

# FINGIS-SOFTWARE AND DATA MANIPULATION

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## ABSTRACT

FINGIS is a FINNish Geographic Information System for management of numerical spatial data. The system is organized in four parts: data creation, updating, data manipulation and output. All software has been "homemade" since 1975.

The system supplies the spatial information:

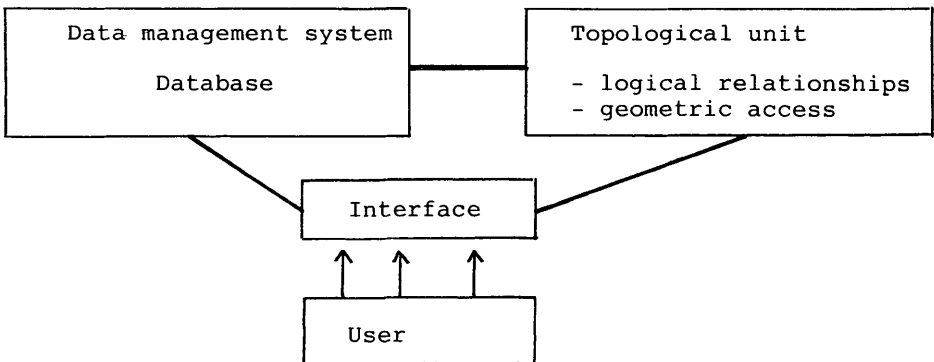
- forms polygons from line data
- inventories the current situation
- collects thematic information
- overlays the planning data on the current situation
- generalizes the data to a convenient drawing scale

Spatial data for retrieval comprises areas, volumes (water, gravel), sizes of objects, number of objects, distances, overlay areas and other relevant data.

This paper presents relevant aspects of polygon management and the computing of overlay areas. For example, how to create and update a polygon, how to retrieve holes inside the polygon and how to intersect two closed polygons.

## FINGIS SOFTWARE

### The structure of the software

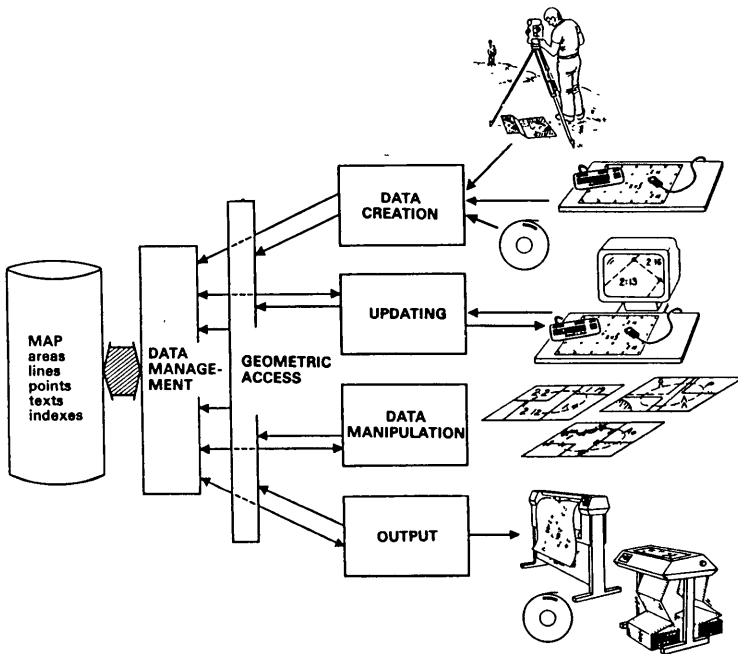


The user manages the system by interfacing software, which takes care of data input and output, generates graphic symbolism for map data, drives periferial units and interactive graphic working.

The database management supports database files, situation indexies and database dictionaries. Topological relationships are computed automatically by means of geometric access. Geometric access means retrieving object(s) from the database by means of the x,y,z coordinates of a point, a line or a polygon (the geometry of the object). Topological relationships to manage are f. ex. a neighbourhood, an overlapping and an overlay of polygons, lines and points.

