INFORMATION SYSTEM DEVELOPMENT, THE TOOL FOR FUNCTION AND DATA ANALYSIS, WHEN COMPLEX CARTOGRAPHIC PRODUCTION IS REQUIRED

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ABSTRACT

In the process of the creation of mapping products we are confronted with many opportunities. For example if we see the World Wide Web and al its possibilities and challenges for more, better and especially more complex mapping products, we do not realise always what is behind the creation of these finally displayed creations.

The cartographer must apply a tremendous number of tools. Moreover, the data sets to be used should be available with all the appropriate attributes in the correct files and directories and with all the specifications for the eventual creation of products. Data must be available in different databases and are quite often stored on different servers and/or in different directories. Apart from this in order to satisfy the client the map maker should meet the requirements of the user. Among other factors the success of the outcome is obviously dependent on the quality of the map maker. Cartography being the intermediate field between the initial data and the final output requires assistance of a structural approach towards its creation of products of high quality. Above all in the time of increasing care for economics and thus to efficient production management guides can provide very functional and time reducing supporting functions.

Although not always recognised by everybody at a first glance the development of information systems provides the map makers with creating managerial structures to display logical relationships between data and functions. In such cases cartography is seen as a system that might be named as the cartographic information system. Information System Development for cartography is a top down approach in the development. This means that the perspective to start is to begin at a global (context) level.

Cartography is then seen as one function. Data provision and data receipt are discovered as elements "to feed" the cartographic function. Terminators are the bodies that receive or provide the data. The terminators are mentioned but do not participate in the actual cartographic system.

If the global level is analysed a second step is developed. The individual cartographic function is decomposed in more processes while the data flows of the global level are still recognised and therefore used as links from the terminators to the processes.

The data flow can be described in this level of detail, but this can also be executed at lower detail level.
This highly depends on the complexity of the processes to be described, as well.

The number of different decomposed processes and levels can go up to four or five levels sometimes.

Information System Development is a pretty new approach that is already available since the mid eighties. But the main development appeared more continuation after better PC's enabled complex and more powerful production.
Cartography will definitely benefit much from the approach as described in this paper.

1. INTRODUCTION

With this paper for the first time the same approach is applied for the map maker's field perspective, in particular for the cartographer. With examples I eventually aim for an introduction which can soon be introduced in mapmaker organisations.

The structure of the function, like discussed, is just one example. It is the design of a functional model that is the representation of one choice executed by one organisation or person.

2. CARTOGRAPHIC INFORMATION SYSTEM DEVELOPMENT: THE FUNCTION ANALYSIS

Like explained in the introduction from the process point of view the field of cartography is a system consisting of processes, data provision and data deliverance. Centrally oriented cartography functions as one main process, which can be decomposed in many sub process. Decomposition of the sub processes lead to smaller sub-sub processes. One can continue splitting into the smallest process: the activity.

Independent on the size or importance of the process each individual process requires input data. Consequently the result of such processes is the provision of data, generally explained as output. In Information System Development one starts with the analysis of those processes and functions. Since cartography is, among other, one of the main functions in map making, if introducing Information System Development we can exactly follow a similar procedure.

Start developing the system in a global framework. We can name this a context level.

In the context (global) level the main function cartography is composed by the main process that needs to be framed by the contours of the field. Data deliverance and data providers for the process of cartography are called terminators. Actually, the terminators do not participate in the process, except the data.

If we speak of the function of cartography in a cartographic process of a city map for the tourist and inhabitants, the process requires, for example, statistical data input from a tourist bureau, the municipality and the survey of the town, district, province or country. In this case the tourist bureau, which keeps the relevant data such as hotels, is considered to be a terminator. It does not participate in the process but provides the process with relevant data.

