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**ENGLISH FOR GEODESY  
AND LAND MANAGEMENT STUDENTS**

*TUTORIAL*

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Навчальний посібник «English for Geodesy and Land Management Students» розрахований на студентів спеціальності «Геодезія та землеустрій» закладів вищої освіти і спрямований на ґрунтовне засвоєння англійської мови цього професійного спрямування. Посібник складається з 2 частин, зміст яких відповідає теоретичному матеріалу, який студенти вивчають на заняттях зі спеціальності. Перша частина містить 11 розділів. Друга частина містить 14 розділів. Розділи посібника побудовано таким чином, щоб студент мав змогу зосередитися на всіх видах мовленнєвої діяльності, які даватимуть змогу вільно спілкуватися в майбутньому професійному оточенні. В останній частині посібника вміщено тексти для додаткового читання, корисні для ефективною самостійної роботи.

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English for Geodesy and Land Management Students is the manual for the students majoring in this specialty «Geodesy and Land Management» at higher education institutions and aimed at mastering the English language for specific purposes in this domain. The manual consists of 2 parts comprising the key theoretical issues students study at their special classes. The 1<sup>st</sup> part consists of 11 units. The 2<sup>nd</sup> part consists of 14 units. Each unit is designed in the way to provide students with the possibility to practice all language skills giving them flexibility in the field of future professional sphere. In the last part of the tutorial students can find texts for supplementary reading useful for efficient independent work.

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## INTRODUCTION

The tutorial is designed for the students of higher education institutions majoring in the field of Geodesy and Land Management. It is for learners studying English for specific purposes and for those who need English in their job.

The tutorial consists of two parts. Part I consists of 11 units. Part II consists of 14 units. Each of 25 units presents the information which explains how and why people use Geodesy and Land Management and is also supported by the description of the geoinformation systems application by many organizations.

The units focus on the geoinformation systems roots in cartography, maps and numbers, on getting the map into the computer and basic database management. Each unit presents a set of tasks which helps students integrate their skills in reading, writing and skills of vocabulary enlarging. The students are also expected to develop strong skills for vocabulary recording and memorizing.

The tasks are based on the authentic texts concerning specifically the geographical information systems and technology.

The tasks cover topics relevant to the students to widen and deepen their knowledge in the subject. They provide learners with necessary language acquisition for their future professional life.

The textbook can be recommended for both classroom work and self-study.

## **PART I**

## UNIT 1 WHAT IS GIS

### Vocabulary notes:

- retrieval – пошук;
- feature – просторовий об'єкт;
- tool – метод, засіб;
- toolbox – пакет допоміжних програм;
- package – пакет програм;
- ad hoc – спеціальний, підготовлений спеціально.

### Activity 1. Read texts A, B, C and D with some definitions of GIS

#### A. A GIS IS A TOOLBOX

A GIS can be seen as a set of tools for analyzing spatial data. These are, of course, computer tools, and a GIS can then be thought of as a software package containing the elements necessary for working with spatial data. If we want to write a book, we might visit a computer store and buy a word processing package in a box to install on our computer. Similarly, if we seek to work with spatial data, one definition of a GIS is the software in the box that gives us the geographic capabilities we need.

If a GIS is a toolbox, a logical question is 'What types of tools does the box contain?' Several authors have tried to define a GIS in terms of what it does, offering a *functional definition* of GIS. Most agree that the functions fall into categories and that the categories are subtasks that are arranged sequentially as data move from the information source to a map and then to the GIS user and decision maker. Another GIS definition, for example, states that GISs are '**automated systems for the capture, storage, retrieval, analysis, and display of spatial data.**' This has been called a 'process definition' because we start with the tasks closest to the collection of data and end with tasks that analyze and interpret the information.

#### B. A GIS IS AN INFORMATION SYSTEM

Jack Estes and Jeffrey Star defined a GIS as '**an information system that is designed to work with data referenced by spatial or geographic coordinates. In other words, a GIS is both a database system with specific capabilities for spatially-referenced data, as well as a set of operations for working with the data.**'

Ken Dueker defined a GIS as '**a special case of information systems where the database consists of observations on spatially distributed features,**

**activities or events, which are definable in space as points, lines, or areas. A geographic information system manipulates data about these points, lines, and areas to retrieve data for ad hoc queries and analyses.'**

#### C. A GIS IS AN APPROACH TO SCIENCE

Goodchild defined geographic information science as **'the generic issues that surround the use of GIS technology, impede its successful implementation, or emerge from an understanding of its potential capabilities.'** He also noted that this involved both research *on* GIS and research *with* GIS. Supporting the science are the uniqueness of geographic data, a distinct set of pertinent research questions that can only be asked geographically, the commonality of interest of GIS meetings, and a supply of books and journals. On the other hand, Goodchild noted that the level of interest depends on innovation, which it is hard to sustain a multidisciplinary (rather than interdisciplinary) science, and that at the core of the science, in geography, a social science tradition has to some extent an antipathy toward technological approaches.

#### D. A GIS PLAYS A ROLE IN SOCIETY

Many people doing research on GIS have argued that defining GIS narrowly, as a technology, as software, or as a science, ignores the role that GIS plays in changing the way people live and work. Not only has GIS radically changed how we do day-to-day business, but also how we operate within human organizations. Nick Chrisman (1999) has defined GIS as **'organized activity by which people measure and represent geographic phenomena then transform these representations into other forms while interacting with social structures.'**

This definition has emerged from an area of GIS research that has examined how GIS fits into society as a whole, including its institutions and organizations, and how GIS can be used in decision making, especially in a public setting such as a town meeting, or on a community group Web site. This latter field is termed PPGIS, for Public Participation GIS.

### **Activity 2. Answer the questions using the information from texts A, B, C and D**

1. What packages are discussed in Text A?
2. What is a GIS as a toolbox used for?
3. How does Jack Estes's definition of a GIS differ from Ken Dueker's definition?
4. What does a geographic information science involve?
5. What is the definition of GIS functions from the point of view of social processes?

### Activity 3. Read and translate the key terms and their definitions

**feature:** A single entity that makes up part of a landscape.

**file:** Data logically stored together at one location on the storage mechanism of a computer.

**format:** The specific organization of a digital record.

**fourth dimension:** A common way of referring to time; the first three dimensions determine location in space, the fourth dimension determines creation, duration, and destruction in time.

**functional definition:** Definition of a system by what it does rather than what it is.

**line feature:** A geographic feature recorded on a map as a sequence of locations tracing out a line.. An example is a stream.

**point feature:** A geographic feature recorded on a map as a location. Example: a single house.

**search engine:** A software tool designed to search the Internet and the WWW for documents meeting the user's query. Examples: Yahoo and Alta Vista.

**software package:** A computer program application.

**spatial data:** Data that can be linked to locations in geographic space, usually via features on a map.

**spatial distribution:** The locations of features or measurements observed in geographic space.

### Activity 4. Look through the text again and find the corresponding verbs to the following definitions.

1 to make it difficult for someone or something to move forward or make a progress

\_\_\_\_\_

2 to mention another book, article, etc. that contains information connected with the subject you are writing about

\_\_\_\_\_

3 to get back information that has been stored in the memory of a computer

\_\_\_\_\_

4 to come out of a difficult experience

\_\_\_\_\_

5 to support an idea or argument or prove that it is right

\_\_\_\_\_



**Activity 5. Read the following text. Find the English equivalents to the terms given below**

Many of the principles of the new geographic information science have been around for quite some time. General-purpose maps date back centuries and usually focused on topography, the lay of the land and transportation features such as roads and rivers. More recently, in the last century, thematic maps came into use. Thematic maps contain information about a specific subject or a theme, such as surface geology, land use, soils, political units, and data collection areas. Although both types of maps are used in GIS, it is the thematic map that led cartography toward GIS. Some themes on maps are clearly linked. For example, a map of vegetation is closely tied to a map of soils.

- 1 шлях перевезення \_\_\_\_\_
- 2 певний об'єкт \_\_\_\_\_
- 3 карта ґрунтів \_\_\_\_\_
- 4 карта рослинності \_\_\_\_\_
- 5 карта загального призначення \_\_\_\_\_
- 6 тематична карта \_\_\_\_\_

**Activity 6. Read the text and decide whether the following statements are true (T) or false (F)**

#### SOURCES OF INFORMATION ON GIS

Historically, GIS has been a somewhat disjoint field from a reader's standpoint, and most of the major books, journals, and online resources date from only the last few years. This is far less an issue today, however, and there are now some excellent sources of GIS information. These fall into groups and are covered here under journals and magazines, books, professional societies, the Internet and the World Wide Web, GIS conferences, and educational organizations and universities.

The amount of information available about GIS is somewhat overwhelming. An excellent place to begin one's search is at a library, or perhaps by connecting to the Internet and using one of the World Wide Web search tools. This is possible even at one's home computer, but slow enough that a visit to the library may be more productive. Some libraries have facilities to connect to network search systems and even specialized staff with training in geographic information.

As in our definition of geographic information science, the information sources on GIS fall into the broad categories of research *with* GIS and research

**on** GIS. As a beginner, try restricting your search to basic material rather than going straight to the research frontier. This can come later. A good way to research a topic is to find publications that came out at about the time a new idea was being introduced. In the older papers, articles, or book chapters, the authors had to write for an audience that would be unfamiliar with the language and concepts under discussion. This is the case in several classic papers in the GIS arena. The writing remains today as a good first step toward understanding and an excellent place to get started with GIS.

1. Most of sources of information on GIS are known from the ancient times. ( )
2. Only a few sources of information on GIS are known nowadays. ( )
3. The Internet is the most productive way to find geographic information. ( )
4. The information sources on GIS have two categories of research. ( )
5. It is advisable to begin the research of geographic information with the reading of familiar publications. ( )

**Activity 7. Use the above given statements to prepare a brief summary of the text**

**Activity 8. Translate the following sentences into English**

1. Наука про географію ґрунтується на знаннях картографії, комп'ютерної техніки і математики.
2. ГІС складається щонайменше з бази даних і картографічної інформації, пов'язаних між собою засобами комп'ютерної техніки.
3. Наука про географічну інформацію стосується багатьох аспектів сучасного життя.
4. Джерелом ГІС є тематична картографія.
5. ГІС – це бізнес, який оцінюється багатьма мільйонами доларів.

**Activity 9. Read the text. Translate it into Ukrainian**

Many colleges and universities teach classes in GIS, and some offer complete programmes with course sequences and certificates. No national body as yet certifies people in GIS, but some vendors offer certification as instructors. Some universities and extension services offer short courses, and most of the major GIS vendors offer short training programmes lasting anywhere from a few hours at a national or regional conference to several days or weeks.

Within universities and colleges, GIS classes are taught in many departments. Most are in geography, but many are also in departments and programmes in geology, environmental science, forestry, civil engineering, computer and information science, and many others. There is little consensus among those teaching GIS as to what the content for a course in GIS should be, although standardization efforts are under way.

## ***UNIT 2 MAP AND ATTRIBUTE INFORMATION***

### **Vocabulary notes:**

- permeate – проникати, поширюватися;
- cluster – група об’єктів із загальними ознаками;
- item – елемент даних.

### **Activity 1. Read and translate the text**

#### **MAP AND ATTRIBUTIVE INFORMATION**

Information permeates our society, but fortunately, it takes on only a few tangible forms. Without the preordering of information, much of it would not be usable by humans in their everyday lives. Among these are the everyday methods for organizing information, visible by everyday examples such as the Yellow Pages, baseball box scores, magazines, or the television listings.

Most information is usually preordered into lists, numbers, tables, text, pictures, maps, or indexes. Clusters of similar information, usually numbers and text, are called ***data***. When data are entered into the computer, we store them as files and refer to them collectively as ***database***. In database language, the items that we gather information about are referred to as ***attributes*** and individual data items as ***records***.

A basic difference between these types of information and the information that is collected into geographic information systems is that GIS information has associated with it an underlying geography, ***or*** descriptions of locations on the face of the earth. This means that pictures and especially maps can be a database, too. A link to the earth must somehow be placed into the GIS database, so that we can refer to the data by the location – and the location by the data. With this feature comes the fact that we can now manage the data using the underlying geography, the attributes, or both.

## Activity 2. Answer the questions using the information from the text

1. Why can the information be not usable by humans?
2. What methods of organizing information are available nowadays?
3. What is the difference between the geographic information and most other information?

## Activity 3. Look through the text again and find the English equivalents to the following:

- 1 дані, інформація \_\_\_\_\_
- 2 база даних \_\_\_\_\_
- 3 ознака, характерний загальний об'єкт, атрибут \_\_\_\_\_
- 4 записана інформація, запис (даних) \_\_\_\_\_
- 5 вводити дані \_\_\_\_\_
- 6 попередня впорядкованість інформації \_\_\_\_\_
- 7 вміти поводитися, управляти \_\_\_\_\_
- 8 робити посилання, згадувати \_\_\_\_\_

## Activity 4. Read the text given below. Decide whether the statements after it are true (T) or false (F)

The power of the GIS is in allowing the attribute and the geographic or map information to be linked together in a useful way. For example, we can search the data both by the attributes and by using the map. Obviously, if the two sorts of information are linked, we can use either one to search the other, or we can use them together.

Central to this map and attribute data use is finding a way to *link* the map with the attributes. As we are using a computer, obviously the link should be in the form of numbers. When we locate people and houses, we usually use street addresses rather than numbers. Later we will see that a GIS gives us the power to move from one to the other of these descriptions of location with numbers. For now, however, we need a simple number description for a location.

It is important to get a feel for what the geographic numbers mean and how they correspond to places on both the earth and the map. It is a little more complex than it first seems, but with a little digression, we can quickly come up to speed, and even be experts. This means that to understand GIS, we need to know a little *cartography*, which is the science that deals with the construction, use and principles behind maps and map use.

1. The attribute and the geographic information are linked together in a way that helps you to do or get what you want. ( )
2. These two sorts of information can be used separately or together. ( )
3. The link between the geographic and the attribute information is in the form of numbers. ( )
4. To become experts we must understand what the geographic numbers mean. ( )

**Activity 5. Use the information in Activity 4 to give a brief summary of the text**

**Activity 6. Read and translate the key terms and their definitions**

***attribute:*** A numerical entry that reflects a measurement or value for a feature. Attributes can be labels, categories, or numbers; they can be dates, standardized values, or field or other measurements. An item for which data are collected and organized. A column in a table or data file.

***cartography:*** The science that deals with the principles, construction, and use of maps.

***data:*** A set of measurements or other values, such as text for at least one attribute and at least one record.

***database:*** A collection of data organized in a systematic way to provide access on demand.

***file:*** Data logically stored together at one location on the storage mechanism of computer.

***geocode:*** A location in geographic space converted into computer-readable form.

***latitude:*** The angle made between the equator, the earth's geometric center, and a point on or above the surface. The South Pole has latitude – 90 degrees, the north +90 degrees.

***level of measurement:*** The degree of subjectivity associated with a measurement. Measurements can be nominal, ordinal, interval, or ratio.

***link:*** The part or structure of a database that physically connects geographic information with attribute information for the same features. Such a link is a defining component of a GIS.

***location:*** A position on the earth's surface or in geographic space definable by coordinates or some other referencing system, such as a street address or space indexing system.

**longitude:** The angle formed between a position on or above the earth, the earth's geometric center, and the meridian passing through the center of the observing instrument in Greenwich, England, as projected down onto the plane of the earth's equator or viewed from above the pole. Longitudes range from – 180 (180 degrees West) to +180 (180 degrees East).

**map:** A depiction of all or part of the earth or other geographic phenomenon as a set of symbols and at a scale whose representative traction is less than 1:1. A digital map has had the symbols geocoded and stored as a data structure within the map database.

**record:** A set of values for all attributes in a database. Equivalent to a row of a data table.

### Activity 7. Find the English equivalents to the terms given in the text below

#### THE SHAPE OF THE EARTH

The satellite era has brought with it more accurate means of measurement, including the global positioning system (GPS). An estimate of the ellipsoid allows calculation of the elevation of every point on earth, including sea level, and is often called a **datum**. Recent data have been calculated using the centre of the earth as a reference point instead of a point on the ground as was the case before.

#### MAP SCALE

All maps, whether on a sheet of paper or inside a computer, are reductions in size of the earth. A map at one-to-one scale (1:1) would be virtually useless; you would barely be able to unfold it. In cartography, the term **representative fraction** is used for the amount of scaling. A representative fraction is the ratio of distances on the map to the same distances on the ground.

#### MAP PROJECTIONS

Given that the earth can be approximated by a shape like the sphere or the ellipsoid, how can we go about converting data in latitude and longitude into a flat map, with  $x$  and  $y$  axes? The simplest way is to ignore the fact that latitude and longitude are angles at the centre of the earth, and just pretend that they are  $x$  and  $y$  values.

- 1 засоби вимірювання, контролю \_\_\_\_\_
- 2 остання вихідна величин \_\_\_\_\_
- 3 точка відліку, орієнтир \_\_\_\_\_
- 4 зменшення розміру \_\_\_\_\_
- 5 масштаб 1:1 \_\_\_\_\_

- 6 приблизно \_\_\_\_\_
- 7 (географічна) широта \_\_\_\_\_
- 8 (географічна) довгота \_\_\_\_\_
- 9 кут \_\_\_\_\_
- 10 оцінка; оцінювати \_\_\_\_\_

### Activity 8. Render the following sentences into English

1. Інформація може бути представлена у вигляді каталогів, чисел, таблиць, тексту, малюнків, карт та індексів.
2. Кластери інформації, які називають даними, можуть зберігатися разом у вигляді бази даних.
3. База даних зберігається в комп'ютері у вигляді файлів.
4. У базі даних ми зберігаємо ознаки у вигляді заголовків, розташованих в колонках (column headers) і групи взаємопов'язаних елементів (records), розташованих рядами.

### Activity 9. Read the following statements and render them into Ukrainian

#### MAP SCALE AND PROJECTIONS

- The earth can be modeled as a sphere, an oblate ellipsoid, or a geoid.  
The sphere is about 40 million meters in circumference.  
An ellipsoid is an ellipse rotated in three dimensions about its shorter axis.  
The earth's ellipsoid is only about 1/297 off from a sphere.  
Many ellipsoids have been measured, and maps have been based on each.  
Examples are WGS83 and GRS80.  
An ellipsoid gives the base elevation for mapping, called a datum. Example are NAD27 and NAD83.
- The geoid is a figure that adjusts the best ellipsoid and the variation of gravity locally. It is the most accurate and is used more in geodesy than in GIS and cartography.
- Map scale is based on the representative fraction, the ratio of a distance on the map to the same distance on the ground.
- Most maps in GIS fall between 1: 1,000,000 and 1: 1,000.
- A GIS is scaleless because maps can be enlarged and reduced and plotted at many scales other than that of the original data.
- To compare or edge-match maps in a GIS, both maps MUST be at the same scale and have the same extent.
- The metric system is far easier to use for GIS work.

- Geographic coordinates are the earth's latitude and longitude system, ranging from 90 degrees south to 90 degrees north in latitude and 180 degrees west to 180 degrees east in longitude.
- A line with a constant latitude running east to west is called a parallel.
- A line longitude running from the North Pole to the South Pole - is called a meridian. The zero-longitude meridian is called the prime meridian and passes through Greenwich, England.
- A grid of parallels and meridians shown as lines on a map is called a graticule.
- A transformation of the spherical or ellipsoidal earth onto a flat map is called a map projection.
- The map projection can be projected onto a flat surface or a surface that can be made flat by cutting, such as a cylinder or a cone.
- If the globe, after scaling, cuts the surface, the projection is called secant. Lines where the cuts take place or where the surface touches the globe have no projection distortion.
- Projections can be based on axes parallel to the earth's rotation axis (equatorial), at 90 degrees to it (transverse), or at any other angle (oblique).
- A projection that preserves the shape of features across the map is called conformal.
- A projection that preserves the area of a feature across the map is called equal area or equivalent.
- No flat map can be both equivalent and conformal. Most fall between the two as compromises.
- To compare or edge-match maps in a GIS, both maps MUST be in the same projection.

