

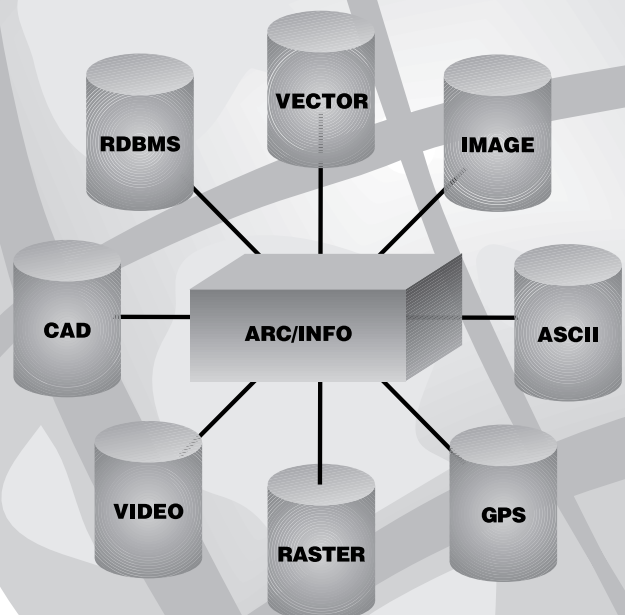
GIS by ESRI™

ARC/INFO®

The World's GIS



ESRI®
White Paper Series
March 1995



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ARC/INFO: The World's GIS

An ESRI White Paper

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ARC/INFO: The World's GIS

This white paper provides the basic information needed to evaluate ARC/INFO® software, the world's leading geographic information system (GIS). It explains GIS concepts and describes how ARC/INFO provides GIS solutions. When you have finished reading this document you will understand its underlying design philosophy, and know how ARC/INFO works and how it is supported and used.

ARC/INFO was developed and is supplied by Environmental Systems Research Institute, Inc. (ESRI). This white paper also describes ESRI's commitment to GIS and the organizational structure that supports ARC/INFO.

GISs are recognized today as useful and necessary tools, and are widely used in many organizations, public and private, around the world. Utility companies use them for facilities management. Businesses use them to better understand their customers, locate new facilities, and improve their operations. Delivery companies use them to route vehicles. Environmental scientists use them to manage wildlife. Police departments use them to study crime patterns.

As a user, as well as a supplier of GIS technology, ESRI is aware of the ever-increasing need for integrated systems. Future GISs must openly accept new functionality, flexibly adapt to virtually any application or technology, and present information through a sophisticated, yet easy-to-use, style of interaction. ARC/INFO is the world's GIS.

**ARC/INFO:
An Integrated
Answer**

In making a decision on implementing a comprehensive GIS solution, a number of questions are likely to be asked about the competing GIS systems and the respective companies that develop and support them.

**Which GIS Is Best for
My Applications?**

- Which vendor can offer me the most technically advanced product?
- Which vendor can provide me with the best technical and user support?
- Which vendor has the highest quality documentation and user education program?
- Which vendor has the largest customer installation base for sharing of data and ideas?
- Which vendor is most committed to research and development?
- Which vendor can provide the various components of my organization with the most integrated geoprocessing system?
- Which vendor can be most trusted to support my system over the long term?
- Which vendor leads the industry with technological breakthroughs?
- Which vendor has the greatest market share?
- Which vendor has the best reputation in the GIS industry?
- Which vendor is most stable financially?

This document describes the ability of ESRI and its ARC/INFO software to meet your requirements and more. In keeping with ESRI's commitment to technological advances and industry-leading geoprocessing breakthroughs, this document is written with special emphasis on how the latest enhancements to the ESRI® ARC/INFO software will satisfy your geoprocessing needs.

The Future of GIS As GIS becomes more widely used in many industries and organizations for an ever-increasing number of applications, it becomes more apparent that the system needs to be more integrated and less modular. Disparate applications must all function under the umbrella of a single, integrated system. The key to the future of GIS is the ability of the data model to openly accept new functionality and flexibly adapt to virtually any application. *ARC/INFO is the world's GIS.*

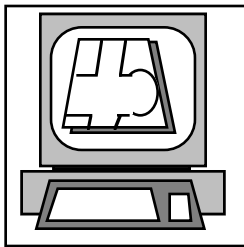
Five Parts of a GIS A GIS is more than just hardware and software. At ESRI, we believe these technologies must merge with data, people, and applications to make a fully functional geoprocessing system. ESRI provides more than just technology; we provide complete GIS solutions. The five parts of a GIS—applications, people, data, hardware, and software—also describe ESRI's commitment to GIS.

Applications Organizational needs define the goals of the GIS, and these needs vary from site to site. To be effective, the GIS must provide core functionality, yet be adaptable and extensible to the unique requirements of each application. ARC/INFO software's ARC Macro Language (AML™) capabilities allow for the development of simple and easy-to-use or sophisticated applications designed specifically for your organization, using your own terminology and procedures. Our off-the-shelf applications systems can help you to get started quickly in applications as diverse as redistricting or crime analysis. ARC/INFO software's open architecture allows for easy integration of custom applications written in external programs. ESRI offers custom software application development services to focus GIS precisely on your needs.

People ESRI is a highly skilled and dedicated group of people, educated and experienced in many disciplines. ESRI personnel resources are available to help your GIS personnel become experts. A complete training program, clear and concise documentation, and responsive technical support services ensure that your people thoroughly understand ARC/INFO and GIS, and can apply it properly to solve complex problems within your organization.

Data The geographic database is the most expensive and long-lived component of the GIS, thus making data entry a very important consideration. Because ARC/INFO integrates a variety of data types from a variety of sources, it provides multiple data entry options. ARC/INFO offers efficient data entry methods for automating paper maps and other nondigital data sources. To take advantage of the vast collection of geographically referenced data that already exist in digital format, ARC/INFO provides the most comprehensive data conversion capability of any GIS on the market. ARC/INFO software's integrative capabilities also allow data sharing with other applications without the need for data conversion.

Hardware ARC/INFO software's hardware independence offers you several distinct advantages. Hardware independence lets you choose the computer platform that best meets the needs of your organization by allowing you to take advantage of your existing hardware investment or giving you the freedom to choose a new system based on your requirements, such as performance, expandability, support, cost, and so forth.



- ARC/INFO software runs on PCs, engineering workstations, and minicomputers *using native operating systems*.
- ARC/INFO software runs on more hardware platforms than any other GIS including Sun, Hewlett-Packard, IBM, Digital Equipment Corporation, Silicon Graphics, NEC, Data General, and others.
- ESRI has established reseller relationships with hardware vendors, allowing us to propose complete turnkey GIS systems if you desire.

Software While the investments in applications, people, data, and hardware far exceed the investment in software, the software ties these other components together. ESRI's software serves as an integrative force in an organization, allowing multiple and scattered sources of information to be accessed from a single workstation using one software system. The ESRI product line includes ARC/INFO, ARC COGO™, ARC TIN™, ARC NETWORK™, ARC GRID™,

ArcExpress™, ArcStorm™, ArcScan™, ArcPress™, ArcView®, Avenue™, ArcCAD®, and PC ARC/INFO® software. In addition to off-the-shelf technology, ESRI offers a full suite of software services to meet the specific needs of individual clients. ARC/INFO adheres to industry standards and open systems, and is designed to keep pace with technological and organizational trends.

GIS Trends

At least once a year, ESRI releases an ARC/INFO revision to provide enhancements requested by ARC/INFO users, and to incorporate appropriate new technology and functionality designed and developed by ESRI's renowned software engineering group. *Trends* in the computer industry, in general, and the GIS industry, in particular, also influence ESRI's decisions to release revisions of ARC/INFO.

Advances in Technology

Technological advances—such as the dropping cost of computer power, new developments in workstation and network architecture, advances in graphic user interface technology, the move toward an instrumental universe, and the adoption of new industry standards—give GIS more power and versatility to solve problems. Recent advances in desktop computer technology have brought sophisticated software within the reach of many more people. ESRI has developed new geoprocessing tools designed to take advantage of the latest technology, and to bring sophisticated GIS capabilities to your desktop.

Complex Problems

With the maturation of GIS technology and the realization of many new sophisticated uses for it, GISs are continuing to solve very simple problems, but increasingly are also expected to solve more *complex problems*.

Data Variety

GIS users take advantage of many types of data to solve these complex problems—not just multiple vector data types (such as DXF, DLG, and TIGER), but other types of data (various raster files, scanned documents, satellite images, video images, etc.). It is apparent that GISs must employ a *wide variety of data*.

Data Volume *Data volume*, along with data variety, is also increasing. The amount of data in the world is growing at an explosive rate. Large and varied data sets are required to solve more complex problems. GISs create data and must also use existing data from a wide variety of applications.

ESRI Software Philosophy

While industry trends influence ESRI's software development decisions, the most influential factor is our users. At ESRI, our users are our most important advocates and sources of ideas. When they ask us for enhancements to ARC/INFO software, we respond. As a privately held company, ESRI considers its users to be its stockholders and its most important asset.

ESRI's philosophy is to provide our users with the types of technologically advanced geoprocessing tools they need to get their jobs done. ESRI's continued success in the global GIS market can be attributed to a number of factors that spring from this philosophy.

- ARC/INFO software engineering is based on open systems and enables adaptation to technological trends, allowing you to take advantage of the latest technological developments.
- ARC/INFO combines a simple data model with a highly sophisticated set of geoprocessing tools, thus providing you with the most advanced geographic modeling and analysis capabilities available in the GIS market.
- ARC/INFO software's simple, yet practical, data model integrates many types of data—raster, vector, image, CAD, tabular, surface, and video—providing you with a single geoprocessing system performing the functions that require a number of separate products from other vendors.
- ARC/INFO software's sophisticated tools for development of application macros enable it to adapt to almost any requirement, giving you an easy avenue for developing and customizing the software to suit your specific needs.

- ARC/INFO adheres to industry standards, letting your GIS talk to, and work with, other standard applications.