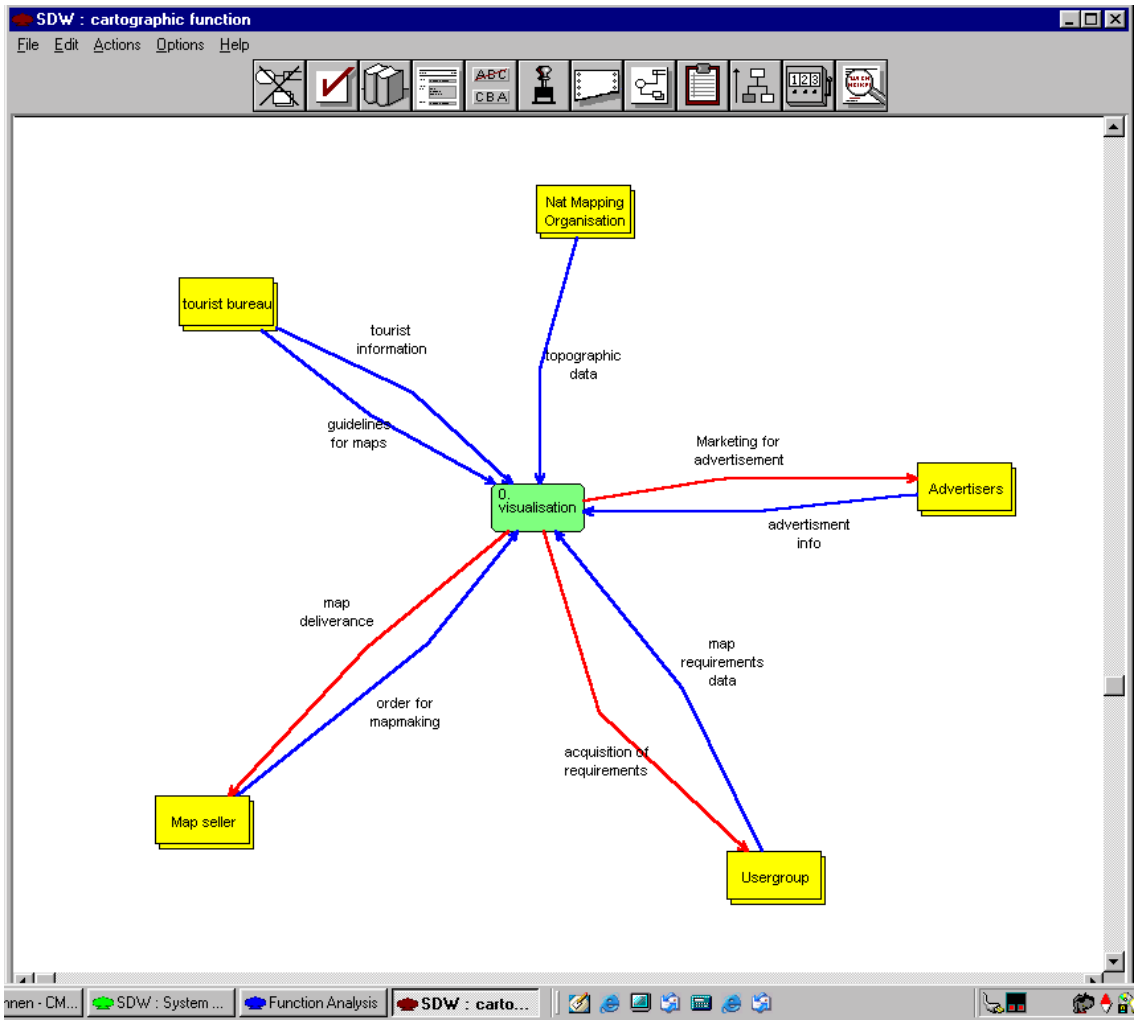

Figure 1. After a function analysis the Data Flow Diagram displays the cartographic function of a city map for tourist and orientation purpose with emphasis on application by pedestrians and cyclists

The same is for the output receipt of the process. Data files are used in order to watch the result of the data file. The Internet provider showing the cartographic product is the terminator. Also in this case the tourist or city citizen does not participate in the cartographic process, is therefore positioned outside the boundary of the function of cartography and is thus a terminator.

In order to find out the exact boundary of the cartography system one requires a thorough function analysis what takes place around this main process. Among other important phenomena it is delicate to know who are the data providers for the input of the data. Most probably these will be more than one institute, department or section. A similar analysis is required for the output of the function. Who are the clients of the cartographic process. Further for developing the system we are also interested in the quality of the data. Generally spoken we do not need details on this global explanation level.

Details such as attributes of data are essential on more detailed explanation. See the following chapters of this paper.

For explanation reasons the analysis of the global cartographic function can be just explained by an explanation in words. However, to comfort readers with better overview to explain our colleagues diagrammatic techniques are preferred rather than a literally explanation.