### ***UNIT 3 COORDINATE SYSTEMS***

#### **Vocabulary notes:**

- to align with – поєднувати;
- to derive – встановлювати походження;
- to remote – видаляти, усувати;
- to seek – шукати, визначати;
- to distort – спотворювати.

#### **Activity 1. Read and translate the text**

Converting maps into numbers requires that we choose a standard way to encode locations on the earth. Maps are drawn (whether by computer or not) on a



flat surface such as paper. Locations on the paper can be given in *map millimeters* or inches starting at the lower left-hand corner. A computer plotter or a printer can understand these dimensions also, and usually requires that the locations be given in  $(x, y)$  format; that is, an east-west distance or *easting*, followed by a north-south distance or *northing*. This pair of numbers is called a *coordinate pair* or, more usually, a *coordinate*. Standard ways of listing coordinates are then called *coordinate systems*. Maps on common coordinate systems are automatically aligned with each other.

A significant problem with coordinates is that while the map dimensions are simple and the  $(x, y)$  axes are at right angles to each other, locations on earth's surface are not so simply derived. The first and foremost problem is that a flat map of all or part of earth's surface is necessarily on a map projection. Something has been distorted to make the surface flat, usually scale, shape, area, or direction. On our flat map, we would like all of the earth's curvature removed. Just how this is done depends on which of the various coordinate systems we use, how big an area we seek to map, and what projection the system uses.

#### **Activity 2. Answer the questions using the information from the text**

1. When do we encode locations on the earth?
2. What does a coordinate pair consist of?
3. What can be distorted on a map projection?

#### **Activity 3. Look through the text again and find the English equivalents to the following:**

- 1 на схід \_\_\_\_\_
- 2 на північ \_\_\_\_\_
- 3 кривизна \_\_\_\_\_
- 4 габаритні розміри \_\_\_\_\_
- 5 графічний пристрій \_\_\_\_\_
- 6 спосіб, метод, засіб \_\_\_\_\_
- 7 поверхня \_\_\_\_\_

#### **Activity 4. Read and translate the key terms and their definitions**

***absolute location***: A location in geographic space given with respect to a known origin and standard measurement system, such as a coordinate system.

**continuity:** The geographic property of features or measurements that gives measurements at all locations in space. Topography and air pressure are examples.

**datum:** A base reference level for the third dimension of elevation for the earth's surface. A datum can depend on the ellipsoid, the earth model, and the definition of sea level.

**dimensionality:** The property of geographic features by which they are capable of being broken down into elements made up of points, lines, and areas. This corresponds to features being zero-, one-, and two-dimensional. A drill hole is a point, a stream is a line and a forest is an area, for example.

**distortion:** The space distortion of a map projection, consisting of warping of direction, area, and scale across the extent of the map.

**easting:** The distance of a point in the units of the coordinate system east of the origin for that system.

**edge matching:** The GIS or digital map equivalent of matching paper maps along their edges. Features that continue over the edge must be 'zipped' together and the edge dissolved. To edge-match, maps must be on the same projection, datum, ellipsoid, and scales and show features captured at the same equivalent scale.

**map millimeters:** A coordinate system based on the dimensions of the map rather than those of the features represented on the earth itself, in metric units.

**northing:** The distance of a point in the units of the coordinate system north of the origin for that system.

**UTM (Universal Transverse Mercator):** A standardized coordinate system based on the metric system and a division of the earth into sixty 6-degree-wide zones. Each zone is projected onto a transverse Mercator projection, and the coordinate origins are located systematically. Both civilian and military versions exist.

**Activity 5. Read the text. Decide whether the given statements are true (T) or false (F)**

**THE UNIVERSAL TRANSVERSE MERCATOR COORDINATE SYSTEM**

The UTM coordinate system is commonly used in GIS because it has been included since the late 1950s on most USGS topographic maps. The choice of the transverse Mercator, probably now used more than any other projection for accurate mapping, has an interesting history. The story begins with the observation that the equatorial Mercator projection, which distorts areas so much at the poles, nevertheless produces minimal distortion laterally along the equator.

The transverse Mercator projection, in various forms, is part of the civilian UTM system described here, the state plane system, and the military grid. It has

been used for mapping most of the United States, many other countries, and even the planet Mars. The first version is the civilian UTM grid, used by the U.S. Geological Survey on its maps since 1977, and marked on many maps since the 1940s as blue tic marks along the edges of the quadrangle maps or grids over the surface. In 1977 the transverse Mercator projection replaced the polyconic for large-scale U.S. mapping.

1. The UTM coordinate system has been excluded from most topographic maps. ( )
2. The transverse Mercator projection is a kind of a coordinate system. ( )
3. The transverse Mercator projection provides accurate mapping. ( )
4. The transverse Mercator projection maximizes distortions at the poles. ( )
5. It is used mainly for bigger than usual maps. ( )

**Activity 6. Match the words on the left with the definitions on the right.**

- |                   |   |
|-------------------|---|
| 1) transverse     | <b>a</b> near the equator   |
| 2) tick           | <b>b</b> a set of numbered lines on a map   |
| 3) polyconic (al) | <b>c</b> flat shape that has four straight sides  |
| 4) quadrangle     | <b>d</b> lying or placed across something   |
| 5) grid           | <b>e</b> an outside part of an object   |
| 6) edge           | <b>f</b> a mark written next to something on a list etc. to show that it is corrected it is |
| 7) equatorial     | <b>g</b> shaped like many cones.  |

1	2	3	4	5	6	7

**Activity 7. Translate the sentences into English.**

1. Географічна інформація включає в себе такі параметри як обсяг, розмірність (dimensionality) і безперервність.
2. Прості географічні ознаки можуть бути використані для створення (build) більш складних параметрів.
3. Ділянки будуються за допомогою ліній, що складаються з точок, представлених координатами.
4. Всі географічні ознаки включають в себе розмір, розподіл (distribution), малюнок, цілісність (continuity), район, форму, масштаб і координати.
5. Велика частина аналізу ГІС та подання (description) складається з вивчення властивостей географічних ознак і у визначенні зв'язку між ними.

**Activity 8. Read the statements on ‘Coordinate Systems’ and translate them into Ukrainian.**

COORDINATE SYSTEMS

- A coordinate system is a standardized method for assigning codes to locations so that locations can be found using the codes alone.
- Standardized coordinate systems use absolute locations.
- A map captured in the units of the paper sheet on which it is printed is based on relative locations or map millimeters.
- In a coordinate system, the  $x$  -direction value is the easting and the  $y$ -direction value is the northing. Most systems make both values positive.
- Some standard coordinate systems used in the United States are geographic coordinates, the universal transverse Mercator system, the military grid, and the state plane system.
- To compare or edge-match maps in a GIS, both maps MUST be in the same coordinate system.
- A GIS package should be able to move between map projections, coordinate systems, data, and ellipsoids.

***UNIT 4. REPRESENTING MAPS AND NUMBERS***

**Vocabulary notes:**

- critical difference – основна відмінність;
- to capture – збирати;
- impact – вплив;
- visual map – наочна, візуальна карта;
- mappy package – картографічний пакет;
- encoding numbers – цифри кодування;
- numerical value – числове значення;
- to devise – винаходити, розробляти.

**Activity 1. Read and translate the text.**

In this chapter we look at the various ways that maps can be represented using numbers. All GISs have to store digital maps somehow. As we will see, there are some critical differences in how the various types of GIS navigate on this ocean of geographic numbers. The organization of the map into digits has a major impact on how we capture, store, and use the man data in a GIS. There are many

ways that the conversion of a visual or printed map to a set of digits can be done. Over the years, the designers of GIS and computer mapping packages have devised an amazing number of ways that maps can be converted into numbers. The difference between the ways is not trivial, not only because different types of files and codes are needed, but because the entire way that we think about the data in a GIS is affected. The link between how we imagine the features that we are working with in the GIS and the actual tiles of bytes and bits inside the computer is a critical one. To the computer, the data are stored in physical structure. The physical structure is not only how computer memory, such as disk and RAM is used, but also how the files and directories store and access the map and attribute information.

On the physical level, the map, just like the attributes, is eventually broken down into a sequence of numbers, and these numbers are stored in the computer's files. In general, two alternative ways exist of storing the numbers. In the first each number is saved in the file encoded into binary digits or bits.

The second way of encoding numbers into files is to treat each number the way that humans do – one decimal digit at a time.

**Activity 2. Answer the questions using the information from the text.**

1. What do geographic numbers represent?
2. What is converted into a set of digits?
3. What two alternative ways of storing numbers exist?

**Activity 3. Look through the text again and find the words that correspond to the following definitions:**

1) not important or serious \_\_\_\_\_

2) a set of events, actions, numbers, etc. \_\_\_\_\_

3) a collection of information stored together in a computer

\_\_\_\_\_

4) to change information into a form that can be processed by a computer

\_\_\_\_\_

5) to consider something in a particular way \_\_\_\_\_

**Activity 4. Read and translate the key terms and their definitions.**

**attribute:** An attribute is a characteristic of a feature that contains a measurement or value for the feature. Attributes can be labels, categories, or numbers. Attributes can be dates, standardized values, or field or other

measurements. Item for which data are collected and organized. A column in a table or data file.

**bit:** The smallest storable unit within a computer's memory with only an on and an off state, codable with one binary digit.

**byte:** Eight consecutive bits.

**feature:** A single entity that composes part of a landscape.

**raster:** A data structure for maps based on grid cells.

**Activity 5. Learn the following words and word combinations. Find them in the text below.**

- 1) 1 attribute data – ознаки, показники;
- 2) 2 raster format – формат растру;
- 3) 3 grid cell – осередок сітки;
- 4) 4 unit – одиниця (виміру);
- 5) 5 increment – інкремент, збільшення;
- 6) 6 assign value – надавати значення;
- 7) 7 attribute data base – атрибутивна база даних.

It is the logical structure of the data that requires us to have a mental 'model' of how the physical data represent a geographic feature, just as a sheet map is a flat paper 'symbol' model of the landscape it covers. Traditionally in GIS and computer cartography, there were two basic types of data model for map data and only one for attribute data. Map data could be structured in **raster** or **vector** format, and attributes as flat files.

A raster data model uses a grid, such as the grid formed on a map by the coordinate system, as its model or structure to hold the map data. Each grid cell in the grid is one map unit, often chosen so that each grid cell shows on the GIS map as one screen display point or **pixel** or on the ground as a whole-number increment in the coordinate system. A pixel is the smallest unit displayable on a computer monitor. If you get a magnifying glass and look at a monitor or a television set, you will see that the picture is made from thousands of these tiny pixels, each made up of a triangle of three phosphor dots, one dot for red, one for green, and one for blue (if your screen displays color). When we capture a map into the raster data model, we have to assign a value to every cell in the grid. The value we assign can be the actual number from the map such as the terrain elevation in a digital elevation model (DEM), or more usually, it is an index value standing for an attribute that is stored separately in the attribute database.

**Activity 6. Fill in the gaps with the prepositions from the box.**

of (3) in (4) at on for with

The other major type (1)\_\_\_ data model for map data is the vector. The vector is composed (2)\_\_\_ points, each one represented by an exact spatial coordinate. For a point or a set of points, vectors just use a list of coordinates. For a line, we use a sequence (3)\_\_\_ coordinates; that is, the sequence of points in the list is the order (4)\_\_\_ which they must be drawn on the map or used in calculations. Note that this gives lines a ‘direction’ (5)\_\_\_ which their points should be read. Areas (6)\_\_\_ the vector model are the space enclosed by a surrounding ring of lines, either one or several of them.

Vectors are obviously very good (7)\_\_\_ representing features that are shown (8)\_\_\_ maps as lines, such as rivers, highways, and boundaries. Unlike the raster grid, where we have to store a grid cell’s attribute whether we need it or not we need only place points precisely where we need them. A square can be four lines connecting four points, for example. Even wiggly lines can be captured quite well (9)\_\_\_ this way, by using more points (10)\_\_\_ the bends and fewer when the line is straight. Using vectors, we can draw an outline map (11)\_\_\_ only a few thousand points, far fewer than the number of grid cells that would be required.

**Activity 7. Read the text. Find the English equivalents to the following terms:**

- 1 атрибутивні дані \_\_\_\_\_
- 2 растровий рядок \_\_\_\_\_
- 3 індекс, номер індексу \_\_\_\_\_
- 4 векторні дані \_\_\_\_\_
- 5 координатні дані \_\_\_\_\_
- 6 плоский файл \_\_\_\_\_
- 7 замкнута лінія \_\_\_\_\_

We have said little yet about the attribute data other than that its model is as a **flat file**. A flat file is how numbers are stored in tables or in a spreadsheet. The model is also a sort of grid, with rows and columns for attributes. Just like for the raster grids, we have to store values in the cells of the table. These values must somehow link the data in the flat file to the data in the map. For a raster grid, we could store index numbers in the grid and any number of attributes for the index

numbers in the flat file. For example, on a land use map, 1 could stand for forest, 2 for farmland, and 3 for urban. For vector data, we need a little more complexity. Point data are simple; we can even put the coordinates in the flat file itself. Lines and areas, however, have variable numbers of points. We again need to number off or ‘identify’ the lines and store an attribute for the whole line in the flat file. We can do the same for an area, except that we need the line flat file as well to refer to in the polygon or area file. If we called the lines *arcs*, for example, we might need both a polygon attribute table file and a file of arcs by polygon.

**Activity 8. Read the text. Discuss whether the following statements are true (T) or false (F).**

Key elements in raster data are shown in Figure 1. First, the cell size determines the resolution of the data, and the cell size has both a map and a ground expression. We often talk about 30-meter Landsat data, for example, meaning that each cell in the data is 30 meters by 30 meters on the ground. On the map, we may use several pixels to display the grid cell, or on paper we may use a dot of a certain size in a given colour. Second, the grid has an *extent*, often rectangular since a grid has columns and rows, and even if we do not wish to store data in the GIS for grid cells outside our region (such as a state), we still have to place something (usually a code for ‘outside’) in the grid cells. Third, when we map features onto the grid there is sometimes an imperfect fit. Lines have uneven widths, points must be moved to the centre or the intersection points of the grid, and areas may need to have their edges coded separately. We sometimes have to determine in advance what connections within the grid are legal. For example, taking a single cell, we can allow connections only north, south, east, and west, like the way a rook moves in chess, or we can allow diagonal connections as well. Which we choose can mean a great deal as to how the GIS works at storing and using the features. Fourth, when we deal with a grid, each grid cell can usually only be ‘owned’ by one feature, that is, the one whose attribute it holds. In many cases, map data are not so simple. Soils, for example, are often listed by their percentage of sand, silt, and clay at every point. Finally, when we have a grid every cell in the grid has to be made big enough to hold the largest value of the attribute or index to be stored in the grid. You may have had the experience of using a spreadsheet or table to store people’s names. Even when we store ‘Jane Doe’ with only eight characters, we still have to allow for the occasional very long name. Every grid cell pays the storage penalty of the extra space, and with the total number of cells being the product of the numbers of rows and columns, the amount of space needed can add up ( or rather multiply up) quickly. Storage sizes for grids often increase by



powers of 2 as more and more ‘bytes’ of 8 bits are needed to store larger and larger values.

Nevertheless, raster grids have many advantages. They are easy to understand, capable of rapid retrieval and analysis, and are easy to draw on the screen and on computer devices that display pixels.

1. The cell size has a map or a ground expression. ( )
2. We use many pixels to display the grid cell. ( )
3. The features mapped onto the grid are always perfect. ( )
4. Sometimes, map data are not so simple. ( )
5. The largest value of the attribute or index can be held in the cells of any size. ( )

**Activity 9. Read the text and give a written translation of it into Ukrainian.**

#### STRUCTURING ATTRIBUTES

In Unit 10, we consider in more detail the logical way that attribute data are stored in files. For now, a simple way to imagine this is to recall the flat file. A flat file is a table. Columns store attributes, and rows store records. We know in advance what sort of information is stored in each attribute, whether it is text or numbers, how large the numbers are and so on. We can then write a sequence into the file. For each record we can write the ASCII codes for the values in each attribute (in database terms often called a *field*) in a consistent way. At the end of each record we could start a new line. The file then would be a sort of table or matrix with rows and columns.

It is now easy to see what some of the database operations actually do. For example, if we wished to sort the data we could renumber the lines in the file. If we wanted a particular record, we could search line by line until we found the correct one and then print it. These operations would be much faster if we could encode the numbers in binary or sort them in the file so that the most commonly referenced records were first in the file.

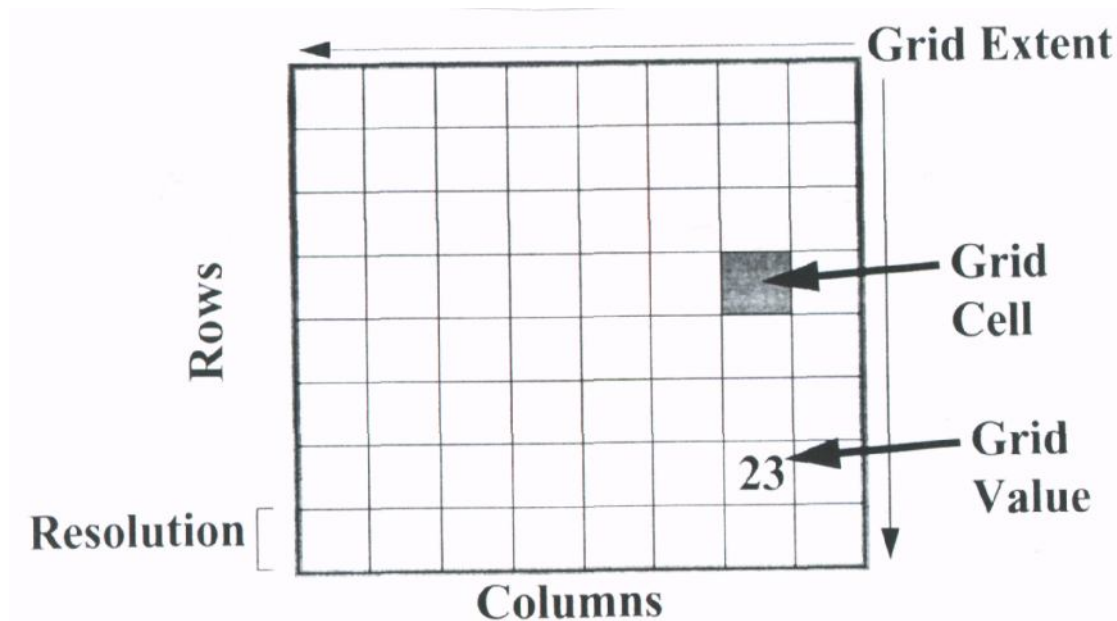


Figure 1 – Generic structure for a grid

**Activity 10. Render the following sentences into English. Use these sentences to summarize the information of Unit 4.**

1. Карти можуть бути представлені цифрами.
2. В цьому випадку візуальна або друкована карта перетвориться в систему бінарних або десяткових цифр.
3. У комп'ютерній картографії та ГІС картографічні дані вносяться в растровий або векторний формат.
4. У моделі растрових даних використовується координатна сітка з системою координат.
5. Векторний формат представлений точками координат.
6. Моделлю атрибутивних даних є плоский файл.
7. У моделі атрибутивних даних числа вносяться в пам'ять у вигляді звичайних або електронних таблиць.

## ***UNIT 5 STRUCTURING MAPS***

### **Vocabulary notes :**

- to structure – складати (карту);
- feature – просторовий об'єкт;
- scaled-down – зменшений в масштабі;
- regular attribute – звичайна характерна ознака;
- land parcel – земельна ділянка;

plotter – плоттер;

unwieldy – громіздкий, незграбний;

ASCII – Американський стандартний код для обміну інформацією.

