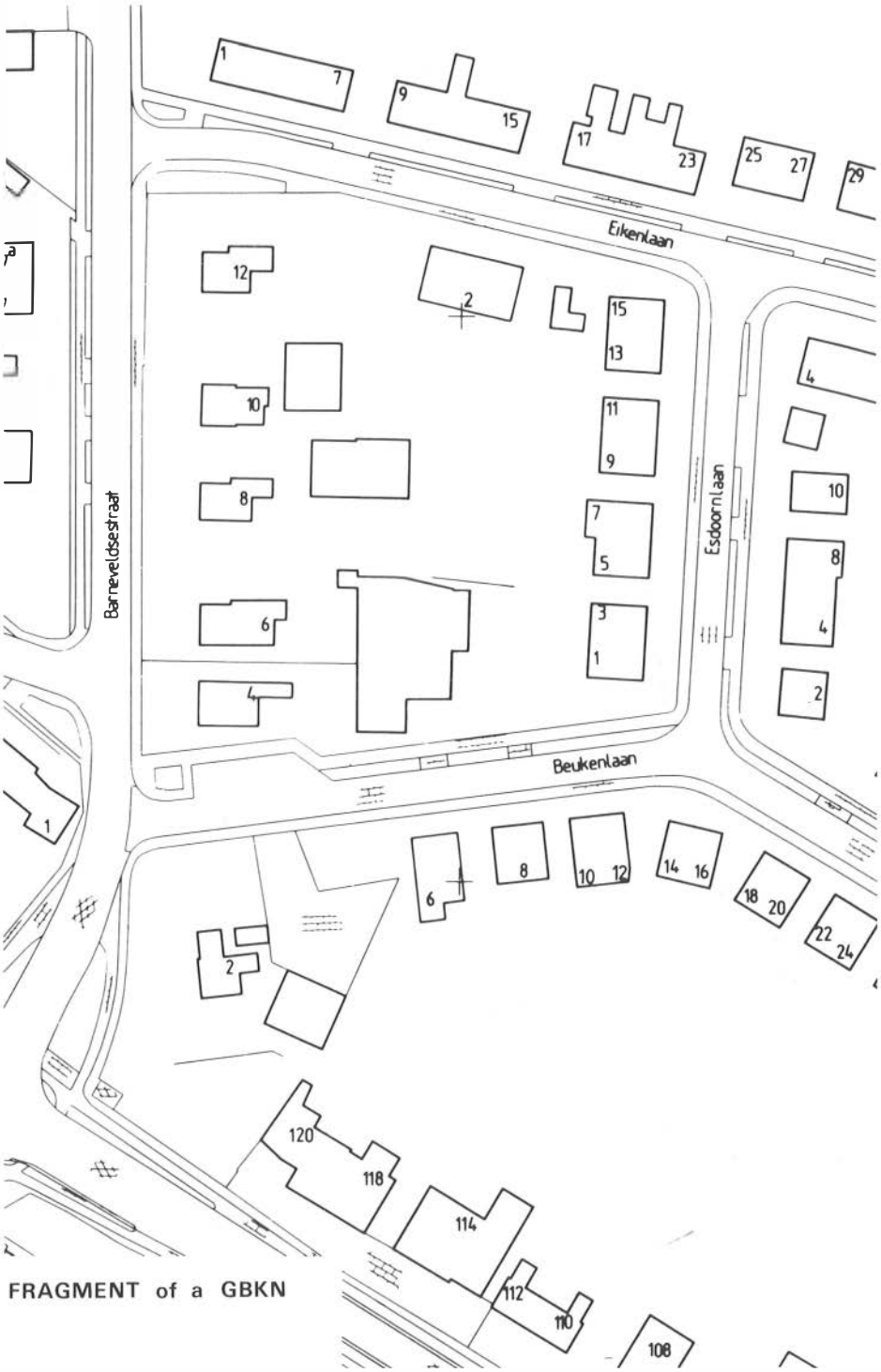
appendix 2

Costs of the GBKN in Dutch guilders and per hectare related to the area classes.
(N.B.1 US $ is about 2 Dutch guilders).

area class	1	2	3	4	5	6
1. ground control points	16,20	19,40	22,80	22,80	22,80	22,80
2. aerial photographs	5,60	7,50	9,40	9,40	9,40	9,40
3. aerial triangulation	9,40	14,50	31,60	31,60	31,60	31,60
4. photogrammetric mapping	17,70	49,20	142,--	221,30	398,--	663,20
5. field completion	21,10	100,80	397,80	850,60	1147,40	1369,10
6. mapping of field measurements	10,--	38,10	155,30	312,90	436,40	570,30
7. plotting	7,70	8,70	16,20	19,--	25,20	25,20
8. reproduction	6,40	6,40	13,60	13,60	13,60	13,60
sub total	94,10	244,60	788,70	1481,20	2084,40	2705,20
9. acquisition/general activities 2%	1,90	4,90	15,80	29,60	41,70	54,10
10 quality control 5%	4,70	12,20	39,40	74,10	104,20	135,30
11 management 12%	11,30	29,40	94,60	177,70	250,10	324,60
	112,--	291,10	938,50	1762,60	2480,40	3219,20

THE NETHERLANDS

PROVINCE UTRECHT



FRAGMENT of a GBKN

FRAGMENT of a CADASTRAL MAP WITHOUT BUILDINGS

FRAGMENT OF AN INTEGRATED GBKN AND CADASTRAL MAP

Discussion after the conference of Mr. Van Hemert

Dale: Together with the computerization, did you introduce new parcel reference numbers ?

Van Hemert: We are using the numbers of the old system but the area can change a little bit. If an area changes more than a certain limit we inform the landowner.

Kölbl: The GBKN is a linemap : do you use a photomap in a large scale and do you use an interactive graphic system or do you just do map production by digital methods ?

Van Hemert: At this moment we are starting a project on a Delta-I system but the software is not completely ready. When we will use it, it will be mostly for updating, not for producing.
Up to now, the GBKN was produced by free enterprises and they used Ingres or Intergraph.

Jerie: How do you realize the overlay of the old cadastral map with the topographical map ? Do you adjust zonewise ?

Van Hemert: We pass border by border, using local fitting. The tolerances depend on the nature of the border. A built up area is treated differently than a waterchannel.

CADASTRAL RENOVATION ON THE BASIS OF A COORDINATE-RELATED SURVEY SYSTEM AND THE DATA BANK 'AUTOMATED REAL ESTATE MAP' IN LOWER SAXONY

W. Tegeler
Department of Cadastral Resurvey
State Survey of Lower Saxony, Hannover

Summary First, types and extent of cadastral renovation are compared. Then requirements and preconditions of a coordinate-related survey system are specified. After the recommendation 'Coordinated cadastre' of the Working Committee of the Survey Administrations of the Federal States of the F.R.G. the Lower Saxon survey regulations about 'Minor control point network' and 'Real estate surveys' are presented. The three components of the data base 'Automated real estate map' are outlined and the future cadastral renovation in Lower Saxony is discussed. Finally the costs of renovation is touched on.

1. Types and extent of renovation

1.1 Introduction

The cadastre in North-Germany was started at the beginning of the 19th century: e.g. in Rhineland-Westphalia in 1819. In 1865 the Prussian cadastral administration was founded; within 3.5 years a cadastre for an area of 275,000 square kilometres was established.
But already in 1881 the Prussian cadastral administration introduced new regulations ('connection with control points'):
'Anweisung VIII': cadastral resurvey
'Anweisung IX ': traversing.

1.2 Types of renovation

Nowadays the following types of renovation are known in Lower Saxony:
(Lower Saxony: area : 47,430 sqkm (sec.larg.in FRG);built-up/road area: 13%; population: 7.2 million; cadastral offices: 51)

1.2.1 Complete resurvey

This is the most comprehensive resurvey: All parcels of land and buildings (real estate) are resurveyed.

1.2.2 Partial resurvey

The boundaries of older surveys - before 1900 (Civil Law) - are ascertained and connected to the minor control point network;
the boundaries of checked surveys (checked measurement and agreement of the applicants) - since 1900 - are not newly ascertained, but only connected to the minor control point network.

1.2.3 Simplified resurvey

At simplified resurveys boundaries are not ascertained. Only those boundaries ascertained since 1900 and all buildings are connected to the minor control points.

1.2.4 Gradual resurvey

This type was introduced in 1920, but it did not prove.

1.2.5 Digitizing
Older cadastral maps (e.g. maps in 'island'-format) are only digitized in those parts where no 'reproducible' numerical survey data exist. The older maps are digitized in connection with the coordinate-determination of 'tie'-points. The selection of reliable tie-points is the main difficulty.

1.3 Extent of renovation

Types / Extent (steps)	Complete Resurvey	Partial Resurvey	Simplified Resurvey	Gradual Resurvey	Digitizing
	1	2	3	4	5
1. Establishing of minor control point network (MCP	+	+	+	partly (corresp. revision survey)	-
2. Ascertainment (and marking) of boundaries				+	-
2.1 checked surveys	+	connection to M C P	connection to M C P		
2.2 old surveys (before 1900)	+	+	-		
3. Complete recording of buildings	+	+	+	corresp. revision survey	-
4. Establishing of 'point-number sketches'	+	+	+	-	-
5. Renewal of real estate maps	+	+	+	at the end of grad.res.	+
6. Updating of the real estate register (areas)	+	only for newly ascertained boundaries	-	-	-

Fig 1: Types and extent of renovation (+(-): steps are (not) carried out)

2. Coordinate-related survey system

2.1 Requirements of the users

2.1.1 Only one reference system for all surveys

2.1.2 Reducing the time-consumption of field survey by using the most economic survey methods (without 'principle of neighbourhood')

2.1.3 Creating/locating of boundaries by design in real estate maps and transferring to their position on the ground

2.1.4 No necessity for marking of boundary-points (point-precision of coordinate-transferring is better than ± 0.02 m: 'without contradiction')

2.1.5 Sufficient precision for setting out of prefabricated buildings and row houses.

2.1.6 Unambiguous determination for the restrictions of planning and building regulations.

2.2 Preconditions
The four preconditions for establishing a coordinate-related survey system are |Tegeler 1983|:

2.2.1 a minor control network of high precision (± 0.01m),

2.2.2 very well marked and defined control points (with witness (security) points);

2.2.3 very precise measurement of object-points (boundaries, buildings etc). related to control points and

2.2.4 a reliable measurement and evaluation ('independent check')

3. Recommendation 'Coordinated cadastre'

of the Working Committee of the Survey Administrations of the Federal States of the F.R.G. (Arbeitsgemeinschaft der Vermessungsverwaltungen der Länder der Bundesrepublik Deutschland-AdV-).

In 1985 the working group 'Real Estate Cadastre' of the Working Committee of the Survey Administrations elaborated the recommendation 'Coordinated cadastre' |AdV 1985|. All boundaries and buildings shall be located by means of Gauß-Krüger coordinates with a precision of 0.03 to 0.04 m. The basis for such a survey system is a state-wide horizontal control network with a standard deviation of 0.02 to 0.03 m.

4. Lower Saxon survey regulations

4.1 Survey- and cadastral law
The Lower-Saxon Parliament (Landtag) enacted in 1985 a new law concerning state survey and real estate cadastre |Möllering 1985|.
With regard to parcel boundaries there are following administrative steps:
- transferring of parcel boundaries
  corresponding cadastral records (Grenzermittlung)
  (comparison with the local boundary (existing marks etc.);
  expertise discretion (sachverständiges Ermessen);
  hearing of the involved persons: date for ascertainment with record)
- official ascertainment (Grenzfeststellung)
- marking of boundary points (not compulsory e.g. at natural and durable artificial features).

4.2 Minor control point network (MCP) (including stagewise establishment)

4.2.1 Horizontal control points

In Lower Saxony the survey of real estate is based on the connection to horizontal control points (law-level of 'connenction-compulsion').

Renewal (precision (dist.less 2km): ± 0.01m) |Augath 1984|
a) of 1st and 2nd order network by trilateration: 1972 - 1982;
b) of 3rd and 4th order network by precise traversing: 1987 only 60 %.
(since 1987 also by GPS).

4.2.2 Distances and density of MCP

Distances:
in urban areas : 100 m to 200 m
in suburban areas: 200 m to 400 m
in rural areas : 400 m to 500 m
Denstity : from 5 to 20 points/km^2

4.2.3 Marking (centre and security points, marks with mm-defined tops)

- iron tubes
- plastic tubes
- wall bolts
- wall bolts with 100 mm-adapter-reflector for EDM

4.2.4 Security Points

Min.: 2 points
Surveying: with theodolite and special tapes or indirect by EDM
Function:
- checking of centre
- reconstruction
- substitute and connection surveying

4.2.5 Determination with EDM

- by traversing
- bi-polarly

4.2.6 Computation

by rigorous adjustment

4.2.7 Quality of Coordinates

a) Precision : s(C) less 0.016m
b) Reliability : -internal:gross errors bigger 20mgon/0,05 m
-external(E/N): less 0,025m (max.: 0,050m)

4.2.8 Documents of Minor Control Points

- MCP-maps 1: 5 000 (German Basic Map with overlay)
- MCP-description (20 x 30 cm)
- point file

4.2.9 Costs

4.2.3 a. 4.2.4	about	220.- DM/point
4.2.5; 4.2.6; 4.2.8.	about	100.- DM/point

4.2.10 Stagewise establishment of minor control points
In areas without renewed trig point network 3rd and 4th order it is necessary to establish provisional systems as basis for the connection of the real estate surveys which come up:

a) network parts
(expanse: e.g. one village/construction area)
with free adjustment, approximated orientation, scale from the calibration-line and provisional Gauß-Krüger-coordinates.

b) '2 minor control point system'
(expanse: traverse-side related)
with local coordinates.

The provisional systems are integrated as soon as possible in the renewed 3rd and 4th order trig net.

4.3 Real estate surveys
(Lower Saxon Specifications and Standards from 1985:
"Administrative Regulations for Real Estate Surveys")
The real estate cadastre has the task to describe the facts of the individual parcels of land (real estate),
while the land register (Grundbuch: register of title) gives information as to legal aspects (status of ownership etc.)

4.3.1 Purposes
- to guarantee parcel boundaries by precise coordinate-transferring
- to determine coordinates for all measured points
  (parcels, buildings and other constructions),
- to inform about position (location),
  shape, size and calculated area
- to inform about nature of use.

All data have to be stored in such a way that they are retrievable and they have to be maintained and updated.

4.3.2 Methods
- Surveying by offsets)
- Polar surveying EDM) (measurement and setting out)
- Photogrammetry

4.3.3 Required standards (max. permitted deviations)
- residuals $r = ((rE^2 + rN^2)expl/2)$ at the control points: less 0.02 m
- max. difference between determin. I and II: less 0.04 m
- setting out (and relocation): less 0.04 m

('precision-components' (limit of precision-increase)):
1) s(MCP-coord.(=centre of tribrach!)) :5-7 mm;
2) s(optical plumbing down to MCP-marker):1-2 mm;
3) s(witness-point survey,with EDM) :3-5 mm;
4) s(relocation survey for MCP) :3-5 mm;
5) s(opt.plumbing up to tribrach) :1-2 mm;
6) s(direct.a.distance to object-points) :5-10mm;
7) s(plumbing in object-points) :2-4 mm)

4.2.4 Data flow
To assist minor control point surveys and real estate surveys commercial handy computers (at present HP 71B) are used in the Surveying and Cadastral Administration of Lower Saxony since 1984. These 'mobile data processing units' offer following possibilities (and that as well for the automatic measurement recording from digital tacheometer as also for the manual recording):

a) Capture of tacheometer data (with field checking) and transmission to office computers,
b) Necessary computations in the field survey,
c) Storage of coordinates with transmission from office computers.

5. The three components of the data base 'Automated real estate map' (Automatisierte Liegenschaftskarte ALK) |Sellge 1986|

The automated real estate map has the task to automate the surveying and mapping data of the real estate cadastre, the data of fundamental surveys and possibly it will be the basis for a topographic information system. Besides Lower Saxony also Northrhine-Westphalia and Hesse are introducing the data base ALK.
The automated real estate map consists of:

5.1 Point file
- general point data
  . point identifier (district of numbering in grid-net, type of point, point-number)
  . responsible office
- position data
  . position status (old or renewed reference system)
  . E-N-coordinates
  . precision
  . reliability
- point remarks

5.2 Planimetric file (graphic file)
Until the establishment of planimetric file in Lower Saxony (perhaps: 1990) the graphical components of the ADP-computations are collected in special records ("Graphik-Sammel-Aufträge").

5.3 File of measuring elements
Because of cost reasons this file is only possible for fundamental surveys.

6. Future renovation and its automated records in Lower Saxony

6.1 Actual state (1986) of real estate maps
26% of Lower Saxony is covered by so-called 'Rahmenkarten' ('grid'-format maps showing details up to the sheet margin) with a size of 50 x 50 cm.
Such maps at the scale of 1 : 1000 cover about 14 %,
and at the scale of 1 : 2000 about 12 %.
The remaining area is shown on older cadastral maps in 'island'-format which still have - depending on history - nonstandard scales, e.g. 1:2,133.3 and 1:3,200.

