TIGRIS MAPPER
VIEWED AS A DIGITAL DATA CAPTURING TOOL
IN OBJECT ORIENTED ENVIRONMENT

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BIOGRAPHICAL SKETCH

Jagdish Mitter was an officer in the Corps of Engineers of
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he commanded various units, conducting Topographical/
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He got his M.S. (Geodesy) in June, 1981 and M.S. (Math)
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State University, Columbus, Ohio, (U.S.A.) in March 1985.
He joined the Geographic Information Systems Development
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Since then he has been actively involved in design/
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(IMA) and TIGRIS.

ABSTRACT

An ideal Geographic Information System (GIS) looks for
collection, storage, analysis and display of spatial and
non-spatial data with speed, accuracy and consistency. To
achieve this objective, Intergraph GIS has produced a
number of packages. To convert the graphic information and
digital images to a digital database, Intergraph has
successfully developed a software package called Mapper. It
is designed to take full advantage of the object-oriented
programming techniques and platforms offered by Intergraph.

Data definition and organization is handled by
Administrator. Three basic data categories that are used as
the building blocks in the data definition are themes,
composite features and base features. Base features are
point, line, area and oriented line base features and have
direct representation by virtue of their direct ownership
of topology. The user can define attributes, attribute

type and default values associated with each theme, composite feature and base feature.

Mapper, being in the Topologically Integrated GeogRaphic Information System (TIGRIS) family of GIS system products, can capture raster and topologically structured vector data at data entry time with a little or no post processing. With capabilities such as extensive error checking/analysis for data integrity and topological consistency, queued edits and feature validation; Mapper can meet a variety of data requirements for many disciplines.
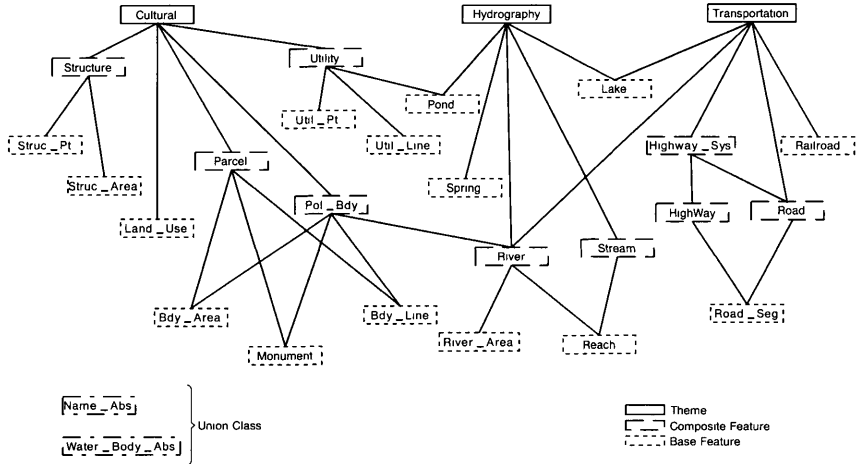
ADMINISTRATOR

Spatial data in GIS occurs in points, lines and polygons or areas that are individual entities and serve as building blocks for all landscape features. Three basic categories in which data is defined are themes, composite features and base features. Data definition and organization of these categories is provided through Administrator, which serves essentially as the front-end database setup for Mapper. The objective is to provide the Project Manager with the capabilities needed to graphically define the class structure of the data and generate all the files necessary for Mapper initialization and start-up. This class structure can be converted to a paper menu for operators to use while they digitize. The graphical representation of the data and relationships between data is called a schema (Fig:-1). Since the user determines the structure of the data, he can create a schema that is unique to his cartographic needs. Three categories are briefly defined as:

Theme: A theme is a complete coverage of a single characteristic of the earth's surface. Themes can directly own any composite feature or base feature, and composite features/base features can be members of more than one theme.

Composite Feature: A composite feature is a representation of a geographic feature. Composite features can be 'components of' other composite features and/or themes as specified in the schema.

Base Feature: A base feature is a representation of a simple geographic entity. Base features are homogeneous in that no attribute of the base feature may vary within the extent of the base feature. Base features are point, line, area and oriented line features. An oriented line base feature is the same as a line base feature except that it has direction. Base features have direct representation by

Fig: 1 Example of an Administrator Schema

virtue of their direct ownership of topology. Base features can be owned by themes and/or by composite features. They are at the lowest level of the schema.

ADMINISTRATOR CAPABILITIES

IGE Primitives:
Placement/manipulation commands, windowing commands and edit commands.