### **Activity 1. Read and translate the text.**

Maps have at least two dimensions; in the earth's space they have latitude and longitude and in the map's space they have the left-right ( $x$ ) and the up-down ( $y$ ) directions. They are also scaled-down representations of features, features that can be points, lines, areas, or even volumes. Point features are very simple to deal with, and you could easily argue that you don't really even need a GIS for point features other than to draw them. This is because  $x$  and  $y$  can be stored just as regular attributes in a standard database. Line and area features are more complicated because they can be different shapes and sizes. A stream and a road would be captured with different numbers of points, and these would not fit easily into the attribute database.

*Vector data structures* were the first to be used for computer cartography and GIS because they were simply derived from digitizing tablets, because they are more exact in representing complex features such as land parcels, and because they are easily drawn on pen-type output devices such as plotters. Surprisingly, few people in the early days thought of standardizing how digitizing was to take place, and since there were different technologies, many different formats evolved. The earliest included ASCII files of ( $x, y$ ) coordinates, but these soon became very unwieldy in size, so binary files rapidly took over.

The first generation of vector files were simply lines, with arbitrary starting and ending points, which duplicated the way a cartographer would draw a map. Obviously the pen would be lifted from the paper to start a new line, but it could be lifted anywhere else. The file could consist of a few long lines, many short lines, or even a mix of the two. Typically, the files were written in binary or ASCII and used a flag or code coordinate to signify the end of a line.

### **Activity 2. Answer the questions using the information from the text.**

1. How many dimensions does a map have?
2. What structures were the first to be used in computer cartography?
3. What did the first generation of vector files consist of?

### **Activity 3. Read and translate the key terms and their definitions.**

*vector*: A map data structure using the point or node and the connecting segment as the basic building block for representing geographic features.

**grid cell:** A single cell in a rectangular grid.

**line:** A one-dimensional (length) map feature represented by a string of connected coordinates.

**point:** A zero-dimensional map feature, such as a single elevation mark as specified by at least two coordinates.

**volume:** A three-dimensional (volume) feature represented by a set of areas enclosing part of a surface, in GIS usually the top only.

**area:** A two-dimensional (area) feature represented by a line that closes on itself to form a boundary.

**ASCII:** The American Standard Code for Information Interchange. A standard that maps commonly used characters such as the alphabet onto one-byte-long sequences of bits.

**Autocad:** A leading CAD programme by Autodesk, often interfaced with GIS packages and used for digitizing, especially floor plans and engineering graphics.

**DLG:** A vector format used by the USGS for encoding lines on large-scale digital maps.

**double digitized:** The same feature captured by digitizing twice.

**DXF:** Autocad's digital file exchange format, a vector mode industry-standard format for graphic file exchange.

**GBF:** Geographic Base File. A database of DIME records.

**PostScript:** Adobe Corp.'s page definition language. An interpreted language for page layout designed for printers but also an industry standard for vector graphics.

**TIGER:** A map data format based on zero-, one-, and two-cells, used by the U.S. Census Bureau in the street-level mapping of the United States.

**HPGL:** Hewlett Packard Graphics Language. A device-specific but industry-standard language for defining vector graphics in page coordinates.

**USGS:** The United States Geological Survey, part of the Department of the Interior and a major provider of digital map data for the United States.

**VPF:** Vector product format, a data transfer standard within DIGEST for vector data  
**zero/one/two cell:** TIGER terminology for point, line, and area, respectively.

**Activity 4. Match the words on the left with their meaning on the right. Use these terms to render the text into Ukrainian.**

1) polygon

**а** крива лінія

2) arc

**б** окремий елемент

3) entry

**с** замкнута лінія

- 4) evolve                                    **d** ефективний, дієвий  
 5) efficient                                **e** дієвий, той, що має силу  
 6) valid                                      **f** розвивати, розробляти

1	2	3	4	5	6

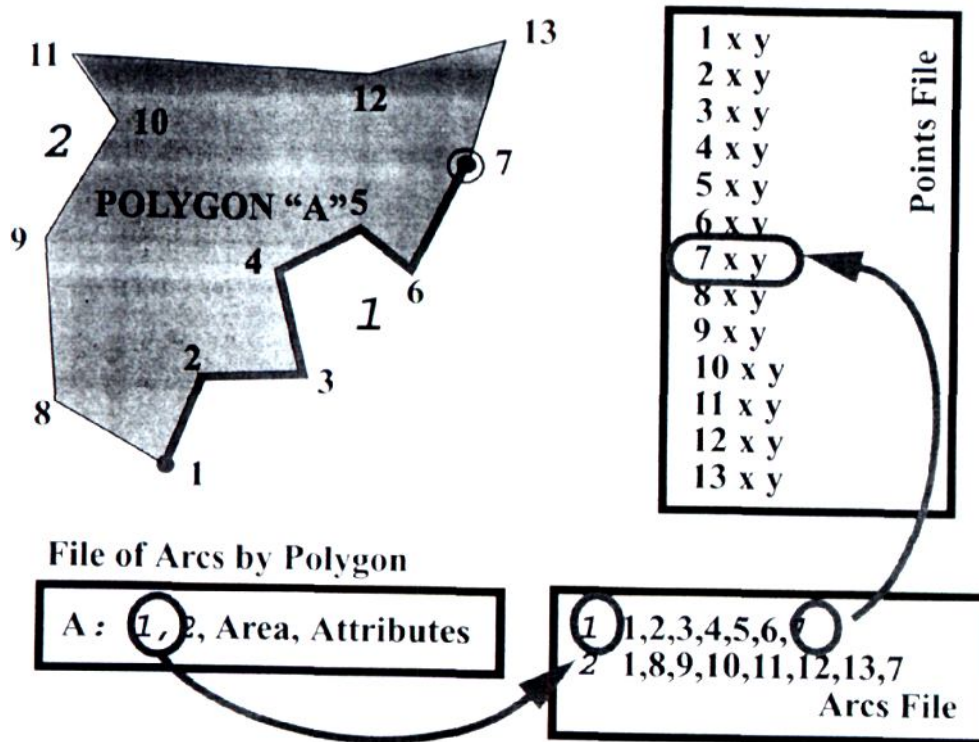


Figure 2 – Arc/node map data structure with files

At the least, we need a file containing the attributes for the polygon, a file listing the arcs within the polygon and finally a file of coordinates that are referenced by the arc file. Figure 2 shows that we need to store in each of these files a set of references between the files. For example, an entry in the arcs files states that to get the points for arc 2 from the points file they begin at the first coordinate point in the file, followed by the eighth, the ninth, and so on.

During the early days of GIS, several systems evolved different versions of this structure. Obviously, to save space we could write the files in binary. There are few ways, however, to store point, line, and area data that are as efficient. As long as the data are valid, this is a very powerful way to store data for map features. When the system breaks down, however, is when data contain errors, which is virtually always.

The formats of the data are documented formally, and the files are ASCII. They use the ground coordinates in UTM, truncated to the nearest 10 meters to reflect their locational precision and to save space. Features are handled in separate files – for example, hydrology, hypsography (contours and topographic features), transportation, and political. Many GIS packages will import these files, but often some extra data manipulation is necessary, such as making the records of some fixed line length in bytes.

**Activity 5. Read the text. Put questions to the words or phrases in italics. Use the answers to the questions to give a brief summary of the text.**

### RASTER DATA STRUCTURES

Raster or grid data structures have formed the *basis for many GIS packages*. The *grid* is a surprisingly versatile way of storing data. The data form an array or matrix of rows and columns. *Each pixel or grid cell* contains either a data value for an attribute, or an index number that points to reference in the attribute database. So a pixel containing the number 42, for example, could *correspond* with the number 42 or ‘deciduous forest’ in the Anderson Level II system, or just the 42nd record in the attribute file.

To write the numbers to a file, we can just start the file with *any necessary attribute* codes, perhaps the number of rows and columns and the maximum size of one value, and then write the data into the file in binary across *all* columns for all rows, one long stream of data with a start and an end, like an unraveled sweater. *When reading the data back in*, we just place the data back into a raster grid of the correct dimensions.

**Activity 6. Fill in the gaps with the prepositions from the box.**

from   for (2)   by (2)   with (2)   of (3)
---

### WHY TOPOLOGY MATTERS

When topological data structures became widespread in GIS, some significant benefits resulted, enough that today the vector arc/node data structure (1)\_\_\_ topology probably is the most widespread (2)\_\_\_ GIS data. Typically, a GIS maintains the arc as the basic unit, storing (3)\_\_\_ it the polygon left and right, the forward and reverse arc linkages, and the arc end nodes (4)\_\_\_ testing. This means that each line is stored only once and that the only duplication is the endpoints. The disadvantage is that whenever areas or polygons are to be used,

some recomputing is necessary. Most programmes save the result, however, such as the computed polygon areas, so that recalculation is unnecessary.

Topology allowed GIS for the first time to do error detection. If a set (5) \_\_\_ polygons is fully connected, and there are no gaps at nodes or breaks in the lines defining the areas, the set (6) \_\_\_ areas is called *topologically clean*. When maps are first digitized, however, this is rarely the case. The topology can be used to check the polygons. Polygon interiors are usually identified (7) \_\_\_ digitizing a point inside a polygon, a label point, and (8) \_\_\_ keeping track of the arcs as they are entered. A polygon gets the label from the label point when the point is found to be inside the polygon. A GIS will have the ability to build the topology (10) \_\_\_ the unconnected arcs. First, each endpoint is examined to see if it is 'close' to another. If it is, the points are 'snapped' together; that is, their (x, y) coordinates are averaged and each is replaced with exactly the same values (Fig. 3).

**Activity 7. Before examining Figure 3 accompanying the above given text find the meaning of the following terms as well as some other useful word combinations:**

- 1) sliver \_\_\_\_\_
- 2) spike \_\_\_\_\_
- 3) unsnapped node \_\_\_\_\_
- 4) erroneous coordinate \_\_\_\_\_
- 5) unended line \_\_\_\_\_
- 6) ark linkage \_\_\_\_\_
- 7) topology matter \_\_\_\_\_
- 8) duplication \_\_\_\_\_
- 9) computed polygon areas \_\_\_\_\_
- 10) the same values \_\_\_\_\_.

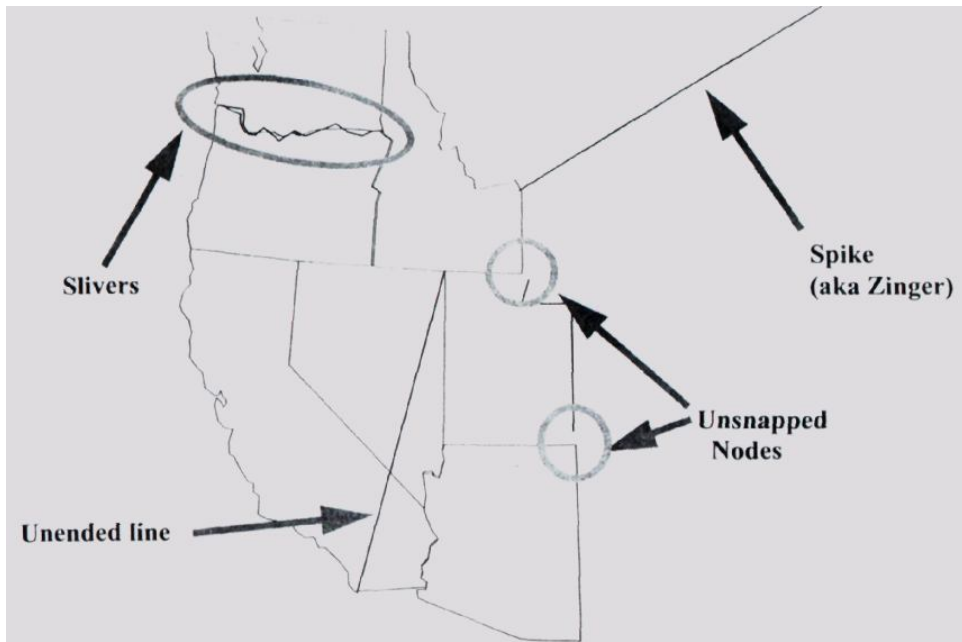


Figure 3 – Example of slivers (unmatched nodes along two lines), unsnapped nodes (endpoints of two lines that should be the same point), spikes (erroneous coordinates), and unended lines

**Activity 8. Look up the following words in your dictionary and find their meaning.**

- 1) consistent \_\_\_\_\_
- 2) overlain \_\_\_\_\_
- 3) node \_\_\_\_\_
- 4) county \_\_\_\_\_
- 5) generalized \_\_\_\_\_
- 6) retrieval \_\_\_\_\_.

**Activity 9. Use these words to read and understand the passage. Figure 3 will be of help to you.**

The primary advantage of having a topologically consistent map is that when two or more maps must be overlain, much of the initial preparation work has been done. What still has to be established are where new points must be added along lines to become nodes, and how to deal with any small or sliver polygons that are created (Fig. 3). The latter can be a real problem. Many borders between regions, states, counties and so on match along lines such as rivers, which are generalized differently at different map scales. Although the line should be the same, in fact it is not. Some packages allow the extraction of a line from one map to be ‘frozen’ for use on another. This seemingly small difference can be very significant, especially if areas or densities are being calculated.



**Activity 10. Discuss whether the statements to the above given passage are true (T) or false (F).**

1. The Test Point is wholly inside the bounding rectangle. ( )
2.  $(x, y)$  data are continuously used in many operations of retrieval and analysis. ( )
3.  $(x, y)$  values are saved without topological information in the arcs file. ( )

## ***UNIT 6 FORMATS FOR GIS DATA***

### **Vocabulary notes:**

to handle – обробляти дані, оперувати даними;  
at one's peril – на свій власний ризик;  
proprietary – патентований;  
to import – вводити;  
utility programme – сервісна програма, утиліта.

### **Activity 1. Read and translate the text.**

With a 30-year history and with so many alternative ways to structure map and attribute data, it is hardly surprising that most GISs use radically different approaches to handling their content. The data structures used are often invisible as far as the GIS user is concerned. We might not even need to understand exactly what is happening when two maps are overlain. However, if we are to be objective, we must have a full understanding of the errors and transformations involved. Regardless of how a GIS structures its maps as numbers, it must be able to import data from other GIS packages and from the most common data sources, as well as scanned and digitized data, and to convert the result into its own internal format. In some cases this is an open process. Some GIS companies have published and documented their internal or exchange data formats, including Intergraph and Autodesk. Others protect their internal data as a trade secret, in the hope of being able to sell data and data converters as well as their GIS.

The most common data formats for GIS data have been used by so many GIS operations and for so much existing data that a GIS ignores them at its peril. Some are so common that utility programmes and even operating systems read, process, and display these formats automatically. These formats include some that have arisen because they are a common data format, such as TIGER and DLG. Others are industry-standard formats, proprietary formats that have been used so much that they are documented and published, although their use may have restrictions.

In the GIS world, a small subset of these formats has become commonplace.

**Activity 2. Answer the questions using the information from the text.**

1. Why do we have to understand the errors and transformations involved in the GIS structures?
2. Why isn't the process of data converting open for some GIS companies?
3. Why does a GIS ignore the most common data formats?

**Activity 3. Read and translate the key terms and their definitions.**

***data format:*** A specification of a physical data structure for a feature or record.

***export:*** The capability of a GIS to write data out into an external file and into a nonnative format for use outside the GIS, or in another GIS.

***image depth:*** The numbers of bits stored for each pixel in a digital image.

***import:*** The capability of a GIS to bring data in an external file and in a nonnative format for use within the GIS.

***internal format:*** A GIS data format used by the software to store the data within the program, and in a manner unsuitable for use by other means.

***node:*** The end of an arc. At first, any significant point in a map data structure. Later, only those points with topological significance, such as the ends of lines.

***snap:*** Forcing two or more points within a given radius of each other to be the same point, often by averaging their coordinate.

***arc:*** A line that begins and ends at a topologically significant location, represented as a set of sequential points.

***arc-node:*** Early name for the vector GIS data structure.

**Activity 4. Fill in the text with the proper prepositions.**

with    of (4)    for (3)
---------------------------

**VECTOR DATA FORMATS**

A general distinction between industry and commonly used standards (1)\_\_\_ GIS data is that between formats that preserve and use the actual ground coordinates (2)\_\_\_ the data and those that use an alternative ***page coordinate description*** (3)\_\_\_ the map. The latter are the coordinates used when a map is being drafted (4)\_\_\_ display in a computer mapping programme or in the data display module (5)\_\_\_ a GIS.

The Hewlett-Packard Graphics Language (HPGL) is a page description language designed (6)\_\_\_ use with plotters and printers. The format is simple and

the files are plain ASCII text. Each line (7)\_\_\_\_ the file contains one move command, so a line segment connects two successful lines or points. The format works (8)\_\_\_\_ minimum of header information, so that files can be written or edited easily. However, the header can be manipulated to change the scaling, size, colours and so on. The HPGL is an unstructured format and does not store or use topology.

**Activity 5. Find the English equivalents to the terms from the passage given below.**

- 1) потенційна можливість \_\_\_\_\_
- 2) робота мережі в інтерактивному режимі \_\_\_\_\_
- 3) складна ущільнена схема \_\_\_\_\_
- 4) роздільна здатність змінної \_\_\_\_\_
- 5) відновлення роздільної \_\_\_\_\_
- 6) (картографічний) пакет \_\_\_\_\_.

A surprising number of utility programmes exist to convert between raster formats. Among them are Image Alchemy and xv. Many packages also read and write a huge number of formats. Some will convert from raster to vector and vice versa, such as CorelDraw. In some cases, this capability is included within the GIS package.

Some common raster formats are the Tagged Interchange Format (TIF), which can use run length and other image compression schemes and has a number of different forms that are publicly available; the Graphics Interchange Format (GIF), popularized by the online network services, especially CompuServe (the developers), which uses a quite sophisticated compression scheme on the data part of the image; and the JPEG format, which uses a variable resolution compression system offering both partial and full resolution recovery depending on the space available.

**Activity 6. Now decide whether the following statements to the above given information are true (T) or false (F).**

1. Image Alchemy and xv are the only utility programmes to be used in raster formats. ( )
2. CorelDraw is a raster format. ( )
3. Many raster formats are popularized by the online network service. ( )

**Activity 7. Translate the following attributive phrases into Ukraine. Mind the relationship between the words in a phrase.**

*Example :* computer system  
different computer system  
entirely different computer system/

- 1) data set \_\_\_\_\_
- 2) standard data set \_\_\_\_\_
- 3) exchange data set \_\_\_\_\_
- 4) exchange-unfriendly data set \_\_\_\_\_
- 5) worldwide                      nautical                      chart                      data  
\_\_\_\_\_
- 6) topological data structures \_\_\_\_\_
- 7) true raster data formats \_\_\_\_\_
- 8) GIS data exchange \_\_\_\_\_
- 9) database                                      management                                      system  
\_\_\_\_\_
- 10) vector                      topology                      data                      structure  
\_\_\_\_\_

**Activity 8. Translate the sentences into English.**

1. У багатьох ГІС використовується багато різних форматів і одна структура даних.
2. Якщо ГІС являє (supports) багато різних структур даних, то відповідальність за зміни структур несе користувач.
3. Процес заміни вектора на растр – нескладний, процес заміни растра на вектор – складний.
4. Часто відбувається або обмін даними, або передача даних в різні пакети ГІС або між комп'ютерними системами.
5. Для майбутнього ГІС важливе значення має ефективний обмін даними.

**Activity 9. Read the text and translate it into Ukrainian.**

EXCHANGING DATA

Exchanging data can be thought of in two ways. First, the vector and the raster formats often store similar GIS data in very different ways. The GIS software adopts one of two strategies for dealing with the two types of data. Some

systems use only one format exclusively, and provide utilities or import options to bring in and convert the data to the format to be used. Raster-based GIS programmes especially use this approach.

Alternatively, the system can support the native format of each type of data, and it can require the GIS operator to explicitly change formats when operations requiring compatibility of formats are executed. In both cases, a computer programme, part of the GIS, either performs a raster-to-vector or a vector-to-raster conversion. While a full discussion of how these operations work is beyond the scope of this passage, it should be clear that going from vector to raster, filling in grid cells as lines cross them or as polygons include them, is relatively simple. The opposite is quite complex.