6.2 Future renovation

6.2.1 Future resurvey

At real estate resurveys it has to be distinguished between parcel boundaries and buildings. The boundary survey can only be improved according to the above-mentioned regulations for real estate surveys if at the same time the boundaries are newly ascertained. Therefore, boundary resurvey without new ascertainment (see fig 1 No 2.1) should be simplified to the connection between older survey points and minor control points ('calculable').

In future, resurveys shall be carried out as a matter of priority because of
a) failure of cadastral maps,
b) transferring of development plans,
c) urban and village redevelopment measure,
d) road constructions and
e) other large mutations.
At redistributions of parcels by replotting of land the resurvey is obligatory.

6.2.2 Future digitizing

In future, digitizing shall be carried out as a matter of priority for the purposeful establishment of digital real estate maps (see No 1.2.5) as required by electric companies, public utility companies etc.

The fees for a digital map with a ground area of 500 m x 500 m are:
First edition:
- rural areas: 200 DM
- suburban areas: 600 DM
- Urban areas: 800 DM

Revision: 20 % of the above-mentioned per year.

6.3 Automated records

6.3.1 Automated real estate register |AdV 1984|

In Lower Saxony the automated real estate register has already been established.

6.3.2 Point file |Schlehuber/Bauer 1987|

In 1987 the point file was established in 50 % of the 51 Lower Saxon cadastral offices; the establishment shall be finished in 1990.
The coordinates can be retrieved on
- visual display units,
- mobile data processing units or
- paper lists.

In addition to the point file 'point-number-sketches' are recorded containing
- planimetry of parcels and buildings,
- point-number and
- symbols of marking etc.

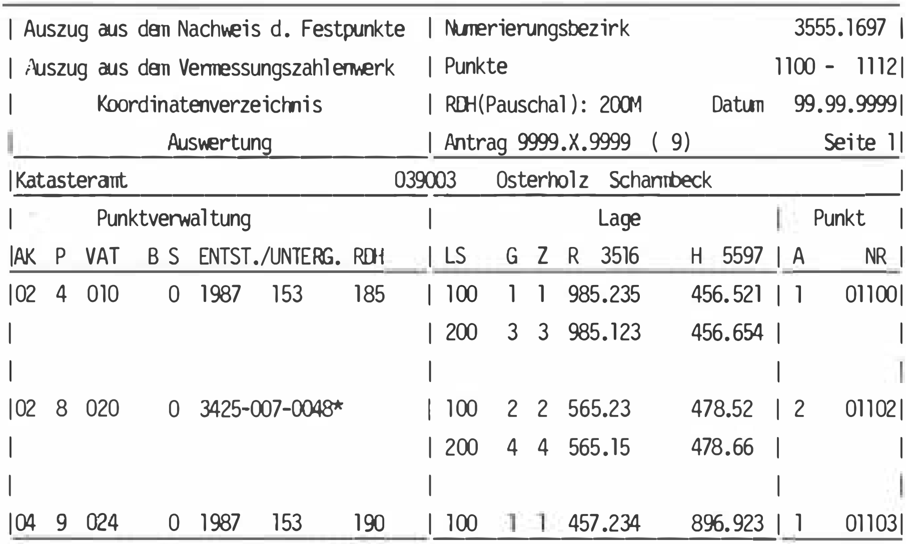
After having established the point file the survey sketches with the orthogonal measuring elements will no longer be necessary. The present sketches will be changed into 'point-number-sketches'. All necessary survey-information can be derived from the coordinates of the point file. The details about precision and reliability are of special importance (see fig 2): the ten stages from each group allow the simultaneous management of 100 years old and modern measurements.

6.3.3 Planimetric file

A computerized real estate map allows the graphic representation of the landed surfaces at different scales and in different sections on graphical displays; besides this, it is possible to revise the real estate map interactively on a graphical display. But the establishment of the planimetric file requires an interactive graphic workstation (IGS) at each cadastral office. At present IGS is only installed at the State Survey Department and the four District authorities.

7. Costs

7.1	Horizontal control points (marking, measurement, evaluation, documentation):	
7.1.1	1st to 4th order trig. points	: 900.- DM/km²
7.1.2	costs for minor control points (minimum)	: 1600.- DM/km²
	(costs in addition to trig. points)	(≙ 1.- DM/site)
7.2	Digital tacheometer with commercial handy computer	
7.2.1	purchase costs	abt 30,000.- DM
7.2.2	costs of maintenance (3.3% of 7.2.1)	1,000.- DM
7.2.3	costs of investment	
	- depreciation (12.5%)	3,750.- DM
	- interest on capital (8%)	2,400.- DM
7.2.4	costs/year (220 days)	7,150.- DM
7.2.5	costs/day	33.- DM
7.2.6	costs of surveying-team/field day (see No 7.4)	1,100.- DM
7.2.7	benefit	
	necessary minimum-benefit (time-saving)	1/4 hour