The subsystems of FINGIS

FINGIS is a GIS software package for managing and manipulating geographic data. It is not only a drawing system, but its main interest is to manage polygons and polygon overlays. The subsystems are data creation, updating, analysis (data manipulation) and output



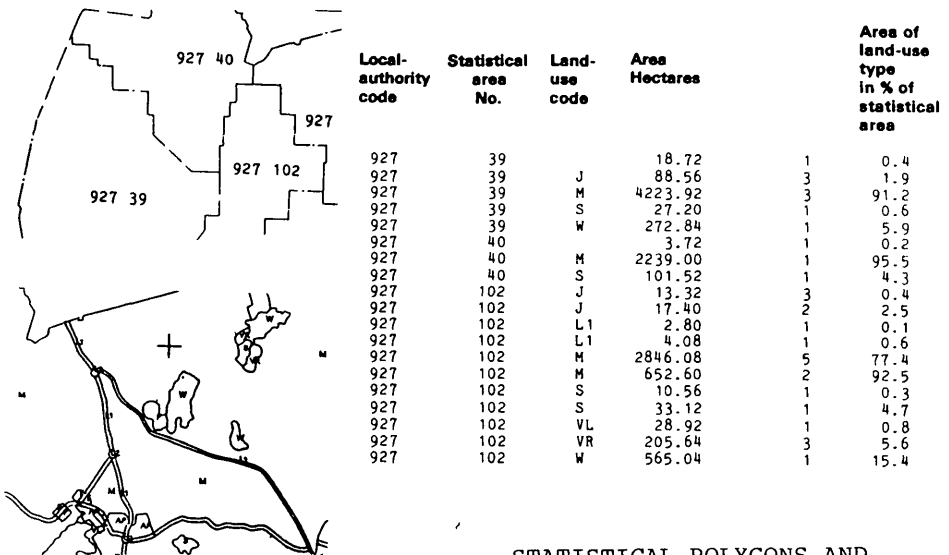
The subsystems of FINGIS software

Data input. Numerical spatial data can be input to the database by digitizing or converting geographic data files from other systems. The digitizing unit is a digitizing table, a stereo plotter or a scanner. Interactive and non-interactive digitizing is supported. The user can set up his own menus (set of commands) to manage the program. A square of a menu, a cursor button or a keyboard button is provided to set up for one command.

Transferring geographic data files from other systems is supported via standard SIF-files or standard FINGIS-files. It is also possible to convert separate coordinate files into the database format. The unit of coordinates (x,y,z) is one millimeter in terrain. The accuracy of coordinates permits the use of basic coordinate geometry functions used in surveying and civil engineering. Digitizing in several databases at the same time is supported.

Updating of data. The system updates the database in real time at a graphic workstation. There are several commands to modify the features of map data. All updates are seen on the screen and put into the database immediately. Topological relationships are updated automatically, when a line of a polygon is added or deleted.

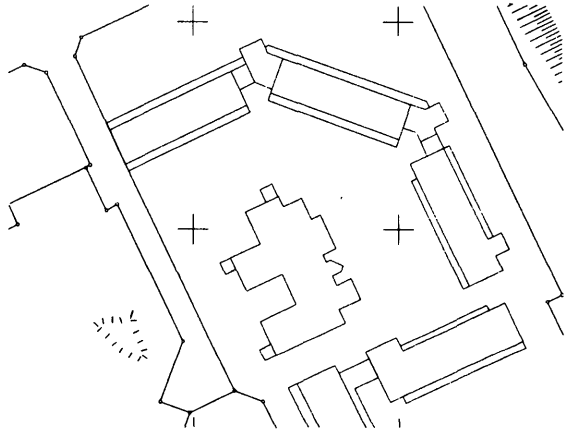
Analysis (data manipulation). The geographic data base system provides all kinds of data manipulation: data overlay, data inventory and data selection. The system calculates automatically areas and perimeters of polygons, lengths of lines, numbers of objects etc. .



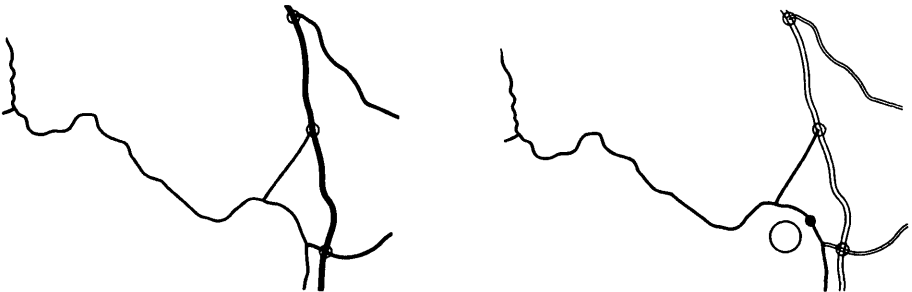
STATISTICAL POLYGONS AND LAND-USE POLYGONS

Data display and output. The data is output in graphic displays, alphanumeric lists and files and standard digital files. Graphic output hardware can include graphic terminals, pen and light plotters, hardcopy printers and scanners. The system provides any selection of map features to be displayed in different scales. System interfacing allows a great variety of graphic displays from the same map data.