## ***UNIT 7 GETTING THE MAP INTO THE COMPUTER***

### **Vocabulary notes:**

tangible – ясний, відчутний, реальний;

virtual – віртуальний, той, що допускається, фактичний, поточний;

to force – змушувати, примушувати;

to fold – складати, перегинати.

### **Activity 1. Read and translate the text.**

Most people think of maps as drawings on paper. Maps hang on walls, lie in map drawers, and fill the pages of books, atlases, street guides, newspapers, and magazines. Maps roll off the nation's printing presses in the millions each year, and they fill the spaces in every car's glove compartment, neatly folded or not! The traditional paper maps of our everyday world can be called *real maps*, because they are touchable. We can hold them in our hands, fold them up, and carry them around. The computer, in contrast, has forced us to reconsider this simple definition of a map. In the digital era, and especially within GISs, maps can be both real and *virtual*.

A virtual map is a map waiting to be drawn. It is an arrangement of information inside the computer in such a way that we can use the GIS to generate the map however and whenever we need it. We may have stored map information about roads, rivers, and forests, for example, but may decide that only the forests and rivers need be shown on any map that the GIS produces. Every real map is simply a conversion of the virtual map into a medium, the form that the map will take. In most cases, the medium we use is paper.

**Activity 2. Answer the following questions using the information from the text.**

1. What do we call a real map?
2. What is a virtual map?
3. What is the medium for both types of maps?

**Activity 3. Read and translate the key terms and their definition.**

***analog:*** A representation where a feature or object is represented in another tangible

medium. For example, a section of the earth can be represented in analog by a paper

map, or atoms can be represented by Ping-Pong balls.

***attribute:*** A characteristic of a feature that contains a measurement or value for the

feature. Attributes can be labels, categories, or numbers; they can be dates, standardized values, or field or other measurements. An item for which data are collected and organized. A column in a table or data file.

***geocoding:*** The conversion of analog maps into computer-readable form. The two usual methods of geocoding are scanning and digitizing.

***real map:*** A map that has been designed and plotted onto a permanent medium such as paper or film. It has a tangible form and is a result of all of the design and compilation decisions made in constructing the map, such as choosing the scale, setting the legend, choosing the colours, and so on.

***virtual map:*** A map that has yet to be realized as a tangible map; it exists as a set of possible maps. For example, the same digital base map and set of numbers can be entire series of possible virtual maps, yet only one may be chosen to be rendered as a real map on a permanent medium.

**Activity 4. Read the text. Decide whether the statements are true (T) or false (F).**

#### FINDING DATA ON THE NETWORKS

An excellent way to begin a data search is to use a computer network. Several computer packages allow you to do this over the various network access methods, such as America Online and CompuServe. The most sophisticated tools, however, are those available on the Internet. Among the various tools, such as Archie, Veronica, WAIS, and Gopher, is a computer program called Mosaic, from

the National Supercomputing Center at the University of Illinois. Mosaic allows you to search the World Wide Web (WWW), an interlinked set of computers and servers, or data repositories on the Internet. Similar and more widely used programmes are Netscape Navigator and Microsoft Explorer. Each major agency has a World Wide Web server, or *gateway*, through which data can be searched and downloaded. Simply enormous amounts of data are available through this simple mechanism.

1. Existing map data are used in a map library. ( )
2. A data search is provided by various network access methods. ( )
3. The Internet is of great help in finding data. ( )
4. Mosaic is an interlinked set of computers and servers. ( )
5. We search data through a World Wide Web server but download the data through a simple mechanism. ( )

**Activity 5. Read the text. Find the English equivalents to the terms below:**

Using maps within GISs means that somehow they have already been turned from real into virtual maps. Another way to say this is that a paper map has gone through a conversion, from a paper or analog form into a digital or number form. We start with paper, or sometimes film, Mylar, or some other medium, and we end up with a set of numbers inside files in the computer. This conversion process is called *geocoding*, which we can define as the conversion of spatial information into computer-readable form. Some GIS vendors would be pleased to help you acquire the data you need but at an immense price. Studies have shown that finding the right maps, and converting these maps from real to virtual form by geocoding, takes up anywhere between 60% and 90% of both the time and money spent on a typical GIS project. Fortunately, this is a once-only cost. As soon as we have the map in a digital form, we can use it in a GIS over and over again for different uses and projects unless it needs an update.

- 1) зазнали перетворення \_\_\_\_\_
- 2) (майларова) плівка \_\_\_\_\_
- 3) просторова інформація \_\_\_\_\_
- 4) той, який зчитується комп'ютером \_\_\_\_\_
- 5) величезна ціна \_\_\_\_\_
- 6) одноразові витрати \_\_\_\_\_
- 7) оновлення \_\_\_\_\_
- 8) продавець ГІС \_\_\_\_\_

## Activity 6. Translate the sentences into English:

1. Дані для ГІС можна
  - а) купити;
  - б) знайти в цифровому вигляді в існуючих джерелах;
  - в) зібрати (capture) за аналоговими картками шляхом геокодування.
2. Геокодування – це перетворення просторової (spatial) інформації в цифрову форму.
3. Геокодування включає в себе збір (capturing) даних по карті і знаходження атрибутів.
4. Дані, наявні на існуючих картах, можна знайти в бібліотеці карт, через пошукову мережу (network searches), або на носіях інформації, наприклад, на CD-ROM або дисках.
5. Більшість провайдерів забезпечують доступ до інформації через всевітню мережу.

## Activity 7. Read the text and translate it in writing into Ukrainian.

Digital map data for use in GIS really falls into two categories. Either the data already exist and all we have to do is find or buy them, or they don't exist and we have to geocode paper maps or maps on some other medium. A third case is that the maps don't even exist, and here we often turn to remote sensing, aerial photography, or field data collection by surveyors or the global positioning system (GPS), to get our first map of a new location. Also, sometimes the maps we need already exist, but whoever geocoded them is not interested in sharing the data with you, even for a price! Even when we can get the maps we need in digital form, they may not suit our particular type of GIS, or may be out of date or not show the features we want. Sooner or later, and usually sooner, we end up geocoding at least some of our own maps.

## ***UNIT 8 DIGITIZING AND SCANNING***

### Activity 1. Read and translate key terms and their definitions.

***digitizing:*** Also called semi-automated digitizing. The process in which geocoding takes place manually; a map is placed on a flat tablet and a person traces out the map features using a cursor. The locations of features on the map are sent back to the computer every time the operator of digitizing tablet presses a button.



**scanning:** A form of geocoding in which maps are placed on a surface and scanned by a light beam. Reflected light from every small dot or pixel on the surface is recorded and saved as a grid of digits. Scanners can work in black and white in gray tones or in color.

**digitizing tablet:** A device for geocoding by semiautomated digitizing. A digitizing tablet looks like a drafting table but is sensitized so that as a map is traced with a cursor on the tablet and the locations are identified, converted to numbers, and sent to the computer.

**Activity 2. Read the text. Find the new terms given above. Translate the text orally.**

### DIGITIZING AND SCANNING

Historically, many different means have been used to geocode. At first, some very early GIS packages required maps to be encoded and entered by hand. The hours of monotonous work required for this task made errors common and their correction difficult. Since special-purpose digitizing hardware became available, and especially since the cost of this hardware fell substantially, virtually all geocoding has been performed by computer.

Two technologies have evolved to get maps into the computer. Digitizing mimics the way maps were drafted by hand and involves tracing the map over using a cursor while it is taped down onto a sensitized digitizing tablet. The second method involves having the computer ‘sense’ the map by scanning it. Both approaches work and have their advantages and disadvantages. Most important, the method of geocoding stamps its form onto the data in such a way that many other GIS operations are affected afterwards.

**Activity 3. Answer the questions using the information from the text.**

1. How were the early GIS packages encoded at first?
2. What was the disadvantage of encoding by hand?
3. What two methods were involved to get maps into the computer?

**Activity 4. Examine FIGURE 4 and discuss the digitizing procedure.**

1. Digitizer cursor transmits a pulse from an electromagnetic coil under the view lens.
2. Pulse is picked up by nearest grid wires under tablet surface.
3. Result is sent to computer after conversion to  $x$  and  $y$  units.

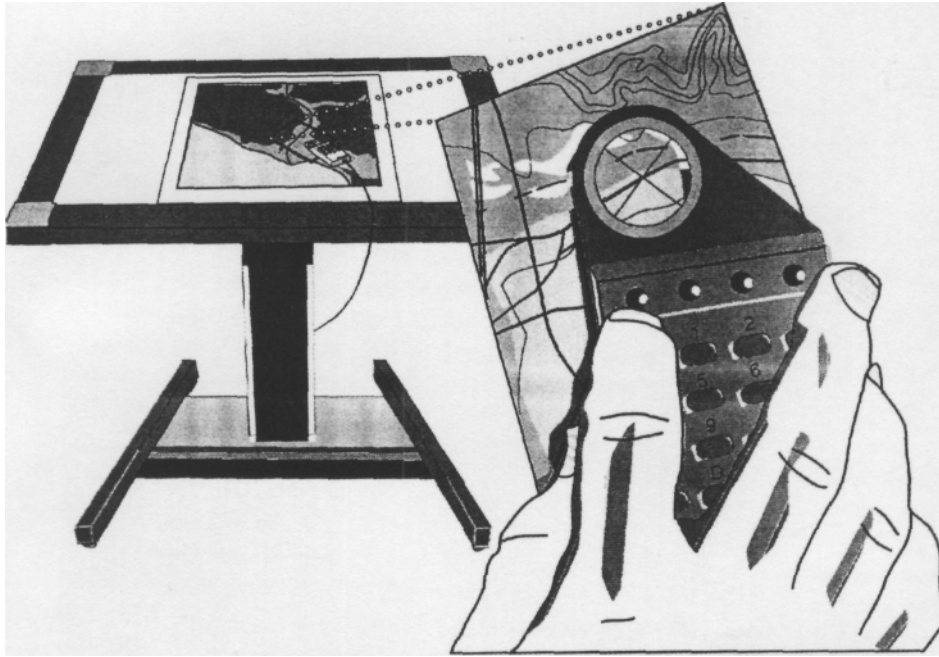


Figure 4 – Digitizing tablet system of operation

**Activity 5. Read the text about digitizing. Find the English equivalents to the terms given below.**

### DIGITIZING

Geocoding by tracing over a map with a cursor is sometimes called *semiautomated digitizing*. This is because in addition to using a mechanical device, it involves a human operator. Digitizing means the use of a digitizer or digitizing tablet (Figure 4). This technology has developed as computer mapping and computer-aided design have grown and placed new demands on computer hardware.

The digitizing tablet is a digital and electronic equivalent of the drafting table. The major components are a flat surface, to which a map is usually taped, and a stylus or cursor, with the capability of signaling to a computer that a point has been selected (Figure 4). The mechanism to capture the location of the point can differ. Many systems have connected arms, but most have embedded active wires in the tablet surface that receive an electrical impulse sent by a coil in the cursor. In some rare cases, the cursor transmits a sound, which is picked up and recorded by an array of microphones.

- 1) креслярський стіл \_\_\_\_\_
- 2) пристрій перетворення в цифрову форму \_\_\_\_\_
- 3) цифровий перетворювач графічної інформації \_\_\_\_\_
- 4) маніпулятор \_\_\_\_\_

- 5) поверхня \_\_\_\_\_
- 6) вбудувати \_\_\_\_\_
- 7) щільно приклеювати за допомогою стрічки \_\_\_\_\_
- 8) друкарська голка \_\_\_\_\_.

**Activity 6. Continue reading about digitizing. Guess what the words in italics mean or find the meaning of these words in your dictionary.**

The beginning of the *digitizing sequence* involves selecting the control points and interactively entering their world coordinates. This is a very important step, because an error at this stage would *lead* to an error in every pair of coordinates. After the map is taped to the tablet, it should not be moved without entering the control points again, and it is preferable to perform this step only once per map. Ideally, the entire digitizing process should be finished at *one sitting*.

Tape should be placed at each map corner after *smoothing* the map, and care should be taken to deal with *folds* and the *crinkles* that develop with certain papers during periods of high humidity. A stable base product such as Mylar or film is preferable for digitizing. The lower edge, which will have the cursor and your right *sleeve* (if you are right-handed) *dragged* over it many times, should be taped over its *entire* length. You should always *permanently* record the *x* and *y* values of the map control points, ideally digitally and with the geocoded data set. This may allow later *recovery* of lost resolution or systematic errors.

**Activity 7. Read the text about scanning. Find the English equivalents to the terms given below.**

#### SCANNING

The second digitizing process is *automated digitizing* or more usually, just *scanning*. The scanner you may have seen at a computer store or in an advertisement, or perhaps the one you use for scanning documents, is a *desktop scanner*.

The *drum scanner* is most commonly used for maps. This type of scanner receives an entire sheet map, usually clamped to a rotating drum, and scans the map with very fine increments of distance, measuring the amount of light reflected by the map when it is illuminated, with either a spot light source or a laser. The finer the resolution, the higher the cost and the larger the data sets. A major difference with this type of digitizing is that lines, features, text, and so on, are scanned at their actual width and must be preprocessed for the computer to recognize specific cartographic objects. Some plotters can double as scanners, and vice versa.

For scanning, maps should be clean and free of folds and marks. Usually, the scanned maps are not the paper products but the film negatives, Mylar separations, or the scribed materials that were used in the map production. An alternative scanner is the *automatic line follower*, a scanner that is manually moved to a line and then left to follow the line automatically. Automatic line followers are used primarily for continuous lines, such as contours. These and other scanners are very useful in CADD (computer-aided drafting and design) systems, where input from engineering drawings and sketches is common.

- 1) настільний сканер \_\_\_\_\_
- 2) барабанний сканер \_\_\_\_\_
- 3) крок, збільшення \_\_\_\_\_
- 4) місцеве (локальне) джерело світла \_\_\_\_\_
- 5) графічний пристрій \_\_\_\_\_
- 6) збільшувати в два рази \_\_\_\_\_
- 7) попередньо обробляти, готувати \_\_\_\_\_
- 8) матеріали з розміткою \_\_\_\_\_
- 9) автоматичний рядок, що стежить \_\_\_\_\_
- 10) контур, обрис \_\_\_\_\_.

**Activity 8. Translate the following sentences into English.**

1. Метод геокодування може впливати на побудову карти (structure) і спричинити помилки, пов'язані з просторовою інформацією.
2. Двома основними методами геокодування є перетворення в цифрову форму і сканування.
3. При перетворенні в цифрову форму дані знімаються (capture) з карти шляхом відстеження (tracing) ліній вручну.
4. При скануванні карта розміщується (place) на скляній площині (plate), яка висвітлюється промінем світла.
5. Для сканування важливі розмір зображення і роздільна (resolution).

**Activity 9. Read the text and translate it in writing into Ukrainian.**

FIELD DATA COLLECTION

An increasing amount of data for GIS projects comes from a combination of field data, global positioning system data, and imagery. Field data are collected using standard surveying methods, in which locations are established in the field as *control points* and then additional locations, tracing out features or covering terrain, for example, are traced out by large numbers of measurements using instruments designed to measure angles and distances. The highest accuracy

instruments, called *total stations* are digital recorders as well as measurement instruments and use laser ranging to prism reflectors to calculate distance.

## **UNIT 9 DATA ENTRY**

### **Activity 1. Read and translate the text.**

Geocoding is the part of GIS data input that results in getting a map into the computer. It is not the entire story, however, for as yet we have not dealt with getting the attributes into the GIS. An attribute is a value, usually a number, containing information about the features contained in the GIS. If the feature we are geocoding is a road, for example, then capturing the route of the road from a map as it winds from intersection to intersection is pure geocoding. We also have to tell the computer what this long and winding line is: a road, and anything else that the GIS needs to know about it. Relevant attributes for a road might be its state route number, the year it was built, what the surface is made of, how many traffic lanes are on the road, if the road is one-way or two-way, how many bridges it goes over, how many cars travel along the road per hour, and so on. These values are the road's *attributes*. They are the very meat and potatoes of GIS analysis.

Somehow, we have to get them into the computer, too.

### **Activity 2. Answer the questions using the information from the text.**

1. What does getting the map into the computer result from?
2. What is an attribute?
3. What is necessary for GIS analysis?

### **Activity 3. Read and translate the key terms and their definitions.**

***data entry:*** The process of entering numbers into a computer, usually attribute data. Although most data are entered by hand, or acquired through networks, from CD-ROMs, and so on, field data can come from a GPS (global positioning system) receiver, from data loggers, and even by typing at the keyboard.

***data-entry module:*** The part of a database manager that allows the user to enter or edit records in a database. The module will normally both allow entry and modification of values, and enforce the constraints placed on the data by the data definition.

***drop-out:*** The loss of data due to scanning at coarser resolution than the map features to be captured. Features smaller than half the size of a pixel can disappear entirely.

**drum scanner:** A map input device in which the map is attached to a drum that is rotated under a scanner while illuminated by a light beam or laser. Reflected light from the map is then measured by the scanner and recorded as numbers.

**editing:** The modification and updating of both map and attribute data, general using a software capability of the GIS.

**flat file:** A simple model for the organization of numbers. The numbers are organized as a table, with values for variables as entries, records as rows, and attributes as columns.

**flatbed scanner:** A map input device in which the map is placed on a glass surface, and the scanner moves over the map, converting the map into numbers.

**network:** Two or more computers connected together so that they can exchange messages, files, or other means of communication. A network is part hardware, usually cables and communication devices such as modems, and part software.

**server:** A computer connected to a network whose primary function is to act as a library of information that other users can share.

**stream mode:** A method of geocoding in semi-automated digitizing, in which a continuous stream of points follows a press of the cursor button. This mode is often used for digitizing long features such as streams and coastlines. It can generate data very quickly, so is often weeded out immediately by automated line generalization within the GIS.

**Activity 4. Read the text. Decide whether the following statements are true (T) or false (F).**

The simplest way to think of attributes is in a flat file. A flat file is really like a table of numbers. The columns of the table are the attributes, and the rows of the table are the features themselves. Each line in the table is a record, but the name used depends on who you talk to. A computer scientist would call a row of **tuple**, a statistician would call it a **case** or an **observation**. A programmer might call it an **instance of a geographic object**. They are all pretty much the same. **Record** sounds more simply.

Take a look at the flat file in figure 5. The records and attributes relate to the example we discussed above, a road. The attribute table then consists of several parts. First, it has attributes with their names. Setting up attributes means deciding what values are going to be associated with each our features. At the time of setup, it is easy to anticipate something we may want to collect in the future and to leave a column in the table.

Second, there are records. A record usually has a value in every one of the columns. Software programmes such as spreadsheets and some databases allow

you to click into a cell in the table and put in a value. Nevertheless, setting up the table has to be a little more formal than that.

ID	Feature	Name	Surface	Lanes	Traffic per hour
1	Road	US 11	tarmac	3	113
2	Road	I 81	concrete	4	432
3	Road	Lisk Bridge Road	tarmac	2	12

*value*, is the number or text associated with a record for an attribute

*attribute* has a name and a value for each record

*record*, all attributes for one feature

Figure 5 – An attribute table organized as a flat file

1. The simplest representation of attributes is a flat file. ( )
2. The columns and rows of the table have names. ( )
3. The choice of the names in a flat file has nothing to do with a user. ( )
4. Setting up the value for the feature means the establishing of the attribute. ( )

**Activity 5. Read the text. Find the English equivalents to the terms given below.**

Each attribute has more than simply a name associated with it. For example, if we tried to put ‘US 11’ into the attribute column ‘Surface’, something is obviously wrong. Each attribute should have several characteristics, all of which usually have to be known in advance. The following is a list of what has to be considered.

1. What is the *type* of the value? For example, values could be text, number, decimal value or units such as meters, vehicles per hour, and so on.

2. What is the legitimate *range* of the values? For example, percentages should be between 0 and 100. Are negative numbers allowed? For text values, what spellings or range of choices (known as *categories*) are allowed? For text, how many characters long is the longest string?

3. What happens when there is a missing cell in the table? For example, a record could be missing an attribute such as the traffic count in Figure 6 because nobody was available to make the count. Often a *missing value flag*, such as the value – 999 or NULL, is used in these cases. We obviously would not want these to count if we summed or averaged the rows or columns.