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| Auszug aus dem Nachweis d. Festpunkte | Numerierungsbezirk               3555.1697 |
| Auszug aus dem Vermessungszahlenwerk  | Punkte                          1100 -  1112|
|        Koordinatenverzeichnis         | RDH(Pauschal): 200M      Datum   99.99.9999|
|______________Auswertung_______________| Antrag 9999.X.9999  ( 9)           Seite 1|
|Katasteramt                        039003    Osterholz  Schambeck                 |
|        Punktverwaltung                |                  Lage              |  Punkt  |
|AK  P  VAT   B S  ENTST./UNTERG.  RDH  | LS    G  Z  R  3516       H  5597 | A     NR |
|02  4  010     0  1987    153     185  | 100   1  1  985.235      456.521 | 1   01100|
|                                       | 200   3  3  985.123      456.654 |          |
|                                       |                                  |          |
|02  8  020     0  3425-007-0048*       | 100   2  2  565.23       478.52  | 2   01102|
|                                       | 200   4  4  565.15       478.66  |          |
|                                       |                                  |          |
|04  9  024     0  1987    153     190  | 100   1  1  457.234      896.923 | 1   01103|
```

Fig 2: Extract from point file

Explanations:
Punktverwaltung (administration of points):
AK : relevance to the present situation
P : check character
VAT : type of marking
S : status of point (official record etc.)
Entst./Unterg.: origin/end (with ref. to traversing file/field book-number)
* : boundary-point with survey and ascertainment
RDH : reduction-height
Lage (position):
LS : status of position (old or renewed reference system)
G : precision
Z : reliability
R : East
H : North
Punkt (point):
A : type of point
NR : number

7.3 Costs of renovation

The costs depend mainly on the content of the maps and the choosen method. As a reference system for the content of the map, summation of the amount of parcels and buildings was made. Under these aspects, three projects are regarded, referred to 'grid'-format map 1 : 1000 |Au 1974|

Project	number of objects (parcels a. buildings)	simplified resurvey (control points) a.mapp. working days (field a.off.)	cost DM	Digitizing and mapping number of points	cost DM
rural areas	about 50	abt 75	abt 25,000	abt 500	abt 1,500
suburban areas	about 150	abt 150	abt 50,000	abt 1,500	abt 2,000
urban areas	about 300	abt 280	abt 90,000	abt 2,500	abt 2,500

Fig 3: Time and costs of cadastral renovation

7.4 Field survey

The cost of a surveying-team (1 surveyor, 2 assistents; 1 digital tacheometer, 1 estate car) is about 1,100.- DM/day.

8. Final remarks

In Germany the state has ever had the task to establish and to maintain a state survey - e.g. horizontal control - and a real estate cadastre;it can be considered as care for existence.

The experiences of 100 years of surveying show that a durable monumentation is the most important to a consistent survey system. Therfore, in this case economy means only the additional costs for the higher (but necessary) precision, not the costs for the proper establishing.

P. Dale stated |Dale 1976, p. 99|:
"Surveying in Canada and Australia is currently paying the price for not investing in control surveys in days gone by....
If, however, an integreted approach is to be adopted, an estimate of the absolute position of any point is neccessary and this implies that the point must be located within an overall framework..... There is therefore a general need to work from the whole to the part and to connect all individual surveys to a national framework.
Once such a framework is established, the need for precision in individual surveys is less pressing and the costs of surveys may be reduced".

At the above mentioned coordinate-based survey system the benefit/cost ratio is especially good when setting out boundaries, prefabricated buildings or row houses because of time-saving (up to 60 %).

9. References

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Discussion after the conference of Mr. Tegeler

Dale: Your costs are very high. Did you ever inquire about the users need or did you only take into account the surveyors need ?

Tegeler: We have different users, from geometry-users like land owners to information-users.

The experiences of 100 years of surveying show that a durable monumentation is the most important to a consistent survey system. Therefore, in this case economy means only the additional costs for the higher (but necessary) precision, not the cost for the proper establishing, that means DM 1.-/site.

Sometimes we ask the utility services but otherwise it is the decision of the surveyors. We need this accuracy for surveying purposes only, mainly to relocate boundaries.

Koen: You have not only to install such a system, you also have to administer and update it every year. The maintenance is also an enourmous investment.

Tegeler: We will establish this system stagewise. The first step will take about 10 years, but we do not know what tools we will have in 10 years, maybe GPS.

Onsrud: Your main goal seems to be to increase accuracy. Probably we should lower our ambitions in favour of speeding up. The reason for our different opinions might be the traditions of the various countries in which we are working. It is interesting to see that it is possible to run a modern society with a very big variation concerning the demand for accuracy in property information. In Norway, we do not feel the need for such an accurate system.

Krüger: Neither do we in Denmark, but indeed we have different laws.

Kölbl: If you want to reconstitute the position of a boundary mark, it is said that you should be able to place the stone later in the same hole.

In Switzerland we have decreasing tolerances from the cities to the high mountain regions. If you have a control net, it should of course be sufficiently precise so that you can guarantee your tolerances, otherwise these tolerances are wrong and you end up with a whole cascade of error propagation. So, for the first order triangulation you ensure that the precision required in towns can be guaranteed based on the control points.

Dale: In many cities around the world it is perfectly possible to have a very high density development without survey control; indeed, the higher the density, the lesser you need detailed control because the buildings themselves define the limits of use and occupation. An important point is the use of land and the control over the use of land. Geometry remains a small factor while information is perhaps the "plus" we should be spending money on.

Koecher: We should notice that there is a tendency towards higher precision. Our sudden craving for results interferes with the precision that field operation demand. The precision we are looking for is the precision we should observe on the field. In the past it was a question of scale whether it was a 1:25'000 scale or a cadastral map, anyhow the precision was high, but we could not detect it because the drawing precision was a limiting factor. Why dont't we admit a whole variety of precisions by the mean of a precision coefficient (1 to 10) in order to overcome the difficulty of not having the highest precision everywhere.

This consideration does not hold for a network because it has to be a solid base so as to serve as reference for the new measurements.

Enemark: The real problem in cadastral renovation is to get connections to the national grid. Once you have this connection you can build up systems in various scales and with different accuracies.

We can deal with very low accuracies for many purposes and if accuracy is very important, we can go down to local measurements.

Dale: The issue should not be accuracy. The question is how you intend to spend all the money you have obtained. Do you want to buy cm precision or do you want to produce a better information system for users ?

Tegeler: A cadastral system needs a higher precision than an information system. At the above mentioned coordinate-based survey system the benefit/cost ratio is especially good when setting out boundaries, prefabricated buildings or row houses because of time-saving (up to 60%).

The connection between the old measurements and the new reference system represents the main costs.

Koecher: This is a general remark :
The time period of data acquisition should be stored together with information. In urban areas this historical information can be of great interest. For example, in the case of pipes or streetlamps management, the notion of age and duration is important.

Verwirklichung der Katastererneuerung in Bayern

Ralf Dörschel

0. Kurzfassung

Für eine Katastererneuerung ist zunächst ein KFP-Feld hoher Genauigkeit durch terrestrische oder photogrammetrische Punktbestimmung aufzubauen. Die Bedingungen für eine photogrammetrische Punktbestimmung werden erläutert. Der nächste Schritt ist die Bestimmung guter Koordinaten für die übrigen Punkte. Hier gibt es Punktfelder, die nicht koordiniert sind, für die aber in Rissen Maßzahlen vorliegen, und andere Punktfelder, die früher bereits koordiniert wurden. Für beide Fälle werden eigene Programme vogestellt. Ein anderer wichtiger Punkt ist die Sicherung des KFP-Feldes in Städten.

1. Die Ziele

- Ein Punktfeld möglichst hoher Genauigkeit
- eine vollständige großmaßstäbliche Karte (1:1000)
- eine völlig digitalisierte Karte
- gespeichert in verschiedenen Ebenen
- ein digitales Höhenmodell.

Die weiteren Ausführungen beziehen sich nur auf die Arbeit in KFP-Feldern.

2. Der Zustand des bayerischen Katasters

2.1 Die erste Landesvermessung von 1801 - 1865

Eine Meßtischaufnahme im Maßstab 1:5000, in Unterfranken, in Städten und größeren Dörfern im Maßstab 1:2500.
Ein geschlossenes Rahmenkartenwerk, aufgebaut auf einer Landestriangulation, die das ganze Land bedeckte.
Grenzpunkte und Meßtischstandpunkte waren nicht vermarkt. Auch die TP waren nicht zuverlässig versichert. Alle Karten wurden auf Lithographiesteine übertragen und gedruckt. Der

Erfinder der Lithographie, Senefelder, war Mitarbeiter am Bayer.Katasterbüro, dem jetzigen Landesvermessungsamt.

2.2 Die Laufendhaltung des Katasters

Die Karten konnten fortgeführt werden durch Übertragung der Veränderungen auf den Lithographiestein und der Herausgabe eines neuen Druckes. Seit 1870 begann eine Neuvermessung der größeren Städte, um Karten im Maßstab 1:1000 herzustellen. Hierbei wurden alle Grenzen abgemarkt. Alle Grenz- und Gebäudepunkte wurden so aufgemessen, daß sie berechnet oder gezeichnet werden konnten. Nur die Polygonpunkte wurden koordiniert.

2.3 Der gegenwärtige Zustand des Katasters

Man kann etwa fünf verschiedene Qualitätsstufen unterscheiden, die bei einer Katastererneuerung zu beachten sind:

- Gebiete, deren Aufmessung heute noch allein auf der altenMeßtischaufnahme beruht. Neuere Messungen werden in diese Aufnahme eingefügt unter Verwendung sogenannter kartensicherer Punkte. Dies kann auch für das Zentrum der Städte zutreffen.
- In gleicher Weise, durch Einpassen neuer Messungen in die Flurkarte wurden ganze Siedlungen ohne Koordinaten in die Meßtischbläter einkartiert. Eine Kartierung in größerem Maßstab ist hier unmöglich, da ein tragendes Polygonnetz fehlt. Es liegen genaue Maßzahlen vor, aber die Genauigkeit der Kartierung ist die der alten Meßtischaufnahme.
- Fast alle bayerischen Städten haben eine Neuvermessung, zumindest in ihren älteren Teilen, mit Karten im Maßstab 1:1000. Diese Neumessungen haben ein eigenes TP-Feld und ein Polygonnetz. Alle anderen Punkte können koordiniert werden. Die Absolutgenauigkeit liegt bei +/- 1-2 dm, während die Nachbarschaftsgenauigkeit wesentlich besser ist und bei +/- 2-4 cm liegt. Die Genauigkeit der alten TP liegt ebenfalls nur bei +/- 4-8 cm.
- In Flurbereinigungsgebieten besteht ebenfalls ein koor-

diniertes Punktfeld, aufgebaut auf Polygonierungen, hier aber ohne Karten 1:1000. Alle Punkte können koordiniert werden.
Ein spezieller Fall sind die Flurbereinigungen, die photogrammetrisch in den Jahren 1954 bis 1973 gemessen wurden. Diese photogrammetrische Punktbestimmung war eine Näherungsausgleichung, damals mit einer durchgehenden Berechnung von der Messung bis zur Kartierung. Die Koordinaten sollten nur für Flächenrechnung und Kartierung verwendet werden. Ihre Genauigkeit schwankt beträchtlich, in der Nachbarschaft bei etwa +/- 1 dm, in der absoluten Lage bis +/- 1 m.Trotzdem wurden diese Koordinaten meist in das Kataster übernommen.
- Es gibt Gebiete, die auf moderne Weise mit einer modernen Ausrüstung gemessen wurden. Bei sorgfältiger Arbeit ist es möglich, eine Genauigkeit von +/- 2-4 cm in der Nachbarschaft sowohl wie absolut zu erreichen.
Zwischen diesen Typen gibt es natürlich alle möglichen Mischformen.

3. Wege zu einer Katastererneuerung

Bedarf für eine Katastererneuerung liegt vor in den Stadtzentren, in den Siedlungsgebieten, die keine 1000-teiligen Karten haben, und in den Neumessungsgebieten, die früher gemessen wurden.
In jedem Fall muß zunächst ein neues Festpunktfeld geschaffen werden. Dann sind unterschiedliche Methoden anzuwenden:
- In den Innenstädten ohne neuere Messungen muß eine vollständige Neumessung mit Grenzermittlung, Abmarkung und Aufmessung durchgeführt werden. Da gibt es keine erwähnenswerten Probleme.
- In den Siedlungsgebieten ohne Koordinaten muß man zunächst so viel Punkte wie möglich koordinieren, die mit den früheren Messungen verbunden sind. Dann kann man alle anderen Punkte mit den alten vorhandenen Maßzahlen ebenfalls koordinieren.
- In Gebieten einer früheren Neumessung muß man ebenfalls

versuchen, möglichst viele Punkte der früheren Messung zu koordinieren, um dann das übrige Punktfeld umformen zu können.

4. Das KFP-Feld

Jede Katastererneuerung muß sich auf eine moderne Triangulation stützen, damit man ein modernes KFP-Feld aufbauen kann. Der Standard einer modernen KFP-Bestimmung ist:
- Eine genaue und gesicherte Punktbestimmung von +/- 2 cm
- eine sichtbare Vermarkung dieser Punkte
- eine Sicherung dieses Punktfeldes durch zusätzliche KFP oder in anderer Weise.

4.1 Sicherungsmessungen

Früher wurden Punkte einzeln durch Polygonierung bestimmt. Sie wurden gesichert durch Spannmaße zu den nächstgelegenen Gebäudeecken. Heute ist der Verlust an Punkten durch Straßenbaumaßnahmen sehr hoch. Deshalb wurde nach Wegen gesucht, das Punktfeld besser abzusichern. Solche Sicherungsmaßnahmen sind zum Beispiel:
- Ein Nest von Punkten, wobei die Punkte nicht allein in der Straße liegen, sondern auch an den Wänden der umliegenden Gebäude. Vermarkt sind diese Punkte durch geschraubte oder geklebte Marken. Der Abstand zum Hauptpunkt sollte kleiner als 20 m sein. Alle diese Punkte sollten so exakt koordiniert sein wie der Hauptpunkt.
- Manchmal ist nicht der Punkt an der Mauer der koordinierte Punkt, sondern ein Punkt, der 10 cm vor der Mauer liegt. Ich bezeichne dies als die sogenannte "Nürnberger" Methode.
- Alle Höhenbolzen können koordiniert werden, um so die Zahl der KFP zu vermehren. Wir haben eine Methode entwikkelt, Höhenfestpunkte an Gebäuden auch photogrammetrisch einfach und sicher zu bestimmen.
- Besonders bei photogrammetrischer Bestimmung, aber auch bei terrestrischer Messung kann man relativ leicht alle Kanaldeckel bestimmen und so ein Punktfeld schaffen, das

auch anderen Benutzern zugänglich ist.
- Punkte können durch Anmessungsskizzen gesichert werden, in welchen die Spannmaße zu nahegelegenen natürlichen Punkten, meist Gebäudeecken eingetragen sind. Durch solche Anmessungsskizzen ist z.B. das ganze Punktfeld in München gesichert. Aber solche Anmessungsskizzen herzustellen, ist ebenfalls ziemlich teuer, und Skizzen allein sind nie so gut wie koordinierte Punkte.
Als Beispiel: Der beste, aber auch teuerste Weg ist die Herstellung von Anmessungsskizzen mit Spannmaßen hoher Genauigkeit und mit koordinierten Punkten. Wesentlich billiger ist es, alle Kanaldeckel mit guter Genauigkeit von Straßenarbeiter signalisieren zu lassen und diese Punkte photogrammetrisch zu bestimmen. Wenn für diese Punkte bestimmte Nummernbereiche vergeben sind, kann man Punktnummernaufträge herstellen, die allein diese Punkte enthalten.

4.2 Überlegungen zur Bestimmungsmethode

Es sollte nach sachlichen Gesichtspunkten entschieden werden, welche Methode der Punktbestimmung, photogrammetrisch oder terrestrisch, gewählt werden soll. Besonders ist dabei zu beachten:
- Genauigkeit und Sicherheit der Punktbestimmung