The introduction of the diagrams in cartographic information system development we can also apply the same symbolisation for:

- cartographic processes,
- the data deliverers and data providers, called terminators
- the dataflow to and from the process(es)

3. MODELLING THE FIRST LEVEL DATA FLOW DIAGRAM OF A CARTOGRAPHIC INFORMATION SYSTEM DEVELOPMENT

Having globally displayed the cartographic function a more detailed diagramme can be designed. With the method from global to more detailed we approach a top down structure.

Data from the terminators like seen on the context level diagramme provide and receive the same data. Therefore, more specifically on the detail levels the same data is feeding the processes and sub processes, seen on this level.
All the processes are divisions of the main cartographic function. The main function has broken down and is displayed in subsequent sub processes. Reverse, all together the sub processes form the cartographic main function.

Generally spoken on the level of the cartographic main function we might discover 3 or 4 distinguishable processes, more or less on the same level of complexity and importance : data compilation, spatial and thematic data preparation, cartographic processing, product dissemination.

Like told before the data coming from and going to the terminators will be shown in the data flows directing from and to the four processes. Thinking of the principle that data feeds a process and that the process output is a dataflow which can be applied by the process to follow the first.

In other words, in cartography, speaking of the (sub)process of data compilation the data input is data coming from e.g. census bureaus and from a National Mapping Organisation. The process of compilation processes the data. The result, the output, is the combination of different kinds of data to be applied for the process to come. This result is the data that will subsequently act as the input of the next process: the spatial and thematic data preparation. In this level there appear to be different data flows within the boundary of the main cartographic function. In this (sub)process data being compiled will be ordered, converted, or prepared in other ways to such extent that the next process can be executed. In this case the output of the process of data preparation forms the input for the following (sub)process: the cartographic processing.

Principally this is the main set of activities that processes the data for its eventual goal: the visualisation of spatial data regarding pre-formulated and pre-determined cartographic symbology. Actually it is the event that the cartographic product is created. On this particular part the cartographer processes the data in the result that the client requires. The cartographic production output, a map, a website, an atlas or an other creation, is then ready for publication. The result of the cartographic processing is the data which will subsequently be processed for its last (sub)process: product dissemination. The last (sub) process on this level of data flow diagram actually delivers the data to be sent to the client, one of the terminators of the main cartographic function. In the entire diagram the data comes from terminators, but are also produced by the individual (sub)processes that take place. On the diagram one can see the logic connection from and to terminator and (sub)processes.

In most cases, due to the complexity of the most cartographic processes further detailing of dataflow diagrams is recommended.