4. Are duplicates allowed? What if we had two road entries for Interstate 81 on Figure 6, one for the northbound and one for the southbound lanes?

The traffic counts, road surfaces, and so on may be different and worthy of their own record. In this case, the values entered in the attribute column under "Name" would be identical.

5. Which attribute is the *key*? The key is the link between the two databases. So, the attribute corresponding to the key should match the tag that was placed on the road when it was digitized from the map. Otherwise all our attributes would be 'lost in space.'

- 1) десяткове значення \_\_\_\_\_
- 2) розумна межа \_\_\_\_\_
- 3) найдовший рядок \_\_\_\_\_
- 4) відсутня клітина \_\_\_\_\_
- 5) ознака (прапор) відсутнього значення \_\_\_\_\_
- 6) порожній покажчик; нуль \_\_\_\_\_
- 7) результат підрахунку транспортного потоку \_\_\_\_\_
- 8) найважливіший, принциповий \_\_\_\_\_
- 9) тег, ознака \_\_\_\_\_.

**Activity 7. Look up the following words in your dictionary and find their translation.**

- entry \_\_\_\_\_  
to edit \_\_\_\_\_  
to validate \_\_\_\_\_  
to border \_\_\_\_\_  
to include \_\_\_\_\_  
to delete \_\_\_\_\_.

*Find the words in the text given below formed from these ones*

#### EDITING AND VALIDATION

Many early geocoding systems had only limited editing capabilities. They allowed data entry, but error detection was by after-the-fact processing, and correction was by deletion of records or even whole data sets and reentry. Anything we can do in the geocoding process that reduces errors, or that makes errors easily detectable, we should indeed do. As an absolute minimum, data for lines and areas can be processed automatically for consistency, and any



unconnected lines or unclosed polygons can be detected and signaled to the user. The connection between lines, known bordering of areas, and inclusion of points in areas is called map *topology*. Topology really comes into its own during the map validation stage.

**Activity 8. Read the text and translate it into Ukrainian in writing.**

The GIS often allows check plots to be generated that simply plot the label or identification number of the key within a polygon or next to a line. These maps and the tedious process of checking them should never be skipped. Moving straight on to making elegant graphics or doing a GIS-based analysis with erroneous data can be anything from embarrassing to dangerous, or even life-threatening.

A data set that is correctly geocoded both positionally and with attributes is not necessarily logically consistent. Logical consistency can be checked most easily for topological data. Topologically, data can be checked to see that all chains intersect at nodes, that chains cycle correctly in a ring around polygons, and that inner rings are fully enclosed within their surrounding polygons. Otherwise, attributes can be checked to ensure that they fall within the correct range and that no feature has become too small to be represented accurately.

**Activity 9. Translate the sentences into English.**

1. Система бази даних містить модуль опису даних (data definition module), який встановлює обмеження (constraints on) цілісності на атрибутивні значення.

2. Система також містить модуль для введення (entry) і корекції даних, а також систему управління (management) для зберігання і пошуку (вибірки) (retrieval) даних.

3. Перевірка і контроль даних для карт здійснюється за допомогою топології.

4. За помилки в картах і атрибутивних даних несе відповідальність особа, що складає ці дані (data producer), і користувач ГІС повинен розуміти це.

5. Точність і чіткість карт (precision map) і атрибутивних даних в ГІС впливає на інші операції, зокрема, порівняння з масштабом (across scales).

## UNIT 10 BASIC DATABASE MANAGEMENT

### Activity 1. Read and translate the text.

A GIS can answer the two questions: "what?" and "where'." More important, a GIS answers the question "What is where?" The *where* component relates to the map behind all GIS activities. The *what* relates to the features, their size, geographical properties and above all else, their attributes. Getting this information is what the toolbox definition of GIS meant *by retrieval*.

These are not trivial questions. Other forms of data organization often fall apart when dealing with 'where.' The telephone book, for example, a list organized alphabetically by last name, gives only relative locations (street addresses) and a house number. An entirely new directory is necessary for each new district, and to retrieve the telephone number of a friend in another town, perhaps just across the river, becomes a major problem because you require a different telephone directory than the one covering your own neighborhood.

The properties of geographic search, finding all the phone numbers of people on a single city block, for example, are not available easily to the user of a telephone directory. The secret to *data retrieval*, the ability to gain access to a record and its attributes on demand, is in data organization.

At the logical level, access requires a *data model*, a theoretical construct that becomes the key for unlocking the data's door.

Without such a data model, data cannot be searched or extracted and therefore become worthless.

We can define a data model, then, as a logical construct for the storage and retrieval of information. It is the computer's way of memorizing all the GIS data that we need to use. This is different from the data structures we examined in earlier, because these deal primarily with how the data are physically stored in files on the computer system. As we have seen, this means that a GIS must have at least two data models, and that the two must have a bridge or link between them to tie the attributes and the geography together. These are the *map data model* and the *attribute data model*

### Activity 2. Answer the questions using the information from the text.

1. What do the questions 'What' and 'Where' relate to?
2. What is the secret to data retrieval?
3. What is the key to searching and extracting the information?

### Activity 3. Read and translate the key terms and their definitions.

***data definition language:*** The part of the DBMS (database management system) that allows the user to set up a new database, to specify how many attributes there will be, what the types and lengths or numerical ranges of each attribute will be, and how much editing the user is allowed to do.

***data dictionary:*** A catalog of all the attributes for a data set, along with all the constraints placed on the attribute values during the data definition phase. Can include the range and type of values, category lists, legal and missing values, and the legal width of the field.

***data entry:*** The process of entering numbers into a computer, usually attribute data. Although most data are entered by hand or acquired through networks, from CD-ROMs, and so on, field data can come from a GPS (global positioning system) receiver, from data loggers, and even by typing at the keyboard.

***data model:*** A logical means of organization of data for use in an information system.

***database:*** Any collection of data accessible by computer.

### Activity 4. Write the English equivalents to the words and phrases from the exercise above. Learn them.

- 1) точно визначати; задавати \_\_\_\_\_
- 2) обмеження цілісності \_\_\_\_\_
- 3) допустиме значення \_\_\_\_\_
- 4) придбаний, виявлений \_\_\_\_\_
- 5) пристрій реєстрації даних \_\_\_\_\_
- 6) логічні засоби організації даних \_\_\_\_\_.

### Activity 5. Read the text. Decide whether the following statements are true (T) or false (F).

The database management system's (DBMS's) heritage is from within computer science, but the user community is as broad as that of GIS, literally millions of firms, accountants, colleges and universities, banks, and so forth that need to keep and organize records by computer. The earliest database management systems date from the efforts of the early 1970s, when large mainframe computers were used, data-entry was by key punch and punched cards, and the technology was called ***automatic data processing***.

The parts of a DBMS have remained fairly consistent over time, regardless of how the attribute data are actually placed into files. The ***data definition language*** is that part of the DBMS that allows the user to set up a new database, to specify how many attributes there will be, what the types and lengths or numerical ranges of each attribute will be, and how much editing the user is allowed to do. This establishes the ***data dictionary***, a catalog of all of the attributes with their legal values and ranges. Every DBMS has the ability to examine the data dictionary, and the data dictionary itself is a critical piece of metadata (data about the data) that is often required when the database has to move between systems.

The most basic management function is ***data entry***, and because most entry of attribute data is fairly monotonous and may be by transcription from paper records, the DBMS's data-entry system should be able to enforce the ranges and limits entered into the data dictionary by the data definition language. For example, if an attribute is to contain a percentage, and the data-entry person types a value of "110", the DBMS should refuse to accept the value and alert the person.

1. The user community that needs to keep and organize records by computer is broad. ( )
2. In the times of the earliest database management the data were processed automatically. ( )
3. The data definition language is an important part of the database management system. ( )
4. The data dictionary is an important part of metadata. ( )
5. The data-entry system limits the data definition language. ( )

#### **Activity 6. Learn the second set of the key terms and their definitions.**

***DBMS (database management system):*** Part of a GIS, the set of tools that allow the manipulation and use of files containing attribute data.

***geographic search:*** A find operation in a GIS that uses spatial properties as its basis.

***batch:*** Submission of a set of commands to the computer from a file rather than directly from the user as an interactive exchange.

***query:*** A question, especially if asked of a database by a user via a database management system or GIS.

***query language:*** The part of a DBMS that allows the user to submit queries to a database.

***relate:*** A DBMS operation that merges databases through their key attributes to restructure them according to a user's query rather than as they are stored physically.

**relational model:** A data model based on multiple flat files for records, with dissimilar attribute structures, connected by a common key attribute.

**retrieval:** The ability of a database management system or GIS to get back from computer memory records that were stored there previously.

**search:** Any database query that results in a successful retrieval of records.

**select:** A DBMS command designed to extract a subset of the records in a database.

**sort:** To place the records within an attribute in sequence according to their value.

**Activity 7. Which of the above given terms and phrases can you find in the passage below? Translate the passage orally.**

All data entry is subject to error, and the first step after entry should be **verification**. This is often done by producing a report or printed copy of the data in a standard form that can be checked against the original. Even if the data are error free, most databases must be **updated** to reflect change. Deletion, insertion, and modification of records, or sometimes changes to the data dictionary itself, must be made frequently. This is done by using the data maintenance part of the DBMS. Care must be taken when updates are made, because changes create a new updated version of the entire database. Sometimes modifications are done in batches and a new version of the database ‘released,’ reflecting a whole suite of changes, perhaps to reflect the calendar year.

With the preceding tasks complete, the DBMS can then be used to perform its more advanced functions. These are the **mining, reordering, subsetting, and searching** functions. For example, a database of student records could be sorted by grade-point average to find all students below a ‘C’ average. A database of students containing zip codes in their address could be reorganized by zip code to make mailing easier for the mailroom staff. Subsetting involves using the **query language**, that part of the DBMS that allows the user to interact with the data to perform these tasks, to create a new data set that meets certain search criteria, such as all students who have more than 100 credits toward their degree. Finally, a **search** for a specific record is often needed. At a public terminal, for example, students may be allowed to type in their Social Security numbers to allow them to examine the grades they got in a given semester. All of these functions are part of regular DBMS and are performed differently in each different system. Nevertheless, all of these functions are common to both DBMSs and GISs.

### **Activity 8. Read the text and translate it into Ukrainian in writing.**

The relational database manager contained a new set of data management commands that allows the keys and links to be exploited. These typically include such actions as *relate*, to select from two flat files that have a common key attribute, *and join*, to take the relate output and merge them into a single database. So the relational data model, while permitting records and attributes to be separated into different files for storage and maintenance, also allows the user to assemble any combination of attributes and records, as long as they are linked by a key attribute. A *join* can create many unneeded sub-records for a single feature, such as multiple records with different dates, so care should be exercised when joining databases.

### **Activity 9. Translate the sentences into English.**

1. ГІС може відповісти на питання «Що де знаходиться?»
2. Багато форм організації даних не підвладні (incapable of) географічному дослідженню.
3. Модель представлення даних є логічною структурою (construct) для зберігання і відновлення інформації.
4. Система управління базою даних містить:
  - мову визначення даних;
  - словник (бази) даних;
  - модуль введення (бази) даних;
  - модуль модифікації (бази) даних;
  - генератор корекції звітів;
  - мову запитів.
5. Реляційна база даних заснована (based on) на множинних плоских файлах для запису даних, що містять різнорідні (несхожі) атрибутивні структури, пов'язані спільним (key) атрибутом.

## ***UNIT 11 SEARCHES BY THE ATTRIBUTE***

### **Vocabulary notes:**

database management system (DBMS) – система управління базою даних;

output – вихідні дані, результати;

layout – розміщення, компоновка; формат;

report generator – генератор звітів;

verification – перевірка (оператором даних, вводяться);

retrieval – пошук, вибірка;  
browse – програма перегляду;  
subset – підмножина;  
assign – привласнювати, призначати (значення).

### Activity 1. Read and translate the text.

#### SEARCHES BY THE ATTRIBUTE

Most GIS systems include as part of the package a fairly basic relational database manager, or simply build on the existing capabilities of a database system. Searches by attribute then are controlled by the capability of the database manager. All DBMSs include functions for basic data display; that is, show all attributes in a database, show all records with their attributes, and show all existing databases. Most also allow records to be output in a standard form, with a particular page layout and style, called a *report generator*. If we need a paper copy of the database, perhaps for checking and verification, then the report generator is used.

As far as actually doing retrieval is concerned, the DBMS must support functions that fall into the category of *query*. As we have seen, a DBMS should allow sufficient data query that any record can be isolated and any subset required for mapping found easily. We may also sometimes wish to reorder or renumber an attribute.

A *find* is the most basic attribute search. Find is usually intended to get a single record. We might find record 15, for example. Finding can be by *search* or by *browse*. Browse searches record by record, displaying each, until the user finds the one needed. Sorting can sort alphabetically for a field, or numerically for a number. Note that a sort may or may not deal with missing values, and where it places them may be significant.

A *restrict* operation allows the user to retrieve a subset of the total number of records by placing a restriction on the attributes' values. For example, we could restrict a search to all records with a date more recent than 1/1/99, or to cities with a population of more than 100,000 people. A *select* operation allows us to choose what attributes will be taken out from another database to form a new database with fewer 'selected' attributes. We usually do this *to join* these records and attributes onto another database in the relational system. A *compute* operation allows us to compute a value for an attribute, to assign a value, or to do mathematical operations between attributes - divide one by another, for example. We can also usually *renumber* an attribute, that is, change the values to our specifications. We might want to find all percentages in an attribute and change

them to a zero if they fall below 50% or a one if they are greater, so that we can do a binary combination with another.

**Activity 2. Answer the questions using the information from the text.**

1. What is the function of a database manager in a GIS?
2. What is the difference between a find and a query?
3. What other operations does a user do during o search by attribute?

**Activity 3. Read and translate the key terms and their definitions.**

***browse:*** A method of search involving repeated examination of records until suitable one is found.

***compute:*** Data management command that uses the numerical values of one or more attributes to calculate the value of a new attribute created by the command.

***find:*** A database management operation intended to locate a single record or a set of records or features based on the values of their attributes.

***overlay:*** A GIS operation in which layers with a common, registered map base are joined on the basis of their occupation of space.

***renumbering:*** Use of the DBMS to change the ordering or ranges of attributes.

***report generator:*** The part of a database management system that can produce a listing of all the values of attributes for all records in a database.

***restrict:*** Part of the query language of a DBMS that allows a subset of attributes to be selected out of the flat file.

***highlight:*** A way of indicating to GIS user a feature or element that is the successful result of a query.

***identify:*** To find a spatial feature by pointing to it interactively on the map with a pointing device such as a mouse.

**Activity 4. Read the text. Decide whether the statements to the text are true (T) or false (F).**

SEARCHES BY GEOGRAPHY

When we considered searching attributes, we looked at the following search and retrieval commands: ***show attributes, show records, generate a report, find, browse, sort, recode, restrict, and compute.*** Moving over to the spatial data within a GIS, some of the operations possible are just spatial equivalents of these, while some are more complex. We discuss the simple retrievals first.



In the map database our records are, instead, features. There are some special attributes specific to the spatial data, and those relate to the coordinates and their measures, plus the characteristics of the lines and polygons. Showing attributes, then, consists of examining the new spatial attributes, such as the actual coordinates themselves, the lengths of arcs, and the areas of polygons. Note that these are already valuable. Using the attribute search functions on these attributes now has spatial consequences. For example, we could find all arcs greater than a certain length, or polygons more than 1 hectare.

Show all records in a spatial sense becomes either show all attributes or display all features on a map. Generating a map which allows us to search for information visually, is a spatial retrieval operation as far as the GIS is concerned. If we wish to generate a report, the spatial equivalent would be to produce a finished map to cartographic standards, including labels, metadata, legend, and so on.

Browsing works on a map by highlighting. We may color-code a specific feature or features. Some GISs allow a displayed single feature to be blinked on and off for visual effect. Finding becomes what many GIS packages call *identify* or *locate*; that is, use a pointing device of some kind such as a mouse to point to a feature. Indicating its selection successfully can then retrieve that feature's attributes from the attribute database.

1. We search for attributes according to particular commands. ( )
2. Special attributes are the same as spatial attributes. ( )
3. Spatial data include the coordinates and their measures, but do not relate to the characteristics of the lines and polygons. ( )
4. In the GIS a spatial retrieval operation results in the display of all the features on the map or the show of all attributes. ( )
5. We indicate a specific feature or element and search for a suitable record by browsing and highlighting. ( )

**Activity 5. Match the terms on the left with their definitions on the right.**

- |               |   |
|---------------|---|
| 1) database   | a data about data, usually for search and reference purposes  |
| 2) data model | b a procedure for checking the values of attributes for all records in a database against their correct values. |
| 3) polygon    | c any collection of data accessible by comp   |
| 4) metadata   | d a single entity that composes part of a landscape   |
| 5) feature    | e a number, value, text string, or other value required as the consequence of submitting a command to the GIS.  |

6) attribute                      **f** a many-sided area feature consisting of a ring and an interior.

An example is a lake on a map.

7) verification    **g** a simple model for the organization of numbers. The numbers are organized into a table, with values for variables as entries,

records as rows, and attributes as columns.

8) parameter                    **h** the logical means of organization of data for use in information system.

9) flat file                      **i** a loose data structure for vector data, with only order as an identifying property to the features.

10) cartographic spaghetti    **j** a numerical entry that reflects a measurement or value for a feature. Attributes can be labels, categories, or numbers; they can be dates, standardized values, or field or other measurements. An item for which data are collected and organized. A column in a table or data file.

1	2	3	4	5	6	7	8	9	10

**Activity 6. Read the text. Find the English equivalents to the terms given below.**

- 1) взаємодія за запитом \_\_\_\_\_
- 2) виконувати команди \_\_\_\_\_
- 3) діалог в пакетному режимі \_\_\_\_\_
- 4) команда для завершення (обчислення) \_\_\_\_\_
- 5) діалог; обмін даними \_\_\_\_\_

### THE QUERY INTERFACE

Both database management and geographic information management share the fact that the user must somehow interact with the data in an appropriate way. The first generation of DBMS and GIS both used only batch-type interaction with the data, usually closely linked to working with the operating system, the physical management of disk, and so on. This type of interaction dates from the punched card, in that all processes had to be thought out in advance and a file (or stack of cards) produced that could execute the different commands one at a time.

When interactive computing became commonplace, the command line as a query vehicle for data query took over. Commands were typed into the computer one at a time, under the control of the DBMS itself, and the software responded by performing the computations one at a time while the user waited for the command to be completed. Many GISs still use this type of interaction, or permit it to allow

the use of macros. *Macros* are files containing commands to be executed one at a time. If an error is detected in a macro, the execution can be stopped and the file modified to correct the mistake.

### **Activity 7. Translate the sentences into English.**

1. Прикладом пошуку за атрибутами є виявлення (find) і перегляд (browse).

2. Комп'ютер дозволяє створювати нові атрибути на основі розглянутих (calculated) значень.

3. У базі даних карти інформація (records) представлена просторовими об'єктами (features).

4. Просторові еквіваленти запитів (queries) в системі управління базою даних допомагають визначати місце розташування (location) просторових об'єктів.

5. Запит в ГІС зазвичай здійснюється по командному рядку (command line), обраного пакету (batch) або макрокоманді (macro).

### **Activity 8. Read the text and translate it into Ukrainian.**

US packages now are fully integrated with the WIMP (windows, icons, menus, and pointers) interlace specified by the operating system, such as Windows or X-Windows. Choices are now most commonly made by menu, with message windows popping up for the user (o provide essential parameters when they are required. Values can also sometimes be set by sliders, widgets, and by screen tools such as dials, choice lists, and buttons.

## **PART II**

## ***UNIT 1 DESCRIBING ATTRIBUTES. STATISTICAL ANALYSIS***

### **Active words and phrases:**

data – дані;

attribute – властивість, атрибут;

attribute data – атрибутивні дані;

analyst – аналітик, розраховувач;

statistics – статистичні данні;

statistical inquiry – статистичне дослідження;

histogram – стовпчаста діаграма;

database – база даних;

geographic properties – географічні параметри.

