# THE INTEGRATIVE PRODUCTION OF THE PAPER MAP AND THE GEOGRAPHIC INFORMATION

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**ABSTRACT**

The paper map production and geographic information production are two important aspects of digital mapping. The production workflows for the paper map and geographic information are not same. In this paper, the integrative workflow of the paper map production and geographic information production was discussed. The paper was consisted of three parts. Firstly, the different requirements of the paper map production and geographic information processing was analysed, and the focus of paper map production is graphics or symbol and the focus of geographic information processing is geographic code, attribute and relationship of geographic features. Secondly, two workflows were compared. The workflow of paper map production includes the map design, multi-source data processing, map symbolization, map editing, data checking, the printing draft, publish processing and map printing. The workflow of geographic information production includes of the geometry information gathering, geo-attribute inputting and the topological relationships building. The paper map n and geographic information in one process can be gained if the 'geo-attribute inputting' and 'the topological relationship building' in the workflow of the paper map production was added. Thirdly, three problems in the integrative workflow should be resolved: to design the data structure of operation object, which is the base of digital mapping system; to research the relationship of the feature attribute and map symbol, the relationship consist of the feature code corresponding the symbol, the attribute corresponding the symbol, the express style of attribute; to use the attribute database in the system, the symbol will remain the geo-attribute all along, that is the key of the integrative workflow. As a result, integration of paper map production and geographic information production come true. It will make single-production mode into multi-production mode. It will help the digital mapping technology go forward greatly and reach a higher level.

**Keywords:** Paper map, Geographic information, Digital map,Integrative workflows, Digital mapping

## 1. INTRODUCTION

The basic geospatial information data set is usually called *digital map*, as same as paper map, has been playing an important role in the development of national economy [1] . Since geographic information is different from the paper map in express methods, application mode and storage medium [2] , the technology of paper map production is also different from the technology of geographic information production. With the development of geographic information application, Both paper map and geographic information were needed, especially in the practice of series scale paper map making and geographic information production. New requirement was put forward to digital mapping, the integrated workflow of paper map production and geographic information production was researched in this paper, two productions could be gained in one workflow.

## 2. DISSIMILARITY OF PAPER MAP PRODUCTION AND GEOGRAPHIC INFORMATION PRODUCTION

Map projection, map symbol and cartographic generalization [3] are the three fundamental characters for paper map production. As to geographic information, it needn't reflect the three fundamental characters directly. When combining with the real visualization application, it is needed to use the real map projection and map symbol. In the paper map-making process, there are still some map publishing problems. The map symbol, map color and symbolization effect are needed to satisfy the specification of paper map. Therefore, during the process of map making, the data management is based on graphic symbol. The representation of main features is prior to the representation of other features. The data organization obeys the following rule in the software of MicroStation, Illustrator, and so on.

Operation object = {prior printing level, printing color, graphics description of map symbol, feature position coordinates};

The feature code and attribute were defined firstly in geographic information production according to the corresponding criterion and standard. Thus, the map content could be expressed with the code, attribute description and the coordinate. The geographic information production is realized by aerial photograph surveying, map digitization and existing geographic data update. In the workflow, the data is organized and managed in geography feature code. There is no clear definition to the map graphics. The storage unit of geographic information is usually geographic coordinates. In geographic information production system, the geographic data structure obeys the following rule:

Operation object = {geography level, feature code, detailed geography attribute, feature position coordinates};

There is some corresponding relationships between the feature code and map symbol. Geographic information could be transformed into visual paper map, while there is great difference between showing map and printing map. It is more difficult to develop paper map production system which focus is graphics than to develop geographic information production system which focus is feature code.

## 3.THE WORKFLOW OF PAPER MAP PRODUCTIONTION

Paper map production workflow was shown as chart 1:

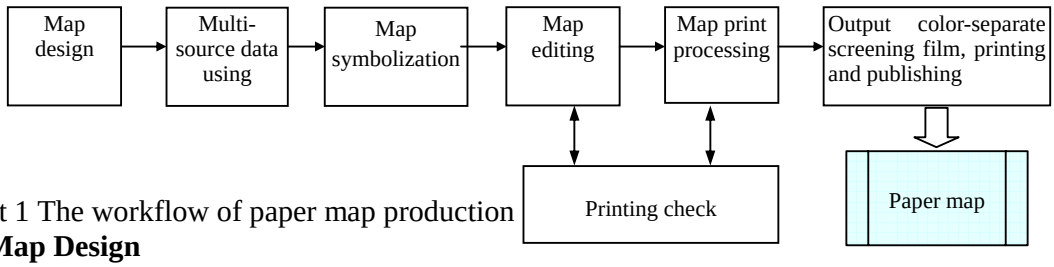



Chart 1 The workflow of paper map production

### 3.1 Map Design

Map projection, scale, range, content and representation were determined according to the user requirement, map purpose and datum situation in this process. Map symbol system, printing color and over-printing relationship of each feature were also determined.