- die Möglichkeit, ein gutes KFP-Feld in Stadtgebieten aufzustellen
- die Behinderungen und Gefährdungen durch den Straßenverkehr.

In unserer Abteilung können beide Methoden angewendet werden. Für beide Methoden sind Instrumente und Programme vorhanden. Man muß versuchen, die beste Methode zu wählen je nach den Umständen und den finanziellen Mitteln.

4.3 Terrestrische Punktbestimmung

Eingesetzt werden selbstregistrierende Tachymeter von Zeiss wie ELTA 2 oder ELTA 3. Alle Netze werden durch Richtungs- und Streckenmessung bestimmt. Die Ergebnisse sind gut. Man muß aber beachten, daß das Punktfeld ins Schwimmen kommt,

wenn die Zahl der Punkte zwischen den Festpunkten zu groß wird. Dann muß zuvor ein übergeordnetes Punktfeld bestimmt werden mit wenigen Verbindungspunkten. Der Aufwand für die Erkundung und Messung eines guten KFP-Feldes ist beträchtlich. Der Vorteil terrestrischer KFP-Bestimmung ist, daß man sie mit der Polarmessung der sonstigen Punkte verbinden kann. Dies ist üblich bei unseren terrestrisch gemessenen Neumessungen.
Es ist auch zu bedenken, daß der Umfang der Rechenarbeiten sehr groß werden kann, wenn man ein gut verknüpftes KFP-Feld bestimmen will und im gleichen Verfahren zahlreiche Polarpunkte bestimmt werden sollen.
Endlich ist anzumerken, daß mit unseren Messungen eine Genauigkeit der Punktbestimmung von +/- 2 cm oder besser erreicht wird.

4.4 Paßpunktbestimmung für photogrammetrische Arbeiten

Terrestrische Messungen sind erforderlich zur Paßpunktbestimmung. Im Gegensatz zur Messung des ganzen KFP-Feldes ist hier meist nur in der Umgebung der Städte und Dörfer zu messen, wo man ein KFP-Feld einfacher aufbauen kann. Behinderungen durch den Verkehr kann man hier meist umgehen. In größeren Städten kann man auch die großen Durchgangsstraßen oder Hochhäuser für den Netzaufbau benutzen.
Ein besonderes Problem ist die Höhenbestimmung der Paßpunkte, wenn mit ELTA 2 oder ELTA 3 gemessen wird. Man braucht hierfür ein gut eingeübtes Team, da solche kombinierten Messungen mit selbstregistrierenden Tachymetern sehr fehleranfällig sind.

4.5 Photogrammetrische Punktbestimmung

Diese Messungen gehen an die Grenze der photogrammetrisch erreichbaren Genauigkeit. Darum sind einige Punkte genau zu beachten:
- Am Rand des Arbeitsgebietes ein gut bestimmtes Paßpunktfeld
- Genau gemalte Signale mit Kontrast

- ein Bildflug bei günstigen Wetterbedingungen
- 60% Längs- und 50% Querüberdeckung
- Bildmaßstab zwischen 1:3000 und 1:8000, üblicherweise 1:4500.
- Verwendung von Color-Diafilm
- Auswertung der Originalbilder
- Auswertung durch Komparatormessung
- ein gutes modernes Bündelausgleichungsprogramm mit den bekannten 12 zusätzlichen Parametern
- eine Methode, grobe Fehler in der Bündelausgleichung möglichst durch Programm aufzudecken.

Diese Punkte sind ein Resultat von 15 Jahren Arbeit, in denen etwa 80 Bündelausgleichungen berechnet wurden.

Einige Anmerkungen dazu:

Mit der Signalisierung haben wir Versuche unternommen. Das Ergebnis ist, daß wir unter normalen Bedingungen weiß streichen mit einem Durchmesser von 15-20 cm und dazu auf jeden Fall eine schwarze Kontrastfläche haben mit einem Durchmesser von 60 cm für den Bildmaßstab 1:4500. Hausecken oder Wandpunkte wurden nie als exakt bestimmte Punkte verwendet.

Den Bildmaßstab zu vergrößern ist nicht sehr nützlich. Die Genauigkeit wird zwar etwas besser, aber dem stehen erhebliche Nachteile gegenüber. Bei einem Bildmaßstab von 1:3000 oder größer muß man alle Bilder verwenden, während man bei einem Bildmaßstab 1:4500 mit 80% Längsüberdeckung nur jedes 2.Bild braucht. Möglicherweise hat man nicht genug Verknüpfungspunkte in den einzelnen Bildern und zur Bestimmung der zusätzlichen Parameter. Die Forderung nach einer 50%igen Querüberdeckung und nach Luftbildern zur Herstellung von Orthophotos für die einzelnen Flurkarten widersprechen sich und lassen sich nur durch zusätzliche Flugstreifen erfüllen.

Colordiafilm läßt wichtige Bildeinzelheiten besser erkennen. Bei einigen Flügen konnten nur Kopien der Luftbilder ausgewertet werden. Dies ergab deutlich schlechtere Ergebnisse. Die Verschiebungsbeträge zwischen der Original- und der Kopieauswertung kann man auf einem beiliegenden Vektorbild sehen.

Die Auswertung erfolgt überwiegend an dem Monokomparator PK 1 von Zeiss, ein schnell und genau messendes Instrument. Er ist durch seine Einzelbildauswertung fehleranfälliger als ein Stereokomparator oder der Planicomp, dafür ist er auch erheblich billiger.
Über lange Jahre hinweg arbeiteten wir mit einem Programm, das in Hannover Anfang der 70er Jahre entwickelt wurde. Seit 2 Jahren haben wir ein Programm von Prof.Grün, Zürich. Im Regelfall haben wir nach der Ausgleichung einen mittleren Fehler der einzelnen Beobachtung von +/- 3 mm/1000 oder +/- 1,4 cm für den Bildmaßstab 1:4500. Etwa 55-60% der Beobachtungen sind redundant. Jeder Punkt ist durch 4-6 Beobachtungen bestimmt. Eine wirksame Methode, grobe Fehler aufzudecken, ist wichtig für die Wirtschaftlichkeit der Bündelausgleichung. Wir glauben, hier jetzt eine gute Lösung gefunden zu haben.
Ein weiterer Punkt: Nach einer Bündelausgleichung haben statistisch betrachtet alle Punkte eine Genauigkeit von +/- 1,5 cm und sie sind bestimmt durch 4-8 Messungen. Ein kleiner Teil dieser Punkte hat aber einen größeren Fehler bis zu +/- 3-4 cm. Daneben gibt es einige Punkte, die bloß von 2 oder 3 Messungen bestimmt wurden. Diese Punkte sollte man durch eigene terestrische Messungen kontrollieren.
Es gibt Stadtverwaltungen, die Zentimetergenauigkeit und eine hohe Zuverlässigkeit der Punktbestimmung fordern. Sie fordern Punktnester koordinierter Punkte mit Anmessungsskizzen und Spannmaßen, die auf mm gemessen sind. Hier ist die Grenze photogrammetrischer Punktbestimmung erreicht. Um die Zuverlässigkeit der Punktbestimmung zu erhöhen, wurde eine Kreuzbefliegung mit dem Bildmaßstab 1:6000 durchgeführt. Der Flug war nur wenig teurer als unsere Normalbefliegung im Bildmaßstab 1:4500. Aber es war natürlich mehr auszuwerten und zu rechnen, wobei die Menge der Beobachtungen einige Schwierigkeiten bereitete. Bei photogrammetrischer Bestimmung der Haupt-(oder Boden-)punkte des KFP--Feldes werden die Punktnester terrestrisch gemessen mit doppelter Aufstellung und jeweils 1-2 Orientierungs- und Kontrollanschlüssen. Diese Arbeitsteilung in einen photogrammetrischen und einen terrestrischen Teil hat gegenüber

der rein terrestrischen Messung erhebliche Vorteile. Bei terrestrischer Messung muß man dafür sorgen, daß die Zwangszentrierung zu allen benachbarten Punkten möglichst aufrechterhalten werden kann. Damit liegt man in einen ständigen Kampf mit den Behinderungen, die der Straßenverkehr mit sich bringt. Die Meßdaten der terrestrischen Messungen in den Punktnestern können nun zur Verbesserung der photogrammetrisch bestimmten Koordinaten verwendet werden. Prof.Ebner hat ein Programm entwickelt, das gleichzeitig terrestrische und photogrammetrische Messungen verarbeitet. Mit diesem Programm hoffen wir, unsere Koordinaten nochmals verbessern zu können.
Bei allen Überlegungen ist zu berücksichtigen, daß Luftbilder auch für andere Zwecke verwendet werden können. Die großmaßstäblichen Karten können durch eine topographische Auswertung ergänzt werden und es können Orthophotos hergestellt werden.

5. Die Neumessung

Bei einer vollständigen Neumessung entstehen keine großen Probleme. Das KFP-Feld kann je nach den Umständen photogrammetrisch oder terrestrisch bestimmt werden. Bei einer kombinierten Methode müssen beide, der Photogrammeter und die terrestrisch messende Gruppe darauf achten, daß sie ein wirtschaftlich günstiges und ein vollständiges Ergebnis erhalten.

6. Die Katastererneuerung in Gebieten, in denen viele Punkte durch Maßzahlen festgelegt, aber nicht koordiniert sind

Auch hier ist es Ziel der Arbeit, genaue Koordinaten und ein großmaßstäbliche Karte zu erhalten. Das Problem ist dabei, daß man sehr viele alte Maßzahlen hat und für einige der alten Punkte auch neue Koordinaten, die nach einer der oben erwähnten Methoden bestimmt wurden. Dabei gibt es Teile mit wenigen alten Messungen, in denen es nur eine Möglichkeit gibt, die Punkte zu koordinieren. Es gibt aber

auch andere Gebiete mit einer Vielzahl alter Risse, wo man unter Umständen unter sich widersprechenden alten Zahlen wählen muß.
Für solche Fälle wurde ORTRA, ein neues Programm, von Prof.Linkwitz, Stuttgart, entwickelt. Dieses Programm verwertet alle alten Messungen, die man für dieses Gebiet finden kann, alle Orthogonal- und Polarmessungen ebenso wie alle gemessenen Spannmaße. Berechnet wird eine Ausgleichung zur Bestimmung der Koordinaten der Neupunkte. Selbstverständlich sind in einer so großen Zahlenmenge auch (meist grobe) Fehler. Diese Fehler werden vom Programm in mehreren Schritten aufgedeckt. Die Fehlersuche ist ein wesentlicher Vorteil dieses Programms. Alle Messungssysteme (orthogonale wie polare) werden durch 4-Parameter-Transformationen zusammengeschlossen. Auch in schwierigen Fällen brachte das Programm gute Ergebnisse. Es konnten sowohl falsche Maßzahlen wie falsche Ausgangspunkte aufgedeckt werden. ORTRA ist der letzte Schritt in einer Entwicklung, welche 1970 mit einer photogrammetrischen Blockausgleichung begann. Zugegebenermaßen muß man mehr Arbeit in eine solche Rechnung investieren als in eine einfache Berechnung. Aber man geht dafür nicht das Risiko ein, am Schluß nicht genau zu wissen, welche Zahlen die besseren sind. Bei ORTRA erhält man ein gesichertes Resultat. Ich bin überzeugt, daß Punktfelder, die so berechnet wurden, fast die gleiche Genauigkeit haben wie die KFP, wenn nur genügend Zahlen für die Ausgleichung vorhanden waren. Für schwierige Fälle braucht man solche Programme.

7. Katastererneuerung in Gebieten alter Neumessung

In diesen Gebieten gibt es bereits Karten und Koordinaten. Aber das Feld der alten Polygonpunkte ist nicht mehr vollständig. Manchmal sind Punkte ungenau wiederhergestellt und die Absolutgenauigkeit liegt oftmals bei +/- 1-2 dm. Ein neues TP-Feld für das Gebiet enthält nur wenige TP des alten Feldes, so daß eine neue Verbindung zu dem alten Katasterpunktfeld geschaffen werden muß. Im neuen KFP-Feld

werden so viel alte Punkte wie möglich mitbestimmt. Eine 4- oder 6-Parameter Transformation, besonders aber der Plot der Restklaffungen oder Gegenüberstellungen, zeigt deutlich, ob zwischen dem alten und dem neuen Punktfeld ein kontinuierlicher Übergang besteht. Punktgruppen oder Einzelpunkte, deren Vektoren sich nicht in den allgemeinen Trend einfügen, zeigen die Stellen, wo bei Messung, Rechnung oder Wiederherstellung Fehler aufgetreten sind. Für diese Transformationen wurden besondere Programme entwikkelt.
Früher waren nur die TP identische Punkte. Für eine 6-Parameter-Transformation wurde das Gebiet in Dreiecke aufgeteilt mit den TP als Eckpunkten. Das Programm berechnete eigene Transformationsparameter für jedes Dreieck. Es ist bekannt unter den Namen "maschenweise Affin-Transformation". Das Programm fordert absolut identische Punkte als Stützpunkte. Für Punkte zwischen den TP ist eine Verbesserung nicht möglich.
Bei unseren neuen Arbeitsweise, der Bestimmung eines neuen KFP-Feldes, haben wir mehr, aber nicht so gesicherte identische Punkte. Hierfür wurde das Programm PUSPE aufgestellt, das für jeden einzelnen zu transformierenden Punkt eigene Transformationsparameter rechnet, eine "PUnktSPEzifische Transformation. Die Parameter werden von den nächsten zehn identischen Punkten automatisch durch Programm berechnet. Der Einfluß dieser Punkte ist entfernungsabhängig gewichtet. Das Umformungsgebiet kann durch eine vorgegebene Grenze festgelegt werden. Es besteht die Hoffnung, daß auf diese Weise ein altes Punktfeld besser an ein neues angeglichen werden kann. Das Programm ist jetzt das Standardprogramm, um alte Punktfelder zu transformieren und zu verbessern.

8. Zusammenfassung

- Katastererneuerung ist notwendig. Sie ist eine große Aufgabe.
- Der erste Schritt hierfür ist der Aufbau eines KFP-Feldes möglichst hoher Genauigkeit.

- Hierfür sind terrestrische und photogrammetrische Methoden gleich geeignet.
- Die KFP müssen gesichert werden durch Punktnester von koordinierten Punkten, durch Anmessungsskizzen, Spannmaße, durch koordinierte Kanaldeckel oder Höhenbolzen.
- Der nächste Schritt ist, ein homogenes genaues Punktfeld aller anderer Punkte aufzubauen, die koordiniert werden sollen.

Dies kann erfolgen durch:
- eine übliche Neuvermessung.
- Berechnung aller Punkte mit den alten Maßzahlen der Fortführungsrisse auf dem normalen Weg oder in schwierigen Fällen durch ORTRA (= eine Ausgleichung aller gültigen Zahlen)
- Transformation des früher koordinierten Punktfeldes mit PUSPE.
- Der dritte Schritt ist, alle anderen Punkte zu digitalisieren und das gemessene und das digitalisierte Punktfeld zu verbinden.
- Für andere Benutzer muß man ein Punktfeld bereithalten von Punkten, die leicht aufzufinden sind wie Kanaldeckel oder Höhenbolzen.
- Die Photogrammetrie ist eine gute Methode für die hier beschriebenen Arbeiten. Die Luftbilder kann man auch zur Ergänzung der Karten durch topographisches Detail und für die Herstellung der Luftbildkarten verwenden.

REALIZATION OF CADASTRAL RENOVATION IN BAVARIA

Ralf Dörschel
Bavarian state survey office

Summary

For a cadastral renovation first there is to build up a control point field of high precision. It is possible to determine such points by photogrammetry or by ground measuremets. The conditions are explained, to get a sufficient photogrammetrical result. The next step is, to get new, better coordinates for all detail points. There are fields of points without coordinates, but a lot of old cadastral field sheets, and other areas with former coordinated point fields. For both cases special developed programs are discussed. An other important point is the securing of control points in town areas.

1. The aims

- A field of points of utmost accuracy
- a complete large scale map (1:1000 or 1:500)
- an entirely digitized map
- stored on different levels
- and a digital height model

In my further explanation I can only tell something about coordinates.

2. The state of the Bavarian cadastre
Notes on the Bavarian cadastral survey

2.1 The first national survey from 1801-1865

A plane-table-survey mostly on the scale of 1:5000, in Lower Franconia and the towns and larger villages at 1:2500.
A map series of adjoining sheets (based on a fixed frame work) with a triangulation covering the whole country.
Neither the boundaries nor the stations of the plane-table-survey points were monumented. Even the triangulaton points were not monumented in a reliable way. All maps were engraved on lithographic stones and could be printed. The inventor of lithography, Mr. Senefelder, was a member of the Bavarian cadastral office, later called Bavarian state survey office.

2.2 The updating of the cadastre

Maps could be updated by transferring the changes on to the lithographic stones and publishing a new print. In 1870 the renewal of cadastral survey started in larger towns in order to produce maps at the scale of 1:1000. All boundaries had to be marked in that process. All boundary-

and building-points had to be measured in such a way, that all points could be drawn or calculated. Only the controlpoints were given coordinates.

2.3 The present state of the cadastre

Generally we can distinguish between five different levels of quality, that are relevant to a renewal of cadastral survey:
- Areas based on the old plane-table-maps. Recent measurements are fitted into the maps by using reliable points not coordinates. This is also used for maps containing the centre of towns or villages.
- In the same manner, by inserting the measurements into the maps, whole new settlements were mapped without coordinates in the plane-table-maps at the scale of 1:5000. Mapping at a larger scale is normally impossible for lack of a framework. There are accurate figures, but the mapping accuracy is the accuracy of the old plane-table-map.
- There has been a resurvey of nearly all Bavarian towns on one or more occasions, at least to the older parts, producing maps at the scale of 1:1000. Here we have a triangulation network, better and more condensed than the former triangulation. There is also a field of traverse points with coordinates. All other points can be calculated. The points have an absolute accuracy of about +/- 1-2 dm or less, corresponding to the accuracy of the traverses. The accuracy to neighbouring points is much better, perhaps +/- 2-4 cm. But remember that the accuracy of the old trig points is only at +/- 4-8 cm.