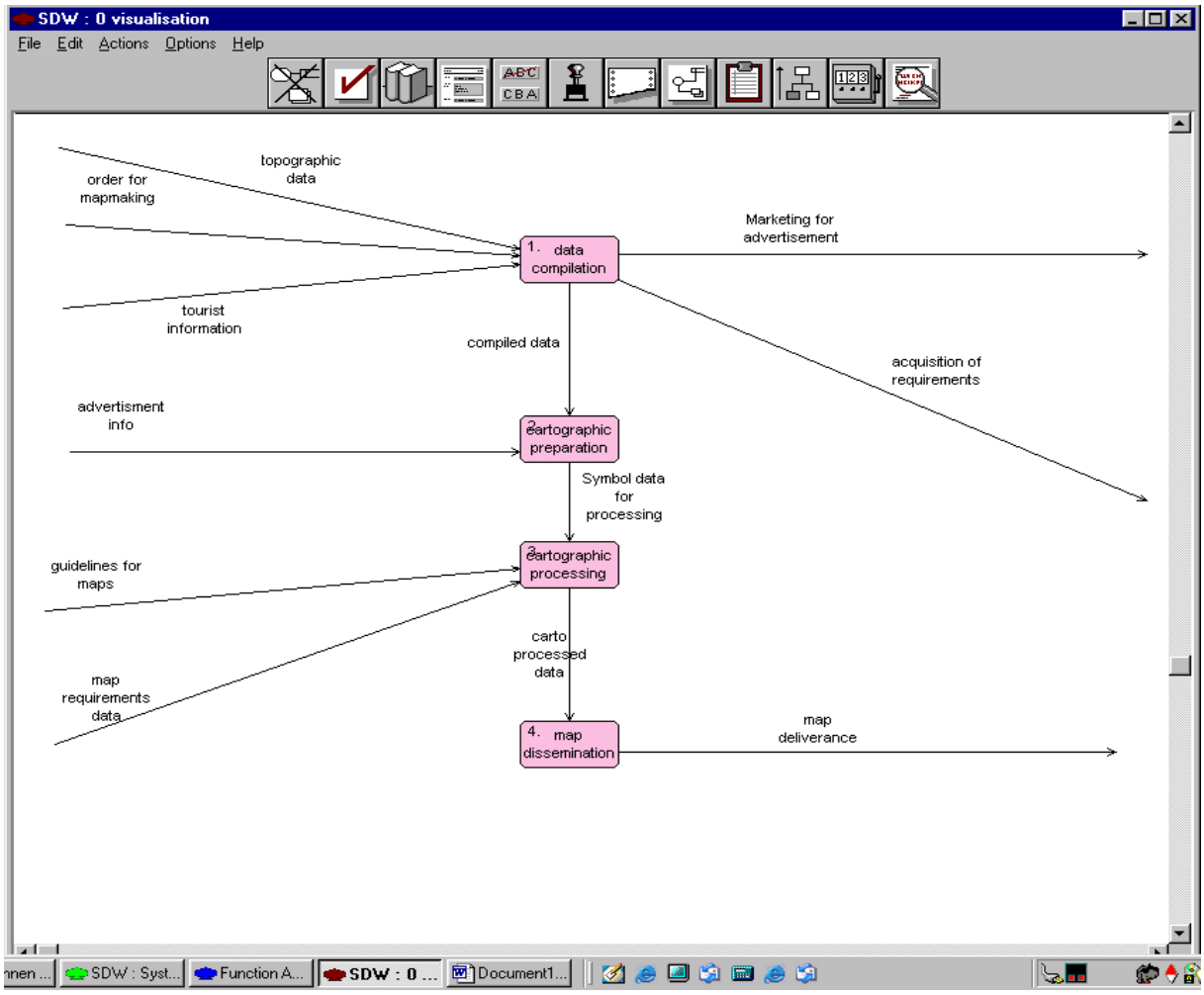

Figure 2. The DFD displays the broken down result of the process of cartographic visualisation

4. MORE DETAILED LEVEL OF A CARTOGRAPHIC INFORMATION SYSTEM DEVELOPMENT

For reasons of insufficient details of data and data flow within the entire system all (sub)process of the first level (i.e. data compilation, spatial and thematic data preparation, cartographic processing and product dissemination) of data flow diagramming of a cartographic information system (context level data flow diagram) are consequently broken down to further extent.

In order to avoid that this paper will grow to a lecture we only concentrate on one (sub)process on the first level: the cartographic processing. From the perspective of the (sub)process of cartographic processing one can further separate it to more sub-sub process.

What actually implies the cartographic (sub)process? This might vary tremendously and is very much dependent on what kind of product the customer of the cartographer needs/demands.

In the introduction was already told that the structure of the process is just an example. It is the design of a model that might be a representation with many different opportunities.

How many sub-sub processes can we describe at the lower level of the cartographic sub process, which are the data flows and what is (or should be) the content of the data to feed the processes and to retrieve from the processes. We wish also to describe the characteristics of the processes and in particular we are interested in the properties of the data: the attributes. An other opportunity is to describe the relation between the entities. This is displayed in the Entity Relation Diagrams. This, however, is beyond the scope of this paper and will therefore be left out. Dealing with processes like cartography most of us know the subdivided smaller sub-sub processes. Apart from the regular control of input data we can recognise generalisation, symbol design implementation and layout implementation. Quite often the

cartographer discusses this with the author of maps. But he/she will mainly rely on his/her knowledge. Depending on the theme of the map and the final product to be produced the sub-sub processes take place in a certain order. Also here we must state that the sequence of activities like described here is just a representation of one example in one infrastructure for one particular customer.

Going back to the sub-sub processes we distinguish the processes mentioned before.

Most of the data flows here come from the sub processes. However, for client satisfaction we need data from the potential map buyer the tourist. We need data that meets the requirements of the customer. This comes from the terminator, in this case the tourist. If we follow the data flows we see many data coming from and outputted by the processes.

The final data flow (latest in sequence) is connected to the sub process of product dissemination.