ESRI's commitment to research and development is unequalled in the GIS industry. As an ARC/INFO user, you not only have access to breakthroughs in GIS technology before anyone else, but you also play an important role in the development of these breakthroughs.

Open, Evolutionary, and Adaptive

ARC/INFO is designed to be open and evolutionary. Based on proven technology but highly extensible, ARC/INFO incorporates new technologies as they develop. Careful, sophisticated, and highly structured software engineering has allowed us to revisit and advance the data model, functionality, and user interface of our product.

Toolbox

ARC/INFO continues to prove itself adaptable to highly varied user requirements and current technology trends. The ARC/INFO toolbox, a generic non-application-specific approach to GIS, allows ARC/INFO to adapt to virtually any situation.

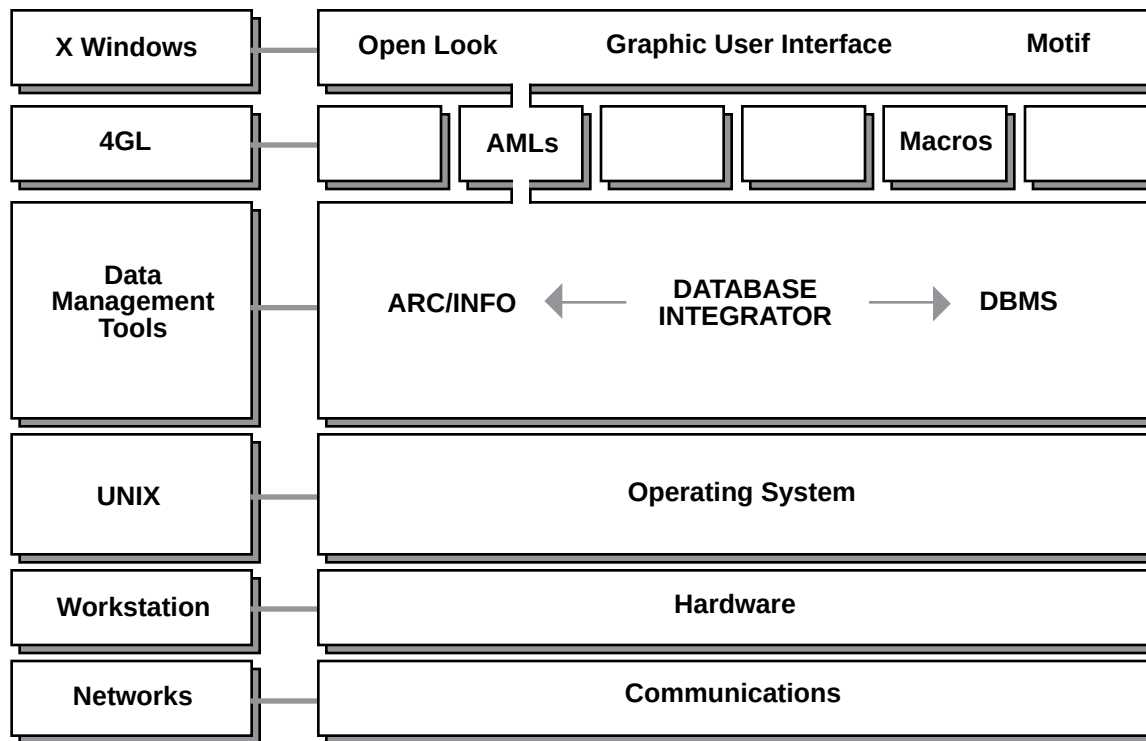
Specific applications for almost any organization can and are being developed by ESRI and our cooperative business partners, using ARC/INFO software's comprehensive collection of tools. Moreover, these organizations all benefit from the uniform implementation of the ARC/INFO system.

Integration

ARC/INFO software is both *integrative* and *integrated*. ESRI strives to make ARC/INFO an *integrative* tool within organizations. A common GIS database used for multiple purposes has proven to be a cost-effective approach to multidisciplinary problem solving. ARC/INFO is also designed to be an *integrated* set of tools, allowing the user to perform varied functions from within a single, common geoprocessing system. Optional features are implemented as fully integrated extensions to the core package.

Standards

ESRI sees standards as important because they give you more opportunity to choose among technical alternatives and preserve investments in data and expertise. Standards are advantageous to us



as well because they ensure that software will be extensible into the future. Standard interfaces enable ARC/INFO software to work seamlessly with other products. ESRI adheres to relevant industry standards, and has played an important role in establishing now-recognized standards where none previously existed. For example, ESRI developed the vector product format (VPF) data format for the Defense Mapping Agency.

ESRI supports *all* standards applicable to GIS, and ESRI personnel are members of the national and industry-based committees that develop many of the standards. ESRI has been influencing and designing standards for GIS for longer than most other GIS vendors have been in business.

Research and Development

Emphasis on research and development is the key to the long-term viability of GIS software. Without a strong commitment to research and development, the software cannot grow as fast as the needs of its users. At ESRI, we do more than stay current with industry trends and standards; we create them. With ARC/INFO, GIS users have the opportunity to use and apply sophisticated tools that will not be available from competing software packages for months or years. Every year, ESRI dedicates approximately 20 percent of its total revenue to research and development. ARC/INFO was the world's first commercial GIS, and ESRI is committed to maintaining ARC/INFO as the GIS leader through the most comprehensive research and development program in the industry.

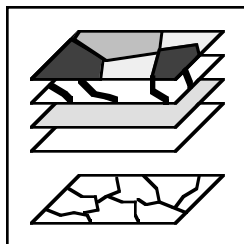
Software Engineering

ARC/INFO software is founded on machine independence and runs equally well on any platform. This is why ARC/INFO runs so well under so many different operating systems on so many different computers, from PCs to workstations and from minicomputers to mainframes. ARC/INFO is *fully optimized for each supported hardware platform* and takes advantage of variations in specific hardware vendor implementations of the UNIX operating system.

Summary of ESRI's Software Philosophy

ESRI's software philosophy has resulted in a superior product that has withstood the tests of time and competition. This is apparent when considering the role that ESRI's research and development efforts play in defining major new directions in GIS technology, and considering the ease with which these enhancements are implemented in the ARC/INFO data model.

Data Models



The backbone of ESRI's ARC/INFO GIS is the data model. ARC/INFO is based on a georelational data model, which abstracts geographic information into a series of independently defined layers or coverages. This approach borrows heavily from the concepts of a relational database management system (RDBMS). The integration of ARC/INFO with numerous leading RDBMSs further extends the strengths of the georelational data model. In this section, the concept of a data model is introduced and its importance explained. The ARC/INFO data model is then defined in more detail.

Data Models versus Reality

A data model is a *formal* system, in which a set of precisely defined objects can be manipulated in accordance with a set of precisely defined rules, without any regard for the "meaning" or real-world interpretation of those objects or rules. Reality is an *informal* system, a system of immense complexity. The difficulty in defining a comprehensive and useful data model is to find a formal system whose behavior mimics the informal behavior of the real world as closely as possible.

The GIS Data Model

A GIS is a formal collection of spatial operators that act on a spatial database in order to relate the user to the real world. A GIS models geographic reality, specifically those aspects of interest to an application. An accurate data model enables display and analysis of geographic reality in ways impossible without a computer. A GIS data model must represent and relate both graphic and tabular data. In addition, a GIS can be used to simulate extremely complex real-world events and situations. This complexity puts an even greater strain on the formal GIS model to accurately imitate the informal behavior of reality.

The ARC/INFO Data Model

The basic ARC/INFO data model is generic and very simple—it describes abstract geographic features—points, lines, and areas—whose attributes are kept in relational tables. The ARC/INFO data model is a hybrid georelational data model based on a cartographic database. Data are stored using a topological data structure in a collection of coverages. Coverages are basic units of vector data storage and can represent several types of geographic features.

The power of ARC/INFO can be attributed to the strength and flexibility of the data model. Each ARC/INFO application builds a specific data model on the base generic data model. For example, a transportation application specifically models roads using the generic line data entity.

A detailed description of the ARC/INFO data model can be divided into the following specific areas:

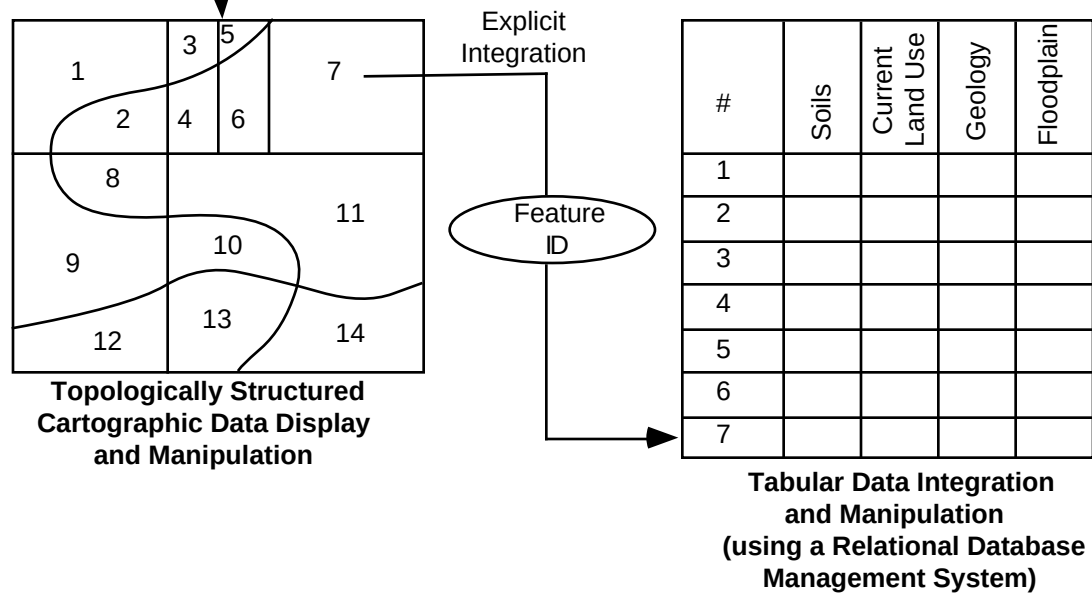
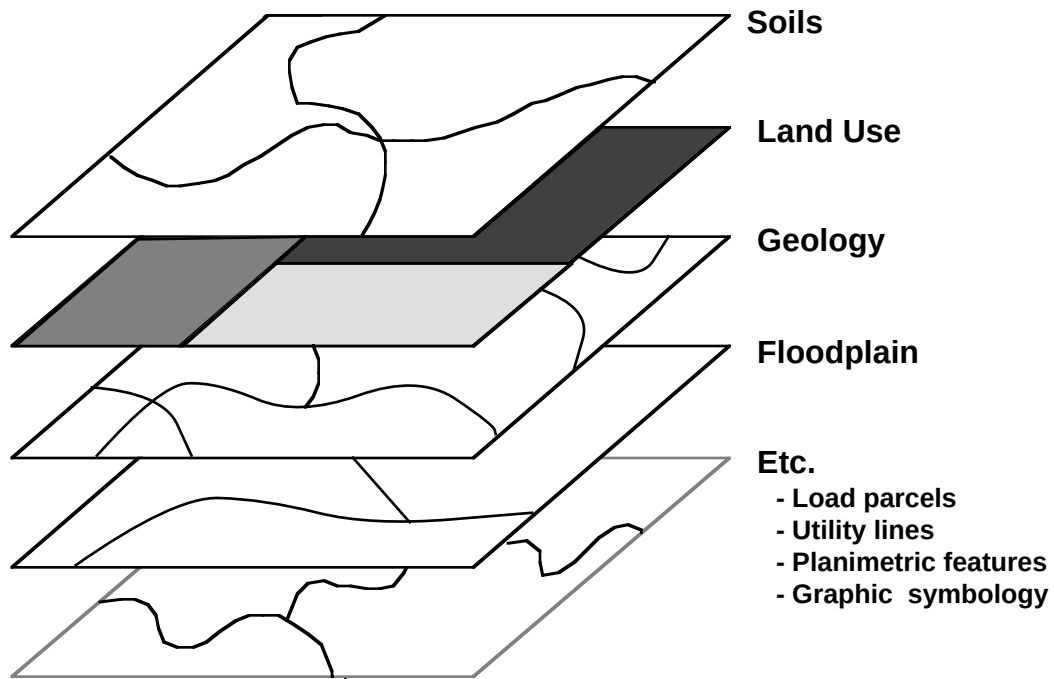
- Cartographic database
- Georelational data model

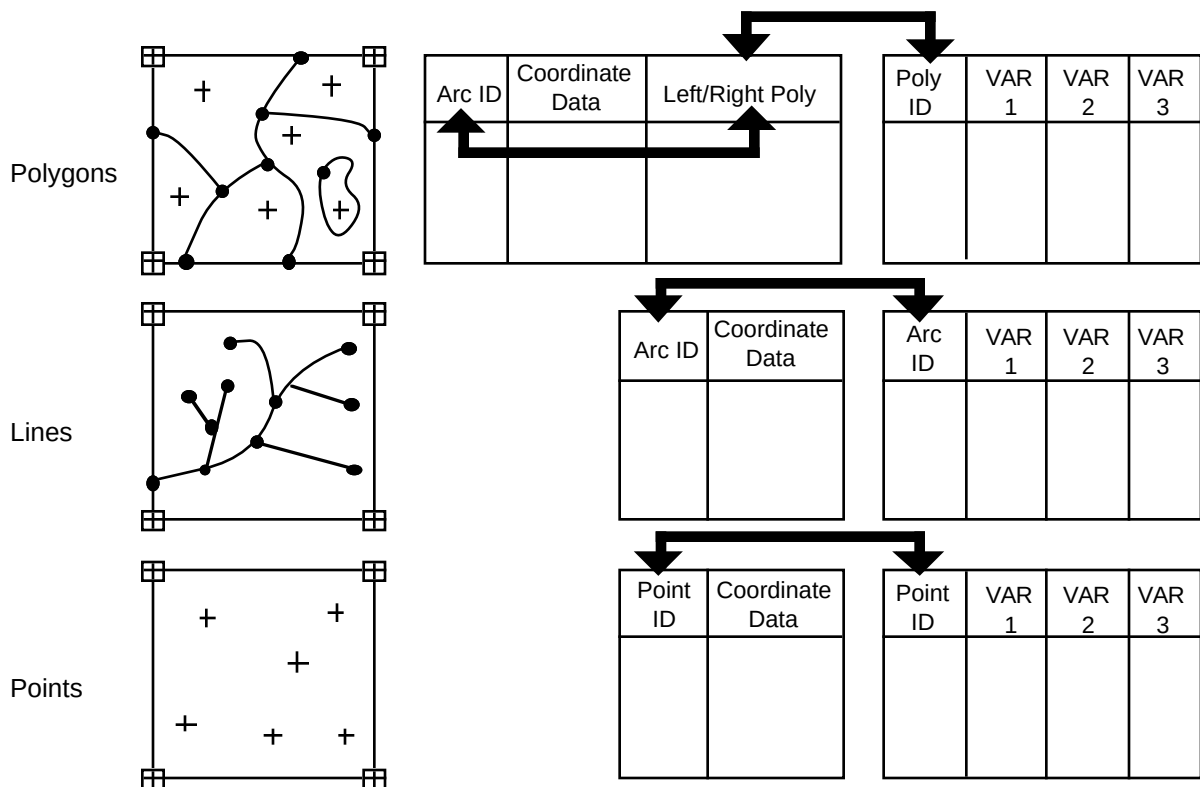
- Coverage concept
- Feature class concept
- Topological data structure
- Map library

In developing an understanding of the data model, it is important to keep in mind the basic definition of ARC/INFO; that is, the integration of graphic data and information. "ARC" is a generic term referring to *graphic* data. "INFO" is an abbreviation referring to *information* of many types, including vector data, tabular data, surfaces, video, raster data, scanned images, documents, and so forth. The acronym "ARC/INFO" refers to the integration of a variety of graphic and non-graphic data types and sources by a single geoprocessing system. ARC/INFO represents the integration of maps and all other "information" data sets.

Cartographic Database

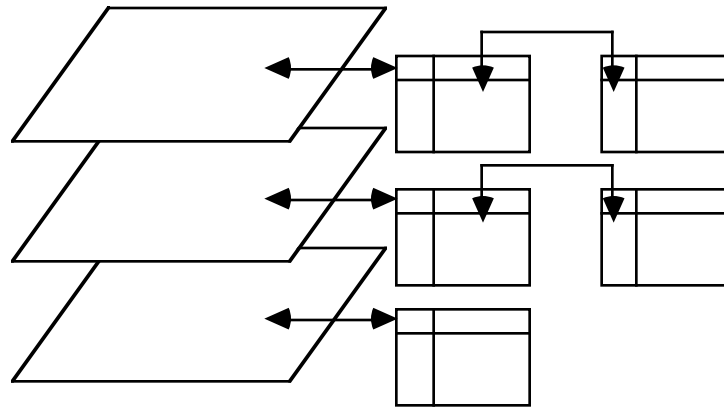
ESRI's ARC/INFO software is a cartographic database system built around a hybrid data model. It organizes geographic data using a georelational and topological model, as described in detail in the next two sections. This facilitates efficient handling of the two generic classes of spatial data: locational data, *graphically* describing the location and topology of point, line, and area features; and attribute data, the *information* describing the characteristics of these features. ARC/INFO software's cartographic database is a collection of spatial data and related descriptive data organized for efficient storage and retrieval by many users.





Georelational Data Model

The georelational approach involves abstracting geographic information into a series of independently defined layers or coverages, each representing a selected set of closely associated geographic features (e.g., roads, streams, and forest stands). With this approach, users can combine simple features in the data model quickly and flexibly to create complex feature sets representing complex relationships in the real world. This approach borrows heavily from the concepts of relational database management systems (RDBMSs), and is typically closely integrated with such systems.



The Georelational Model

ESRI has implemented an advanced georelational approach to GIS in its ARC/INFO software because it gives our users the most powerful and flexible data management and analysis tools available for working with geographic data. This georelational approach also allows the software to be used successfully for a broad range of applications.

Coverage Concept

The basic unit of data management in ARC/INFO software is the coverage, which defines locational and thematic attributes for map features in a given area. A coverage is a digital version of a single map sheet layer and usually describes one type of map feature, such as roads, parcels, soil units, or forest stands. The coverage concept is based on the topological model of geographic information and may contain several types of geographic information in the form of various feature classes of data.

Themes

A theme is a user's definition of a collection of geographic features. A theme references a data source; that is, an ARC/INFO coverage or an image file in one of several supported formats. A theme has a single feature class, either point, line, polygon, centroid, annotation, or image.

In a coverage, map features are stored as simple points, arcs, or polygons. The locational data about these features may be represented explicitly (as a series of x,y coordinates) or topologically (as a combination of other features). For example, city streets might be

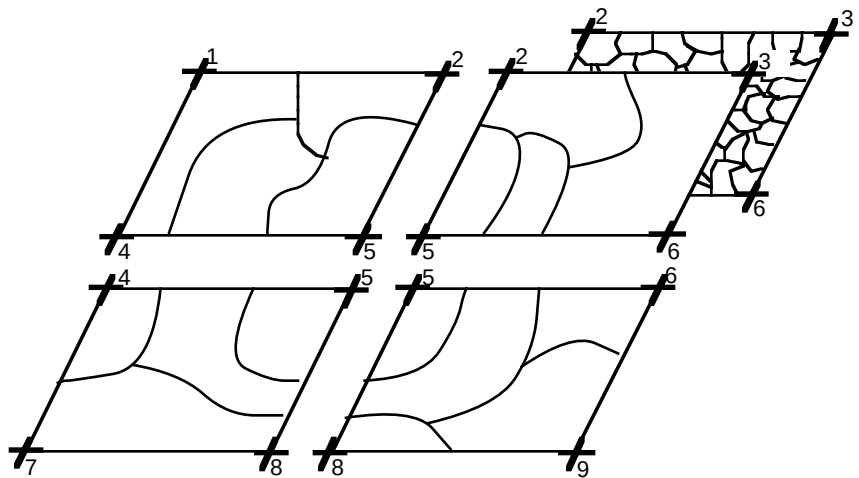
represented by a set of arcs and stored as sets of ordered x,y coordinates that define each street, whereas each city block might be defined by the set of streets comprising its border.