- In rural reconsolidated districts we have also point fields with coordinates based on traverses, here without maps at 1:1000. But if it is necessary, you can coordinate all points.
A different case are land consolidations measured by photogrammetry. The photogrammetrical point determination at that time was an approximate adjustment, but there was an automatical calculation from the measurement to the mapping. The work was carried out from 1954 until 1973. The coordinates were only used for calculation of areas and for mapping. The accuracy varied considerably, in the vicinity about +/- 1 dm, but absolutely up to +/- 1 m. Nevertheless the coordinates had to be included in the cadastre for the most part.
- There are some areas, measured in a modern way with modern equipment. By working carefully it is possible to obtain an accuracy of +/- 2-4 cm both absolutely and in the vicinity.
By the way all types of variations between these states are possible.

3. Ways to cadastral renovation

There is a demand for a renovation in the centre of towns or villages and in settlements not covered by 1:1000 scale maps and on the other hand in the renewal areas measured in the old manner.
In both cases we have first to build up a control point field of higher precision. Then we have to employ different methods.
- In the old towncentres without any measurements we have to find all boundaries and survey these boundaries and all buildings then. This is a example for a total renewal of cadastre. I assume there are no problems, so I need not to go into details.
- In settlements without coordinates first you have to try to coordinate as many points as possible of the former measurements and then coordinate

all other points with the old figures.
- In the area of former renewal of cadastral survey you also have to try to coordinate as many points as possible. Afterwards you can transform the whole field of coordinated points.

4. The control network

Every renovation of cadastre is founded on a modern triangulation, to be able to build up a modern controlpoint network. The standard for modern control points is:
- An accurate and verified point determination of about +/- 2 cm
- A visible monument of these points
- A securing of this field by additional points or in other ways

4.1 Security measures

In former times there were only single points measured by traverses. These points were secured by struts measured from the corner of the nearest buildings. Nowadays we lose many points as a result of all the roadworks. Therefore we had to look for possibilities, to secure the traverse points in a better way. Such security measures are for example:
- A cluster of points, not only in the street area, but also on the walls of the nearest buildings, monumented by a screwed or glued mark, at a distance of less than 20 m from one another. All these points have to be as exactly coordinated as the main point.
- Sometimes the point is not the mark on the wall, but a point 10 cm in front of the wall. In the wall you have only a marked dowel. The "Nürnberg" method.
- All bench marks can be coordinated. Thus they multiply the number of control points. We have developed a way of coordinating such points by photogrammetry.
- By using photogrammetry, but also by ground measurements you can easily determine all lids of sewer shafts in the streets and so create a field of points also for other users.
- Points can be secured by sketches, in which the struts to certain natural points, mostly on buildings or so are indicated. With such sketches the whole control network of Munich for example is secured. But it is also expensive to produce these sketches and finally sketches are not as good as coordinated points.

For example: The best, but most expensive way is, to produce sketches with coordinated points and struts of high accuracy. A much cheaper method is, to have all sewer lids marked by roadworker with a good accuracy and compute these points by photogrammetry. If you assign certain numbers for these lids, you can easily draw a plotting by using only these points.

4.2 Considerations which method of determination to choose

There should be no struggle on principle about the method of point determination, by photogrammetry or ground measurements. Only certain aspects should be considered:
- The accuracy and the verification of the point determination
- The possibility to build up a good network in town areas

- The interference and danger caused by the traffic

We are capable of using both methods in our department. We have the instruments and the programs for both. We choose the best method according to the circumstances or the financal means.

4.3 Point determination by ground measurements

We use selfrecording tacheometers as ZEISS ELTA 2 or ELTA 3. All our networks are determined by directions and distances. Such networks provide good results. However if the number of points between the trig points is too high, you can get a shifting pointfield. Then you have to build up an additional network of few connecting points. The expense for the reconnaissance and the measurement of a good network is considerable.
The advantage of ground measurements is that you can combine the network measurement with the radial determination of other points. That is done in our renewal survey, if they use ground measurements.
You also have to take into consideration that the extent of calculation work can become very high, if you want to get a well connected network and at the same time a great number of radially determined points.
Finally I would like to point out, that with our measurements we can reach a verified accuracy of +/- 2 cm or even better for each point.

4.4 Ground control points for photogrammetry

Ground measurements are needed for photogrammetry to build up a field of ground control points. In contrast to the measurement of the whole network, the field of work is here mostly in the surroundings of the towns or villages, where it is much easier to develop a network for ground control points. Traffic interference is negligible there. In larger towns we can use the big thoroughfares or some higher buildings for our work.
A special problem is the determination of the height of all control points measured with ELTA 2 or ELTA 3. We do so, but you need a well experienced team. Such combined measurements with selfrecording tacheometers are highly liable to make mistakes.

4.5 Point determination by photogrammetry

You have to realize that here we are approaching the limit of the efficiency of what photogrammetry can do. So you have to pay attention to some important points:
- Well determined ground control points on the border of our working area
- Accurate paint targets with contrast colour
- The photoflight during favourable weather conditions
- 60% forward- and 50% sideward overlap
- Image scale ought to be between 1:3000 and 1:8000, in our photoflights usually 1:4500
- Use of a colourdia film
- Evaluation of original air photos
- Evaluation by comparator measurements
- A good modern bundle adjustment program with 12 additional parameters
- And a method of detecting blunders by program

These points are the result of 15 years work with about 80 bundle adjustments.
Some remarks to the points mentioned above:

We have made some experiments concerning the signalization. After all we normally use white targets with a diameter of 15 - 20 cm and in any case with a black contrast field with a diameter of 60 cm for an image scale of 1:4500. We never wanted to determine corner or wall points as exactly measured points.
To enlarge the image scale is not very useful. The accuracy will become somewhat better, but there are great disadvantages. In a larger scale you need all photos. You can not strictly observe the conditiones of the photo-flight concerning the side overlap. Possibly you have not enough points in each photo for producing secure connections and for the determination of the additional parameters. And you can not use the photos for producing orthophotomaps for the scale 1:1000 covering our normal cadastral map.
Colourdia film is better to distinguish more detail in every respect. At some flights we evaluated only filmcopies and we got significant results which were 30-50% worse than normally. The difference between the original and the copy evaluation you can see in the vector plot.
We are working with the monocomparator ZEISS PK1, which is a quick and exact measuring instrument. It is more liable to cause errors than a stereocomparator or a planicomp, but it is much cheaper.
For years we worked with a program developed in Hannover. Now we have a modern program by Prof.Grün, Zürich. Normally after the adjustment the single observation has an accuracy of +/- 3 mm/1000 or +/- 1.4 cm for an air photo scale of 1:4500. About 55-60% of the observations are redundant. Every point is determined by 4-6 observations. The effective detection of blunder is important for an economical use of this method. We are confident that we have found a good solution for this problem.
But some important points are to bear in mind: Bundle adjustment yields a highly stiff network, so it is capable of covering large areas without controlpoints better than ground measurements. For that it requires enough connections formed by painted targets and a reliable border of ground control points. Frequently semi-systematic errors remain in the control points between +/- 2 and 4 cm. That is too much if you want a point accuracy of +/- 1.5 cm. Do not forget that small systematical errors are inavoidable in both bundle adjustment and ground control network. These deviations can only be adjusted by giving the control points a greater weight.
The other point to consider: Statistically all points after a bundle adjustment have an accuracy of about +/- 1.5 cm and they are determined by 4-8 measurements. A small part of these points shows a greater error up to +/- 3 or 4 cm. Then there is another group, which is less accurate determined by only 2 or 3 measurements. These are the points which I think you have to detect and to improve by ground measurements.
There are town administrations which require even a greater accuracy and verification of the points. They demand clusters of ground points and some coordinated wall points with sketches and struts measured in mm. Here we come to the limit of the accuracy of photogrammetrical methods. In this case we had a cross-flight with an image scale of 1:6000, to get a better connected point field. By the way, the flight was only somewhat more expensive than a normal photoflight in the scale of 1:4500. But there was more to evaluate and to calculate and there were some difficulties.
Nowadays an adjustment-program exists by Prof.Ebner, München, which simultaneously processes photogrammetrical and ground measurements. With this program we hope to improve our coordinates once more.

We have to combine both methods, photogrammetrical and ground measurements, if we have to determine such clusters of points. From this ground measurements we get the material to improve our photogrammetrical coordinates. The main network is measured in the photogrammetrical way. Then my survey teams have to work respectively in one cluster. They only need one or two points from the adjoining cluster to get an orientation for the cluster-measurement. Otherwise when a network is only determined by ground measurement, they have to link up all surrounding clusters.

Finally I should like to point out that I can use the air photos for some other tasks. Our large-scale-maps can be updated by a new topographical evaluation of air photos. We can also produce orthophoto maps from our air photos and the results of our bundle adjustment.

5. The renewal of cadastral survey

No great problems will arise, if there is going to be a total renewal of cadastre. The control point network can be determined photogrammetrically or by ground measurements depending on the circumstances. Both, the photogrammetrist and the survey teams have to be trained to obtain an economical and comprehensive result by a combined method.

6. The cadastral renovation in areas containing a lot of old measurements, but no coordinates

Here, too, the aim is to get accurate coordinates and large-scale maps. The problem is, you have old measurements and you have recent coordinates for some of these old points which have been determined by one of the methods mentioned above. There are parts, where you have only few measurements. Here you can calculate all points in only one way. But there are other parts where you have a lot of cadastral field sheets and where you must choose between sometimes divergent old figures.
For this case there has been developed a new program by Prof.Linkwitz, Stuttgart, called ORTRA. This program combines all old measurements you can find for this field, all detailed measurements by quasi-perpendiculares or by radial determination and all struts. We calculate an adjustment for the coordinates of all unknown points. But there are of course some errors in such a great number of figures. Our program removes these errors in several steps. And I think that error removal is a main advantage of this program. All measurement systems (quasi-perpendicular- or radial-systems) are joined together by four-parameter-transformation. Even in difficult cases we obtained good results by this program. We can detect bad figures and also bad fix points. ORTRA is the last step in a development, which started with a photogrammetrical program about 1970. Admittedly there is a lot more work involved than in a simple calculation, but you do not run the risk, finally not to know which figure is better than the other. You get a good and verified result and all your fix points are verified. I am convinced that point fields calculated in this way have nearly the same accuracy as the control points, if you only have enough figures for your adjustment. I think in difficult cases we need such programs.

7. Cadastral renovation in areas of older renewals

Here we have large-scale maps, and also coordinates. But the field of the old control points is not complete any more. Sometimes the points are inexactly restored and the accuracy, especially the absolute accuracy is often only about +/- 10-20 cm. A new trig net for this area also contains only few of the old trig points. Then you must create a new connection between the new trig network and the whole older point field.
Our new control point network contains as many older points as possible. A 4- or 6-parameter-transformation, especially a plot of the vectors of the residual errors shows clearly, whether there is a continual transition between both fields or not. Discontinous parts mostly indicate parts where errors have occured in restoring or determining of the old control points or in calculation. We have special programs for the transformation of the old point field into the new one.
In former days only trig points were identical points. We had a 6-parameter-transformation and divided the area into triangles formed by the trig points. The program calculated separate transformation-parameter for each triangle. The program is called an affinity transformation in triangles (maschenweise Affintransformation). The program assumes absolutly identical points in the corners. For the points between the trig points no improvement is possible.
Now in our modern way we have more, but not so well monumented points, not such certainly identical points. For this case we have created the so called PUSPE, a transformation which calculates parameters separately for each point, which has to be transformed, a point specific transformation. The parameters are calculated only from the nearest ten identical points chosen automatically by program. The influence of each of these points is weighted by distances. I can limit the transformation to a certain predetermined border. We hope that in this way the older point field can be better adjusted to the new field than otherwise. This program is our standard program to transform and to improve old coordinated pointfields.

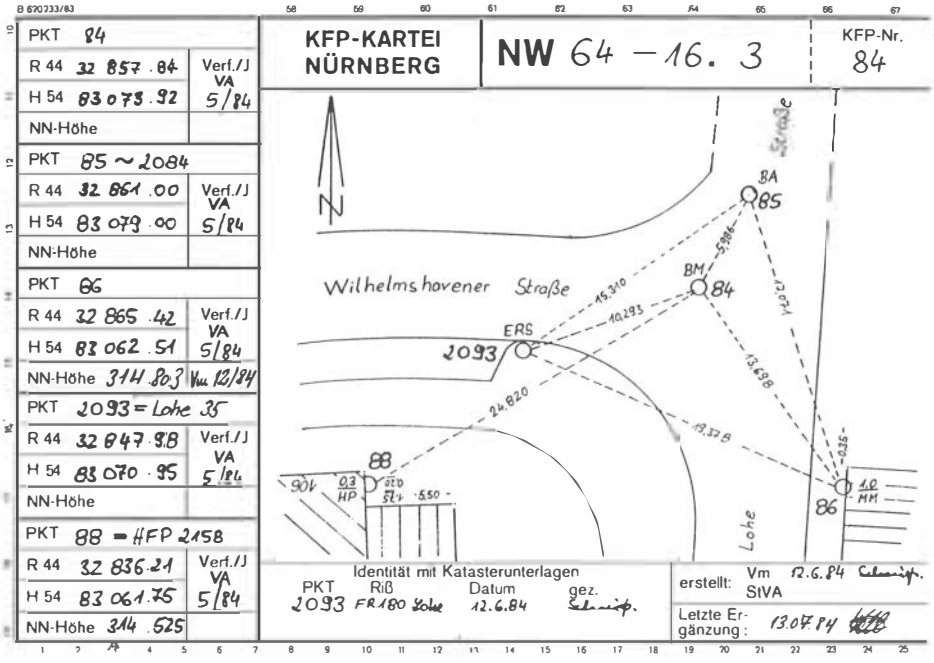
8. Conclusions

- Cadastral renovation is necessary and a great task.
- The first step is to build up a control framework for the cadastre with the utmost accuracy.
- Photogrammetry and ground measurements are both suitable for building up such networks.
