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Report of Special Study Group 4.66 "Management of Geodetic Data" for the period dec. 1979 - june 1983.

by

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Abstract:

A brief survey is given of the development within the field of geodetic data management for the period dec. 1979 - june 1983, and the activities of the Special Study Group 4.66, which deals with this subject, are reported. It is concluded that in the future high priority must be given to the standardisation of geodetic data. Also investigations into the choice and development of optimal storage and access methods are considered to be very important.

1. Introduction.

The Special Study Group (SSG) 4.66, "Management of Geodetic Data" was established at the IAG General Assembly in Canberra, 1979. It is a continuation of the former SSG 4.38 working group "Application of Computers for the Handling of Geodetic Data". The group have the following members: D.Alger (USA), C.Boucher (F), K.Degerstedt (S), W.Erhnsperger (FRG), F.A.Fajemirokun (Nigeria), J.Gadzicki (PL), J.Gergen (USA), J.Isner (USA), H.Kremers (FRG), L.Niklasz (H), K.Poder (DK), C.Poitevin (B), A.Sazonov (USSR), C.R.Schwarz (USA), and the author. Three circular letters have been distributed to the ordinary and a group of corresponding members.

The main activity of the SSG was the International Symposium "Management of Geodetic Data", which took place in Copenhagen, Denmark, August, 24 - 26, 1981. A meeting of the SSG was held on the day following the symposium. A report of the symposium has been published in Bulletin Geodesique (Boucher et al., 1982). The symposium proceedings have been published in (Tscherning, 1981b).

2. Work executed.

A large number of papers have been published within the SSG's field of interest. The litterature list contains around 70 references to papers published since the IAG General Assembly in 1979. 18 of these papers have been published by the SSG members. Note, that a survey of the litterature published before 1979 is contained in (Tscherning, 1981).

A program of work (or more correctly: a definition of the common field of interest) was adopted when the SGG was established in 1980. In this section an overwiev will be given of the research and development in the field, as described in the published literature. Unfortunatly some papers have been inaccessible to me, because of my incomplete knowledge of a number of foreign languages. Futhermore, much work has been done in the field, which has not been described in the literature, so this report will be incomplete.

A: Design and function of geodetic data bases.

General discussion of principles for or inplementation of data storage systems, access methods and report generation facilities for several types of data are given in (Degerstedt, 1981), (Gazdzicki, 1981), (Lara, 1981) and (Reichardt, 1981). Descriptions of data storage systems and access methods primarily for trigonometric survey data are found in (Andersson et al., 1982), (Bartelme et al., 1980), (Benning, 1979), (Ehrnsperger and Kelm, 1981), (Spaeni, 1982) and (Steinich, 1981), for levelling data in (Krjikov, 1980), (Poitevin, 1981a), for gravity and earth-tides data in (Bureau Gravimetric International, 1981), (Ducarme, 1981), (Fury, 1981), (Isaac, 1981), (McConnel, 1981), (Poitevin, 1981) and (Steinberg and Steinich, 1981), for altimeter data in (Agreen, 1980), for doppler data in (Skags, 1981), (National Geodetic Survey, 1982) and for height and bathymetric data in (Frank and Moran, 1981) and (Fury, 1981).

It seems, as also noted in (Tscherning, 1981), that the index-sequential access method is generally preferred for most data types.

Only a few papers discuss the general requirements to data base management systems (DBMS). (Degerstedt, 1981) describes how such requirements have to be adapted to a computer, which also serves a cartographic production purpose. (McConnel, 1981) describes the successfull use of a commercial available DBMS, and (Schwarz, 1981) discuss the general geodetic requirements to a commercial system. It is concluded, that a strong data manipulation language is needed, as as well as a strong support for algoritmic languages used for scientific processing.

The data content of the geodetic data base (GDB) is discussed in several of the above mentioned papers. Of special interest is a system described in (Ehrnsperger and Kelm, 1981), which permit the storage of variance-covariance matrices of adjusted quantities. Their system may not be applicable when used to hold information related to a large geodetic network, but it is the first system which assures that important statistical parameters are readily available.

The data handling capabilities we have available in the much used programming language FORTRAN are described in (Kremers, 1981). However, the futher development of data handling facilities and query languages are very important for the efficient use of the geodetic data base. The algoritmic languages we have (like Algol, FORTRAN, Pascal) are quite primitive, and new tools have to be invented. Such a tool is the concept of "data abstraction", discussed in (Isner, 1981, 1982), which may permit the programmer to regard e.g. a levelling network as an entity and to define operations on it. The use of this new tool in the readjustment of the North American Geodetic Networks is described in (Isner, 1981a). The development in this field will not only be important for geodetic data management, but also for the general use of computers in geodesy.

Query languages are parts of most commercially available DBMS and the use of such a language for a gravity data base is described in (McConnel, 1981). A language specially adapted to geodetic users with many interesting facilities has been developed at the U.S. National Geodetic Survey as described in (Alger, 1981). Here it is emphazised, that the facilities must be easy to use, easy to program and easy to maintain.

Many interesting data handling facilities developed in DDR have been described in (Reichardt, 1981), (Steinberg and Steinich, 1981) and (Steinich, 1981). Here are also mentioned facilities for automatic generation of reports, ready for publication.