### **Activity 1. Read and translate the text.**

A GIS has at least two parts: the attribute part and the map part. The attribute data, managed by their regular database manager, are little different from any other type of statistical information when it comes to analysis. In this chapter we move away from the construction and management of data in a GIS to actual use of the information. To best understand information in the form of numbers, we must describe geographic data in methodical and quantitative ways, that is, with well-understood statistics. If this was as far as GIS went, however, there would be few advantages to GIS compared to any of the major computer statistical packages available to scientists.

What makes analysis within a GIS different is that the attribute data have established links to maps. Any statistic we can think of to describe the data then automatically has geographic properties and as a result can be placed on a map for visual processing. The situation is more fruitful than that, because we can use the geographical properties for statistical inquiry as well. This means that in addition to answering the question ‘Where?’ as far as the features is concerned, we can also ask ‘Why is it there?’ We can come up with some definitive answers to these questions and display the answers to the questions and analyses as maps. As this chapter shows, this can give the user an amazing amount of power when GIS - analysis is brought to bear on a problem.

### **Activity 2. Answer the questions using the information from the text.**

1. What two parts does a GIS have?
2. What is the attribute data?
3. What must we do to best understand information in the form of numbers?

**Activity 3. Look through the text again and find the words that correspond to the following definitions.**

1) a depiction of all or part of the earth or other geographic phenomenon as a set of symbols and at a scale whose representative fraction is less than 1:1 \_\_\_\_\_

2) the stage in science when measurements are sorted, tested, and examined visually for patterns and predictability \_\_\_\_\_

3) a characteristic of a feature that contains a measurement or value for the feature \_\_\_\_\_

4) a single entity that composes part of a landscape \_\_\_\_\_

5) a collection of data organized in a systematic way to provide access on demand \_\_\_\_\_.

**Activity 4. Read and translate the key terms and definitions.**

Histogram – a graphic depiction of a sample of values for an attribute, shown as bars raised to the height of the frequency of records for each class of group of values within the attribute  
GIS – geographic information systems  
geography – a field of study based on understanding the phenomena capable of being described and analyzed with a GIS  
statistics – a collection of information shown in numbers  
information – facts or details about somebody or something.

**Activity 5. Complete the sentences with the following words:**

*statistics   analysis   information   histogram   database  
geography   GIS   map   features*

1. For this \_\_\_\_\_ we need some \_\_\_\_\_.
2. According to official \_\_\_\_\_ the disease killed over 500 people.
3. An interesting \_\_\_\_\_ of the city is the old market.
4. The book is an \_\_\_\_\_ of poverty and its causes.
5. Can you find Clack hill on the \_\_\_\_\_?
6. For further \_\_\_\_\_, write to us at this address.
7. Kim knew the \_\_\_\_\_ of New York City very well.

**Activity 6. Fill in the gaps with the prepositions from the box.**

to	in (x)2	of (x)2	from (x)2
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The visual description (1) \_\_\_\_\_ the histogram and the number descriptions (2) \_\_\_\_\_ the average and difference (3) \_\_\_\_\_ the average are covered. (4) \_\_\_\_\_ addition, these simple measures are described (5) \_\_\_\_\_ terms of their spatial attributes when the two spatial dimensions or coordinates are used as the numbers under description. As shown, map statistical description leads (6) \_\_\_\_\_ an initial ability to place (7) \_\_\_\_\_ a map what the numbers demonstrate. The average (mean) and difference (8) \_\_\_\_\_ the average (variance) both have visual and geographical meaning.

**Activity 7. Learn the following words and word combinations. Find them in the text given below.**

- 1) extreme – екстремальне значення;
- 2) value – показник, значення;
- 3) record – запис;
- 4) elevation – височина, висота;
- 5) descriptive question – наочне питання;
- 6) to sample – пробувати, робити вибірку;
- 7) reading – показання, (змінені) значення.

The first question that might be asked about the database is ‘What are the extremes of the data?’ Data extremes are simply the highest and lowest values for all records for one attribute.

We concentrate first on the elevation attribute. A first descriptive question about the data beyond the ranges is: What are the elevations of the point that were sampled? Even though most of the readings were taken along the coast, the values for the elevation range considerably. Some of the data are clearly poor readings, outside the range we would normally expect and perhaps due to the positions of the satellites or some other factor. Quite likely, the reception problems of the GPS system had something to do with it but there is also clearly a measurement error in terms of accuracy that far exceeds the precision of the elevation reading. How can these bad elevation values be screened out? Obviously we need to see what a good reading looks like and how it can be distinguished from the remainder of the readings.

**Activity 8. Read the text. Find the English equivalents to the following terms.**

- 1) сумісний, несуперечливий \_\_\_\_\_
- 2) виключати, видаляти \_\_\_\_\_
- 3) непарний \_\_\_\_\_
- 4) виводити середнє число \_\_\_\_\_
- 5) середня лінія, середнє значення \_\_\_\_\_
- 6) вибір, варіант \_\_\_\_\_
- 7) репрезентативне, характерне (значення) \_\_\_\_\_

If errors are consistent, we can correct for them. We could safely eliminate these numbers and probably correctly believe them to be wrong. We do not have this option if we have only one number or reading - we have no choice but to use it! If we have two readings only, and they disagree, we would probably average them. If we had three readings and they disagreed, we could average them, reject one reading that was obviously wrong (varies by too much), or average the two readings that most closely agree with each other.

The more numbers we have, the more we can see what the typical amount of variation is, that is, how corrupted are the readings by a random amount of error. If this is the case then we can go ahead and average the numbers, or at least give expected amounts of error. There are alternatives to averaging. For example, a simple representative value for a group of records can be selected by sorting the elevations by height, which the GIS database manager can do and then taking the value of the middle reading. This value is called the median. This works fine for an odd number of elevation readings; the centre comes out exactly. An advantage is that this is a 'real' typical value because it is an actual part of our data set. If the attribute in the database was, for example, state average salary for GIS professionals in dollars, we could pick the middle or median state and compare our own state to it. This is not so simple if we have an even number of records. We have to take the two centre values and average them, losing the attachment to a single data record.

**Activity 9. Read the text and give a written translation of it into Ukrainian.**

The final step that we can put these elevation values through is to do statistical tests. Important for this stage is the idea that the measurements we took with the GPS receiver are just a few of a large number of possible readings. In statistical jargon, the entire possible set of GPS readings is called a population.



For most statistical purposes, the sample is considered as only a tiny proportion of the population as a whole. For example, we could consider our sample as representative of all coastal area elevations in Southern California.

We can use a statistical model of the bell curve, called the standard normal distribution; to estimate how likely any given measurement of the elevation is to be correct. This distribution, provided in most statistical textbooks, allows us to look up the standard deviation and the number of records and to estimate the odds against getting this elevation measurement given the tabulated standard deviation. The numbers in the statistical table are the amount of area beneath the standard normal curve that corresponds to probabilities. This is one way that we can determine whether the largest and smallest measured elevations are reasonable.

**Activity 10. Render the following sentences into Ukrainian. Use these sentences to summarize the information of Unit 1.**

### ***Describing Attributes***

- GIS data description answers the question: Where?
- GIS data analysis answers the question: Why is it there?
- GIS data description is different from statistics because the results can be placed onto a map for visual analysis.

### ***Statistical Analysis***

- The extremes of an attribute are the highest and lowest values, and the range is the difference between them in the units of the attribute.
- A histogram is a two-dimensional plot of attribute values grouped by magnitude and the frequency of records in that group, shown as a variable-length bar.
- A test of means can establish whether two samples from a population are different from each other, or whether the different measures they have are the result of random variation.

## ***UNIT 2 SPATIAL DESCRIPTION***

### **Active words and phrases:**

- attribute description – характеристика атрибутів;
- spatial measurements – просторові виміри;
- spatial data – просторові дані;
- spatial description – просторовий опис;

treat – розглядати;  
duplication – подвоєння;  
define – визначати;  
bounding rectangle – прямокутник, що обмежує;  
centroid – центроїд.

### **Activity 1. Read and translate the text.**

The first and most significant factor in dealing with spatial data is that there are at least two spatial measurements, an easting and a northing. We could summarize spatial description, as describing two attributes simultaneously.

In the simplest and most basic way, we can duplicate the attribute descriptions above for the locational data to give spatial descriptions. In this case, we can treat the two separate parts of the coordinates, the eastings and the northings, as if they are each a single attribute, which indeed they are. Just as we began the discussion of describing the values of a single attribute by discussing the concept of a minimum and a maximum value for an attribute and the concept of a range, when the attributes describe coordinates, a first point is described by the minimum easting and the minimum northing, and a second point describes the corresponding maxima. The two points define a rectangle, whose two side lengths are the ranges in easting and northing, respectively, and that encloses all the points.

This is called the bounding rectangle of the points. It can be found by simply sorting the records by easting, and taking the first and last record, and then repeating for the northing.

In much the same way that we calculated means and standard deviations separately for the two GPS receiver's elevations, so also were they calculated for the latitudes and longitudes. These were first translated into decimal degrees, then summed and divided to find the average latitude and longitude for the eTrex and for the GPS48. The result of the two means is itself a point, with both a real geographic location and a special geographic name, the mean centre. This point is also sometimes called a centroid, a point chosen (in this case statistically) to represent a geographic distribution. Although the GPS data are a set of points, lines and area features can also have a centroid, selected in any one of several ways.

**Activity 2. Answer the questions using the information from the text.**

1. What is the most significant factor in dealing with spatial data?
2. What two separate parts can we treat to give spatial descriptions?
3. What is called the bounding rectangle of the points?

**Activity 3. Look through the text again and find the words that correspond to the following definitions.**

- 1) large or important enough to have an effect or to be noticed \_\_\_\_\_
- 2) the act or process of finding the size quantity or degree of something \_\_\_\_\_
- 3) happening or done at the same time as something else \_\_\_\_\_
- 4) an exact copy of something \_\_\_\_\_
- 5) to deal with or discuss something in a particular way \_\_\_\_\_.

**Activity 4. Read and translate the key terms and definitions.**

Attribute – a quality or feature of somebody or something  
concept – an idea or a principle that is connected with something  
range – the distance over which something can be seen or heard  
deviation – the act of moving away from what is normal or acceptable  
latitude – the distance of a place north or south of the equator  
longitude – the distance of a place east or west of the Greenwich Meridian  
in degrees.

**Activity 5. Complete the sentences with the following words:**

*significant attributes measurement deviation latitude  
concepts simultaneous longitude duplicate range treated*

1. The results of the experiment are not statistically \_\_\_\_\_.
2. His behavior was \_\_\_\_\_ from the previously accepted norms.
3. Accurate \_\_\_\_\_ is very important in science.
4. Patience is one of the most important \_\_\_\_\_ in a teacher.
5. The value plotted for each point is the difference in \_\_\_\_\_ and \_\_\_\_\_ for each point.
6. Mrs. Smith, you should \_\_\_\_\_ this document.
7. He can't grasp the basic \_\_\_\_\_ of mathematics.
8. There were several \_\_\_\_\_ attacks by the rebels.
9. The question is \_\_\_\_\_ in more detail in the next chapter.

**Activity 6. Fill in the gaps with the prepositions from the box.**

of (x2)    in (x3)    between (x2)    at    on    by

Looking (1) \_\_\_\_\_ this map, is it possible to see any difference between the two sets of measurements? Since the overall spread of the points exceed the differences in location (2) \_\_\_\_\_ the two receivers, it is very hard to say, even (3) \_\_\_\_\_ the zoom of Santa Barbara harbor. Instead, we can compare the distributions statistically (4) \_\_\_\_\_ examining the standard deviations (5) \_\_\_\_\_ the easting and northing directions (6) \_\_\_\_\_, this case in latitude and longitude. Imagine the line between the two GPS locations for each point, with all eTrex points drawn on top (7) \_\_\_\_\_ each other. We could look at the bearing (8) \_\_\_\_\_ these lines, ‘rays’ stretching out between the two readings for each point. We would expect the bearings and the lengths to be random, but the average length would now give a mean with a real meaning, the expected average distance difference (9) \_\_\_\_\_ the two receivers. This can also be calculated from the standard deviation (10) \_\_\_\_\_ the easting and northings, calculated as the square root of the sum of the squared distances in the two directions.

**Activity 7. Learn the following words and word combinations. Find them in the text given below.**

- 1) error – помилка;
- 2) impact – вплив;
- 3) statistical descriptor – статистична ознака, ідентифікатор;
- 4) to cause – обумовлювати;
- 5) to get rid of – позбутися;
- 6) to convert to – переводити в;
- 7) square root – квадратний корінь.

While statistics are useful in demonstrating that an error is present, and that it has an impact on the aggregate statistical descriptors, the GIS can help us to isolate exactly which readings have caused the problem.

The value plotted for each point is the difference in latitude and longitude for each point, squared to get rid of negatives, divided by the size of the sample, and added for latitude and longitude. The values were converted to meters using the same tables as above, and the square root of the sum taken. This is then a map of the magnitude of the total spatial discrepancy between the two GPS receivers.

Two points clearly stand out, point numbers 12 and 24. These two points alone account for almost all of the error in the data. Without them, the two receivers seem to be not only quite accurate, but also in agreement.

**Activity 8. Read the text. Find the English equivalents to the following terms:**

- 1) розмір \_\_\_\_\_
- 2) кількісний \_\_\_\_\_
- 3) розташування \_\_\_\_\_
- 4) словесно \_\_\_\_\_
- 5) обрис \_\_\_\_\_
- 6) той, що повторюється \_\_\_\_\_
- 7) стандартний \_\_\_\_\_.

In this chapter we met the idea that geographic features can be classified into points, lines, and areas by their dimensions on the map. Describing each of these can lead to measuring spatial properties directly from the digital files containing the geocoded representations of the features. We started the chapter with a set of points, the GPS example, because points are the easiest type of a feature to describe. Although we have so far used quantitative measures to describe geographical features, many arrangements of features are described verbally.

For example, points are sparse, uneven, random, regular, uniform, scattered, clustered, shotgun, or dispersed. Patterns are regular, patchwork, repetitive, or swirling. Shapes are rounded, oval, oblong, drawn-out, or resemble Swiss cheese. The challenge is to find numbers that say the same thing. The bounding rectangle, the mean centre, and measures such as the standard distance can provide excellent descriptors of points, although more complex measures are obviously needed for the higher-dimension features.

**Activity 9. Read the text and give a written translation of it into Ukrainian.**

Lines have a number of points, a line length, a distance between the start and end points (or nodes), the average length of one of the line segments, and a line direction. A useful description of a line could be the ratio of actual line length divided by the start-to-end node length, what could be called a straightness index. For a straight line, this measure would be 1. For the Mississippi River this would be a far larger number. The direction could be taken as the clockwise angle bearing from north (the overall 'trend' of the line), although this value would have a big variance along a curved or wiggly line, too.

Areas are even more difficult to describe. Simplest to measure with a GIS are the area in square meters, the length around the boundary, the number of points in the boundary, the number of holes, and the elongation, taken as the length of the longest line axis divided by the axis at 90 degrees to it. We can also divide the area of the bounding rectangle into the area, a space-filling index with a maximum value of 1. If the area has neighboring areas, we could count them or determine the average length of the area's boundary shared in common with a neighbor.

**Activity 10. Render the following sentences into Ukrainian. Use these sentences to summarize the information of Unit 2.**

### ***Spatial Description***

- For coordinates, data extremes define the two corners of a bounding rectangle.

- For coordinates, the means and standard deviations correspond to the mean centre and the standard distance, both of which are good descriptors of spatial properties.

- A centroid is any point chosen to represent a higher-dimension geographic feature, of which the mean centre is only one choice.

- The standard distance for a set of point spatial measurements is the expected spatial error.

- Descriptions of geographic properties such as shape, pattern, and distribution are often verbal, but quantitative measures can be devised, although few are computed by GIS.

- GIS statistical computations are most often done using retrieval options such as buffer and spread, or by manipulating attributes with arithmetic commands.

## ***UNIT 3 SPATIAL ANALYSIS***

### **Active words and phrases:**

- feature – просторовий об'єкт;
- predict – теоретично оцінювати, обчислювати;
- property – властивість;
- pattern – зображення, загальна картина, вид;
- scale – масштаб;
- contiguity – суміжність, близькість;
- relation – залежність;
- overlay – накладення, суміщення;
- merge – об'єднувати.

### **Activity 1. Read and translate the text.**

Numbers that describe features are useful, but the purpose of geographic inquiry is to examine the relationships between geographic features collectively and to use the relationships to describe the real-world phenomena that the map features represent. The geographic properties were size, distribution, pattern, contiguity, neighborhood, shape, scale, and orientation.

Each spatial relation begs three fundamental questions: (1) How can two maps be compared with each other?; (2) How can variations in geographic properties over a single area or GIS data set be described and analyzed?; and (3) How can we use what we have learned using the analysis to explain and therefore predict future maps of the geography in question? The third question may be as simple as selecting the best route from A to B on a map, or as complex as modeling the future growth of cities based on their size, shape, and development over time. GIS gives us the capability of doing both, and anything in between. In terms of comparing maps, a simple way is to bring multiple maps into coregistration and then merge their themes to make a composite. This is what is meant by map overlay analysis. An example of map overlay will follow a first discussion of spatial models and how GIS adds to their construction, examination, and use.

### **Activity 2. Answer the questions using the information from the text.**

1. What is the purpose of geographic inquiry?
2. What are the geographic properties?
3. What fundamental questions does each spatial relation beg?

### **Activity 3. Look through the text again and find the words that correspond to the following definitions.**

- 1) an excellent example to copy \_\_\_\_\_
- 2) the act of asking questions or collecting information about somebody or something \_\_\_\_\_
- 3) the way in which two or more things are connected \_\_\_\_\_
- 4) a quality or characteristic that something has \_\_\_\_\_
- 5) the fact of touching or being next to something \_\_\_\_\_

#### Activity 4. Read and translate the key terms and definitions.

feature – a single entity that composes part of a landscape

scale – the geographic property of being reduced by a representative fraction

area – a two-dimensional feature represented by a line closed on itself to form a boundary

data – a set of measurements or other values, such as text for at least one attribute and at least one record.

analysis – the stage in science when measurements are sorted, tested and examined visually for patterns and predictability.

#### Activity 5. Complete the sentences with the following words:

*contiguous features relation properties analysis*  
*data pattern enquiry scale area*

1. Both plans are drawn to the same \_\_\_\_\_.
2. This \_\_\_\_\_ was collected from 69 countries.
3. Scientific \_\_\_\_\_ is a very important process.
4. Compare the physical \_\_\_\_\_ of the two substances.
5. The software has no particular distinguishing \_\_\_\_\_.
6. This system sets the \_\_\_\_\_ for others to follow.
7. The two countries are \_\_\_\_\_.
8. There is heavy traffic in the downtown \_\_\_\_\_ tonight.
9. The book is an \_\_\_\_\_ of poverty and its causes.
10. The fee they are offering bears no \_\_\_\_\_ to the amount of work involved.

#### Activity 6. Fill in the gaps with the prepositions from the box.

of (x3)   from   to (x3)   in   into   with
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One means (1) \_\_\_\_\_ map overlay is to intersect all (2) \_\_\_\_\_ the layers involved to generate a set of most common geographic units (3) \_\_\_\_\_ map algebra, the raster plays this role. The attributes are then inherited or passed down (4) \_\_\_\_\_ subsetted areas, and the attribute table gets longer and longer as more and more units are created. We have already seen the many problems (5) \_\_\_\_\_ vector map overlay, including sliver polygons. Blind map overlay will happily assign attributes (6) \_\_\_\_\_ very small sliver polygons, and use them in further analysis. A solution (7) \_\_\_\_\_ this problem is to first process each layer to reduce the number (8) \_\_\_\_\_ solution classes that will find their way (9) \_\_\_\_\_ the final map. A selective query (10) \_\_\_\_\_ each layer is one simple way to do this.