- Such points have to be secured by clusters of coordinated points, sketches, struts or coordinated sewer lids or bench marks.
- The next step is to build up a homogeneous accurate field of all the other points which are to be coordinated.

That can be done by:
- The usual renewal of the cadastral survey with new measurements for all points.
- Calculating the other points with the old figures of the old cadastral field sheets in the normal way or in difficult cases by ORTRA, an adjustment of all valid figures.
- Transformation of former coordinated point fields by PUSPE.
- The third step is to digitize all other points and to connect both the measured and the digitized pointfield.
- For all other users you have to keep ready a field of points they can

find out easily as bench marks, sewer lids and so on.
- The photogrammetry is always a good method of working in this field. You can use air photos not only for point determination, but also to complete the large-scale-maps with topographical details or to produce orthophotomaps.

KFP-Kartei

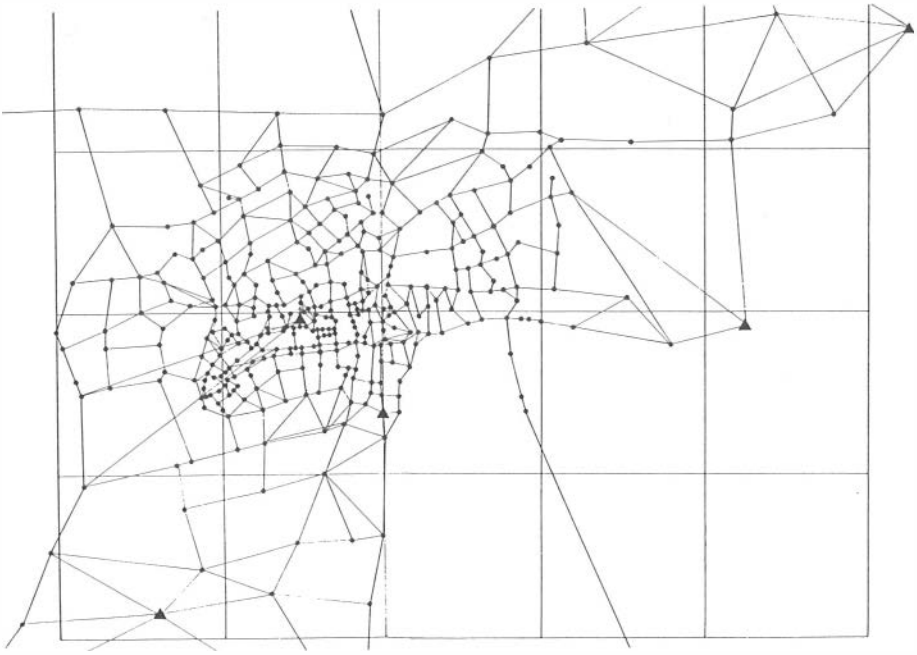


Sketch for a point cluster

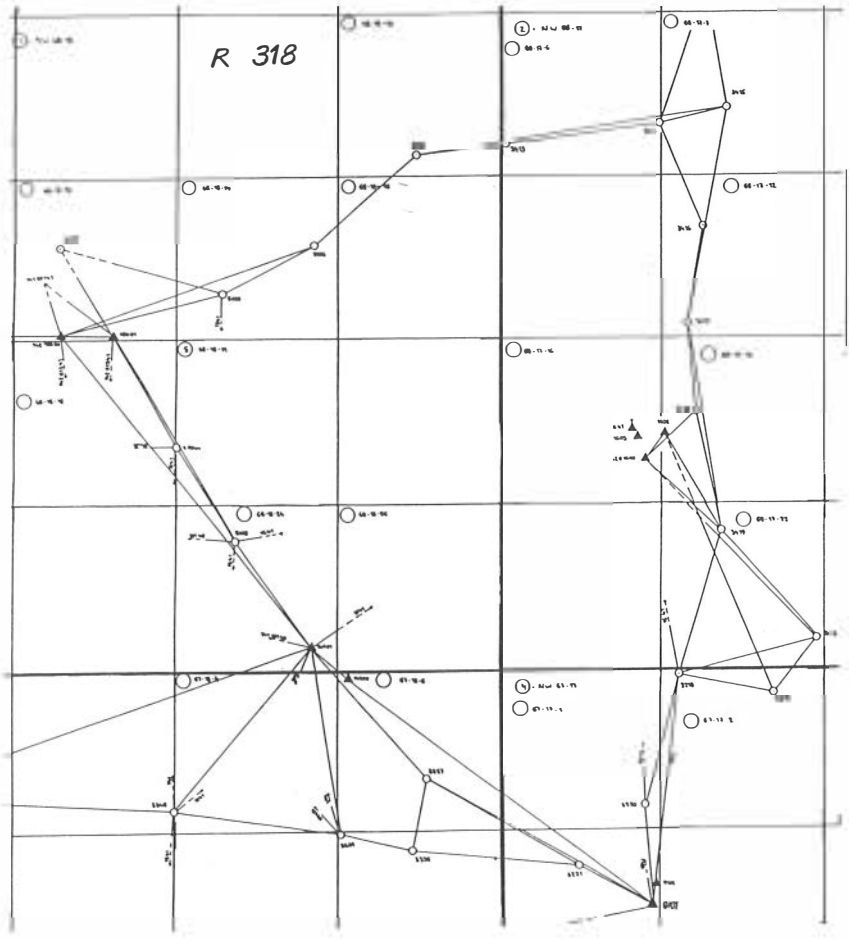
Abbreviations

ERS = pipe with guard lid (Rohr m.Schutzkappe)
BM = brass bolt (Bolzen aus Messing)
BA = other bolt (sonstiger Bolzen)
MM = dewel with thread (Mauermarke m.Innengewinde), the survey point is 10 cm in front of the wall (Der koordinierte Punkt liegt 10 cm vor der Mauermarke. Er wird durch einen eingeschraubten Messingstift markiert)
HP = bench mark (Höhenfestpunkt)

Control point field by ground measurement



Ground control points for photogrammetry



Jobs (calculated with the former program)

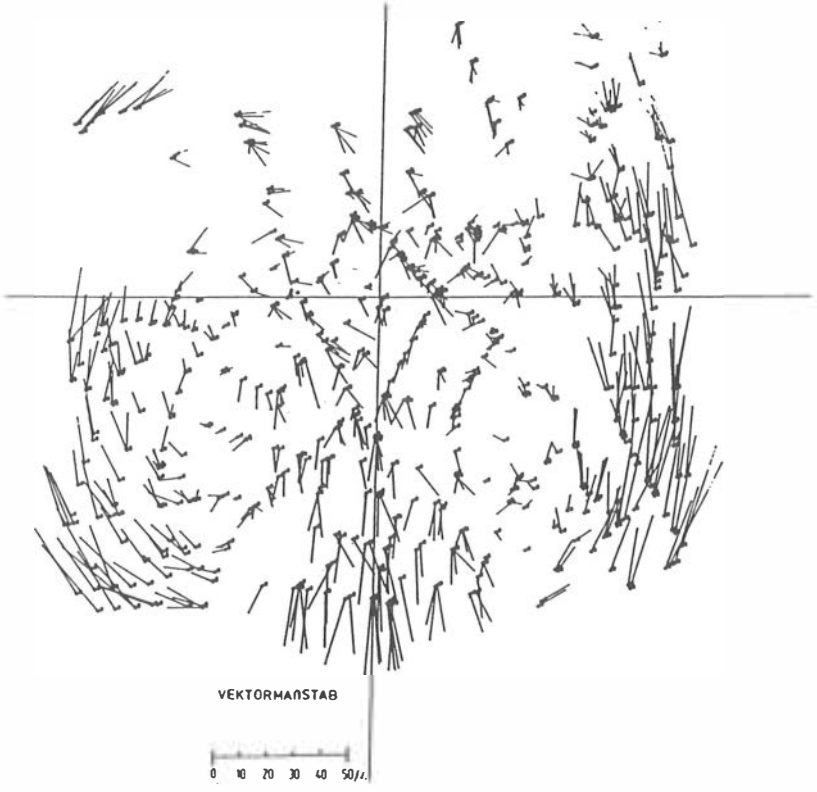
	75 - 81	82 - 85	Flurber 66 / 78	Isar 79	BAB 83
Number of jobs	35	21	2	4	3
Area km²;FK 1	4.4;20	5.5;25	4.8;22	4.4;20	5.9;27
Image scale 1:	4000	4500	10000	6000	6000
Number of					
- air photos	45	55	8	30	38
- control points	70	160	42	40	70
- calcul. points	1120	1520	900	230	1320
- KFP KFP/FK 1	700;35	1270;51	700;32	80; 4	890;33
- observations	8700	14960	6700	1500	17290
- unknown	3650	4860	2880	900	4210
Redundanz %	58	68	57	40	76
Mean error (±cm)					
- of an observation	1.9	1.8	2.8	2.2	3.3
- of the residues in the control points	2.1	1.8	2.9	2.2	3.3
Remarks			glass-copies	only one strip	

Jobs (calculated with the new program)

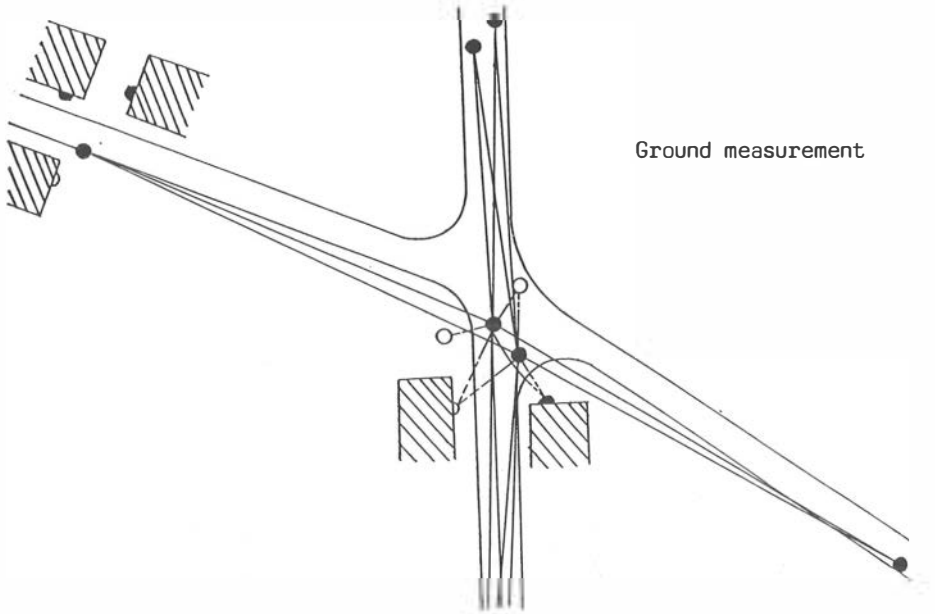
	1985	1985	N.Lg.86	1986	1985
Number of jobs	2	3	1	5	1
Area km²;Fk 1	14.6;67	4.1;19	15.0;69	1.5; 7	3.7;17
Image scale 1:	4500	4500	6000	4500	5400
Number of					
- air photos	112	40	122	26	34
- control points	408	140	315	66	103
- calcul. points	2200	1310	1060	990	1520
- KFP;KFP/FK 1	1410;21	850;45	650; 9	680;97	850;50
- observations	26460	14240	22840	10600	13750
- unknownnten	7660	3770	3920	2960	4480
Redundanz %	71	74	83	72	67
Mean error (±cm)					
- of an observation	1.4	1.4	2.0	1.8	2.3
- of the residues in the control points	1.4	1.3	1.0	2.5	2.2
Remarks			cross-flight	(1)	(2)

(1) photo- flights not in order!
(2) evaluation on film copies

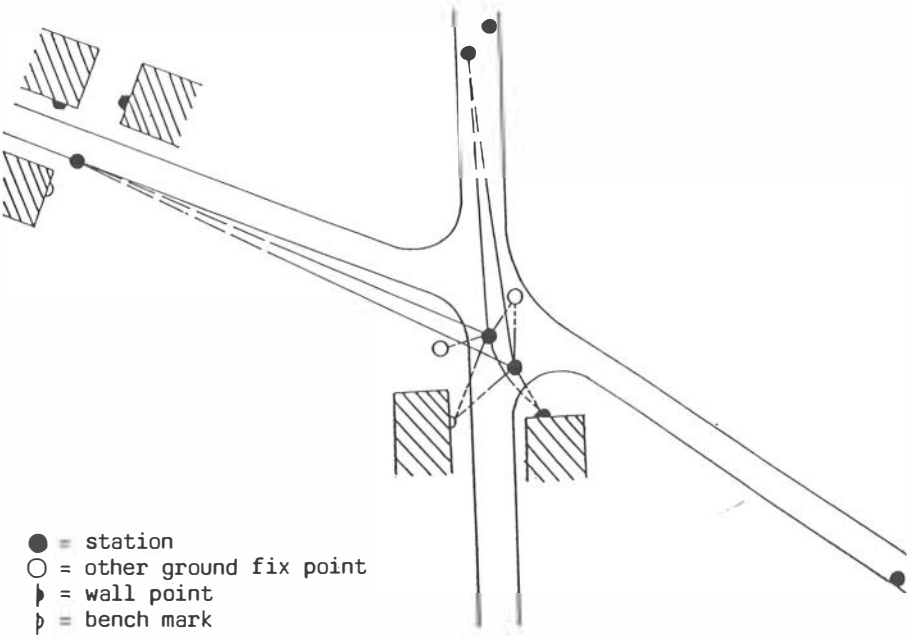
Differences in air photo-coordinates
by evaluation of the original air photo
or of a copy



Comparison
between ground measurement of control and cluster points
and
photogrammetrical determination of the control points
combined with ground measurement of the cluster points



Photogrammetrical / ground measurement



ORTRA

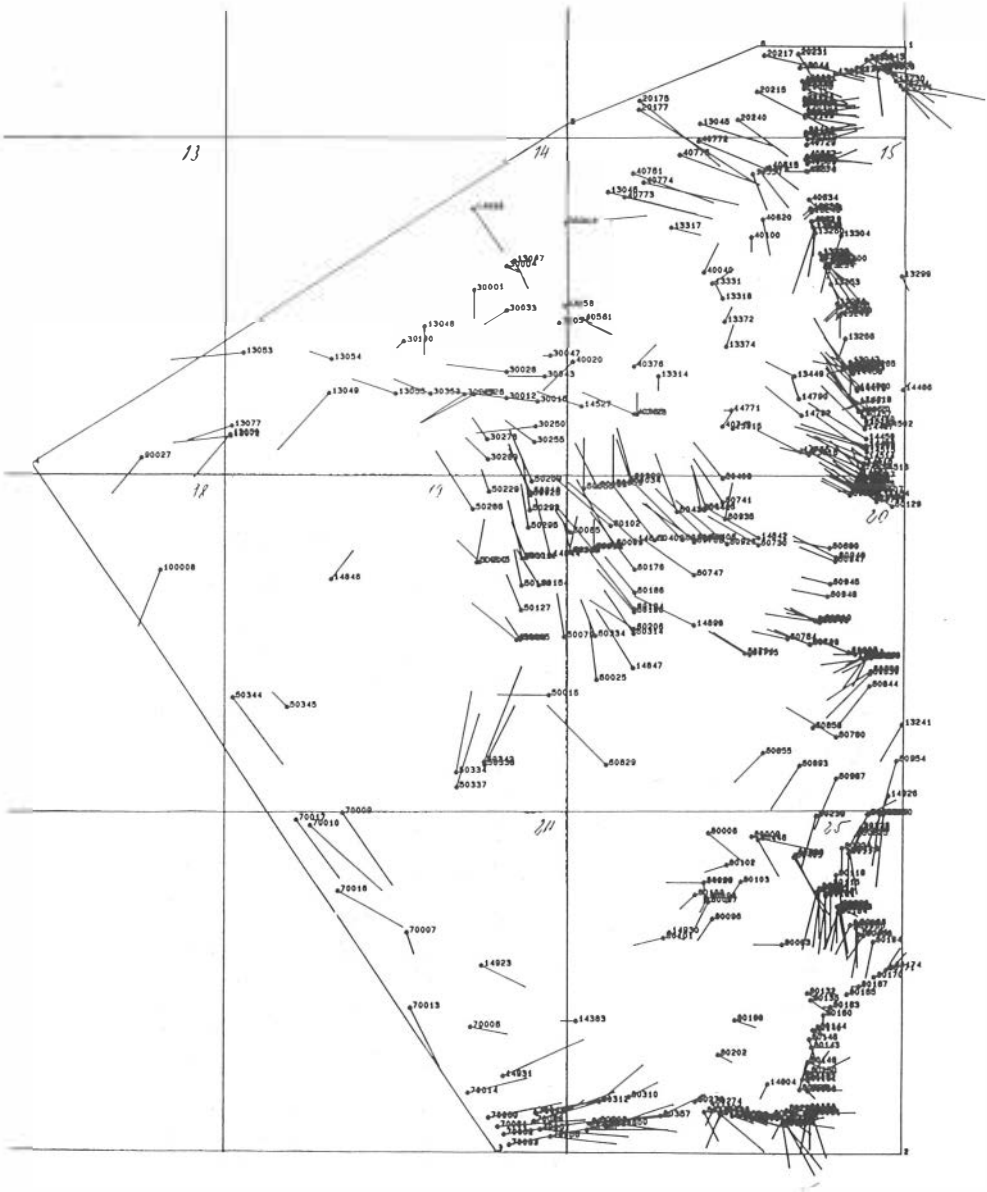
Steps of the adjustment

Step 0: Only a comparison between the single measurement-systems by a 3-parameter-transformation and between these systems and the struts concerning the plausibility of the figures.

Step	errors will be removed until	weight of the the fixpoints	adjustment of struts	remarks
1	5.0 m	1000	no	no coordinates
2	0.5 m	1000	yes	" "
3	0.15m	1000	"	
4	0.15m	1	"	

Plot of all stored points
for a SR - GK - transformation

Vector plot of the residues
for a SR - GK - transformation



Synopsis of the cadastral renovation in large towns

Town	Area (km²)	Inhabit.	Main aim of cad.renovation	Further aims	TP-field	Control point field	Securing of the contr.p.	Further work for detail p. field	cadastr map
Augsburg	147.15	245 760	GK	KFP	N 78-79	T 80-83	ASK,KWP	FF	-
Bad Tölz	30.95	13 600	GK	KFP,TE	N 84	P 85-86		U	TE
Bamberg	54.73	69 500	GK	KFP,FKR, TE	N 78	T 79 P 80-82	KD	U	FKR,TE
Ingolstadt	133.37	92 850	FKN	GK,KFP,TE	V 88-89	P 84-(91)	KD,HFP	U,FKN	FKN,TE
München	310.39	1 275 200	GK	KFP	N 75-85	P 75 T 76-80 P 81-(91)	ASK,HFP	U	-
Nürnberg	1B5.77	467 100	GK	KFP	N 84-87	T 84-86 P 86-(92)	ASK,KWP HFP	EV,FF	-
Passau (only suburb-reg.)	69.71 (50.00)	52 645	FKN	GK,KFP	-	P 75-82	KD	FKN	FKN

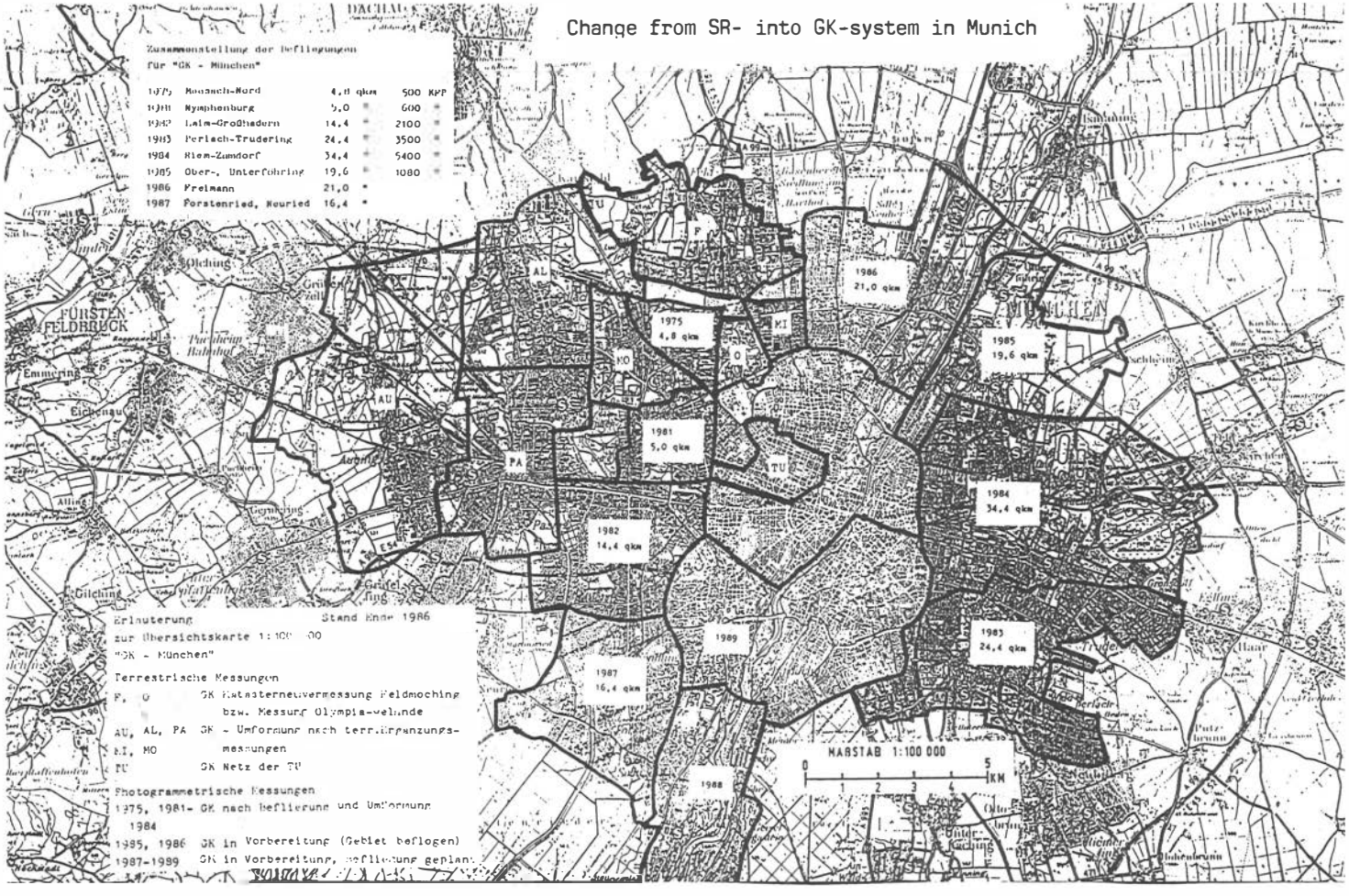
Abbreviation:

ASK...sketches
EV....single jobs
FF....cadastral surveying
FKN...cadastral map production
FKR...cadastral map renewal

GK....change to GK-system
HFP...coord. heightpoint
KD....coord. sewer lid
KFP...control point field
KWP...coord. wall point

N.....renewal
P.....photogr. determination
T.....terrestr. determination
TE....completion of topogr.detail
U.....transformation in GK
V.....renewal wanted

Change from SR- into GK-system in Munich



Discussion after the conference of Mr. Dörschel

Chevallier: For which purposes do cities need such a high accuracy ?

Dörschel: The main reason is that it is easier to measure in a well determined point field. You can send less trained colleagues in the field and it is still possible to obtain good measurements.

Most cities have old point fields from 1870-1880 onwards calculated by the mean of an old system (Soldnersystem). It is still possible to work with them, even if some points are missing or displaced, but it will become worse and some day we will need a new one. Cadastral renovation, even the re-measurement of a new control-point field, is in every case expensive, also the securing of this field, and so it will be better to build up well determined points. You have to do a new measurement, you have to secure the control-point field, then it is better to choose a high accuracy.

Dale: Do you give any guarantee on the quality of your measurements ?

Dörschel: Well, we have a lot of redundant measurements for our bundle-adjustment, about 60%, and so we also give a guarantee for the quality.

REALIZATION OF CADASTRAL RENOVATION IN NORWAY

Helge Onsrud
Ministry of Environment
Oslo, Norway

Summary

Norway has no cadaster in the european understanding of the word. Property information is however included in large scale maps and verbal registers. Activities towards realization of land information systems and digital maps are started.

The author discusses the need for completeness and accuracy of property information in large scale maps, digital or analog.

He also discusses what activities concerning the introduction of property data in computerized systems should be given the highest priority.

1. Introduction

At the edge of Europe, and beyond the influence of Napoleon, the idea of implementing cadasters in the way we see them in most other European countries never reached Norway. We have however had laws telling how to monument and verbally describe boundaries since the viking-age. But as late as 1980 the subdivisions, including putting up the monuments and making a description of the parcels were done by appointed laymen, except for the cities.

In the cities we have had fairly good systems since last century, and even longer in some places, which means that maps and registers there are of the same quality as we find in most other european countries like Switzerland. In rural districts existing boundaries are quite often not well described and the monuments are often lost. As a consequence disputes among neighbors frequently occur. A special court is established for land realottments and boundary cases. As much as up to 4000 km of existing lines are defined and surveyed every year. But the gap between known and unknown boundaries is probably still growing, as the present generation of farmers, who used the land more intensively, is dying out.

Since 1980 Norway has had one common "Land subdivision act" for the whole country. The individual municipality is given the responsibilities for all practical work in the field as well as the registration on maps and in different files. This means that every municipality, whether it has as little as 300 inhabitants or as much as half a million, has its own technical staff for land surveying.

A document is issued ,including a plan, for every new property or boundary line which is changed in any way. In most cases every corner point is surveyed in the national grid system, but this is not always done in the rural districts. The municipal surveying department is also, according to the general guidelines, obliged to include the surveyed lines in "the municipal main map-series" - which may be of different scale and quality.(1:500, 1:1000 or 1:5000 in rural districts)

Except for making the laws and bylaws the government is not directly involved in land registration works. The Norwegian Mapping Authority is however undertaking three major programs with a close connection to the registration works on local level:

1. Establishing the national grid system, which is completed.

2. A series of maps in the scales 1:5000 or 1:10000 for all land of economic importance, i.e. all land below the timber-line.
   This is the so called "Economic Map of Norway".

3. Running the GAB-system, which is a computerized register with basic information about properties, adresses and buildings.

As a conclusion it is probably right to say that Norway has no cadaster, and consequently no cadaster to renovate. On the other hand I like to say that we do have cadastral works, or land registration activities. My way of angling this report will therefore be to try to answer the question: In what way can land registration activities best contribute to the implementation of land information systems in Norway, and what kind of activities within this frame should be given the highest priority ?

2. Legal aspects

It is not in our legislation included any kind of legal definition of properties or boundaries. Consequently you can not tell that the position of a corner point is finally defined by its surveyed coordinates, indicated side lengths, map position, or even monuments. In case of a dispute between neighbors, a decision will have to be made on the basis of all available information. Existing

monuments will of course normally be respected, otherwise the question to be answered is: " where did it stand".

In connection with this it is interesting to ask what is the role of the map - analog or digital- , and what are the consequences of wrong maps. Answering this I think we have to distinguish between two different ways of utilizing large scale property maps:

- the map as a tool to find the exact position of corner points
- the map as a source for general property information for purposes like physical planning etc.

It is my opinion that it is too expensive to try to solve the first need when we make new maps, either by photogrammetry or by converting analog information into digital maps. By other words, we should make our maps as good and correct as possible, but not better than what is needed for the daily use in municipal planning and similar activities. When more detailed information about boundaries are needed, a special investigation including old documents, old maps or even field surveys, then should be undertaken.

These guidelines have actually been applied for our economic map on scale 1:5000, and should be followed for new digital maps.

The economic map, which is the only comprehensive map series including boundaries in Norway, has a lot of errors and missing information. It must be checked and supported when very detailed information is needed, like for land reallotment or expropriation, but the quality is acceptable for most other uses.
All our investigations show that most users do not utilize or need the accuracy, they want completeness more than high accuracy.

So far we have experienced no real problems from the errors in the map, in the way that it has been made wrong decisions based upon the map. But it is also a fact that a boundary line in the map , right or wrong, after some years may be regarded as a valid one, when other information is missing.

It is of course a disadvantage that some users have to undertake additional investigations, but to my opinion it is too expensive to maintain a quality of our economic map which is good enough even for the user with the highest demand for accuracy.

From a legal point of view I do not think it is a problem that there are some errors in the property information in our large scale maps. Furthermore I do not think this will change when we move from analog to digital maps.

As a conclusion I do not think that the legal aspect- giving priority to the protection of the landowners interests - should play the most important role when making large scale maps. This means that the choice of techniques or methods for establishing digital property information in land information systems should be based on cost-benefit analyses where all kinds of uses are taken into account, not only the legal aspect.

3.The economic map of Norway

It is a big need for property information in a modern society. As mentioned we have had no continuous cadastral mapping in Norway. As a result a governmental program was started around 1965 to map all land of any economic importance in the scale 1:5000 or 1:10000. The program has been delayed due to financial situation the recent years, but it will cover about 190000 km2 of a total area of 325000 km2 when the first version is completed 3-5 years from now.

Traditional photogrammetric methods have been applied.
The intention is that all boundaries, except in towns and cities, shall be included. The corner points are marked with white square panels, 50 x 50 cm, made of wood, plastic or cardboard before flying, and then checked in the field afterwards by a surveyor making a manuscript directly on a contact print.

According to the guidelines the mean square error for corner points shall not exceed +/- 2 meter in the scale 1:5000 and twice as much in the scale 1:10000.

The quality of property information both in accuracy and completeness has improved through the years, but will still vary quite a lot from district to district due to the special way cadastral works have been organized in Norway.The number of mapped corner points has been as low as 30 % for some maps, but I would guess that the average rate now is 80 - 90 %

It has been carried out several user investigations, all with one very clear conclusion: The most used data elements are property numbers and property boundaries, and most users ask for completeness rather than accuracy. The most typical questions are probably: Where is a specific property, and who are the neighbors, or which properties are situated in a certain area

The user investigations have lead to the conclusion that we probably can reduce the accuracy in the representation of corner points in favour of increasing the completeness. By

completeness we mean the amount of property numbers and parcels shown with complete boundary lines in the map.

Updating has proved to be a problem, and it has so far not been established a clear program.The introduction of digital techniques has created a new base for mapping activities.

3.Standard exchange format

In the digital world the scale of maps does not mean the same any more, and it is very clear that we should combine and integrate municipal and governmental mapping activities to avoid double work. There are many elements in a program for cooperation in this field. Among them is exchange of digital map information between different databases and computers a very important element.

Within such a framework for cooperation the government and the local authorities will share the responsibilities for common land information systems.

We will never get only one LIS in Norway. It will rather be a lot of databases on different levels and in different organizations. Some of them will in the future be hooked together in a network. For others it is enough to ensure the possibility of exchanging data. One of the most important LIS-activity at this stage is therefore to set up guidelines, rules and standards for data exchange and cooperation.

The Norwegian Mapping Authority has developed an exchange format for geographic data, which has been accepted as a norwegian standard.