Attributes:
Attributes are characteristics of themes, composite features and base features. The user can define attributes, attribute types and default values associated with each theme, composite feature and base feature. He can define attributes through code lists and edit attributes. If the schema has several elements that require the same attributes, the user can create an attribute grouping that has all the common attributes and union the attribute grouping with either composite features, base features or other attribute groupings.

Define Default Symbology:
To ensure the symbology is placed correctly and to save the operating time and the effort of defining symbology for each geometry, the project leader can define default symbology for themes, composite features or base features for subsequent use in data collection in Mapper. Point

symbols can be defined and stored in a cell library for use whenever desired.

Dictionary Creation:
From the graphical depiction of the data, a compiled dictionary is generated for use in Mapper data collection. All or a portion of the data may be compiled into a dictionary, and multiple dictionaries may be generated. For instance, one may wish to provide one master schema but support several data collection environments, say one for each theme, and therefore would graphically identify those portions of the data to be compiled into separate dictionaries.

Bulk Loading of Attributes:
This option allows the user to load the attributes into the schema from an ASCII file.

MAPPER

The strength of any GIS system depends upon the efficiency of its data capturing techniques, input/output subsystems, manipulation and analysis of data. Mapper is designed for manual conversion of hardcopy maps and digital images to a digital database, by utilizing a wide variety of graphics placement, manipulation and modification commands. The digital database comprises a cartographic feature structure with features that may be held in any combination of topological graphics. TIGRIS Mapper offers a set of facilities for geometric and attribute capture, as well as editing and manipulation. As the operator uses these commands to trace the cartographic features of a hardcopy map on a digitizing surface, feature data is recorded in the database; and images of the features are displayed on the workstation screen.

Mapper allows the user to choose two kinds of graphics that display identically but differ in the amount of sophistication of data recorded in the database. The first kind of graphics is IGE vector graphics, consisting of point, linear and area elements. For these elements the database records the x, y and z coordinates of input points and such simple symbology as color, line weight and line style. However, the database does not record attributes or retain any sense of element structure or spatial relationships.

The second and more intelligent kind of graphics is attributive, topological graphics created by the feature digitization capability. Each point, linear and area base feature so placed is defined in the database in terms of

its place within the feature and in terms of topological structure. The feature structure makes it possible to record attributes both at the base feature level and at a higher composite feature level. Topological structuring makes it possible to automatically record the spatial relationships among digitized features for the purpose of spatial analysis.

The user interface is simple icon-driven and reduces the need for the operator to have extensive training or system knowledge.

Mapper Platforms:

The workstation platforms on which the Mapper is built primarily consist of the following:

o **Object Manager (OM):** For definition of object classes, instance data and the methods they possess;

o **Query Subsystems:** For the definition of dynamic classes and instance data, and an SQL language interface to locate and extract information from these classes;

o **The IGE and I/Draft Development Platforms:** IGE element placement/manipulation, windowing and edit commands.

o **The Topological Platform (TOPO):** It defines a set of general classes for maps; themes; composite features; base features; relationships of point, line and area map features; and a set of feature classes to hold the geometric definition of these in a topological structure.

MAPPER CAPABILITIES

Coordinate Transformations:

Mapper is capable of supporting a variety of coordinate systems and provides the facilities to transform between them while maintaining topological integrity. Map projections, datum transformations and coordinate transformations provided in the Intergraph VAX-based World Mapping System (WMS) are supported by Mapper. It provides facilities for coordinate system definition, datum definition, single coordinate point readouts and feature placement with the coordinates of a secondary coordinate system.

Feature Placement:

This is a capability through which the operator can identify and manually digitize topological features already defined in the dictionary. Different digitizing modes, stream deltas and tolerances can be set before placing a feature. The user can store the commands in the system's memory in the order in which he wants to select; and by using the command stacking feature, he can suspend and resume multiple commands quickly without reselecting an icon.

Fig:- 2

The feature identification and placement process is carried out through the Place Feature Form (Fig:-2) and subforms. For operational convenience, options are provided for keying in class names, reviewing attributes of any feature class and placing a feature of the class already digitized. Change feature status and review attributes enable the user to have the appropriate class name or feature. He can query to find the attribute of a feature when the one displayed on the screen is not the one he wants or cycle through multiple features that have been found during a query for a characteristic attribute. The user can also select a theme, composite feature and/or base feature from a paper menu using the Paper Menu option.

While actually digitizing the feature, the user can borrow any digitized map feature or other graphic element. The borrowed feature becomes part of the geometric

definition of the feature he is digitizing as well as that
of the original. This capability can be useful when part of
a map feature, needed to be digitized, follows the
geographical outline of another. The user can also append
adjacent topological line segments to the feature being
digitized.