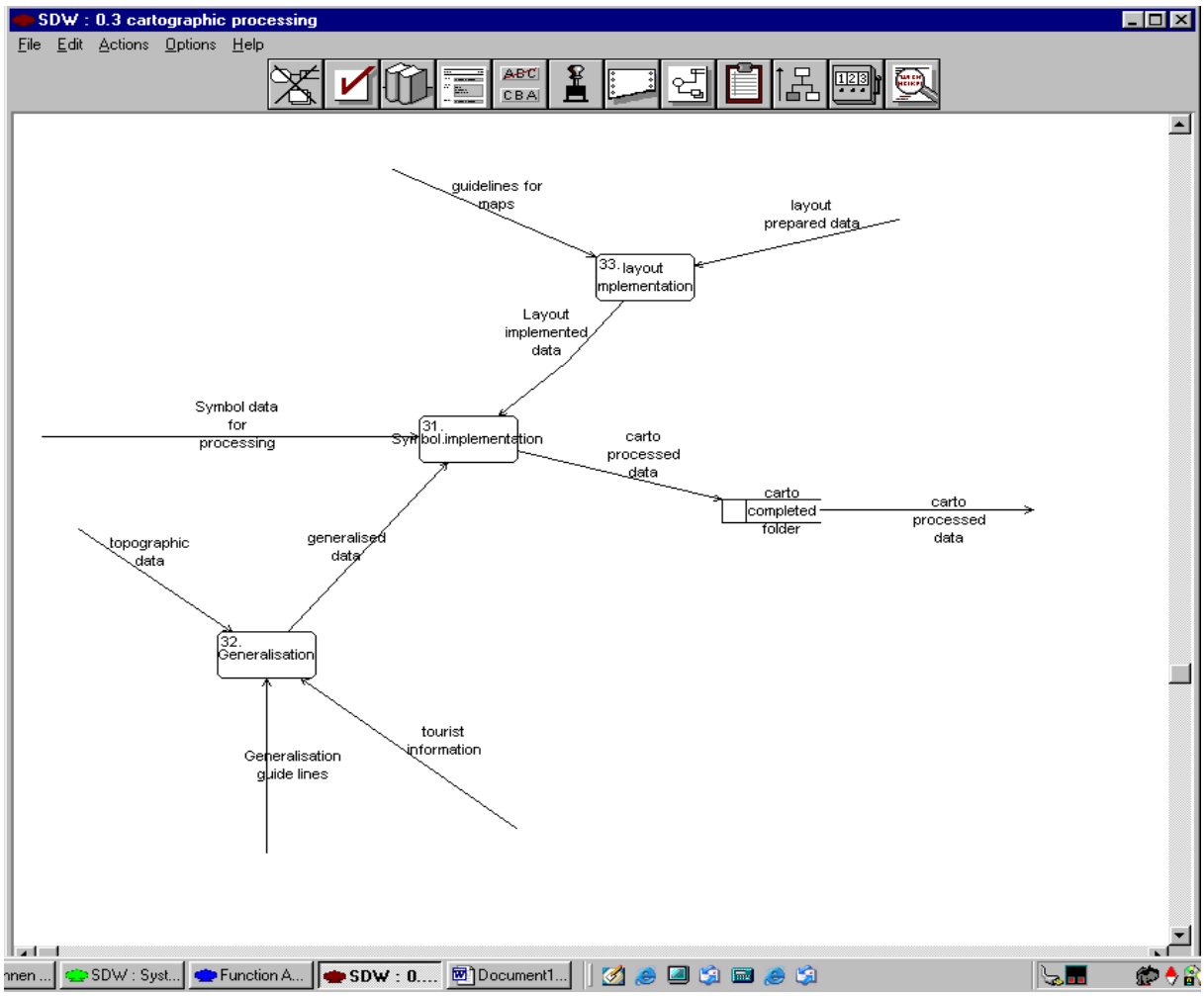

Figure 3. If one decomposes the process of cartographic processing the data flow diagram appears with all its details. Further decomposition is possible.

5. THE STUDY OF THE DATA CONTENT AND ITS ATTRIBUTES

In the previous parts of the paper we have dealt with the function of the process, the subdivision of the processes, the principal discussion on the data coming from other processes and from terminators. Further the storage of data has been determined by establishing the data stores.

The most essential part of the data flow diagram is now the analysis of the data. How are we modelling the data so that we enable adequate products to meet the clients demands.

Data has to be modelled such that we create proper databases. The databases serve the cartographer for eventual producing the result we like to create. This step we phase the properties of the data. What is the data, for what do we create it, how will the data have to look like.