### 3.2 Multi-source data using

If there is no existing data available, then map data should be collected by digitizing map. The new changes are needed to add the digitized base map in order to keep the quality. If the data was gained from the database or other sources, it must be satisfied the map-making requirement. There is lots of preprocessing, such as map data format conversion, coordinate conversion, correction and map projection transformation of map data in this step.

### 3.3 Map symbolization

The map content was symbolized according to the designed symbol system. In the symbolizing process, the size, color, thickness of symbol and the corresponding relationship of the features were kept consistent to the last printing result. The lettering layout, cartographic displacement and the other problems are needed to resolve. Only in this way, the quality of the final map could be guaranteed.

### 3.4 Map editing

For symbolized map, it is needed to edit the map contents and adjust the corresponding relationship. In the editing process, the map content needs to be updated by current and supplemental information. With certain correction, remote sensing image and aerial image could be placed under the vector data. Then, updating and modifying of the map could be carried on.

### 3.5 Printing check

The map content should be checked seriously in the process of the map production. Since it is difficult to check problems by people on the computer screen currently, the symbolized map is usually output for checking. The map contents are modified according to the checking results until there is no fault.

### 3.6 Map publish processing and printing

According to the printing requirement, printing relationship should be adjusted. The EPS data file was produced at last. After the films or plates of the map were output, the color paper could be printed.

## 4. THE WORKFLOW OF GEOGRAPHIC INFORMATION PRODUCTION

The geographic information is consisted of geometry information, attribute information and relationship information. The main task of the geographic information production is to collect the datum. Compared with the workflow of the paper map production, the main difference the workflow of the geographic information production is “geo-attribute acquisition” and “the topological relationship building”.

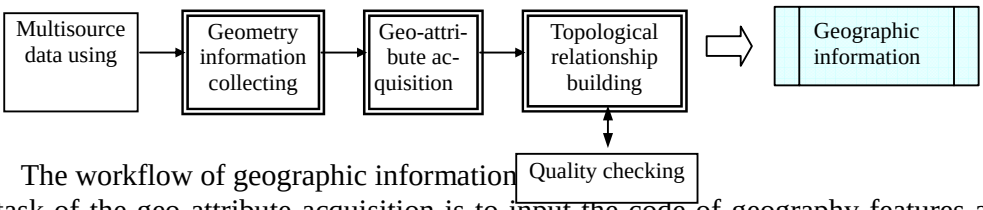



Chart 2 The workflow of geographic information

(1) The task of the geo-attribute acquisition is to input the code of geography features and corresponding attribute information.
(2) The task of the topological relationship building is to build relationship of geography features and form geographic information data.

## 5. THE INTEGRATED WORKFLOW

There is strong comparability between paper map production and geographic information production. Comparability is the fundamental of the integrated workflow.

Seen from the workflow of chart 1, in paper map production process, graphics data was collected from map and the final map was accomplished. If two processing of the “geo-attribute acquisition” and “the topological relationship building” were added in the workflow of chart 1, the paper map production and geographic information production could be integrated. Then geographic information and paper map could be gained in the one workflow(Chart 3).

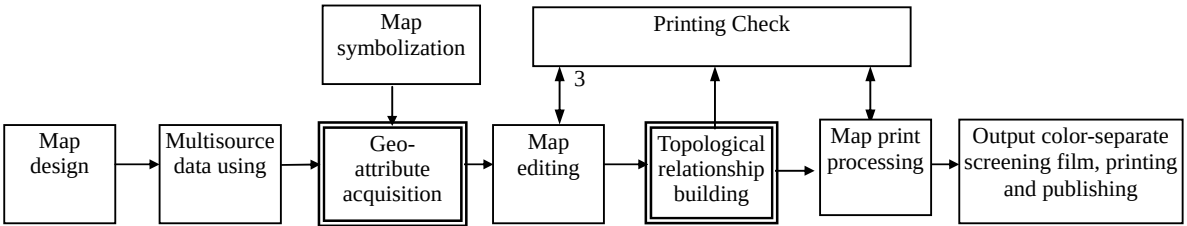


Chart 3 The integrated producing workflow

## 6. KEY TECHNOLOGY FOR THE INTEGRATED WORKFLOW

The digital mapping system plays an important role in the integrated workflow of paper map production and geographic information production. Such digital mapping system is not only different from paper map production system, but also the geographic information production system. In this system, three key problems should be resolved effectively. The first was to design the data structure of operation object, the second was to research the relationship of the feature geo-attribute and map symbol, and the third was to use the attribute database keeping the geo-attribute.