Only a very few municipalities and other organizations has yet started to build up computerized land information systems including geographic information in graphical form. Most organizations do however order the data in digital form when they make new maps, and then the standard exchange format is always included in the specifications.

4.Program for coordinated LIS

The Norwegian Mapping Authority has implemented two major activities which will form important parts of a coordinated program for land information systems in Norway:

1. The GAB-system with basic data about properties, adresses and buildings
2. The "property data base", which is a system for storage and presentation of boundaries and other property information which are to be shown in graphical form.

THE GAB - SYSTEM

GAB, which stands for Ground properties, Adresses and Buildings, is actually the largest governmental computer system in Norway with more than 300000 lines of program codes, and about 5 gigabytes of data. It is a common information system for public agencies on all levels to be used by central bureaus as well as local authorities. It is an on-line system with continuous updating of land subdivisions, change of ownership, building activities etc.

It is completed for the whole country, except for data about buildings, where only buildings erected after 1983 are included so far.

About 5000 different users receive data from GAB, either on paper, microfilm or terminals.

With reference to land registration activities and future land information systems, it is important to notice that GAB gives us for the first time a complete list of the properties which really exist in the various municipalities.The system will also include coordinates for a central point for every parcel, and a reference to map sheet, but this is yet not completed.

In our situation with very poor systematic information about properties, I do think it was a right and necessary policy to build up complete verbal registers before any digital map databases were introduced.

Furthermore it is my opinion that we also for the nearest years to come should consider giving priority to the completion of the registration of central points and map references for the properties in GAB, before we introduce coordinates for the boundaries in our land information systems.

I would like to mention that the original idea for introducing coordinates for central points was to establish new planning methods with possibilities to produce statistics and analyses based on the geographic references. This has not been a success, the users rather demand data for different fixed areas -districts- which are registered in the system. But the coordinates serve as a very useful link between the database and the conventional map.

GAB will certainly play an important part of future information systems were also digital maps are included. This is already realized in the so called "Oslo-project" where GAB and a Sysscan system for maps are linked together: You can point at a parcel on the graphic screen, and the GAB-data for that particular parcel is automatically shown on the screen.

THE PROPERTY DATA BASE

The Norwegian Mapping Authority is slowly moving into digital techniques also for the production of the economic map. It is given priority to establishing a digital property database. It is developed a computer system for this, and all the involved offices are equipped with digitizers etc.

The plan is to establish the database following the regular revision of the maps. It will then be a combination of digitizing existing information in the old maps, data collection by photogrammetry with digital output, and direct registration of coordinates from individual property documents.

For the moment it is more expensive to produce the property overlay for the map by digital techniques than manually. From an economic point of view digital techniques can therefor only be justified if the users are willing to pay the additional costs. This is probably so for a few big municipalities with a large population, but the general picture is that the majority of users are not willing to pay the additional cost to get a digital property map.

For the time being I personally doubt that introduction of digital property maps for the cadastral works in the municipalities alone, can be justified from an economic point of view.
Only as part of a larger land information system this will show a positive cost/benefit ratio.

The organizations which really push the establishment of land information systems including digital maps, are the telecommunication -, electricity-, and water and sewage departments. The development in these sectors will probably go to fast to include basic map data in vectorized form. In the first phase they will store topography, roads, contour lines, boundaries,etc in raster form as a background for their specific data about cables, pipes etc.

The cadastral works on local level in Norway are undertaken by surveying offices which also shall serve other sectors in the municipality. Activities like establishing digital property maps will have to compete with other surveying and cartographic needs. That is also the case for the governmental bodies in this field, where the Norwegian Mapping Authority is the most important.

The big challenge for surveyors and mapmakers in Norway will in the nearest years probably not be the renewal of the cadastral works, but their contribution to the maintenance of the utility networks. Norwegian municipalities spend 10 to 20 time as much money on water and sewage pipelines as they do on land registration

activities.

With the present tempo of renewing existing municipal networks it will take 1000 years. It is obvious that modern information systems including cartographic data will play a very important role to keep up with this problem.

6.Kvantif

Most surveyors believe that the society would benefit from putting more money into mapping and land information systems.
To prove this with more solid data it has been carried out a rather large research program, called "Kvantif", to establish cost/benefit analyses for investments in large scale maps and digital databases. It was started as a norwegian program, but was later extended to include the participation of the other nordic countries.

The analyses show a cost-benefit ratio of about 3 to 4 for large scale maps, which means that every kroner invested during a certain period gives a pay back of around three to four kroner.

Among other things it has been produced a video film to promote investments in this sector. A copy in english is also available.

It is not done any special analyses for cadastral information in the maps, but the research confirms that property information is among the most used information in the maps. The cost-benefit ratio which is found is therefore a least valid for these kind of data.

7.Sum up

We move pretty fast towards a situation where the heavy users of cadastral information will demand data in digital form.
In Norway we will have to produce these databases faster and with less costs than we will be able to <u>if we shall maintain an accuracy high enough to include a correct, i.e. a legally valid positioning of corner points.</u>

Most users in Norway want better completeness rather than accuracy, and for the majority of users we could probably reduce the accuracy of corner points in our large scale maps.
This means that the conversion into digital map databases can be done with various methods, where low costs will be a key factor.

For many municipalities it is probably too expensive to introduce digital property maps for cadastral works alone. Digital property data must be integrated in technical maps and made available for many users to justify the costs.

Completion of the registration of central points and map references in our property register, should probably be given priority before introducing coordinates for boundaries in our land information systems.

Discussion after the conference of Mr. Onsrud

Jerie: One could summarize what we saw as follows : spend money on lawyers rather than on surveyors. Did you ever ask yourself what the costs of all those lawsuits represent in Norway ? Each time you do not agree you can not go to the cadastre but instead have to ask a lawyer to clear the case.
On the other hand one claims that a cost-benefit ratio of 1:3 has been proven. This should determine any government to rush forward investing as much money as possible.

Onsrud: The costs of lawyers are not included. Figures for social investments like kindergardens show a payback of seven to one. In our country, the calculations are made over 25 years, the same way social investments are calculated.

Enemark: In Denmark, we are talking of 2 different things. You should be able to make a Land Information System without cadastral information at all, and you could apply cadastral renovation without thinking of a Land Information System. In cadastral systems the legal rights require to take some other aspects into account, and to built up a legal cadastre in pixels form might take some time. But we also have to take part in the development of Land Information Systems. We need both and so we are riding two horses.

Onsrud: We have different traditions. In Norway, cadastral works are very much integrated in the work of technical maps and Land Information Systems. For us it is not a question of riding two horses as it is the case in other countries.

Kölbl: The reform of the Swiss cadastral system is closely akin to your aspect. We think we must meet the needs of utility services otherwise we will lose to others our job of surveyors.

Dale: If you look at the development of information systems, some came out of the alphanumeric like MAJIC2, others came out of digital mapping bases. You first start with a digital mapping base, then you put more and more information into it : it will turn into an information system.
The reason why so many people promote the "cadastral idea" is that property rights are fundamental to any development.
It is perfectly correct that you can have Land Information Systems that are not property based at all : they may contain soils and other matters. In many aspects of management, particularly in urban areas, where you get utility problems as well, you must identify the property rights. The utilities as much as anybody are interested in that. I think however that at least 60% of the information can be just related to a property identifier and treated on that basis without the use of maps.

LIST OF THE OEEPE PUBLICATIONS

State — July 1988

A. Official publications

1 *Trombetti, C.:* „Activité de la Commission A de l'OEEPE de 1960 à 1964" — *Cunietti, M.:* „Activité de la Commission B de l'OEEPE pendant la période septembre 1960—janvier 1964" — *Förstner, R.:* „Rapport sur les travaux et les résultats de la Commission C de l'OEEPE (1960—1964)" — *Neumaier, K.:* „Rapport de la Commission E pour Lisbonne" — *Weele, A.J. v. d.:* „Report of Commission F." — Frankfurt a. M. 1964, 50 pages with 7 tables and 9 annexes.

2 *Neumaier, K.:* „Essais d'interprétation de »Bedford« et de »Waterbury«. Rapport commun établi par les Centres de la Commission E de l'OEEPE ayant participé aux tests" — „The Interpretation Tests of »Bedford« and »Waterbury«. Common Report Established by all Participating Centres of Commission E of OEEPE" — „Essais de restitution »Bloc Suisse«. Rapport commun établi par les Centres de la Commission E de l'OEEPE ayant participé aux tests" — „Test »Schweizer Block«. Joint Report of all Centres of Commission E of OEEPE." — Frankfurt a. M. 1966, 60 pages with 44 annexes.

3 *Cunietti, M.:* „Emploi des blocs de bandes pour la cartographie à grande échelle — Résultats des recherches expérimentales organisées par la Commission B de l'O.E.E.P.E. au cours de la période 1959—1966" — „Use of Strips Connected to Blocks for Large Scale Mapping — Results of Experimental Research Organized by Commission B of the O.E.E.P.E. from 1959 through 1966." — Frankfurt a. M. 1968, 157 pages with 50 figures and 24 tables.

4 *Förstner, R.:* „Sur la précision de mesures photogrammétriques de coordonnées en terrain montagneux. Rapport sur les résultats de l'essai de Reichenbach de la Commission C de l'OEEPE" — „The Accuracy of Photogrammetric Co-ordinate Measurements in Mountainous Terrain. Report on the Results of the Reichenbach Test Commission C of the OEEPE." — Frankfurt a. M. 1968, Part I: 145 pages with 9 figures; Part II: 23 pages with 65 tables.

5 *Trombetti, C.:* „Les recherches expérimentales exécutées sur de longues bandes par la Commission A de l'OEEPE." — Frankfurt a. M. 1972, 41 pages with 1 figure, 2 tables, 96 annexes and 19 plates.

6 *Neumaier, K.:* „Essai d'interprétation. Rapports des Centres de la Commission E de l'OEEPE." — Frankfurt a. M. 1972, 38 pages with 12 tables and 5 annexes.

7 *Wiser, P.:* „Etude expérimentale de l'aérotriangulation semi-analytique. Rapport sur l'essai »Gramastetten«." — Frankfurt a. M. 1972, 36 pages with 6 figures and 8 tables.

8 „Proceedings of the OEEPE Symposium on Experimental Research on Accuracy of Aerial Triangulation (Results of Oberschwaben Tests)"
Ackermann, F.: „On Statistical Investigation into the Accuracy of Aerial Triangulation. The Test Project Oberschwaben" — „Recherches statistiques sur la précision de l'aérotriangulation. Le champ d'essai Oberschwaben" — *Belzner, H.:* „The Planning. Establishing and Flying of the Test Field Oberschwaben" — *Stark, E.:* Testblock Oberschwaben, Programme I. Results of Strip Adjustments" — *Ackermann, F.:* „Testblock Oberschwaben, Program I. Results of Block-Adjustment by Independent Models" — *Ebner, H.:* Comparison of Different Methods of Block Adjustment" — *Wiser, P.:* „Propositions pour le traitement des erreurs non-accidentelles" — *Camps, F.:* „Résultats obtenus dans le cadre du project Oberschwaben 2A" — *Cunietti, M.; Vanossi, A.:* „Etude statistique expérimentale des erreurs d'enchaînement des photogrammes" — *Kupfer, G.:* „Image Geometry as Obtained from Rheidt Test Area Photography" — *Förstner, R.:* „The Signal-Field of Baustetten. A Short Report" — *Visser, J.; Leberl, F.; Kure, J.:* „OEEPE Oberschwaben Reseau Investigations" — *Bauer, H.:* „Compensation of Systematic Errors by Analytical Block Adjustment with Common Image Deformation Parameters." — Frankfurt a. M. 1973, 350 pages with 119 figures, 68 tables and 1 annex.

9 *Beck, W.:* „The Production of Topographic Maps at 1 : 10,000 by Photogrammetric Methods. — With statistical evaluations, reproductions, style sheet and sample fragments by Landesvermessungsamt Baden-Württemberg, Stuttgart." — Frankfurt a. M. 1976, 89 pages with 10 figures, 20 tables and 20 annexes.

10 „Résultats complémentaires de l'essai d'«Oberriet» de la Commission C de l'OEEPE — Further Results of the Photogrammetric Tests of «Oberriet» of the Commission C of the OEEPE"
Härry, H.: „Mesure de points de terrain non signalisés dans le champ d'essai d'«Oberriet» — Measurements of Non-Signalized Points in the Test Field «Oberriet» (Abstract)" — *Stickler, A.; Waldhäusl, P.:* „Restitution graphique des points et des lignes non signalisés et leur comparaison avec des résultats de mesures sur le terrain dans le champ d'essai d'«Oberriet» — Graphical Plotting of Non-Signalized Points and Lines, and Comparison with Terrestrial Surveys in the Test Field «Oberriet»" — *Förstner, R.:* „Résultats complémentaires des transformations de coordonnées de l'essai d'«Oberriet» de la Commission C de l'OEEPE — Further Results from Co-ordinate Transformations of the Test «Oberriet» of Commission C of the OEEPE" — *Schürer, K.:* „Comparaison des distances d'«Oberriet» — Comparison of Distances of «Oberriet» (Abstract)." — Frankfurt a. M. 1975, 158 pages with 22 figures and 26 tables.

11 „25 années de l'OEEPE"
Verlaine, R.: „25 années d'activité de l'OEEPE" — „25 Years of OEEPE (Summary)" — *Baarda, W.:* „Mathematical Models." — Frankfurt a. M. 1979, 104 pages with 22 figures.

12 *Spiess, E.:* „Revision of 1 : 25,000 Topographic Maps by Photogrammetric Methods." — Frankfurt a. M. 1985, 228 pages with 102 figures and 30 tables.

13 *Timmerman, J.; Roos, P. A.; Schürer, K.; Förstner, R.:* On the Accuracy of Photogrammetric Measurements of Buildings — Report on the Results of the Test "Dordrecht", Carried out by Commission C of the OEEPE. — Frankfurt a. M. 1982, 144 pages with 14 figures and 36 tables.