**Activity 7. Learn the following words and word combinations. Find them in the text given below.**

- 1) grid – координатна сітка;
- 2) extent – діапазон, розмір;
- 3) theme – тема;
- 4) reference – посилання, виноска;
- 5) datum – вихідна (базова) точка;
- 6) granularity – ступінь деталізації;
- 7) alignment – вирівнювання.

One of the oldest analytical methods used in GIS is map overlay. Map overlay is the set of procedures by which maps with different themes are brought into geometric and scale alignment so that their information can be cross referenced and used to create more complex themes. We have met the method already several times, and should recall that the maps to be overlain must be of the same spatial extent, on the same map projection and datum, be at comparable granularity (that is, the spatial units, whether pixels or polygons, should be about the same average size), and if the layers are to be used with map algebra, at the same raster grid size and resolution.

The power of the GIS is in handling the geometry of the overlay process. Handling and preparing the themes is up to the GIS analyst. Under the simplest possible configuration, GIS layers are all converted to binary maps, and an overlay then sifts the map space to leave open the areas that satisfy the selection criteria in use. This is the case in the simple overlay analysis and duplicates in the GIS methods that were worked out using transparent overlay maps and blacked out areas on the transparencies. Many of these methods date back to the turn of the twentieth century.

**Activity 8. Read the text. Find the English equivalents to the following terms:**

- 1) статистичний \_\_\_\_\_
- 2) логічне продовження \_\_\_\_\_
- 3) розкид (наприклад, точок на графіку) \_\_\_\_\_
- 4) прогноз, розрахунок \_\_\_\_\_
- 5) прийняття, схвалення, визнання \_\_\_\_\_
- 6) непросторові графіки, зображення \_\_\_\_\_
- 7) графік \_\_\_\_\_.

Most GIS analysts use statistical and GIS tools in tandem during the analysis stage of GIS operation. The ability to produce nonspatial graphics – for

example, a scatter plot or a histogram – is often far easier this way. Given the broad acceptance of statistical packages and the large number of scientists and others trained in and familiar with their use, a compromise solution seems best. GIS packages can avoid duplicating the many functions necessary for statistical analysis by making two-way data movement between GIS and statistical software easy.

In summary, one of the greatest strengths of a GIS is that it can place real-world data into an organizational framework that allows numerical and statistical description and permits logical extension into modeling, analysis, and prediction. This important step, along with examining and thinking about one's data, is the bridge to understanding data geographically.

**Activity 9. Read the text and give a written translation of it into Ukraine.**

In the early days of GIS, much criticism was made of the fact that GIS software rarely came with any true analytical options. As we have seen, the basic tools of description are those of arithmetic and statistics, and the tools of modeling involve allowing the encoding of a model or formula into the system. Omitted here have also been models based entirely on the geographic distribution. Many models work on network flows, dispersion in two - or three dimensional spaces, hierarchical diffusion, or probabilistic models based on weights determined by buffers, and so on. This sort of model is manageable in a GIS using the tools of retrieval: overlay, buffering, and the application of spatial operators. Even a simple model, however, can become a quite lengthy sequence of steps for the GIS's user interface.

Almost all GIS packages allow operations to be bundled together as macros or as sequences of operations as part of a model, such as in the GISMO options. Although this goes a long way toward routine analysis, exploratory GIS data analysis is still something of an art. Many operations can be performed in the database manager only, and often GIS users move the data from the database manager into a standard statistical package such as SAS (Statistical Analysis System) or SPSS (Statistical Package for the Social Sciences) for analysis. One GIS (Arc/Info) offers a direct link to another statistical package (S-Plus) as an option.

**Activity 10. Render the following sentences into Ukraine. Use these sentences to summarize the information of Unit 3.**

- Geographic inquiry examines the relationships between geographic features collectively to help describe and understand the real-world phenomena that the map represents.

- Spatial analysis compares maps, investigates variation over space, and predicts future or unknown maps.
- Differences between observed values of the dependent variable and those predicted by a model are called residuals.
  - A model helps explanation and prediction after the GIS analysis.
  - Overlay analysis is a very common form of GIS analysis.
  - Often one theme dominates in controlling the final solution set to an overlay problem.

#### ***UNIT 4 THE PARTS OF A MAP. CHOOSING A MAP TYPE***

##### **Active words and phrases:**

- source – джерело
- extract – витягувати, вибирати
- realm – область, сфера
- reconstruct – відтворювати, відновлювати
- temporary – тимчасовий
- permanent – постійний
- cartographer – картограф
- general purpose map – універсальна карта, карта загального призначення
- thematic map – тематична карта.

##### **Activity 1. Read and translate the text.**

A map can be defined as a graphic depiction of all or part of a geographic realm in which the real-world features have been replaced by symbols in their correct spatial location at a reduced scale. Maps are the paper storehouses of spatial information that we use as sources of data for GIS. They are also the final stage in GIS work, the means by which the information being extracted, analyzed, and reconstructed using the powers of the GIS is at last communicated to the GIS user or the decision maker who relies on the GIS for knowledge. Maps within a GIS can be temporary, designed merely for a quick informative glance, or permanent, for presentation of ideas as a substitute for a picture or a report.

Just as a map has a structure, so that structure can vary according to which media we use for map display. GISs usually use the computer monitor to display a map, rather than the traditional paper. Only now, after many years of computer mapping, are cartographers beginning to understand how map design depends on

the display medium. The GIS has been a major reason why this has become an important consideration.

Over 3000 years of cartographic history, cartographers have designed numerous ways of showing data on a map. One way to divide up the methods is to look at those that show attributes by their geometric dimension, so that we can have point maps, line maps, and area maps, plus maps that show a three-dimensional view. Many maps show some or all of the types of features at the same time. These are often called general purpose maps. Thematic maps show just one or two themes or layers of information, often coded, colored, or grouped, for convenience. In this section we take a look at the breadth of map types available.

**Activity 2. Answer the questions using the information from the text.**

1. What is a map?
2. What kinds of maps within a GIS can be?
3. What is a general purpose map?
4. What is a thematic map?

**Activity 3. Look through the text again and find the words that correspond to the following definitions.**

1) a map designed for use as an intermediate product in the GIS process, and not usually subject to the normal map design sequence

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2) a depiction of all or part of the earth or other geographic phenomenon as a set of symbols and at a scale whose representative fraction is less than 1:1

---

3) a map designed primarily for reference and navigation use

---

4) a map designed for use as a permanent end product in the GIS process

---

5) a map designed primarily to show a 'theme', a single spatial distribution or pattern, using a specific map type \_\_\_\_\_

**Activity 4. Read and translate the key terms and their definitions.**

Topographic map – a map type showing a limited set of features but including at the minimum information about elevations or landforms  
flow map – a linear network map that shows, usually by proportionally varying the width of the lines in the network, the amount of traffic or flow within the network  
dot map – a

map type that uses a dot symbol to show the presence of a feature, relying on a visual scatter to show spatial pattern network map – a map that shows as its theme primarily connections within a network, such as roads, subway lines, pipelines, or airport connections reference map – a highly generalized map type designed to show general spatial properties of features

**Activity 5. Complete the sentences with the following words:**

*temporally   thematically   permanent   reference map  
dot map   topographic map   map   network map*

1. A \_\_\_\_\_ is often used as reference information behind GIS map layers.
2. Can you find Black Hill on the \_\_\_\_\_?
3. The accident has not done any \_\_\_\_\_ damage.
4. A \_\_\_\_\_ shows the simplest properties of the map data.
5. The maps have been grouped \_\_\_\_\_.
6. More than half the staff is \_\_\_\_\_.
7. A \_\_\_\_\_ uses dots to depict the location of features and may show a distribution such as population against a base map.
8. A \_\_\_\_\_ shows a set of connected lines with similar attributes.

**Activity 6. Learn the following words and word combinations. Find them in the text given below.**

- 1) border – межа
- 2) neat line – чітка лінія
- 3) additional information – додаткова інформація
- 4) coordinate system – координатна система
- 5) copyright – авторське право
- 6) rectangular frame – прямокутна рамка
- 7) design standpoint – точка зору проектувальника.

The border is the part of the display medium (paper, window, computer screen, or other medium) that shows beyond the neat line of the map. In special circumstances, additional information can be provided in this space, such as the map copyright, the name of the cartographer, or the date. The neat line is the visual frame for the map and is usually a bold single or double line around the map that acts as a rectangular frame. From a design standpoint, the neat line provides

the basis for the page (i.e., cartographic device) coordinate system, in display units such as inches or centimeters on the page.

**Activity 7. Fill in the gaps with the prepositions from the box.**

to	for	of-4	in	with
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A basic outline or reference map shows the simplest properties (1)\_\_\_\_\_ the map data. An example is a world outline map, with named continents and oceans. A general reference map, usually showing a suite of features including terrain, streams, boundaries, roads, and towns, is called a topographic map. Topographic maps are often used as reference information behind GIS map layers.

A dot map uses dots to depict the location (2) \_\_\_\_\_ features and may show a distribution such as population against a base map. A picture symbol map uses a symbol, such as the silhouette of a skier, to locate point features such as ski resorts. The graduated symbol map is the same, except that the symbol size is varied with the value of the feature. Typically, geometric symbols such as circles, squares, triangles, or “shaded spheres” are used.

A network map shows a set of connected lines (3)\_\_\_\_\_ similar attributes. A subway map, an airline route map, and a map (4)\_\_\_\_\_ streams and rivers are examples. The flow map is the same, but it uses the width of the line (5) show value (6)\_\_\_\_\_ example, to show the air traffic volume or the amount (7)\_\_\_\_\_ water flow (8)\_\_\_\_\_, a stream system.

**Activity 8. Read the text. Find the English equivalents to the following terms:**

- 1) a map that in two dimensions shares many of the characteristics of a map  
\_\_\_\_\_
- 2) a map of topography involving a colour sequence filling the spaces between successive contours, usually varying from green through yellow to brown  
\_\_\_\_\_
- 3) a map of three dimensional surface showing a set of profiles, often parallel to the  $x$ , the  $y$ , or the viewer's axis so that the surface appears three dimensional as a raised fishnet viewed in perspective \_\_\_\_\_
- 4) an isoline map of topographic elevations \_\_\_\_\_
- 5) a map in which an apparent shading effect of raised topography is produced by computer so that the land surface appears differentially illuminated, as it would in low sun angles naturally \_\_\_\_\_
- 6) a map of a tree-dimensional surface showing a coloured or shaded image draped over a topographic surface and viewed in perspective  
\_\_\_\_\_.

Surface continuity is assumed, meaning that sharp breaks are usually smoothed. The terrain equivalent is the contour map, with its characteristic datum and *contour interval*. A variant is the *hypsometric map* in which the space between contour lines is filled with color using a sequence designed to illustrate variation. Image maps and schoolroom topographic maps use this type.

Three-dimensional views of surfaces rendered in perspective can be either a gridded *fishnet* where a grid is distorted to give the impression of three dimensions, or a *realistic perspective*, when an image or shaded map is draped over the surface rather than a grid. The latter technique is often used in animations. Map views of terrain are often represented using *simulated hill shading*, where illumination of shadowing is simulated by the computer, and a gray scale or a colored map is used to show the surface. A variant is *illuminated contours*, in which the shading algorithm is applied only to the contours themselves. The final map type considered here is the *image map*, in which a value is depicted as variation in tone on a color or monochrome grid. Most raw and false-colored satellite image maps fall into this category, as does the orthophoto map.

**Activity 9. Read the text and give a written translation of it into Ukrainian.**

So far we have covered the various map types. The GIS user should think of these as a set of possible methods, to be used when the GIS data to be shown have a given set of characteristics. Earlier in the book we classified features on a map into those that are points, lines, areas, and volumes. Obviously, the nature of the map data in the GIS is different for each of these. A three-dimensional location, for example, usually needs latitude, longitude, and elevation. In addition, the type of attribute information determines what mapping methods can be used.

The types of maps make certain assumptions about the nature of the attributes themselves, not just their graphic representation. For example, a reference map that shows cities has point information and text attributes - the names of the cities. The proportional circle map requires that for every point the attribute must be an integer or a floating-point number. A choropleth map requires a floating-point number that has been grouped into shade categories.

**Activity 10. Render the following sentences into Ukrainian. Use these sentences to summarize the information of Unit 4.**

***The Parts of a Map***

- A map is defined as a graphic depiction of all or part of a geographic realm in which real-world features have been replaced with symbols in their correct spatial location at a reduced scale.

- A map has a visual grammar or structure that must be understood and used if the best map design is desired.

- The selection of a map type is often determined by the geographic properties of the data and the attributes.

- The figure is that part of the map shown in ground coordinates rather than laid out in page coordinates.

### ***Choosing a Map Type***

- There are many different types of maps, divided by purpose into thematic and general purpose, and by dimension.

- Some types of volume maps that GIS can produce are isolines, hypsometric maps, gridded fishnet, realistic perspectives, and hill-shaded maps.

## ***UNIT 5 DESIGNING THE MAP***

### **Active words and phrases:**

mapping process – процес картографування

trial and error interaction – на основі проб і помилок

font (AE) – комплект шрифту

fount (BE) – комплект шрифту

design loop – проектний цикл

to supply – виконувати, забезпечувати

to place – розміщувати

macro-like command – команда, подібна макрокоманді.

### **Activity 1. Read and translate the text.**

The last stage in the mapping process is the conversion of the GIS data into a map design. Note that for any map type we can have an almost infinite number of choices of symbols, fonts, colors, line thicknesses, and so on. Selecting the ‘best’ design can make an enormous difference in the effectiveness of the map. If a map has taken a large amount of work to generate, it is well worth the GIS user’s effort to make doubly sure that the design is sound.

Some characteristics of the design are predetermined by the choice of the type of map. Primarily, the design stage consists of devising a balanced and effective set of cartographic elements to make the map. A trial-and-error interaction between a map design and a set of symbols or colors comes into play, called the design loop. The GIS makes this process possible in the first place by supplying the tools to create, modify, and recreate the map.



It is important to place the map elements correctly. Placement of the elements is usually in one of two ways: first, by having the GIS draw a map, then passing it to a graphic design program and interacting with the map in a design loop; and second, especially in a GIS, by editing a set of macro-like commands that move elements to specific places in the map space. This technique is less efficient and involves many traverses through the design loop.

Most cartography texts state that the cartographer should aim for harmony and clarity in the composition – visual balance and simplicity. This comes from experience and an aesthetic sense that can take years to perfect. For the beginner in GIS, MacEachren (1994) and Dent (1996) give fine summaries of the design experience of professional cartographers.

**Activity 2. Answer the questions using the information from the text.**

1. What is the last stage in the mapping process?
2. What does the design stage consist of?
3. What is the aim of most cartography texts?

**Activity 3. Look through the text again and find the words that correspond to the following definitions.**

1) the appearance that things have that results from the way in which they reflect light \_\_\_\_\_

2) a consistent design for the display of the full set of English or other language characters, including special characters such as punctuation and numbers \_\_\_\_\_

3) an abstract graphic representation of a geographic feature for representation a map \_\_\_\_\_

4) the iterative process in which a GIS map is created, examined for design, improved, and then replotted from the modified map definition until the user is satisfied that a good design has been reached \_\_\_\_\_

5) the set of choices relating to how a map's elements are laid out, how symbols such as colors are selected, and how the map is produced as a finished tangible product \_\_\_\_\_.

**Activity 4. Read and translate the key terms and their definitions.**

Cartographic elements – the primitive component part out of which a map is assembled, such as the neat line, legend, scale, titles, figure, and so on

clarity – the property of visual representation using the absolute minimum amount of symbolism necessary for the map user to understand map content without error:

credit – a cartographic element in which the sources, authorship, and ownership of the map and the map attributes are cited, often including a date or reference

ground – the part of the body of the map that is not featured in the figure. This area can include neighboring areas, oceans, and so on. The ground should fall lower than the figure in the visual hierarchy

figure – the part of a map that is both referenced in the map coordinate system rather than the page layout coordinates and that is the centre of the map reader’s attention. The figure is contrasted against the ground, or background.

**Activity 5. Complete the sentences with the following words:**

*design loop   symbols   fount   credits   colours  
map design   cartographic elements   clarity   figure*

1. For this map we need some definite \_\_\_\_\_.
2. The \_\_\_\_\_ of that map helped me to find the way.
3. This process is called the \_\_\_\_\_, because first we design a map and then set of \_\_\_\_\_ and \_\_\_\_\_.
4. A \_\_\_\_\_ is the last stage in the mapping process.
5. The \_\_\_\_\_ are not cited on this map.
6. On a map of New York State, the state is the \_\_\_\_\_, and surrounding states, though shown and labeled, are part of the ground and may be toned down.
7. The neat line, legend, scale are the \_\_\_\_\_.

**Activity 6. Fill in the gaps with the propositions from the box.**

above   of(x3)   in(x4)   at from
-----------------------------------

Text is an important design element. Map text should be clear, correctly and tersely worded, and the words should be positioned as the graphic elements they are. It is easy to make a map title or legend labels either too small or too big, unnecessarily grasping the map reader’s attention. Map text should be edited carefully. Many a map (1) \_\_\_\_\_ final form has retained a typographical error that should have been eliminated (2) \_\_\_\_\_ first glance, or has misspelled a foreign name that should have been checked.

Facts to bear (3) \_\_\_\_\_ mind to balance the map elements are that the ‘weight’(4) \_\_\_\_\_ the elements can change when a symbol set (line widths, colors,

text fonts, etc.) is chosen; that the elements act (5)\_\_\_\_\_ concert with each other (6) \_\_\_\_\_ a visual hierarchy, that is, some of the elements naturally stand out (7) \_\_\_\_\_ or ‘above’ others, and that using deliberately exaggerated contrast to enhance this hierarchy is usually most effective; and that the combined effect (8) all the elements is to draw the eye to the center (9)\_\_\_\_\_ gravity of the elements. Theory implies that the ‘visual centre’ of the map be placed 5% of the map height (10)\_\_\_\_\_ the geometric centre.

**Activity 7. Learn the following words and word combinations. Find them in the text given bellow.**

- 1) rules of thumb – практичні правила
- 2) map data configurations – схеми розташувань даних карти
- 3) misuse – неправильне вживання
- 4) sequence – послідовність
- 5) monochrome – одноколірне зображення
- 6) dot pattern – точкове зображення
- 7) cartographic convention – умовні позначення.

The symbolization aspect of design has been studied by cartographers in detail, and more than a few rules of thumb exist. Some symbolization methods are simply not suitable for certain types of maps and certain map data configurations. For example, a frequent misuse of color is on choropleth maps, especially when the computer gives access to thousands of possible colors. Choropleth maps usually establish value by shading, pattern, or color intensity, but rarely by color as such. Thus a sequence from light yellow to orange with a slight color change looks right, but a sequence from red to blue across the rainbow makes the map look like a decorated Easter egg! Color changes are appropriate to distinguish between opposites on the same map, such as a surplus/deficit, above/below a statistical average, or two-party election results.

When only monochrome is to be used, the equivalent applies. Shade sequences should be even following from dark to light, with dark usually being high, and light being low. Don't forget that white or blank can be a shade tone, leaving the map looking less cluttered as a result. Another issue is pattern. Combinations of crosshatching, dot patterns, and so on can be extremely confusing to the map reader. Combining unmatched patterns can create undesirable optical illusions.

Even on general-purpose maps, color balance is essential. Computer displays use pure color, to which the eye is not usually subjected. Less saturated

colors, if available, are more suitable for mapping. In addition, *cartographic convention* should be followed. Ground colors are usually white, gray, or cyan, not black or bright blue. Contours are frequently brown, water features cyan, roads red, vegetation and forest green, and so on. Failure to follow these conventions is particularly confusing to the map reader. Imagine, for example, a globe with green water and cyan land! Map colors can also look completely different on a white rather than a black background, and even on different monitors and plotters.