Feature Class Concept The feature class is the fundamental unit of the ARC/INFO geographic database. A coverage can contain several feature classes. A feature class represents a specific type of geographic data. Each feature class may have associated attribute tables. Each table defines the attributes, called *items*, for all features of that class in the coverage. Each individual feature has a record in its attribute table. The feature attribute tables are an integral part of the coverage and are processed by ARC for all ARC/INFO commands that affect the coverage. The basic feature classes used in ARC/INFO and the specific types of geographic information that they represent are summarized below.

- **Arc.** An arc is a continuous string of x,y coordinate pairs (vertices) beginning at one location and ending at another location, having length but no area. An arc is a digital line.
- **Node.** Nodes are the beginning and ending locations of an arc, and are topologically linked to all arcs that meet at the node.
- **Polygon.** A polygon is an areal feature topologically defined by the series of arcs comprising its boundary; it contains a label point inside its boundaries, and has attributes.
- **Label point.** Label points are used to represent point features (e.g., telephone poles, well sites, or mountain peaks), or to identify a polygon so that additional attribute information can be related to the feature.
- **Annotation.** Annotation is descriptive text used to label coverage features, is not topologically linked with other features, and is used only for display purposes, not for analysis.
- **Tic.** A tic is a registration or geographic control point.

- **Route.** A route is a linear feature on which attributes are defined or on which events are referenced. Routes are created along arcs by combining sections.
- **Section.** A section represents a whole or part of an arc.
- **Link.** Links are two-point segments that represent from- and to-locations in coordinate adjustment.
- **Coverage extent.** The coverage extent is the bounding limit of the coverage.
- **Regions.** Regions support the modeling of area features. Much like what route-systems do for linear features, regions provide greater flexibility in how you can represent area features. With regions, you can represent a single area feature as many polygons without having to duplicate attributes.

Common tics can be used to register adjacent coverages, as well as "layers" of coverages for the same area.



Topological Data Structure

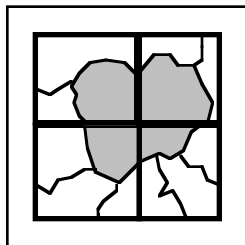
Topology is the spatial relationships between connecting or adjacent coverage features (e.g., arcs, nodes, polygons, and points). For example, the topology of an arc includes its from- and to-nodes (beginning of an arc and ending of an arc) and its left and right polygons. Topological relationships are built from simple elements into complex elements: points (simplest elements), arcs (sets of

connected points), and areas (sets of connected arcs). Redundant data (coordinates) are eliminated because an arc may represent both a linear feature (or part of a linear feature) and part of the boundary of an area feature.

ARC/INFO software explicitly represents all map features by sets of arcs and label points and as topological relationships between connected lines and points. For example, a polygon in ARC/INFO is defined by the set of arcs that makes up its boundary. In this case, an arc is the border between two polygons. Also, an arc could be part of a path connecting other arcs. For example, arcs can be used to represent streets and the routes that pass through them.

The relationships used to represent the connectivity or contiguity of these features is referred to as topology. By storing information about the location of a feature relative to other features, topology provides the basis for many types of geographic analyses (e.g., overlay connectivity and route finding are performed using topology).

Map Library



ARC/INFO users have two choices for spatial data management:

- Tile- or map sheet-based management using the ARC/INFO LIBRARIAN™
- Feature-based management using the ArcStorm extensions

The LIBRARIAN component of ARC/INFO provides a unique system for managing large cartographic databases, such as those covering a region, state, or country. LIBRARIAN employs a unique spatial library system for efficient insertion, storage, extraction, and overall management of geographic data. LIBRARIAN uses an internal spatial indexing system for partitioning geographic data into regions called tiles. These user-defined tiles may contain any number of geographic data sets (layers) with information describing the area and its characteristics.

Even though tiling a database divides it into physically separate pieces, ARC/INFO supports continuous databases with a new concept called

layer indexing. Layer indexing allows features split by a tile boundary to be grouped or treated as one entity if the user so chooses. Tile boundaries can be coded to be hidden. Layer indexing is supported for all ARC/INFO feature types and all ARC/INFO operations, such as tracing routes across the continuous map database. ARC/INFO manages layer-indexed data in a continuous map format. To the user, the ARC/INFO data appear to be in one data set. Layer indexing offers the functionality of a continuous map structure with the performance advantages of the partitioned map library structure. Indexed and partitioned layers allow a continuous database to be divided into a number of manageable components.

ARC/INFO software's "grout" capabilities establish cross-tile node/arc connectivity for a layer, creating coverage files in each map section that contain information about coincident nodes and node/arc indexes. These files are automatically maintained by ARC/INFO commands and enable sophisticated applications such as cross-tile network tracing.

What Is ArcStorm?

ArcStorm (Arc Storage Manager) is a storage facility and transaction manager for spatial information. ArcStorm is a feature-oriented, continuous geographic database that can be closely integrated with the same relational database systems supported by the ARC/INFO DATABASE INTEGRATOR™ (such as ORACLE, INGRES, INFORMIX, and SYBASE).

ArcStorm offers the following features:

- ***Feature-level transactions.*** ArcStorm manages data at the feature level. This means that if you only want to edit one feature, you can do that without preventing other users from editing data in the same area.
- ***Unified transactions (spatial and aspatial).*** ArcStorm coordinates the changes to feature (spatial) data and their corresponding external RDBMS (aspatial) data so that the database remains consistent.

- **Persistent locks on related records in external DBMSs.** Once an ArcStorm lock is placed on a row in an external DBMS table, that row is locked until the transaction is ended.
- **Recovery mechanism.** In the event that a failure of some sort occurs (system failure, DBMS failure, power outage, etc.), ArcStorm has a recovery mechanism that will return the database to its last consistent state.
- **Schema integrity always maintained.** Only the ArcStorm database administrator may modify the schema of the database.
- **Data archiving.** ArcStorm has a facility for maintaining the history information for the database. Changes to data are written to history records that can be reconstructed or viewed.
- **Client/Server architecture.** ArcStorm is built with a client/server architecture meaning it can be the data server for many clients, not just ARC/INFO.
- **A data definition language.** ArcStorm allows only the database administrator (DBA) to create libraries and layers and to include external attribute tables in the database.
- **ARC/INFO LIBRARIAN™ conversion tools.** There are tools for putting an ARC/INFO LIBRARIAN library into an ArcStorm database.
- **Direct Browse access for clients.** ArcStorm servers are not required to display or query the data.
- **Transactional access for ARC/INFO Version 7.0 (ARCEDIT™, ARCPLOT™).** Transactional access is required to make copies of data or to modify data.

Enhancements to the ARC/INFO Data Model

Recent enhancements to the simple yet robust ARC/INFO data model are detailed below. These enhancements extend ARC/INFO software's capabilities by adding functionality at the most basic level. Thus, they apply to all applications. The addition of such

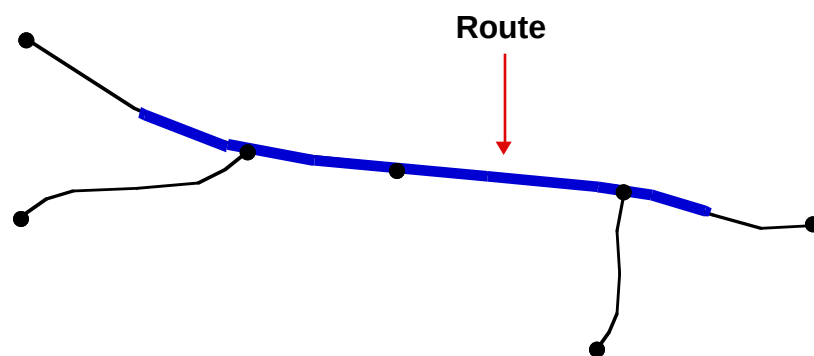
sophisticated features within the ARC/INFO data model without major re-engineering attests to the robust adaptability of ARC/INFO.

The evolution of the data model has made ARC/INFO more feature oriented, building on the basic point/time/poly primitives to allow data to be represented the way users see features.

Linear Geoprocessing: Dynamic Segmentation

ARC/INFO software includes a linear geoprocessing functionality that includes dynamic segmentation capabilities. Simply defined, dynamic segmentation allows you to assign attributes to *partial arcs*, which means it is not necessary to break a single, logical arc into many separate arcs just because the attributes change. Dynamic segmentation is a major breakthrough for GIS, affecting numerous applications, such as transportation modeling, multilayer basemapping, and utility management. Dynamic segmentation has revolutionized the way GIS is used for processing, managing, and analyzing linear features.

A *route* can be thought of as a linear feature on which attributes are defined. A route defined on a set of arcs can have its own method of measuring and positioning attributes or events on it. The measuring system is basically a linear method consisting of a start measure and values along the route. The values defining this measuring system are referred to as *measures*.



The graphic above shows a route defined on a set of four arcs. The start and endpoints of the route do not have to coincide with the start and endpoints (nodes) of the arcs.

The attributes associated with any segment of a route are known as *events*. A *route system* is a collection of routes and sections defining multiple linear features having the same attributes and a common system of measurement.

A *section* represents a whole or part of an arc without adding any pseudo nodes. *Routes* can also be thought of as linear features on which events are referenced.

Raster Extensions

ESRI offers a fully integrated software product to allow more sophisticated handling of raster data. ARC GRID adds raster modeling and management capabilities to the ARC/INFO data model.