We determine the exact properties in this critical step of data flow diagram creation. In fact we establish the final structure of the database. Which is the relation between the various elements of the data. For the cartographic process the database should include the symbolisation properties. How do we symbolise the tourist information. How are we distinguishing the symbolisation between the hotel and the restaurants. But also what are the conventions if available. Is there a standard for certain symbolisation? For geological maps, for instance, an international standard can be applied. For cartography this also implies the introduction of Bertin's scientific rules for visualisation symbology.

As an example we concentrate on certain aspects of tourist data that have to symbolise for the map to be produced:

- interesting visits, recommended tourist places to be visited
- restaurants with different types of served food

With interesting visits we only want to concentrate on the tourist elements that we advise the tourist to visit and show on the map, such as interesting building, performances etc..

Just to keep things simple, out of the cartographic printed maps data flow we have selected the interesting visits class. As an example only nine interesting places are mentioned. For reasons of tables for database creation one field was added being the -tourist attraction Id#-

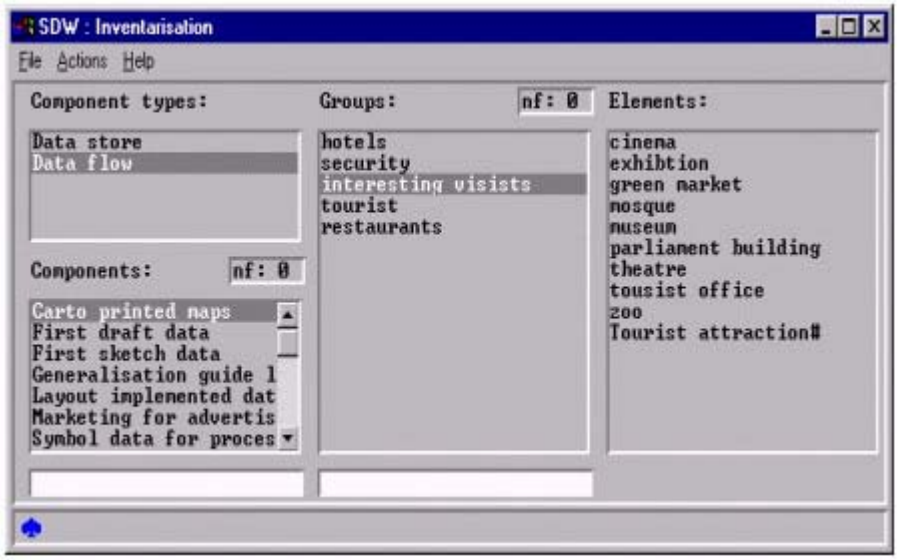

Figure 4. After an inventory with emphasis on data flows one can establish classes of elements for each individual group.

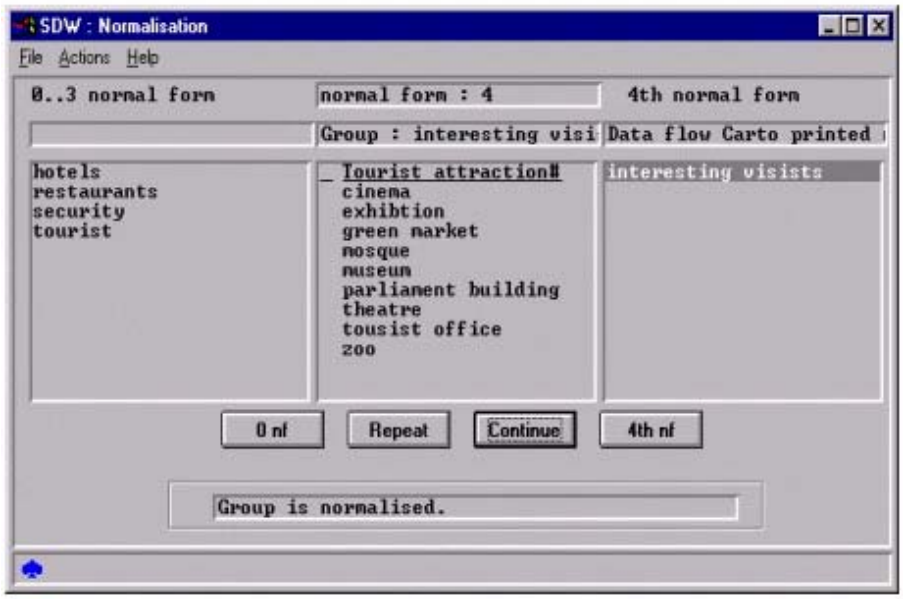

Figure 5. After determining the primary key and the process of normalisation this kind of table appears. (see the middle box)

A similar activity is the creation of a table of restaurants with different types of served food. In this case we have selected a group of five specific types of restaurants that might be visited by tourist with addition of the tourist Id # and a budget. Each restaurant has a unique identity and therefore we have created the field of restaurant type.