Base map 1:500



Different graphics,  
different masks

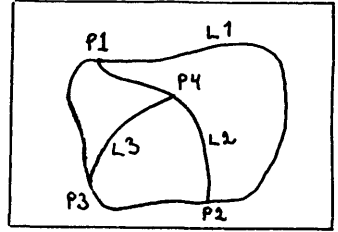


## SOFTWARE DETAILS

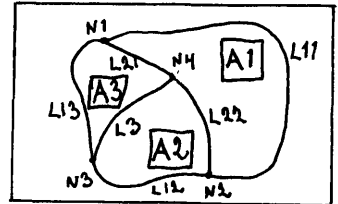
### Polygon management

#### Line digitizing

L1 (P1 .. P1)  
L2 (P1 .. P4) or (N1 .. P4)  
L3 (P2 .. P3)



Automatic node-matching updates line links and cuts lines from node to node during the digitizing or the node-matching has been done in the batch mode.



Polygons are managed in the database in the real-time mode. Topological relationships are linked only between lines. Linepointers to the right side and to the left side of the ends of the line are stored. All other topology is managed by geometric access. There are no polygon records stored in the database. The attribute data of the polygon is a digitized text point anywhere inside the closed polygon. The relationship between polygon and text is the coordinate point.

For example, retrieving a closed polygon A1 by means of a digitized textpoint or by means of one point inside the polygon: Retrieving is started by computing the nearest line L11 to the textpoint A1. This is the first line in the polygon. The next line L22 clockwise in node N2 is found in line record L11. The next line L21 clockwise in node N3 is found in record L22. When node N1 is found and next line clockwise is L11, the polygon feature is retrieved. If there are islands (holes) inside the polygon, these holes are found automatically by means of line geometry and the situation index. The updating of the polygon is very simple. It is no extra work for a user to add or delete a line in a polygon compared to normal digitizing. Elimination and dissolving of polygons are omitted.

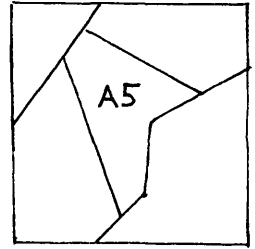
Polygon overlays

The overlay techniques between two coverages is presented by one example:

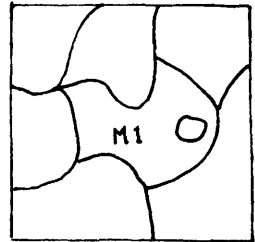
The overlay of an A5-polygon to M-polygons

- compute the situation index squares (SI), where the A5-polygon is located.
- retrieve the lines in M-coverage overlapping the A5-polygon by means of SI-squares
- create M-polygons, which possibly intersect the A5-polygon by means of M-lines
- Intersect two closed polygons and compute the overlay area with the line-overlay function
- retrieve the attribute data (a text point inside the polygon, point-in-polygon func.)

A-coverage

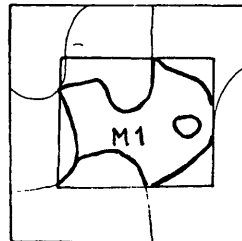
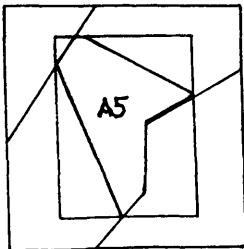


M-coverage

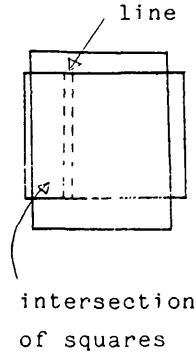


Computing the overlay area of A5- and M1-polygons with the line-overlay function

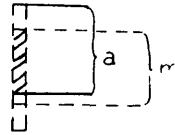
- compute squares around the A5- and M1-polygons



- compute the intersection of two squares
- use this overlay square to compute the exact area
- divide this square into narrow pieces (lines)
- intersect these lines to A5- and M1-polygons
- catch the segments of lines which are inside A5- and M1-polygons
- compute the overlay area of line segments
- add all these line overlays and the result is the whole overlay area of A5-polygon



$Dx$



- $a$ ; a piece of line inside A5-surface
- $m$ ; a piece of line inside M1-surface
- $Dx$ ; width of line
- ; a part of overlay area (overlay of two lines)

### CONCLUSION

FINGIS software has been applied to terrain maps, geological maps, communal maps, forestry taxation, water resources management, cadastral and real estate surveys. These applications have shown that the FINGIS is a powerful, geographic information software tool. In pursuing follow-up development we shall devote particular attention to error correction that is user-friendly, cleaning programs on the polygon management, 3D functions and tabular data management.

The future use of GIS will be quite clear, but I guess the main question is: How to build up the integrated GIS application?