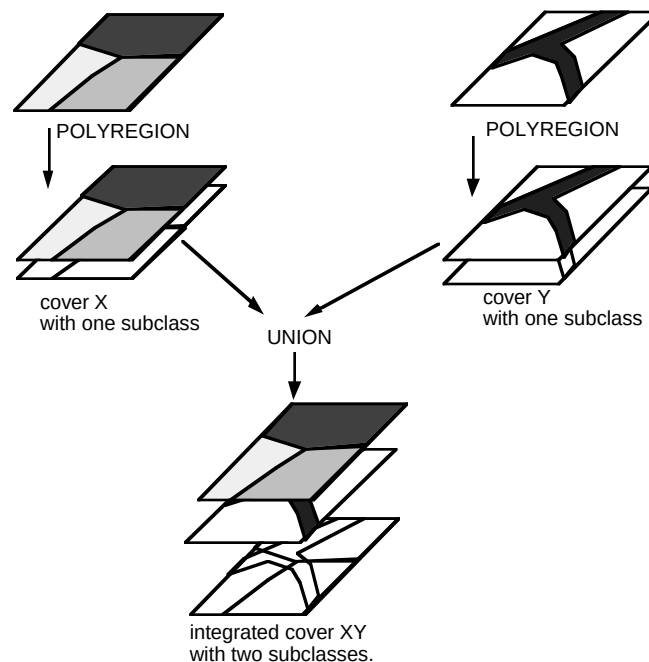
Regions

Many GIS users have been faced with a requirement to handle overlapping polygons in a single coverage. Core support for overlapping polygons in ARC/INFO has been implemented with the feature class called "region."

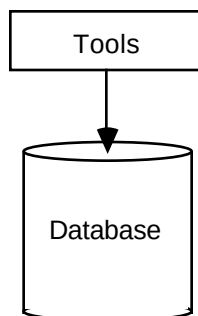
A region covers the area of one or more possibly nonadjacent polygons. Regions may overlap. Regions allow nonadjacent polygons to be handled as a single object.

Regions are a complex feature type that have a one-to-many relationship with polygons. Sets of regions with similar attributes are stored as a subclass. A region may belong to only one subclass, and a subclass can have many regions.

The regions data model maintains a direct region-polygon relationship, and a direct region-arc relationship.



ARC/INFO Data Model Summary



More complex and rigid data models impose greater restrictions on the data, which can severely limit the potential for diverse modeling and analysis applications. In implementing a simple and open data model, ESRI has given ARC/INFO software more extensibility and adaptability than any other GIS. The data are stored as simply as possible, while still retaining all necessary information for modeling and analysis. The sophisticated and comprehensive tools in ARC/INFO make the combination of data possible for advanced modeling and analysis.

Data Types

On top of its strong capabilities for the input, management, and analysis of geographically referenced information, ARC/INFO is also used as the data integrator within organizations. ARC/INFO integrates a number of types of data including image and raster data, vector data, tabular DBMS data, survey descriptions, and triangulated irregular network (TIN) surfaces. All of these types of data are accessed through ARC/INFO software's common user interface.

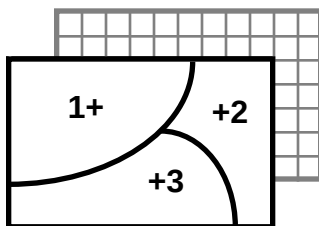
Image and Raster Data

Raster images encountered in geographic applications are grouped into two classes: (1) those that are associated with features in a geographic space of interest, such as a scanned architectural drawing of a building represented as a point feature in a coverage, or an oblique photograph from a vista point along a road represented as a linear feature in a coverage; and (2) those that occupy the geographic space of interest, such as an aerial photograph, a satellite image, or a scanned topographic map.

ARC/INFO software's IMAGE INTEGRATOR™ tool allows users to display raster images in several supported image formats. IMAGE INTEGRATOR is included with the core ARC/INFO software. The GRID extensions are available as an option for ARC/INFO users who need raster data management and modeling capabilities. ARC GRID includes a powerful set of GIS analysis and management tools and a modeling language. GRID offers more advanced raster manipulation functionality than any other raster GIS on the market today.

Some external DBMSs can store image and document files in the database in a data type known as binary large object (BLOB). A BLOB is a byte or text string of data stored as a column in a database row. In ARC/INFO, BLOBs are used to store large image or textual data files as attributes. Storing image data in the external DBMS tables provides a powerful and flexible method for building a mixed media attribute database. Images, documents, text information, and CAD drawings are all stored as attributes of geographic features in one location, the DBMS.

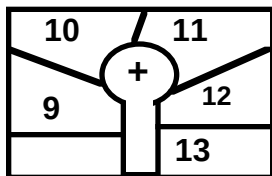
Vector Data



Vector data, originally the core ARC/INFO data type, have become just one of many supported data types. However, vector data are still extremely important, and ESRI places much emphasis on enhancing ARC/INFO software's vector data handling capabilities. For instance, ARC/INFO integrates CAD and GIS, which have fundamentally different data structures. CAD data are vector data without topology, and need special handling when brought into a GIS. ARC/INFO supports two-way data transfer with any CAD system that supported an intermediate file format, such as DXF or IGES. Recently

introduced commands allow two-way conversion of binary data between ARC/INFO and Intergraph IGDS format.

GPS and Survey Data



The ARC COGO extensions to the ARC/INFO software use survey description data to support coordinate geometry applications. Operators allow survey data from electronic field data collectors to be brought into COGO.

GPS data capture has exploded, increasing the availability and reducing the cost of gathering GIS data. GPS coordinate and related attribute data can be easily incorporated into ARC/INFO databases.

Tabular Data

Arc #	Left Poly #	Right Poly #
1	1	2
2	3	1
3	2	3
4	2	4
5	4	3
6	1	4
7	3	5

With ARC/INFO software's DATABASE INTEGRATOR™ component, tabular data from multiple external industry-leading DBMSs are accessed directly from ARC/INFO. DATABASE INTEGRATOR is embedded in the ARC/INFO core. External tabular data are not translated into an intermediate format, but are *directly accessed in their native format*. Users can simultaneously access multiple external databases, even across networks, stored in different DBMSs. In this way, ARC/INFO accesses ORACLE, INGRES, INFORMIX, SYBASE, DB2, SQL/400, Rdb, DB2, SQ4DS, and other DBMSs. ARC/INFO offers you more advanced and flexible tabular data access capabilities than any other GIS.

Surface Data



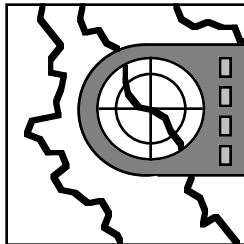
The ability to represent regularly and irregularly sampled surfaces is a fundamental component of the ARC/INFO data model supported by the ARC TIN extensions to ARC/INFO. There are no data size limitations on TINs, which can represent structural information, such as breaklines, and the TIN lattice surface representation has the same physical data structure as a GRID, such that lattices can be efficiently handled without any conversion by both TIN and GRID. Analytical and surface display capabilities in TIN are *fully integrated* with the rest of ARC/INFO.

ARC/INFO Tools

ARC/INFO software provides a rich set of tools for the entry, analysis, manipulation, and management of data. Special tools in ARC/INFO support custom application building and cartographic production.

Data Entry and Edit

ARC/INFO includes a comprehensive set of data entry and data editing tools to create data in the topological format required for GIS.



- **Tablet digitizing.** ARC/INFO provides tools for capturing points, lines, and polygon outlines by tracing features on a digitizer tablet.
- **Heads-up digitizing.** ARC/INFO software's IMAGE INTEGRATOR provides you with the capabilities needed for creating a vector coverage by tracing features over background vectors or a raster image on the screen.
- **Scanning.** The ArcScan extensions provide interactive raster-vector editing capabilities for ARC/INFO.
- **Key entry.** ARC/INFO can accept key entry of coordinates or programmatic entry of coordinates from existing files. Acceptable formats include traditional x,y coordinates, relative coordinates, polar coordinates, and address coordinates.
- **Photogrammetry.** Stereoplotter x,y, and z coordinates can be input into ARC/INFO.
- **COGO total station data recorders.** Field data from total station data recorders can be input into ARC/INFO to create coordinate geometry vector sets.
- **Global positioning system (GPS).** Coordinate data and corresponding attributes collected by GPS receivers are easily entered into ARC/INFO.
- **RDBMS tools.** Screen forms and data loaders are a versatile way to make tabular data accessible to your GIS.

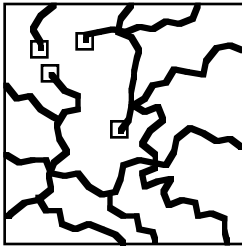
- **Data conversion.** ARC/INFO accepts more than thirty-five industry-standard and government-supported data formats.

The tools available in the ARCEDIT component of ARC/INFO increase productivity in data entry and edit operations. Symbology and background data can be used to increase operator comprehension and efficiency. The user opens multiple graphic display windows to display different views of the same coverage. Commands in ARC COGO create coverages from files downloaded directly from field data ARC collectors. CAD data can be easily brought into ARC/INFO using an intermediate format such as DXF or IGES.

Data Analysis ARC/INFO software is known throughout the world for its extensive analytic capabilities. The heart of ARC/INFO is its set of sophisticated geographic modeling tools and its ability to generate reports and display the results of analysis. Vector spatial analysis tools include topological map overlay, map manipulation, buffer generation and proximity analysis, polygon dissolve and eliminate, spatial and logical query, sophisticated tabular analysis, address geocoding, three-dimensional surface modeling, network analysis, and more.

The general classes of geoprocessing tools available in ARC/INFO are

- **Contiguity tools.** Contiguity tools find the adjacent areas that are within a given distance of a set of specified areas. Districting is an example of a contiguity tool.
- **Coincidence tools.** ARC/INFO provides a number of spatial coincidence tools for sophisticated data analysis. These operations create new data relationships as you need them.
 - Polygon overlay
 - Point and line overlay



■ **Connectivity tools.** The ARC NETWORK extensions to ARC/INFO provide a number of tools for analysis and management of data representing linear networks.

- Routing
- Allocation
- Address matching
- Dynamic segmentation

■ **Surface modeling.** The ARC TIN extensions to ARC/INFO provide a suite of tools for the analysis and management of surface data.