B. Entry and validation of geodetic data.

Instruments with digital output have now been available for a number of years. Surveys of the development are given in (Lundin, 1979) and (Zwickert, 1980). A general purpose system is described in (Paquet, 1981). Specific digital systems are described in (Fritsch and Wilmes, 1981), (Kahmen, 1979), (Loesekraut, 1980, 1980a), (Poitevin, 1981), (Rumpf, 1981) and (Van den Herrewegen, 1981).

Output from such instruments must be checked (validated) currently or at least when they are entered in the data base. (This must naturally be done for all types of observational data). Some of the already mentioned papers treat these aspects, which is also explicitly dealt with in (Andersson et al., 1982), (Benning and Ahrens, 1979), (Isaac, 1981), (Milbert, 1981) and (Poder, 1982). The method preferred is (as one could expect) least squares adjustment, followed by an analysis of outliers. However, the use of graphical display of e.g. contour lines or difference vectors are also recommended.

C. Data handling in support of geodetic operations or major computational processes.

If geodetic data is to be used for geodynamic purposes (in research or operational programs of disaster prevention), data from various data bases must be used simultaneously. An "information system" must be established.

A very interesting proposal for such a "crustal dynamics information system" is described in (Lohman and Renfrow, 1980). Their ideas have been used in (Tscherning, 1981c) when describing the design of a similar system for Europe.

The establishment of a comprehensive geodetic data base is a necessary requirement for the adjustment of a large geodetic network, and for the subsequent use of the results by a multitude of users. However, the reduction and solution of the large systems of equations which may arize turns into a data management problem in itself. Many submatrices must be established and combined in an efficient manner.

A new method for creating the submatrices (= doing the Helmert blocking) have been described by (Poder, 1981). Also various reordering algorithms and blocking strategies have been discussed, e.g. in (Benciolini and Mussio, 1981), (Grundig and Stark, 1981) and (Mark and Poder, 1981). Here is an area where much progress has been made, but where more research is needed.

The geodetic data base will also form a kee element in a Land Information System. This is primarily due to the unifying character of the geodetic coordinate systems. These aspect are discussed in (Frank, 1981) and (Smehil, 1980).

D. Data availability and standardisation.

One of the purposes of geodetic data management is to prepare data for the most general use, naturally within the limits a specific computer environment must impose. However, if data is to be used by others, special preparations must be made. This is facilitated, if data is standardized, but it is not a necessary requirement. The most important requirement seems to be, that all the needed data elements are available. Frequently information about the standard deviation of a computed quantity will be unavailable.

Standardisations have been proposed in the fields, where data frequently must be exchanged, such as Doppler survey data, see (National Geodetic Survey, 1982) and (Morgan et al., 1983). (References to older standardisation proposals may be found in (Tscherning, 1981)). A general discussion of the impact and necessity of standardisation is found in (Boucher, 1981) and (Space Science Board, 1982).

F. Other topics.

The purpose of a study group is also to facilitate the general exchange of information about experiences and of new ideas. Quite a few papers contribute to this exchange.

The problems one has to face when establishig or preparing a geodetic data base and data base management system are described in (Agajelu, 1981), (Degerstedt, 1981), (Fajemirokun, 1981) and (Lara, 1981). That data management must be included in the curriculae are argued for in (Kremers, 1981).

The general problems in data management (and also in the use of computers) are discussed in (Boucher et al., 1982), (Dillahunty et al., 1980), (Schueller, 1981), (Space Science Board, 1982), (Tscherning, 1981a) and most interesting in (Zemanek, 1982).

3. Outstanding problems.

In order to find out how the SSG members viewed the main subjects dealt with by the group, a questionaire was distributed with the third circular letter in 1982. The members were asked to indicate, how they viewed the "state of the art" in four areas, see Table 1. The questions asked were:

(1) is the theory sufficiently developed ?
(2) are reliable methods/techniques available ?
(3) as an overall assessment: is futher development in this area
not necessary ?
necessary, but not of high priority ?
urgent ?
of highest priority ?

Table 1. Ranking of importance of data management issues.

	Theory	Methods available	Priority of futher development
Development of data validation procedures	Yes (a)	Yes	Necessary
Choice and development of optimal storage and access methods	Yes (b)	Yes	Urgent (c)
Standardization of geodetic data	No	-	Of highest priority (d)
Futher development of field data entry systems	Yes	Yes	Necessary (e)

Comments:
(a) Some methods lack theoretical justification,
(b) There is a lack of comprehensive comparative studies,
(c) Most urgent for organisations handling large volumes of data,
(d) Standardization should mainly be in terms of necessary elements,
(e) We must take advantage of new technological advancements.

The conclusion which can be obtained from this table is, that the original problems dealt with in geodetic data management now seem to have been fairly well solved. However, the available solutions have in many organisations not yet been implemented, and complete solutions are not found anywhere at the moment.

The work of the SSG has been successful in documenting that solutions exist. What remains is a futher refinement of the methods and

- most important - a coordinated effort assuring that needed standards for geodetic data are established.

There will also be a continued need for an exchange of ideas between geodesists working with data management problems. However, the problems seems to be of quite a different character, in the various subdisciplins of geodesy. Data management problems are probably best discussed in close connection with other problems in these fields. However, the magnitude and importance of the problems should not be forgotten, see (Boucher et al., 1982, Table 1).

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