Define Class Symbology: This option works through a form
(Fig:-3) in the same way as define default symbology,
explained in Administrator.

Fig:- 3

Registration Setup:
Maps are two dimensional representations of topography;
therefore, there exists a direct translation of all
topographical entities into the equivalent elements of
planar geometry (i.e. points, lines or polygons). Hence,
they form one of the major sources of information for any
GIS database. Mapper allows the user to define a coordinate
transformation between a hardcopy or a raster image and the
mapping plane. The user can input control points and check
points and their standard deviations in the database,
digitize each control point several times and perform a
four- or six-parameter transformation to map the digitizer
surface to the design file coordinate system. Mapper
supports an inquiry process so that the residuals and the
parameters of the transformation may be studied and

iterated until the transformation is rejected or accepted. The user can edit the set up, control points and residuals lists. He also has the option to select the cursor shape and set/reset track areas.

Feature Edits:
A set of commands exists for the manipulation of data within the TIGRIS design file. These commands provide the workstation operator full control to enter, modify and maintain element and attribute data. Since TIGRIS correctly maintains all topological relationships automatically, the operator is free to concentrate on the correctness of the geometric and attribute data.

Attribute Manipulation and Ownership Options:
These capabilities apart from saving user time, enhance flexibility and operational efficiency. While editing features belonging to the same class, the operator can compare, review and copy the attributes of one feature to another. The change owner option enables him to attach a component to additional owners or detach from the current owner. With the connect to owner option the user can connect a base feature to an additional owner, whereas the connect to component capability allows him to connect a composite owner feature to an additional feature. A component can be a base feature owned by a composite feature in the feature structure or a composite feature, higher in the hierarchy.

Display and Reporting:
Mapper provides a variety of display and reporting capabilities to enhance the representation of TIGRIS data. The user can display, highlight or fill the geometry of themes, composite features, base features or the results of queries. All display symbology is user-defined. TIGRIS provides for the definition of display hierarchy rules that are applied when different features share topology. This permits the user to choose which classifications of information take precedence over others in the display. TIGRIS reporting facilities allow the user to define report formats for features selected by attribute or query. Users provide a representation of the content and appearance of a report through interactive methods prior to its generation.

Feature Validation:
To ensure quality control and digitizing standards, Mapper provides capabilities for validation of geometric and attribute data. Anomalies detected can be posted to a queue for subsequent review in the Queued Edit (QE) subsystem.

Attribute Validation: Mapper provides for verification of attribute data to the user through the build query, select set and select query options. Build query enables the user to build a query that searches for all the members of a class based on any combination of attribute values (composite or base feature). The data found like this may be placed on a queue, saved in a result set or input to a graphics command such as move or delete. The query itself may be saved for re-execution later. All or portions of the dataset may be queried. The select set and select query options provide the appropriate functions for reviewing sets or queries, copying sets to queues, outputting sets to graphics or re-executing queries. In addition, an interface to Structured Query Language (SQL) is provided through the SQL editor, which provides the operator with the capability to perform the standard SQL functions on the data such as update, select, etc.

Geometric Validation: This option locates digitization anomalies (errors) such as node mismatches, undershoots, overshoots and slivers. The user may invoke any combination of these anomaly detectors by specifying a UOR tolerance for each selection. The process may be run against the entire dataset or some portion defined by the user. Digitization errors found using the geometric validation are automatically sent to a queue called geometric anomalies. To review/edit the errors in the queue, the QE commands are used.

Queued Edit (QE): QE provides a means for viewing and manipulating a queue of data items. An item is a location in the design file that has been recorded in a queue, built by the attribute or geometric validation, according to a criteria defined by the user. The QE command displays the locations one by one for the user to view, and if necessary, edit with standard topological graphics placement and manipulation commands and make necessary changes in associated attribute values. QE also allows the operator to interactively create queues and subqueues, and define items to be stored in them.

Translate In and Translate Out:
Capabilities exist to translate IGDS/Relational Data Base (RDB) design files to TIGRIS design files or TIGRIS design files into IGDS/RDB design files. A capability exists to take IGDS/RDB into and out of IGDS/DMRS. TIGRIS design files can be generated from Neutral File Format (NFF) and vice versa (i.e. NFF to TIGRIS design file). Separate

translators are also available to support input or output to and from formats such as USGS Digital Line Graph (DLG) and Initial Graphics Exchange Specification (IGES).

CONCLUSION

It is evident that with Administrator the user can define and organize his data according to his requirements, and Mapper provides the capability to capture data with speed, accuracy and consistency. Object-oriented programming philosophy in the development of GIS software packages provides tremendous flexibility and capability to meet the future challenges of the dynamically changing industry.

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