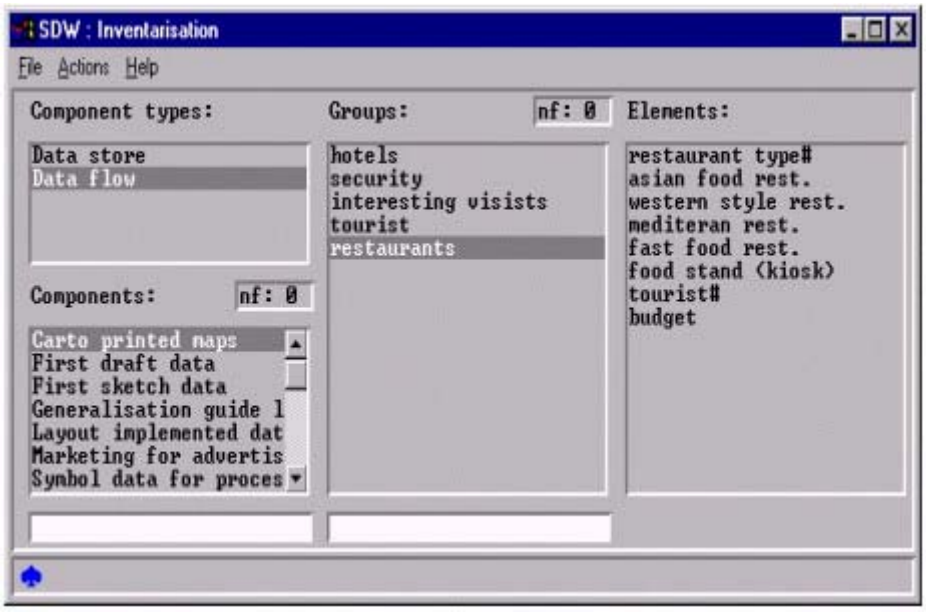

Figure 6. After determining the primary key and the process of normalisation of the tables one can distinguish a table with 5 unique attributes which are important to be identified by the map author/ cartographer.

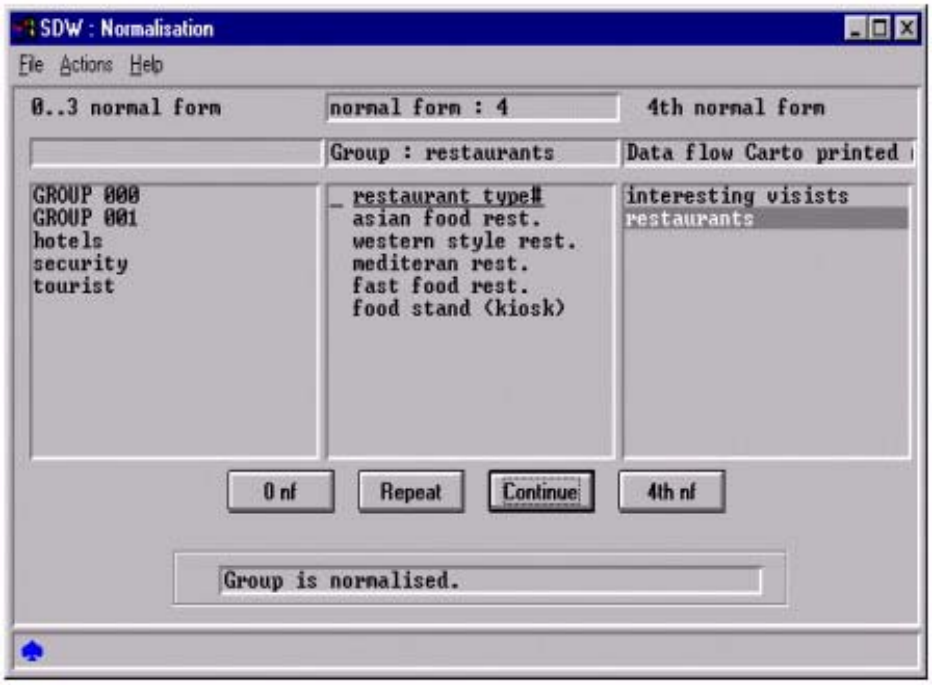

Figure 7. The same table, but normalised

If we know the attributes the cartographers are also able to establish its symbology.