■ **Logical expressions.** ARC/INFO uses a complete set of logical expressions for the analysis and modeling of geographic attribute data.

- Boolean operators
- Logical operators
- Arithmetic operators
- Raster modeling operators
- Tabular analysis capabilities
- SQL capabilities

■ **Raster modeling.** ARC GRID is a set of raster-based geoprocessing tools for applications from simple queries to complex grid cell analysis and modeling.

- Arithmetic operators
- Boolean operators
- Relational operators
- Bitwise operators
- Combinatorial operators
- Logical operators
- Accumulative operators
- Assignment operators
- Trigonometrical functions
- Exponential and logarithmic functions
- Reclassification functions

- Selection functions
- Statistical functions
- Focal functions
- Zonal functions
- Distance functions
- Combinatorial functions
- Conditional statements
- GRID management commands
- Geometric transformation functions
- Color model conversion
- Surface functions
- Shape analysis functions
- Data cleanup functions
- Data conversion functions
- Grid display functions

■ **Coverage processing tools.** The coverage processing tools provided in ARC/INFO enable the user to deal efficiently and flexibly with the myriad of data-related issues in development of the database.

- Edgematching
- Mapjoin
- Split
- Sliver removal
- Attribute verification

■ **Coordinate management.** ARC/INFO provides a complete coordinate management tool set. Projection information is stored, managed, and accessed as a standard part of the ARC/INFO data model.



- Projections
- Datum adjustments
- Transformations
- Coordinate precision
- Rubber sheeting
- Coordinate density control

■ **Miscellaneous tools.** A number of other types of tools for the analysis and management of data are included in ARC/INFO.

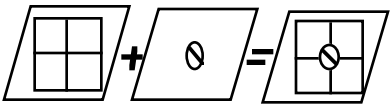
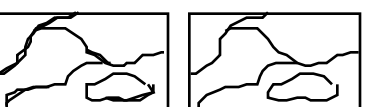
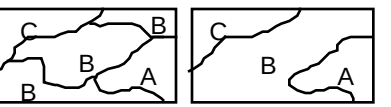
- Buffering
- Aggregation

■ **Query tools.** ARC/INFO provides an array of database query options.

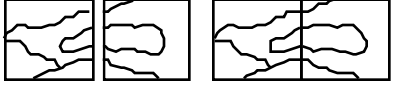
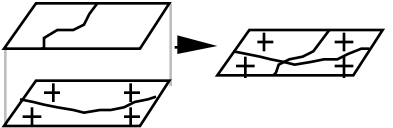
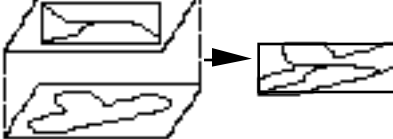
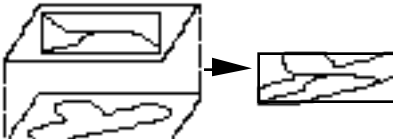
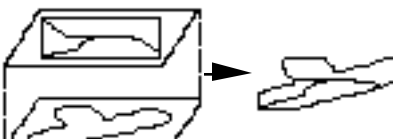
- Spatial query/Locational search
- Logical query
- Feature attribute search
- Visual inspection
- Graphic reporting
- Tabular reporting

A number of enhancements to ARC/INFO software's analysis and modeling capabilities have recently been implemented. All analysis functions can be performed on points, arcs, polygons, nodes, routes, and sections. ARC/INFO, which already has more projection and transformation options than any other GIS, has added a number of new projections and transformations. Product integration and a new state-of-the-art graphic user interface make the wealth of sophisticated tools in ARC/INFO *simple to use* and available to a wider audience.

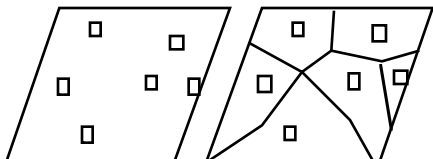
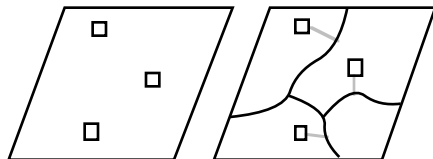
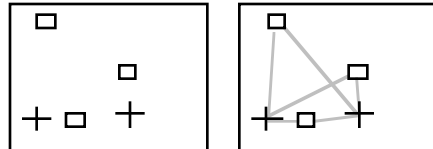
Summary of Spatial Operations Included in ARC/INFO

Type of Operation	Description	Command	Example
Coverage updating	Merge new features via a "cut and paste"	UPDATE	
	Erase part of a coverage before adding update features	ERASE	
Feature extraction (subset or reduce a coverage)	Cut out a piece of a coverage using a "cookie cutter"	CLIP	
	Split a coverage into a number of smaller coverages	SPLIT	
	Remove part of the inside of a coverage	ERASE	
	Logically select features to be kept	RESELECT	
Feature merging	Logically select polygons to be merged into a neighboring polygon	ELIMINATE	
	Drop borders between neighboring polygons with equal values for a selected item	DISSOLVE	

Summary of Spatial Operations (continued)

Type of Operation	Description	Command	Example
Merging adjacent maps	Merge adjacent polygons and rebuild topology	MAPJOIN	
	Merge the same feature classes from adjacent coverages	APPEND	
Appending coverages vertically	Merge various feature classes into a coverage to create new features (e.g., merge arcs and label points to create polygons)	APPEND with the NOTEST option	
Spatial join (merging feature attributes)	Overlay polygons and keep all areas in both coverages	UNION	
	Overlay points, lines, or polygons on polygons and keep all input coverage features	IDENTITY	
	Overlay points, lines, or polygons on polygons but keep only those portions of input coverage features falling within overlay coverage polygons	INTERSECT	

Summary of Spatial Operations (continued)

Type of Operation	Description	Command	Example
Buffer generation	Generate buffer zones around selected coverage feature	BUFFER	
Proximity analysis	Define area of influence around each point	THIessen	
	Find nearest feature	NEAR	
	Find distance between points	POINTDIST	

- Data Management** All vector data can be efficiently managed, a standard feature of the core ARC/INFO package. The concept of a tiled, continuous database is realized with the implementation of cross-tile relationships.
- ARC GRID and the IMAGE INTEGRATOR place emphasis on working with raster data within the ARC/INFO system. IMAGE INTEGRATOR provides image management. IMAGE INTEGRATOR can manage both organized collections of spatially referenced images and collections of related but not spatially referenced images.
- Custom Application Building** The AML caused a revolution in the way GIS applications are developed and in the way GIS is implemented in organizations. With AML, ESRI gave the GIS community the opportunity for the first time to create custom applications and menus. AML provides full programming capabilities and a set of tools to tailor the user interface of your application with features such as the capability to create on-screen menus with text files, a function to report on the status of the parameters of many ARC/INFO commands, and the ability to get and use map or page unit coordinates. AML includes an extensive set of directives and in-line functions that you can use interactively or in programs without leaving the ARC/INFO environment because AML includes its own processor that is independent of the host computer's command interpreter.
- Users can save specific startup parameters in an AML file, avoiding work environment setup procedures. The various components of the ARC/INFO system have the same interface, the same command structure and syntax, and the same terminology. AML is fully adapted to the graphic user interface (GUI) windowing environment. It offers use of icons, buttons, slider bars, and special GIS GUI extensions for map display. AML surpasses its competition with its native capabilities and offers exceptional ability to extend its reach.
- AML is a fully functional, fourth-generation programming language with facilities to use named variables, perform logical branching and loops, manipulate character strings and text, perform arithmetic and trigonometric operations, make calls and pass variables to other AML

programs, and perform selected GIS operations. It also provides capabilities to perform special terminal operations, and it controls the graphics environment for ARC/INFO software. The ARC GRID modeling language is fully integrated with AML.

You can build your own commands or programs that incorporate ARC or any of the subsystem commands, create menu interfaces, and set up your own hardware environment. In addition, many of the tools you build with AML can be shared by placing them in a common workspace that has a path name that can be specified by other users. In this way, you can reduce the number of copies of these tools in your host environment and standardize in-house procedures.

Cartographic Production

ARC/INFO has the computer mapping and display capabilities needed to generate high-quality cartographic displays. ARC/INFO software's database-driven graphics approach to GIS makes it the ideal tool for map production. All cartographic displays in ARC/INFO are based on the premise that features are drawn using symbols that aid in describing the feature, such as various road types being drawn with specific line colors, patterns, and widths. Features can be labeled with descriptive data about them, such as street names, school names, or lot-line dimensions. Cartographic appearance is based on the values in the database.

ARC/INFO offers a comprehensive tool set for cartographic production. Typeset-quality typefaces in a variety of fonts give maps the look of publication quality. ARC/INFO supports output to Scitex, PostScript, Adobe Illustrator, and numerous pen and electrostatic plotters. These output options provide access to an array of plotters and other desktop publishing software. Vector and raster data can be combined in a single map.

ArcTools: The ARC/INFO Graphic User Interface

The ArcTools™ graphic user interface makes ARC/INFO software easier to use. ArcTools has become popular both as an off-the-shelf interface and as a core technology for customization. A number of new features further enhance the power and utility of ArcTools.

The ArcTools User Interface

ArcTools is an AML-based GUI that provides access to much of the functionality available in ARC/INFO including data management, display and query, data automation, vector geoprocessing, and grid analysis. The ArcTools GUI is composed of sets of tools, each with their own interface, that represent individual ARC/INFO commands or sets of commands. In addition, ArcTools provides generic messaging and file browsing tools useful for general application development.

A tool includes three components: the menu interface, the macro that drives the interface, and a help file describing the operation of the tool. All tool menus follow standards based on the OSF/Motif, OPEN LOOK, and Microsoft guidelines for developing a user interface. Following these standards ensures a common look and feel between tools, making it easier for users to learn new tools as they are added to the tool set.

ArcTools is being used with great success at many ARC/INFO sites as a stand-alone GUI. Others are discovering the usefulness of ArcTools in building applications that require custom GUIs. Tools are designed to be stand-alone, allowing application developers to extract existing tools to be used in a custom application. Existing tools can also be modified to suit particular user needs.