### 6.1 Data structure of operation object

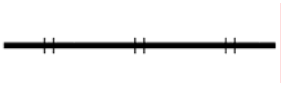
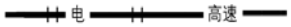
Map is composed of map symbols (lettering is one kind of symbol), which appends geo-attribute or not. Therefore, symbol is the operation object of the whole mapping system. The fundamental data structure is showed as follows:
Operation object = {impact printing priority, printing color, map symbol graphics description, location coordinate, < pointer of geo-attribute information>, …}
The pointers of geo-attribute information are connected with the geographic attribute database. The codes and the corresponding detailed attributes of the features are stored in the geography attribute database. The number of pointers is unfixed. There may be no geo-attribute pointers, may be one or several. Then, the geo-attributes of one operation object could be several or none. For example, a symbol could be connected with several geo-attribute pointers. These pointers could point to different records of the same attribute database, also could point to the records of different databases. This makes the multi-attribute query of map objects available. The attribute pointers are connected by the attribute table and the pointer record ID.

### 6.2 Corresponding relationship of geographic attribute

In the geographic information production system, the feature code always be bound with map symbol, which means the relationship expressed one by one. For some systems, the visualization request of the map is just screen display, this kind relationship is enough to use. However, reflected to the paper map production, the visualization request of the map is the printing map. The geographic information code could not express the whole map content, so the relationships of the geo-attribute and map symbol are consisted by three parts.

(1) Building corresponding model of feature code and map symbol to deal with the symbolization of most content.
(2) Building corresponding model of geo-attribute content and map symbolization (Table 1).
(3) Building corresponding model of attribute express method. There is obvious difference among the express methods of different feature attribute. For example, bridge takes the disparted-lettering to express the attribute parameters, while the material and width of a road is expressed by the compact character strings.

Table 1 The relationships of the geo-attribute and map symbol, selected from the symbols of 1:250,000 topographic map

| Content | Feature Code | Attribute | Attribute parameters ordinary situation | Attribute parameters special situation |
|---|---|---|---|---|
| Railway | 340201 | Style | None  | Electrization and high speed   |
| National highway<br><br>Provincial highway<br><br>County highway | 340305<br><br>340307<br><br>340309 | Grade | 1 or 2 or 3  | High speed  |

### 6.3 Application of geographic attribute database

Paper map production system could realize symbolization and connect with computer electronic prepress system directly. But, once the contents of the map are symbolized, the inherent geographic information of map features could be turned into graphics content. The map editing is just graphics editing, such as highway, When binding with the attribute and mileage lettering, the attribute explain lettering break away from the highway symbol and there is no real connection; the formative data file is graphics file rather geography data. To realize integration, it should be connected with query-able geo-attribute information to the graphics data. Therefore, it is needed to connect with the attribute database to storage various geo-attribute information of map feature in the integrated production process. The map graphics symbol connects with the corresponding records by geo-attribute pointers. Thus, after map editing, the attribute information of map feature won't be lost and the geographic information could be captured and updated. The spatial coordinate could be gained from the coordinate after projection transformation; the attribute information could be extracted from the geo-attribute database; the topological information could be gained according to the attribute information and fixing coordinate of map feature.

The complexity of map content expressing engenders several relationships of map symbol and geo-attribute: one by one, one by several, several by one, several by several. To various situation, we should build the corresponding manage department to make sure the map graphics changing along with the change of geo-attribute. Then, the map editing would be changed from graphics editing to attribute managing.

## 7. CONCLUSION

Paper map and geographic information could be obtained at the same time in the integrated workflow. Digital mapping production system, which adopts this technology, can take single-production mode into multi-productions mode. Then, it would lessen the

production cost, avoid duplicate work, and improve quality. In addition, it could ensure the coherence of map content and verisimilitude. Especially the national wide paper map production and geographic information production is a huge project, which needs large input. The integrated producing technology has more significant application values.

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