For tourist information one can discover many symbols. For tourist maps pictorial symbolisation is one of the most dominantly available, but for example walking areas one can implement area or line symbolisation, as well.

Modern mapping software enables the connection from the database table to the cartographic look up table.

6. CONCLUSION

In this paper I have introduced information system development in cartographic systems, of which a cartographic production system is one example. The idea is to apply information system development as a function for the cartographic processes. So far this is not a common behaviour.

Since these become increasingly complex the manager of cartographic and other mapping systems require structure. In order to create structure employers must emphasise on analysis of functions, looking what is available, what is working well and what is malfunctioning, etc...

For the development of systems in common one works with a top down approach, from global analysis to more detailed. General impressions do not supply sufficient information, so do not work here. Detailed analysis should lead to better information for a higher level of improvement. From context level to very detailed level the function is completely decomposed into finest data flows and processes. The final result of this approach is that all data can be broken down and separated to its finest property detail. As a consequence of this the tables of the database can be pre-determined, as well. Skeleton tables can be set up for designing and creating the database.

Working with this structured approach the function of map maker manager, map maker, cartographer and others are guided with a powerful support tool for appropriate mapping management.

The advantage can particularly be notified for producing map series. Moreover the construction of similar cartographic products benefit tremendously. Introducing information system development in mapmaking will lead to more professional discussion rather than individual and repetitive talks on the creation of map products.

The system will professionally function well, provided that a substantial amount of preparation time will be reserved for setting up the structure or improving a structure. As a last point to be viewed we face the advantage of improved professional performance leading to adequate discussion with ICT-oriented staff or with GIS staff who are often separated from the cartographic field. The last point will definitely refer to the implementation of aspects of data quality: quality control, quality standardisation, quality certification, etc..

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Biography

Sjef J.F.M. van der Steen is employed at the at the International Institute for Geoinformation Sciences and Earth Observation (ITC) from 1974 until now.

He lectures for the department of Geoinformation processing (former Geoinformatics, division Cartography and Visualisation) and Urban Planning of Geoinformation Management (former division Management and Infrastucture).

He is a lecturer on the following topics:

- Project management
- Cost aspects for mapping projects
- Process flow diagrams for on different levels within the organisation
- Information System Development

He is the coordinator of several courses at the ITC for the Egyptian Survey Institute (ESA) and must control the Cairo courses in Egypt on quality aspects. He supervises students at their Individual Final Assignments and Final Projects.
At the moment he is also the ITC alumni coordinator.

Sjef van der Steen has been involved in a couple of foreign Consulting and Advisory projects in Colombia, Indonesia, Burkina Fasso and in Egypt. The projects involved mainly management, fact finding and educational tasks.

He is the chairman of the Commission on Map Production of the International Cartographic Association 1995 until now. The activities have personally been realised in the organisation and chairing of several international seminars and workshops, (Istanbul, Bandung, Trondheim, Santiago de Chile, La Habana.).

He contributed to many international congresses in which he presented papers. In the congresses he chaired paper presentation sessions. Moreover he has been participating in panel discussions of seminars and workshops.

Duties:
Director of Studies:
Special courses for the ESA courses (at ITC and in Egypt)

Lecturer:
Aspects of Geoinformatics management
Project management for mapping organisation
Integration Geoinformation Production Management
Informastion System Development

Personal Supervisor:
Final Projects
Individual Final Assignment
Group Assignements

Consulting and advisory
Countries: Bourkina Fasso, Indonesia, Colombia

Description of missions:
Fact finding mission and Teaching and Instructive missions
Locating problems, particularly in mapping.
Teaching management and fundamentals.
Standardisation of terminology instruction.
Analysis, reporting and advising on short and long term basis.
Advising on new floor plans for up-to-dating
Advising on investments.

Other functions:
Chairman of the ICA commission on Map Production 1995-2003

Duties:
Lead the Commission in the goals of the Commission
Initiate and keep track of activities of the Commission
Stimulate and guide the members of the Commission
Participate in discussion in the determination of policy