Building and Modifying Tools

All tools included with ArcTools are written entirely with AML and follow coding standards created by ESRI. Adhering to these standards results in code consistency, allowing application developers to easily modify existing tools to accommodate specific user needs. The ArcTools Programmer's Guide contains a comprehensive set of ArcTools coding standards for developers who plan to modify existing tools or create new ones. The ArcTools coding style can also be mastered by referring to the many examples contained in the existing sets of tools provided by ESRI.

Access to tools occurs in one of two ways—through pulldown menu choices or scrolling lists. Although ArcTools is a powerful, stand-alone user interface for ARC/INFO functionality, its real utility lies in empowering users to build new tools or customize existing tools and attach them to the ArcTools interface.

The main ArcTools menu scrolling list provides access to ArcTools submodules—editing tools, map layout tools, grid tools, and vector geoprocessing tools. A choice added to this list could initiate a complete custom application, for example, an electrical facilities management system. In ARC/INFO Version 7.0, a sample property management application has been added to this list.

The main pulldown menu for each ArcTools submodule is easily customized by adding choices that access new or modified tools. There are scrolling lists of tools that can easily be modified to contain new tools. For example, the vector geoprocessing (command) tool list can be modified to exclude tools that are not needed, or modified to include choices for accessing application-specific tools.

ArcTools and FormEdit

FormEdit™, ARC/INFO software's graphical form menu editor, is an excellent tool for designing ArcTools user interfaces, as well as for modifying existing ArcTools interfaces. Many ARC/INFO users have found FormEdit to be the perfect tool for rapid prototyping of user interfaces for specific tools.

Parcel Management Tool

ARC/INFO Version 7.0 includes a "sample" parcel management application based on ArcTools standards. Specific parcel management tools include

- Generic applications for parcel entry and management
- Examples for creating and maintaining integrated parcel maps
- Sample data and documentation

This application includes tools for parcel entry and management, providing an example for creating and maintaining integrated parcel maps. It supports parcel management activities typically undertaken by local government officials, surveyors, and assessors. The application also includes sample data as well as documentation discussing application usage and database design. This documentation can help users create their own parcel management databases more easily. The sample data provided work with the new "regions" and ArcStorm functionality found in ARC/INFO Version 7.0 software.

Sharing ArcTools Applications

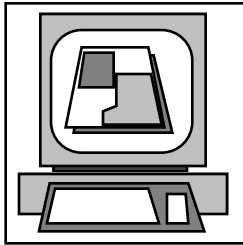
The ArcTools environment provides opportunities for both commercial developers and end users to build custom applications. Commercial products developed within the ArcTools framework will be marketed directly by their developers, and their availability may be announced in future issues of *ARC News*[™] as well as in other publications. End user applications from a number of ARC/INFO sites will likely become shareware. The ESRI-L discussion list on Internet and the ESRI forum on CompuServe are good places to let ARC/INFO users know about the availability of ArcTools applications you may develop. The applications themselves may then be posted to an anonymous *ftp* site, facilitating their dissemination among the user community.

Supported Hardware/Operating System Environments

ARC/INFO software is hardware independent, allowing you to choose your hardware systems. Hardware independence enables ARC/INFO to keep up with and take advantage of trends in computer technology. ARC/INFO isolates low-level functions, such as disk input/output operations and graphic screen display, into a limited number of routines. Software engineering of this sort allows ARC/INFO to work the same regardless of differences between computers.

Supported Hardware

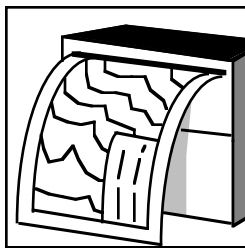
ARC/INFO continues to support more hardware platforms than any other GIS in the industry. ARC/INFO uses the native operating system of the hardware platform, such as vendor-specific implementations of UNIX. Running ARC/INFO on an unmodified platform gives you the widest range of choices and tremendous flexibility in implementing GIS in your organization. It also allows the GIS to easily run in conjunction with numerous other applications that are supported by the native operating system. In the case of the PC, for example, ARC/INFO runs under DOS.



Currently supported hardware platforms and operating systems include the following:

Hardware Platform	Operating System(s)
Data General AViiON workstations	DGUX
Dec AKP Workstations	OpenVMS
DEC [™] Alpha workstations	OSF
DECstation [™]	ULTRIX
HP [™] and HP Apollo [™] workstations (700, 8x7)	HP-UX
IBM [®] workstations (RISC System/6000 [™])	AIX
NEC [®] workstations	EWS-UX
Silicon Graphics [®] workstations	IRIX
Sun Microsystems workstations	SunOS, Solaris
IBM PC AT [®] and compatibles	MS-DOS [®] and Windows
DEC VAX [™] minicomputers	OpenVMS

Supported Peripheral Devices



ARC/INFO supports hundreds of peripheral devices through the support for standard input and output formats such as HPGL, PostScript, VCGL, and more. More are added at each new release.

Software Connections

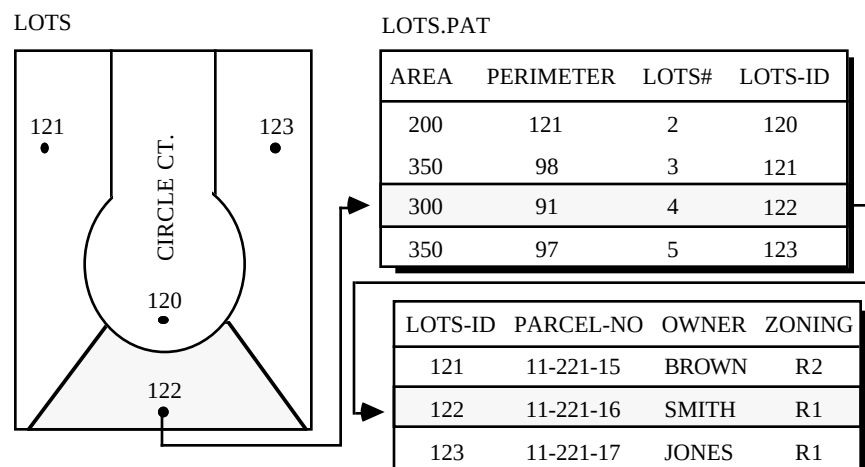
Connections to third party software are basic requirements of an integrative GIS. ARC/INFO software connections have been significantly enhanced in recent years.

Image Connections

ARC/INFO software's IMAGE INTEGRATOR tool allows users of a variety of image processing systems (and other systems that output raster or image data) to draw the data into ARC/INFO. The ERDAS Live Link allows both ARC/INFO and the ERDAS image processing system to access the same data files. Live Link allows you to instantaneously switch between the two systems.

Connections to Tabular Databases

ARC/INFO was the first GIS to offer open integration with a number of industry-standard commercial RDBMSs. With ARC/INFO, users can create, edit, manage, and analyze graphic data and link it to external RDBMSs. Tabular data can be stored completely within any one of the supported RDBMSs, or spread between different databases across networks as needed. Tabular data are accessed *directly* from the supported database and do not have to go through an intermediate database.



The DATABASE INTEGRATOR tool, part of the core ARC/INFO package, allows you to access SYBASE, ORACLE, INGRES, INFORMIX, and INFO, as well as Rdb on DEC VAX systems. Optional DATABASE INTEGRATOR connections allow ARC/INFO users to transparently access tabular data stored in DB2 format on IBM mainframes, and in SQL/400 format stored on IBM series AS/400 minicomputers.

ARC/INFO software's tool for accessing relational databases, the DATABASE INTEGRATOR, includes some powerful breakthroughs, including the following:

- **Generic interface.** DATABASE INTEGRATOR allows access to data in multiple DBMSs in a consistent fashion. All data are accessible through ARC/INFO software's OSF/Motif and OPEN LOOK AML-based menus and forms.
- **Native mode SQL.** DATABASE INTEGRATOR provides full functionality for the use of SQL statements in the form specific to the particular DBMS, that is, in *native* mode. In this way, users can still take advantage of the full power of DBMS vendor-specific enhancements to the SQL standard.
- **Client/Server model.** This state-of-the-art software protocol for exchanging data between processes is used to connect the ARC/INFO *client* program with multiple database management systems *servers*. DATABASE INTEGRATOR supports multiple, simultaneous, and independent RDBMS connections.
- **Cursor processing.** Cursor processing is ARC/INFO software's implementation of procedural SQL access to all DBMS data. Cursor processing is also supported in AML.

By taking advantage of existing RDBMS software, the GIS has a smaller impact on the existing organizational infrastructure. The user is not required to learn a new software, and the investment in RDBMS data is preserved. In addition, DATABASE INTEGRATOR works in a truly distributed fashion across networks and allows users to use *multiple RDBMSs* in a *heterogeneous* environment.

CAD Connections

ARC/INFO can exchange data with any CAD package that supports the intermediate file transfer, such as DXF, IGES, and so forth.

ArcCAD

For the ultimate integration of CAD and GIS, ESRI has developed ArcCAD. ArcCAD links the world's leading GIS software, ARC/INFO, to the world's leading CAD software, AutoCAD from Autodesk. ArcCAD removes limitations previously associated with

integrating GIS and CAD because ArcCAD is not implemented as a GIS built on top of AutoCAD, but as an extension of the AutoCAD data model to incorporate ARC/INFO GIS functionality. ArcCAD extends the AutoCAD data model for creating topological and spatial database relationships, and for communicating with entities of an AutoCAD drawing database.

ArcCAD is not an AutoCAD–ARC/INFO data translator, but a complete GIS that creates geographic data directly in native ARC/INFO format. This means that ArcCAD is fully integrated with the rest of the ARC/INFO product line. In addition to providing an integrated environment for traditional users of GIS and CAD, it also opens GIS technology to a variety of new applications.