14 *Thompson, C. N.:* Test of Digitising Methods. — Frankfurt a. M. 1984, 120 pages with 38 figures and 18 tables.

15 *Jaakkola, M.; Brindöpke, W.; Kölbl, O.; Noukka, P.:* Optimal Emulsions for Large-Scale Mapping — Test of "Steinwedel" — Commission C of the OEEPE 1981—84. — Frankfurt a. M. 1985, 102 pages with 53 figures.

16 *Waldhäusl, P.:* Results of the Vienna Test of OEEPE Commission C.— *Kölbl, O.:* Photogrammetric Versus Terrestrial Town Survey. — Frankfurt a. M. 1986, 57 pages with 16 figures, 10 tables and 7 annexes.

17 *Commission E of the OEEPE:* Influences of Reproduction Techniques on the Identification of Topographic Details on Orthophotomaps. — Frankfurt a. M. 1986, 138 pages with 51 figures, 25 tables and 6 appendices.

18 *Förstner, W.:* Final Report on the Joint Test on Gross Error Detection of OEEPE and ISP WG III/1. — Frankfurt a. M. 1986, 97 pages with 27 tables and 20 figures.

19 *Dowman, I. J.; Ducher, G.:* Spacelab Metric Camera Experiment — Test of Image Accuracy. — Frankfurt a. M. 1987, 112 pages with 13 figures, 25 tables and 7 appendices.

B. Special publications

— Special Publications O.E.E.P.E. — Number I

Solaini, L.; Trombetti, C.: Relation sur les travaux préliminaires de la Commission A (Triangulation aérienne aux petites et aux moyennes échelles) de l'Organisation Européenne d'Etudes Photogrammétriques Expérimentales (O.E.E.P.E.). Ière Partie: Programme et organisation du travail. — *Solaini, L.; Belfiore, P.:* Travaux préliminaires de la Commission B de l'Organisation Européenne d'Etudes Photogrammétriques Expérimentales (O.E.E.P.E.) (Triangulations aériennes aux grandes échelles). — *Solaini, L.; Trombetti, C.; Belfiore, P.:* Rapport sur les travaux expérimentaux de triangulation aérienne exécutés par l'Organisation Européenne d'Etudes Photogrammétriques Expérimentales (Commission A et B). — *Lehmann, G.:* Compte rendu des travaux de la Commission C de l'O.E.E.P.E. effectués jusqu'à présent. — *Gotthardt, E.:* O.E.E.P.E. Commission C. Compte-rendu de la restitution à la Technischen Hochschule, Stuttgart, des vols d'essai du groupe I du terrain d'Oberriet. — *Brucklacher, W.:* Compte-rendu du centre «Zeiss-Aerotopograph» sur les restitutions pour la Commission C de l'O.E.E.P.E. (Restitution de la bande de vol, groupe I, vol. No. 5). — *Förstner, R.:* O.E.E.P.E. Commission C. Rapport sur la restitution effectuée dans l'Institut für Angewandte Geodäsie, Francfort sur le Main. Terrain d'essai d'Oberriet les vols No. 1 et 3 (groupe I). — I.T.C., Delft: Commission C, O.E.E.P.E. Déroulement chronologique des observations. — Photogrammetria XII (1955—1956) 3, Amsterdam 1956, pp. 79—199 with 12 figures and 11 tables.

— Publications spéciales de l'O.E.E.P.E. — Numéro II

Solaini, L.; Trombetti, C.: Relations sur les travaux préliminaires de la Commission A (Triangulation aérienne aux petites et aux moyennes échelles) de l'Organisation Européenne d'Etudes Photogrammétriques Expérimentales (O.E.E.P.E.). 2e partie. Prises de vues et points de contrôle. — *Gotthardt, E.:* Rapport sur les premiers résultats de l'essai d'«Oberriet» de la Commission C de l'O.E.E.P.E. — Photogrammetria XV (1958—1959) 3, Amsterdam 1959, pp. 77—148 with 15 figures and 12 tables.

— *Trombetti, C.:* Travaux de prises de vues et préparation sur le terrain effectuées dans le 1958 sur le nouveau polygone italien pour la Commission A de l'OEEPE. — Florence 1959, 16 pages with 109 tables.

— *Trombetti, C.; Fondelli, M.:* Aérotriangulation analogique solaire. — Firence 1961, 111 pages, with 14 figures and 43 tables.

— Publications spéciales de l'O.E.E.P.E. — Numéro III

Solaini, L.; Trombetti, C.: Rapport sur les résultats des travaux d'enchaînement et de compensation exécutés pour la Commission A de l'O. E. E. P. E. jusqu'au mois de Janvier 1960. Tome 1: Tableaux et texte. Tome 2: Atlas. — Photogrammetria XVII (1960—1961) 4, Amsterdam 1961, pp. 119—326 with 69 figures and 18 tables.

— „OEEPE — Sonderveröffentlichung Nr. 1"

Gigas, E.: „Beitrag zur Geschichte der Europäischen Organisation für photogrammetrische experimentelle Untersuchungen" — *N. N.:* „Vereinbarung über die Gründung einer Europäischen Organisation für photogrammetrische experimentelle Untersuchungen" — „Zusatzprotokoll" — *Gigas, E.:* „Der Sechserausschuß" — *Brucklacher, W.:* „Kurzbericht über die Arbeiten in der Kommission A der OEEPE" — *Cunietti, M.:* „Kurzbericht des Präsidenten der Kommission B über die gegenwärtigen Versuche und Untersuchungen" — *Förstner, R.:* „Kurzbericht über die Arbeiten in der Kommission B der OEEPE" — „Kurzbericht über die Arbeiten in der Kommission C der OEEPE" — *Belzner, H.:* „Kurzbericht über die Arbeiten in der Kommission E der OEEPE" — *Schwidefsky, K.:* „Kurzbericht über die Arbeiten in der Kommission F der OEEPE" — *Meier, H.-K.:* „Kurzbericht über die Tätigkeit der Untergruppe „Numerische Verfahren" in der Kommission F der OEEPE" — *Belzner, H.:* „Versuchsfelder für internationale Versuchs- und Forschungsarbeiten." — Nachr. Kt.- u. Vermesss.-wes., R. V., Nr. 2, Frankfurt a. M. 1962, 41 pages with 3 tables and 7 annexes.

— *Rinner, K.:* Analytisch-photogrammetrische Triangulation eines Teststreifens der OEEPE. — Österr. Z. Vermess.-wes., OEEPE-Sonderveröff. Nr. 1, Wien 1962, 31 pages.

— *Neumaier, K.; Kasper, H.:* Untersuchungen zur Aerotriangulation von Überweitwinkelaufnahmen. — Österr. Z. Vermess.-wes., OEEPE-Sonderveröff. Nr. 2, Wien 1965, 4 pages with 4 annexes.

— „OEEPE — Sonderveröffentlichung Nr. 2"

Gotthardt, E.: „Erfahrungen mit analytischer Einpassung von Bildstreifen." — Nachr. Kt.- u. Vermess.-wes., R. V, Nr. 12, Frankfurt a. M. 1965, 14 pages with 2 figures and 7 tables.

— „OEEPE — Sonderveröffentlichung Nr. 3"

Neumaier, K.: „Versuch »Bedford« und »Waterbury«. Gemeinsamer Bericht aller Zentren der Kommission E der OEEPE" — „Versuch »Schweizer Block«. Gemeinsamer Bericht aller Zentren der Kommission E der OEEPE." — Nachr. Kt.- u. Vermess.-wes., R. V, Nr. 13, Frankfurt a. M. 1966, 30 pages with 44 annexes.

— *Stickler, A.; Waldhäusl, P.:* Interpretation der vorläufigen Ergebnisse der Versuche der Kommission C der OEEPE aus der Sicht des Zentrums Wien. — Österr. Z. Vermess.-wes., OEEPE-Sonderveröff. (Publ. Spēc.) Nr. 3, Wien 1967, 4 pages with 2 figures and 9 tables.

— „OEEPE — Sonderveröffentlichung Nr. 4"

Schürer, K.: „Die Höhenmeßgenauigkeit einfacher photogrammetrischer Kartiergeräte. Bemerkungen zum Versuch »Schweizer Block« der Kommission E der OEEPE." — Nachr. Kt.- u. Vermess.-wes., Sonderhefte, Frankfurt a. M., 1968, 25 pages with 7 figures and 3 tables.

– „OEEPE — Sonderveröffentlichung Nr. 5“

Förstner, R.: „Über die Genauigkeit der photogrammetrischen Koordinatenmessung in bergigem Gelände. Bericht über die Ergebnisse des Versuchs Reichenbach der Kommission C der OEEPE.“ — Nachr. Kt.- u. Vermess.-wes., Sonderhefte, Frankfurt a. M. 1969, Part I: 74 pages with 9 figures; Part II: 65 tables.

– „OEEPE — Sonderveröffentlichung Nr. 6“

Knorr, H.: „Die Europäische Organisation für experimentelle photogrammetrische Untersuchungen — OEEPE — in den Jahren 1962 bis 1970.“ — Nachr. Kt.- u. Vermess.-wes., Sonderhefte, Frankfurt a. M. 1971, 44 pages with 1 figure and 3 tables.

– „OEEPE — Sonderveröffentlichung Nr. D–7“

Förstner, R.: „Das Versuchsfeld Reichenbach der OEEPE.“ — Nachr. Kt.- u. Vermess.-wes., Sonderhefte, Frankfurt a. M. 1972, 191 pages with 49 figures and 38 tables.

– „OEEPE — Sonderveröffentlichung Nr. D–8“

Neumaier, K.: „Interpretationsversuch. Berichte der Zentren der Kommission E der OEEPE.“ — Nachr. Kt.- u. Vermess.-wes., Sonderhefte, Frankfurt a. M. 1972, 33 pages with 12 tables and 5 annexes.

– „OEEPE — Sonderveröffentlichung Nr. D–9“

Beck, W.: „Herstellung topographischer Karten 1 : 10 000 auf photogrammetrischem Weg. Mit statistischen Auswertungen, Reproduktionen, Musterblatt und Kartenmustern des Landesvermessungsamts Baden-Württemberg, Stuttgart.“ — Nachr. Kt.- u. Vermess.-wes., Sonderhefte, Frankfurt a. M. 1976, 65 pages with 10 figures, 20 tables and 20 annexes.

– „OEEPE — Sonderveröffentlichung Nr. D–10“

Weitere Ergebnisse des Meßversuchs „Oberriet“ der Kommission C der OEEPE. *Härry, H.:* „Messungen an nicht signalisierten Geländepunkten im Versuchsfeld «Oberriet»“ — *Stickler, A.; Waldhäusl, P.:* „Graphische Auswertung nicht signalisierter Punkte und Linien und deren Vergleich mit Feldmessungsergebnissen im Versuchsfeld «Oberriet»“ — *Förstner, R.:* „Weitere Ergebnisse aus Koordinatentransformationen des Versuchs «Oberriet» der Kommission C der OEEPE“ — *Schürer, K.:* „Streckenvergleich «Oberriet».“ — Nachr. Kt.- u. Vermess.-wes., Sonderhefte, Frankfurt a. M. 1975, 116 pages with 22 figures and 26 tables.

– „OEEPE — Sonderveröffentlichung Nr. D–11“

Schulz, B.-S.: „Vorschlag einer Methode zur analytischen Behandlung von Reseauaufnahmen.“ — Nachr. Kt.- u. Vermess.-wes., Sonderhefte, Frankfurt a. M. 1976, 34 pages with 16 tables.

— „OEEPE — Sonderveröffentlichung Nr. D–12“

Verlaine, R.: „25 Jahre OEEPE.“ — Nachr. Kt.- u. Vermess.-wes., Sonderhefte, Frankfurt a. M. 1980, 53 pages.

— „OEEPE — Sonderveröffentlichung Nr. D–13“

Haug, G.: „Bestimmung und Korrektur systematischer Bild- und Modelldeformationen in der Aerotriangulation am Beispiel des Testfeldes „Oberschwaben.“ — Nachr. Kt.- u. Vermess.-wes., Sonderhefte, Frankfurt a. M. 1980, 136 pages with 25 figures and 51 tables.

— „OEEPE — Sonderveröffentlichung Nr. D—14“

Spiess, E.: „Fortführung der Topographischen Karte 1 : 25 000 mittels Photogrammetrie“ (in Vorbereitung).

— „OEEPE — Sonderveröffentlichung Nr. D—15“

Timmerman, J.; Roos, P. A.; Schürer, K.; Förstner, R.: „Über die Genauigkeit der photogrammetrischen Gebäudevermessung. Bericht über die Ergebnisse des Versuchs Dordrecht der Kommission C der OEEPE.“ — Nachr. Kt.- u. Vermess.-wes., Sonderhefte, Frankfurt a. M. 1983, 131 pages with 14 figures and 36 tables.

— „OEEPE — Sonderveröffentlichung Nr. D—16“

Kommission E der OEEPE: „Einflüsse der Reproduktionstechnik auf die Erkennbarkeit von Details in Orthophotokarten.“ — Nachr. Kt.- u. Vermess.-wes., Sonderhefte, Frankfurt a. M. 1986, 130 pages with 51 figures, 25 tables and 6 annexes.

— „OEEPE — Sonderveröffentlichung Nr. D—17“

Schürer, K.: Über die Genauigkeit der Koordinaten signalisierter Punkte bei großen Bildmaßstäben. Ergebnisse des Versuchs „Wien“ der Kommission C der OEEPE. — Nachr. Kt.- u. Vermess.-wes., Sonderhefte, Frankfurt a. M. 1987, 84 pages with 3 figures, 10 tables and 42 annexes.

C. Congress reports and publications in scientific reviews

- *Stickler, A.:* Interpretation of the Results of the O.E.E.P.E. Commission C. — Photogrammetria XVI (1959—1960) 1, pp. 8—12, 3 figures, 1 annexe (en langue allemande: pp. 12—16).
- *Solaini, L.; Trombetti, C.:* Results of Bridging and Adjustment Works of the Commission A of the O.E.E.P.E. from 1956 to 1959. — Photogrammetria XVI (1959—1960) 4 (Spec. Congr.-No. C), pp. 340—345, 2 tables.
- *N. N.:* Report on the Work Carried out by Commission B of the O.E.E.P.E. During the Period of September 1956—August 1960. — Photogrammetria XVI (1959—1960) 4 (Spec. Congr.-No. C), pp. 346—351, 2 tables.
- *Förstner, R.:* Bericht über die Tätigkeit und Ergebnisse der Kommission C der O.E.E.P.E. (1956—1960). — Photogrammetria XVI (1959—1960) 4 (Spec. Congr.-No. C), pp. 352—357, 1 table.
- *Bachmann, W. K.:* Essais sur la précision de la mesure des parallaxes verticales dans les appareils de restitution du Ier ordre. — Photogrammetria XVI (1959—1960) 4 (Spec. Congr.-No. C), pp. 358—360).
- *Wiser, P.:* Sur la reproductibilité des erreurs du cheminement aérien. — Bull. Soc. Belge Photogramm., No. 60, Juin 1960, pp. 3—11, 2 figures, 2 tables.
- *Cunietti, M.:* L'erreur de mesure des parallaxes transversales dans les appareils de restitution. — Bull. Trimestr. Soc. Belge Photogramm., No. 66, Décembre 1961, pp. 3—50, 12 figures, 22 tables.

- „OEEPE — Arbeitsberichte 1960/64 der Kommissionen A, B, C, E, F"

  Trombetti, C.: „Activité de la Commission A de l'OEEPE de 1960 à 1964" — *Cunietti, M.:* „Activité de la Commission B de l'OEEPE pendant la période septembre 1960—janvier 1964" — *Förstner, R.:* „Rapport sur les travaux et les résultats de la Commission C de l'OEEPE (1960—1964)" — *Neumaier, K.:* „Rapport de la Commission E pour Lisbonne" — *Weele, A. J. van der:* „Report of Commission F." — Nachr. Kt.- u. Vermess.-wes., R. V. Nr. 11, Frankfurt a. M. 1964, 50 pages with 7 tables and 9 annexes.
- *Cunietti, M.; Inghilleri, G.; Puliti, M.; Togliatti, G.:* Participation aux recherches sur les blocs de bandes pour la cartographie à grande échelle organisées par la Commission B de l'OEEPE. Milano, Centre CASF du Politecnico. — Boll. Geod. e Sc. affini (XXVI) 1, Firenze 1967, 104 pages.
- *Gotthardt E.:* Die Tätigkeit der Kommission B der OEEPE. — Bildmess. u. Luftbildwes. 36 (1968) 1, pp. 35—37.
- *Cunietti, M.:* Résultats des recherches expérimentales organisées par la Commission B de l'OEEPE au cours de la période 1959—1966. Résumé du Rapport final. — Présenté à l'XIe Congrès International de Photogrammétrie, Lausanne 1968, Comm. III (en langues française et anglaise), 9 pages.

- *Förstner, R.:* Résumé du Rapport sur les résultats de l'essai de Reichenbach de la Commission C de l'OEEPE. — Présenté à l'XIe Congrès International de Photogrammétrie, Lausanne 1968, Comm. IV (en langues française, anglaise et allemande), 28 pages, 2 figures, 2 tables.
- *Timmerman, J.:* Proef „OEEPE-Dordrecht". — ngt 74, 4. Jg., Nr. 6, Juni 1974, S. 143—154 (Kurzfassung: Versuch „OEEPE-Dordrecht". Genauigkeit photogrammetrischer Gebäudevermessung. Vorgelegt auf dem Symposium der Kommission IV der I.G.P., Paris, 24.—26. September 1974).
- *Timmerman, J.:* Report on the Commission C. "OEEPE-Dordrecht" Experiment. — Presented Paper for Comm. IV, XIIIth Congress of ISP, Helsinki 1976.
- *Beck, W.:* Rapport de la Commission D de l'OEEPE sur l'établissement de cartes topographiques au 1/10 000 selon le procédé photogrammétrique. — Presented Paper for Comm. IV, XIIIth Congress of ISP, Helsinki 1976.
- *Verlaine, R.:* La naissance et le développement de l'OEEPE — Festschrift — Dr. h. c. *Hans Härry*, 80 Jahre — Schweizerische Gesellschaft für Photogrammetrie und Wild Heerbrugg AG, Bern 1976.
- *Förstner, R.:* Internationale Versuche (Essais contrôlés) — Festschrift — Dr. h. c. *Hans Härry*, 80 Jahre. — Schweizerische Gesellschaft für Photogrammetrie und Wild Heerbrugg AG, Bern 1976.
- *Baj, E.; Cunietti, M.; Vanossi, A.:* Détermination Expérimentale des Erreurs Systématiques des Faisceaux Perspectifs. — Société Belge de Photogrammétrie, Bulletin trimestriel, Brüssel 1977, pp 21—49.
- *Timmerman, J.:* Fotogrammetrische stadskaartering de OEEPE-proef Dordrecht. — Geodesia 19, Amsterdam 1977, pp. 291—298.
- *Waldhäusl, P.:* The Vienna Experiment of the OEEPE/C. Proceedings — Standards and Specifications for Integrated Surveying and Mapping Systems. — Schriftenreihe HSBw, Heft 2, München 1978.
- *Bachmann, W. K.:* Recherches sur la stabilité des appareils de restitution photogrammétriques analogiques. — Vermessung, Photogrammetrie, Kulturtechnik, Zürich 1978, pp. 265—268.
- *Parsic, Z.:* Untersuchungen über den Einfluß signalisierter und künstlicher Verknüpfungspunkte auf die Genauigkeit der Blocktriangulation. — Vermessung, Photogrammetrie, Kulturtechnik, Zürich 1978, pp. 269—278.
- *Waldhäusl, P.:* Der Versuch Wien der OEEPE/C. — Geowissenschaftliche Mitteilungen der Studienrichtung Vermessungswesen der TU Wien, Heft 13, Wien 1978, pp. 101—124.
- *Waldhäusl, P.:* Ergebnisse des Versuches Wien der OEEPE/C. — Presented Paper for Comm. IV, XIVth Congress of ISP, Hamburg 1980.
- *Timmerman, J.; Förstner, R.:* Kurzbericht über die Ergebnisse des Versuchs Dordrecht der Kommission C der OEEPE. — Presented Paper for Comm. IV, XIVth Congress of ISP, Hamburg 1980.

- *Bachmann, W. K.:* Elimination des valeurs erronées dans un ensemble de mesures controlées. — Papers written in honor of the 70th birthday of Professor *Luigi Solaini* — Richerche di Geodesia Topografia e Fotogrammetria, Milano 1979, pp. 27—39.
- *Visser, J.:* The European Organisation for Experimental Photogrammetric Research (OEEPE) — The Thompson Symposium 1982. — The Photogrammetric Record, London 1982, pp. 654—668.
- *Spiess, E.:* Revision of Topographic Maps: Photogrammetric and Cartographic Methods of the Fribourg Test. — The Photogrammetric Record, London 1983, pp. 29—42.
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