The CAD "Drawing Reader" in ArcView

The CAD Drawing Reader enables the use of existing AutoCAD drawings as data sources for viewing in ArcView Version 2. One of the first extensions to ArcView Version 2, the Drawing Reader increases the complementary use of the ArcCAD and ArcView products. The Drawing Reader supports standard AutoCAD drawings as data sources for ArcView themes. It enables ArcView Version 2 to read AutoCAD Release 7 (Version 2.5) through Release 12 drawings in either .DWG or .DXF format. AutoCAD Release 13 native drawing format files can be accessed from the Drawing Reader by first using the "save as R12" function in Release 13. The Drawing Reader requires the user to have a copy of ArcView Version 2, but does not require the user to have AutoCAD or ArcCAD present on the system.

ARC/INFO Applications

The most important consideration at ESRI is the success of our ARC/INFO users. The real test of any software product is what users do with it. Thousands of ARC/INFO users have successfully used GIS to solve real problems all over the world.

Total GIS

Your application may view GIS as part of a greater whole. ARC/INFO software's support for standards and common interfaces enables ESRI to work in the total context of your application. For example, the DATABASE INTEGRATOR tool enables ARC/INFO to perform as one of several applications that access a central relational database. ESRI sees GIS as the integrator that allows disparate

information sources (e.g., vector, raster, image, and DBMS) to be brought together under a common framework for access and analysis. GIS is the only technology that supports this type of integration, and ESRI pioneered this way of looking at GIS. Realizing the integration capabilities of GIS means understanding the modern concepts of integrated spatial data systems, enterprise operations, federated databases, and meta data management.

The generic, nonapplication-specific approach of ARC/INFO to GIS, coupled with the powerful customization capabilities provided with AML, make it a flexible solution for a vast number of potential GIS applications. The AML and GUI tools make custom application development rapid and easier than ever.

Changing Applications

New GIS applications are steadily coming into existence. Similar organizations perform common applications differently. ARC/INFO can react to changing application requirements because the ARC/INFO software philosophy is not application specific. It is application independent, which allows specific user requirements from all applications to be put into the product development for general use by all. ESRI solutions are deeply rooted in user feedback, but are adapted to a wide variety of needs.

ESRI

ESRI has had a commitment to GIS since 1969. ESRI maintains financial stability through policies of slow, responsible growth, zero debt, private ownership, and cost control. Believing that client satisfaction is the only true measure of quality, ESRI is committed to improving products and services.

GIS is an effective way to respond to the demands of a growing and ever more complex world. We need to respond rationally, intelligently, and quickly to the land-related problems of today.

We believe that better information makes for better decisions. We contribute our technical knowledge, skills, and experience to the collection, analysis, and communication of geographic information and the development of GIS technology.

ARC/INFO increases productivity—it helps people get the job done by reducing the redundancy of data and work. It puts timely, accurate information into the hands of decision makers.

More than 70 percent of ESRI employees use ARC/INFO daily in services, in development, in support, or in product delivery. Dedicated GIS professionals with degrees in related disciplines comprise 50 percent of the staff contributing to ESRI products and services. More than 150 people have hands-on involvement with developing, testing, and writing ARC/INFO. We use it just as our clients do, so we know it works. We prove the quality of ARC/INFO daily—before clients ever see it.

ESRI offers the user the experience that comes from having the largest GIS install base in the world. No client has ever traded ARC/INFO software for another vendor's GIS software. ESRI is a \$160 million plus, worldwide GIS organization, and GIS is all we do.

ESRI Software Products	All ESRI software products are designed around a single, integrated data model. This enables each ESRI software component to seamlessly interact with the others. This emphasis on data interconnections enables ARC/INFO to adapt to stringent GIS requirements.
ESRI Documentation	The ArcDoc on-line documentation system is new to ARC/INFO at Version 7.0. It is designed to provide all users with quick, direct access to all the software documentation without having to leave their workstations. All ARC/INFO command references and concept manuals are provided on-line, while retaining all the information and much of the organization of the previously printed volume.
ESRI Training	The training curriculum is developed as part of each new release of ARC/INFO. The highly acclaimed <i>Understanding GIS—the ARC/INFO Method</i> workbooks provide an effective, self-paced, no-travel method of learning GIS and ARC/INFO. The "ARC/INFO Guided Tour," a menu-driven system included with the software, is an on-line program designed to help you get acquainted with ARC/INFO.

ESRI Technical Support As you implement your GIS, ESRI continues to support you with software updates and documentation. ESRI's technical support philosophy is simple: to provide our users with the information, support, and guidance they need to achieve their objectives with ARC/INFO. Our mission is to answer questions, resolve problems, inform you of new developments and enhancements, promote self-help, and listen to your needs and ideas. To accomplish this, our primary maintenance package includes the following features: technical support hot line, frequent software and documentation updates and revisions, *ARC News* subscription, the annual ESRI User Conference, and ARC/INFO user groups.

The ESRI Technical Support Group is staffed by experienced ARC/INFO analysts. Technical support analysts can answer your question on the first call 80 percent of the time. Our automated call tracking system ensures that more complex problems will immediately be routed to the proper expert within ESRI.

ESRI-L, a discussion list on the Internet, and the ESRI Forum on CompuServe also provide an invaluable technical support resource for users of ARC/INFO.

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ESRI Family of Products

GIS Functionality	Packaging	Product/Component
Core GIS functionality	Base ARC/INFO product	ARC/INFO
GIS graphic user interface	Included with base ARC/INFO product	ArcTools
On-line documentation	Included with base ARC/INFO product	ArcDoc
Map projections manipulation/mgmt.	Included with base ARC/INFO product	ARC/INFO
Polygon overlay and buffering	Included with base ARC/INFO product	ARC/INFO
Spatial data analysis	Included with base ARC/INFO product	ARC/INFO
Data conversion	Included with base ARC/INFO product	ARC/INFO
Data entry and edit tools	Included with base ARC/INFO product	ARCEDIT
Data display and analysis tools	Included with base ARC/INFO product	ARCPlot
Cartographic publishing tools	Included with base ARC/INFO product	ARCPlot
Plotter support	Included with base ARC/INFO product	ARCPlot
Geographic data management	Included with base ARC/INFO product	LIBRARIAN
Macro language	Included with base ARC/INFO product	ARC Macro Language (AML)
RDBMS access	Included with base ARC/INFO product	DATABASE INTEGRATOR
Tabular data management	Included with base ARC/INFO product	INFO
Image display and management	Included with base ARC/INFO product	IMAGE INTEGRATOR
Linear modeling	Included with base ARC/INFO product	Dynamic Segmentation
Interactive graphic menu creation	Included with base ARC/INFO product	FormEdit
Network analysis	Optional extensions to ARC/INFO	ARC NETWORK extensions
Raster modeling and management	Optional extensions to ARC/INFO	ARC GRID extensions
Surface modeling	Optional extensions to ARC/INFO	ARC TIN extensions
Coordinate geometry/surveying	Optional extensions to ARC/INFO	ARC COGO extensions
Display speed enhancement	Optional extensions to ARC/INFO	ArcExpress
Spatial data management	Optional extensions to ARC/INFO	ArcStorm
Scan digitizing	Optional extensions to ARC/INFO	ArcScan
Plot rasterization	Optional extensions to ARC/INFO	ArcPress
ARC/INFO Developer's Kit	Optional product	ArcSdl
DATABASE INTEGRATOR Developer's Kit	Optional product	DBI Kit
Integration with AS/400 databases	Optional product	DBI-AS/400
Desktop GIS	Core ArcView product	ArcView
Desktop GIS	Core ArcView product	ArcView for Windows/NT
Desktop GIS	Core ArcView product	ArcView for Macintosh
Application development	Core ArcView product	Avenue
Display/Query CAD drawings in ArcView	Optional product	Drawing Reader
Integration of ARC/INFO and AutoCAD	Core ArcCAD product	ArcCAD

GIS Functionality	Packaging	Product/Component
PC core GIS functionality	PC base product	PC ARC/INFO STARTER KIT
PC data entry and edit tools	Included with PC base product	PC ARCDIT
PC data display and analysis tools	Included with PC base product	PC ARCPLOT
PC polygon overlay and buffering	Included with PC base product	PC OVERLAY
PC network analysis	Included with PC base product	PC NETWORK
PC data conversion	Included with PC base product	PC DATA CONVERSION
Packaged data for ARC products	Optional data products	ArcData

Annual User Conference

All ARC/INFO users are invited to attend the annual ESRI User Conference, held each spring for one week in Palm Springs in southern California. As the world's largest gathering of GIS users, it is a tremendous opportunity for learning and sharing information. The conference is truly unique for the level of professional expertise and technical information shared. Guests attend their choice of user presentations and technical sessions on how to use ARC/INFO software for various applications. The conference is an ideal forum for exchanging ideas with other users, learning new skills, and making your voice heard on what you would like to see in the future.

Users have the opportunity to meet with their regional groups, learn about new software developments, enjoy a social and poster presentation session, listen to keynote speakers, attend presentations and technical sessions that occur continually throughout the week, discuss and view state-of-the-art hardware and peripheral devices, attend GIS video presentations and software demonstrations, and receive support and consulting for any questions that need answering about the use of ARC/INFO software.

ESRI GIS SOLUTIONS

For over 25 years ESRI has been helping people manage and analyze geographic information. ESRI offers a framework for implementing GIS in any organization with a seamless link from personal GIS on the desktop to enterprisewide GIS client/server and data management systems. Our GIS solutions are flexible and can be customized to meet the needs of our users. ESRI is a full-service GIS company, ready to help you begin, grow, and build success with GIS.

ArcView® software enables users to quickly select and display different combinations of data and to creatively visualize information from their desktops.

ARC/INFO® software is a high-end GIS with capabilities for the automation, modification, management, analysis, and display of geographic information.

PC ARC/INFO® software is a full-featured GIS for DOS and Windows™-based PCs.

ArcCAD® software links ARC/INFO, the world's leading GIS software, to AutoCAD®, the world's leading CAD software.

SPATIAL DATABASE ENGINE (SDE™) software is a high-performance spatial database that employs a true client/server architecture to perform fast, efficient spatial operations and management of large, shared geographic sets.

For more information, call
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Printed in USA