**Activity 8. Read the text. Find the English equivalents to the following terms.**

- 1) положення, розташування поруч \_\_\_\_\_
- 2) інтенсивність \_\_\_\_\_
- 3) одночасний контраст \_\_\_\_\_
- 4) насиченість (кольору) \_\_\_\_\_
- 5) відтінок, тон \_\_\_\_\_
- 6) фон \_\_\_\_\_
- 7) десяткова величина \_\_\_\_\_.

Color is a complex visual variable. Colors are often expressed as red, green, blue triplets (RGB) or sometimes as *hue*, *saturation*, and *intensity* (HSI). These values are either determined by the hardware device (e.g., 8-bit color allows a total of 256 colors from any of  $256 \cdot 256 \cdot 256$  combinations of individual values of RGB) or are decimal values of HSI between zero and one. For example, in RGB, a mid-gray would correspond to [128, 128, 128]. It is possible to translate directly between the RGB and HSI representations of color. Whereas RGB values are simply the degree to which the respective colored phosphors of the monitor emit light, HSI is closer to the way in which people perceive color.

*Hue* corresponds to the wavelength of light, going from red at the long-wave end of the visible light spectrum to blue at the other end. *Saturation* is the amount of color per unit display area, and *intensity* is the illumination effect or brightness of the color. Cartographic convention dictates that hue is assigned to categories and that saturation or intensity is assigned to numerical value. When several hues appear in juxtaposition on a map, the colors are perceptually altered by the eye, a phenomenon known as *simultaneous contrast*. Thus maps that use several hues, even as background and line color, should be designed with caution. In addition, the eye's ability to resolve contrast varies significantly with hue, highest in red and green and lowest in yellow and blue.

**Activity 9. Read the text and give a written translation of it into Ukrainian.**

The design of a map is a complex process. Good design requires planning, achieving visual balance among map elements, following conventions, employing the design loop, and correctly using symbols and map types. Without consideration of design, and certainly without having all the required map elements, however impressive it may look on a computer screen, the product is just not as effective. If the map is the result of a complex GIS process, good design is even more important to the person who will have to interpret the map. As we have seen, the relationship between cartography and GIS is a close one.

While making a map is often given little thought in the GIS process, it is nevertheless an important stage because it is using maps that particularly distinguishes GIS as being a different scientific approach, and it is the map that has the primary visual impact on the GIS user or decision maker using GIS. Just a little extra care and attention to detail at this final stage can lead to immense improvements in the finished GIS product and to the perception that the entire information flow used in the GIS process is professional and complete.

**Activity 10. Render the following sentences into Ukrainian. Use these sentences to summarize the information of Unit 5.**

***Designing the Map***

- A GIS map is designed in a process called the design loop.
- Visual balance is affected by the ‘weight’ of the symbols, the visual hierarchy of the symbols and elements, and the location of the elements with respect to each other and the visual centre of the map.
- Symbols, especially colors, are subject to the constraints of cartographic convention (e.g., forests should be green).
- Design errors are common with GIS use, and these include incorrect selections of map type and symbolization errors.
- The map is what distinguishes GIS as a different approach to the management of information, so extra care should be taken to improve the final maps that a GIS generates in a GIS task.

***UNIT 6 THE EVOLUTION OF GIS SOFTWARE***

**Active words and phrases:**

intelligent selection – правильний вибір  
account – підстава, причина

spectacular failure – явна неспроможність  
background – обґрунтування, пояснення  
sophisticated – ускладнений  
advance – прогрес  
interface – пристрій сполучення  
standardize – нормувати  
overall development – загальний розвиток.

### **Activity 1. Read and translate the text.**

One of the first tasks a GIS user faces is deciding which GIS software to use. Even if a GIS has already been purchased, installed, and placed right in front of your nose, it is very natural to wonder whether some other GIS system might be better, faster, easier to use, have clearer documentation, or be better suited to the actual task you are working on. This unit gives some of the background necessary to make an intelligent GIS selection. There is quite a history to learn from, including some excellent accounts of spectacular failures, but also many examples of clear statements of how things went right. Examples from the early days of GIS are the papers by Tomlinson and Boyle (1981) and Day (1981). The philosophy here is that the educated consumer is the best GIS user, and an effective user soon becomes an advocate and sometimes a GIS evangelist. This unit is not intended to tell you which GIS to buy or use. Rather, it is hoped that, it will help you to decide this for yourself.

As is often the case, a good education begins with a little history. The texts introduced overall GIS development in terms of the distant origins of geographic information science as a whole. This was difficult to do without mentioning specific GIS software packages. Now it is appropriate to discuss the development of software in more detail.

### **Activity 2. Answer the questions using the information from the text.**

1. What is the first task a GIS user faces?
2. What is Tomlinson's philosophy?
3. What are the examples of the early days of GIS?

### **Activity 3. Look through the text again and find the words that correspond to the following definitions.**

- 1) the circumstances or part events which help explain why something is how it is \_\_\_\_\_
- 2) connected with one particular thing only \_\_\_\_\_

3) a set of beliefs or an attitude to life that guides somebody's behaviour

4) to buy something \_\_\_\_\_

5) all the events that happened in the past \_\_\_\_\_

**Activity 4. Read and translate the key terms and definitions.**

Software package – a set of related programs for a particular type of task

congress – a large format meeting or series of meetings where representatives from different groups discuss ideas, make decisions

survey – the act of examining and recording the measurements, features etc. of an area of land in order to make a map or plan of it

sophisticated – clever and complicated in the way that it works or is presented

program – a set of instructions in code that control the operations or function of a computer.

**Activity 5. Complete the sentences with the following words:**

*congress   program   purchased   software package   history  
background   specific   philosophy   survey   sophisticated*

1. The system came with a database \_\_\_\_\_.
2. This international \_\_\_\_\_ was very interesting.
3. Geological techniques are becoming more \_\_\_\_\_ all the time.
4. The equipment can be \_\_\_\_\_ from your local supplier.
5. Her \_\_\_\_\_ of life is to take every opportunity that presents itself.
6. Load the \_\_\_\_\_ into the computer.
7. Many people throughout \_\_\_\_\_ have dreamt of a world without war.
8. The money was collected for a \_\_\_\_\_ purpose.
9. Can you give me more \_\_\_\_\_ on the company's financial position?
10. First of all you must do a geological \_\_\_\_\_.

**Activity 6. Fill in the gaps with the prepositions from the box.**

by	of (x2)	in (x5)	on	at
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GIS software did not suddenly appear as if by magic. There was a lengthy period leading up to the first real GISs during which the breed evolved rather rapidly. As we saw the intellectual ancestry included the creation (1) \_\_\_\_\_ a

spatial analysis tradition (2)\_\_\_\_\_ geography, the quantitative revolution, and dramatic technological and conceptual improvements (3)\_\_\_\_\_ the discipline of cartography.

An early GIS landmark was an international survey of software conducted (4)\_\_\_\_\_ the International Geographical Congress in 1979 (Marble, 1980). This survey had three volumes, one (5)\_\_\_\_\_ which was entitled *Complete Geographic Information Systems*, although (6)\_\_\_\_\_ fact few true GIS packages were represented. This volume was influential (7)\_\_\_\_\_ deciding on the name “GIS” because many alternatives were in use at that time. Just as important were the two volumes *Cartography and Graphics* and *Data Manipulation Programs*. Together, these three volumes encapsulated the state of geographic data processing (8)\_\_\_\_\_ the 1970s (Brassel, 1977). Most cartographic programs were single-purpose FORTRAN programs to do individual GIS operations such as digitizing, data format conversion, plotting (9)\_\_\_\_\_ a specific hardware device such as a pen plotter, map projection transformations, or statistical analysis of data. None of these packages were integrated; a typical use would be to apply a series of one-at-a-time geographic operations to arrive (10)\_\_\_\_\_ a final result or map.

**Activity 7. Learn the following words and word combinations. Find them in the text given below.**

- 1) point to grid conversion – перенесення вузлових точок на координатну сітку
- 2) line printer – пристрій рядкового друку
- 3) mainframe computer – велика ЕОМ
- 4) spreadsheet – великоформатна таблиця
- 5) statistical graphics – статистична графіка
- 6) extension – збільшення.

Some of the early computer mapping systems had already devised many GIS functions by this time, however. Among these were SURFACE II by the Kansas Geological Survey, which could do point-to-grid conversions, interpolation, surface subtraction, and surface and contour mapping; CALFORM, a package that could produce thematic maps; SYMAP, a sophisticated analytical package from the Harvard Laboratory for Computer Graphics and Spatial Analysis that nevertheless ran only on mainframe computers and gave line-printer plots; and the Central Intelligence Agency's CAM, which made plots from the World Data Bank outline maps with different map projections and features.

By 1980 the first computer spreadsheet programs had arrived, led by the VisiCalc program, a very early microcomputer software ‘killer app.’ VisiCalc



contained only a few of the capabilities of today's equivalent packages, yet for the first time gave the; ability to store, manage, and manipulate numbers in a simple manner. Above all, data could be seen as active a spreadsheet rather than as a static "report" that consisted of a pile of computer printout. The links to statistical graphics, now common in packages such as SASGRAPH and Harvard Graphics, were a natural extension of this capability.

The ancestry of GIS is completed by the first advances in database management systems. Early systems for database management were based on the less sophisticated data models of the hierarchical and related data models. A landmark was the beginning of the relational database managers in the early 1970s. Relational database managers quickly became the industry standard, first in the commercial world of records management and later in the microcomputer world.

**Activity 8. Read the text. Find the English equivalents to the following terms:**

- 1) особливі вимоги \_\_\_\_\_
- 2) часті переробки та коригування \_\_\_\_\_
- 3) система цивільного призначення \_\_\_\_\_
- 4) система виробничих записів \_\_\_\_\_
- 5) порівняння з (географічним) геообразцом \_\_\_\_\_
- 6) комплексний пакет програм \_\_\_\_\_
- 7) інтерфейс, призначений для користувача \_\_\_\_\_

By the late 1970s all of the necessary parts of a GIS existed as isolated software programs. The largest gap to be filled was between the relational database manager and the programs that dealt with plotting maps. The specific demands of hardware devices from particular manufacturers kept this as a constantly evolving field, with frequent rewrites and updates as systems and hardware changed. Later, the device independence attributable to common operating systems such as Unix and computer graphics programming standards such as GIS, Core, and PHIGS led to a narrowing of this chasm, to the point where today it remains as barely a discernible dip in the GIS ground. The scene was set for the arrival of the first true GISs.

One of the earliest civilian systems to evolve all the capabilities of a true GIS was the CGIS (Canadian Geographical Information System), mostly because this system was the first to evolve from an inventory system toward doing analyses and then management. Essential to the emergence were the georeferencing and geocoding of the data, database management capability, a single integrated

software package without separate, stand-alone elements, and a single user interface.

**Activity 9. Read the text and give a written translation of it into Ukrainian.**

At first, GIS packages had unsophisticated user interfaces, and many actually made the user write short computer program-like scripts or to type highly structured formatted commands one at a time into the computer in response to prompts. As the GIS software evolved, the need for upward compatibility—that is, the need for existing users to be satisfied with a new version because things still work in much the same way as before—meant that many systems preserved elements of these older user interfaces long after they had been replaced by better tools.

The second generation of GIS software included graphical user interfaces, usually involving the use of windows, icons, menus, and pointers. In the typical configuration today, the windows are standardized by the operating system and function in the same way that it does, ‘inheriting’ its characteristics. A first generation of GIS software used windows custom-built by the vendor. Later, after the broad distribution of windowing systems such as X-Windows and Microsoft Windows, the graphical user interface (GUI) tools that are part of the operating system became accessible to software designers and programmers.

The typical system has pop-up, pull-down, and pull-right menus for selecting choices. Choices and locations are indicated with a mouse, although some systems use track balls or light pens. Similarly, the typical GIS can support multiple windows—for, example, one for the database and one to display a map—and the tasks can be opened and closed as needed. While closed, they function in the background while they are graphically represented on the screen as an icon or small picture.

**Activity 10. Render the following sentences into Ukrainian. Use these sentences to summarize the information of Unit 6.**

***The evolution of GIS Software***

- Informed choice is the best way to select the best GIS.
- A historical GIS ‘snapshot’ was the IGC survey conducted in 1979.
- Many early computer mapping programs had evolved GIS functionality by 1979.
- In the early 1980s, the relational DBMS evolved as the leading means for database management.

- Addition of a single integrated user interface and a degree of device independence led to the first true GISs.
- The second generation of GIS software used graphical user interfaces (GUIs) and the desktop/WIMP model.

## ***UNIT 7 GIS AND OPERATING SYSTEMS.***

### ***GIS FUNCTIONAL CAPABILITIES: DATA COMPUTER***

#### **Active words and phrases:**

- workstation – автоматизоване робоче місце
- multitasking – багатозадачність
- functional definition – функціональне визначення
- input – введення (інформації)
- digitizing tablet – планшет, що кодує
- node – точка перетину
- generalization – узагальнення
- warp – викривлення
- implementation – розробка, реалізація (програми)

#### **Activity 1. Read and translate the text.**

Early GIS was heavily influenced by the types of operating systems in use. Early operating systems were quite unsophisticated but were used with GIS nevertheless. Among these were IBM's mainframe operating systems, MSDOS by Microsoft, and DEC's VMS. These were rapidly replaced as the various GUI-based operating systems came into operation and as the microcomputer and workstation took over from the minicomputer and mainframe.

In the microcomputer environment, the GUI-based operating systems include Windows, Windows-NT, and Windows 95. The unified user interface, revolutionized by the Apple Macintosh's GUI and desktop metaphor, quickly took over as the dominant microcomputer operating environment, although others have remained popular also. These operating systems added two critical elements to the microcomputer's capabilities: *multitasking* (allowing many simultaneous work sessions) and *device independence*, meaning that plotters and printers could be taken out and assigned to the operating system instead of the GIS package, in somewhat the way that printing and screen fonts are handled centrally, rather than duplicated in every Windows package.

One system that had encompassed these capabilities since its inception, and that swept the workstation environment, was Unix. Unix is a very small and

efficient central operating system that is highly portable across computer systems. It has been the dominant workstation environment for two reasons: first, because it has complete integrated network support, and second, because several full GUIs exist for Unix in the public domain, the most important being the X-Windows system. X-Windows implementations of most leading GUIs exist, including OpenLook and the Open Software Foundation's MOTIF interface. In many Unix systems, the user can switch the GUI to suit particular needs or applications. A full GUI programming tool kit, including such tools as Xt, Xview, and the X-Windows libraries Xlib, is part of the X-Windows release.

**Activity 2. Answer the questions using the information from the text.**

1. What early operating systems do you know?
2. What two critical elements did the GIS-based operating systems add to the microcomputers capabilities?
3. Why has Unix been the dominant workstation environment?

**Activity 3. Look through the text again and find words that correspond to the following definitions.**

1) a computer operating system that has been made workable on virtually every possible computer and has become the operating system of choice for workstations and science and engineering applications \_\_\_\_\_

2) the ability of a computer's operating system or a GIS to handle more than one process at once; for example, editing and running a command sequence while extracting data from the database and displaying a map \_\_\_\_\_

3) the ability of software to run with little difference from a user's perspective on any computer or on any specialized device, such as a printer or plotter \_\_\_\_\_

4) the set of visual and mechanical tools through which a user interacts with a computer, usually consisting of windows, menus, icons, and pointers \_\_\_\_\_

5) the complete structure within which a user, computer or program operates \_\_\_\_\_.

**Activity 4. Read and translate the key terms and their definitions.**

Affine transformation – any set of translation, rotation, and scaling operations in the two spatial directions of the plane

clump – to aggregate spatially; to join features with similar characteristics into a single feature

dissolve – eliminating a boundary formed by (the edge or boundary of a feature that becomes unnecessary after data have been captured: for example, the edges of sheet maps)

generalization – the process of moving from one map scale to a smaller (less detailed) scale, changing the form of features by simplification, and so on

node snap – instructing the GIS software to make multiple nodes or points in a single node so that the features connected to the nodes match precisely, say at a boundary.

**Activity 5. Complete the sentences with the following words.**

*GIS   multitasking   environment   clump   device independence   Unix  
affine transformations   dissolved   generalization   node snapping*

1. All the original calcium had \_\_\_\_\_ away.
2. \_\_\_\_\_ is a very small and efficient central operating system that is highly portable across computer systems.
3. My computer can operate several programs at the same time \_\_\_\_\_ is its capability.
4. \_\_\_\_\_ – based operating systems include Windows, Windows NT in the microcomputer\_\_\_\_\_.
5. Galaxies tend to \_\_\_\_\_ together in clusters.
6. \_\_\_\_\_ are other functions typical of an editor.
7. Try to avoid \_\_\_\_\_.
8. These operating systems have two critical elements to the microcomputers capabilities: multitasking and \_\_\_\_\_.
9. \_\_\_\_\_ allow maps with different scales, orientations, and origins to be co registered.

**Activity 6. Fill in the gaps with the prepositions from the box.**

to   of (x4)   for   in   on (x3)
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As a final benefit, several versions of Unix and all (1)\_\_\_\_\_ the GUI systems run extremely efficiently (2)\_\_\_\_\_ microcomputers, including shareware Unix releases such as Linux, not only outperforming the Windows-type GUIs, but

being available free or as shareware on the Internet or from inexpensive suppliers (3) \_\_\_\_\_ CD-ROM. A key element here has been the Free Software Foundation's releases, including GNU (GNU is NOT UNIX) versions (4) virtually every key element of Unix.

Thus, two main avenues for GISs have evolved as far as operating systems are concerned. On the microcomputer platform a lingering set (5) \_\_\_\_\_ DOS applications is rapidly being rewritten (6) \_\_\_\_\_ the updated versions (7) \_\_\_\_\_ Microsoft's Windows. (8) \_\_\_\_\_ this GIS environment, the number of systems installed, the mobility of laptop and subnotebook computing, and the low cost of software have been major strengths. (9) \_\_\_\_\_ the workstation platform, Unix and X-Windows, often with MOTIF as the GUI, reign supreme. This work environment has led (10) \_\_\_\_\_ high-end applications, large data sets, networking, depth of software, and high-quality graphics. Both are healthy and prospering workplaces for GIS.

**Activity 7. Learn the following words and word combinations. Find them in the text given below.**

- 1) first critical step – перший відповідальний етап
- 2) outline map – карта-схема
- 3) generic format – типовий формат
- 4) hand written annotation – примітка, написана від руки
- 5) extensive support – широка, екстенсивна підтримка
- 6) editing system – система редагування
- 7) digitizing error – графічна помилка.

Getting the map into the computer is a critical first step in GIS. Geocoding must include at least the *input* of scanned or digitized maps in some appropriate format. The system should be able to absorb data in a variety of formats, not just in the native format of the particular GIS. For example, an outline map may be available as an AutoCAD DXF format file. The GIS should at a minimum be capable of absorbing the DXF file without further modification. Similarly, attributes may already be stored in standard database format (DBF) and should be absorbable either directly or through the generic ASCII format.

Before a map can be digitized, however, it needs to be prepared. Different GIS packages handle the amount of preparation required in quite different ways. If the package supports scanning, the map needs to be clean, fold-free, free of handwritten annotation and marks, and on a stable base such as Mylar. If the map is digitized by hand it may need to be cut and spliced if the package does not

support *mosaicing*, and control points with known locations and coordinates need to be marked for registering the map onto the digitizing tablet. Some GIS packages have extensive support for digitizing and sophisticated *editing* systems for detecting and eliminating digitizing errors. Others have few or none.

We also saw how essential it was to edit the maps after they have been captured. This requires the software to have an editing package or module some kind. FOR a vector data set, at the minimum we should be able to delete and reenter a point or line. For a raster, we should be able to modify the grid by selecting subsets, changing the grid spacing, or changing a specific erroneous grid value.

**Activity 8. Read the text. Find the English equivalents to the following terms.**

- 1) різка зміна вузлових точок \_\_\_\_\_
- 2) тотожні координати \_\_\_\_\_
- 3) розкласти на складові \_\_\_\_\_
- 4) цільна, монолітна (база даних) \_\_\_\_\_
- 5) розрив, відсутність безперервності \_\_\_\_\_
- 6) мінімальне розходження \_\_\_\_\_
- 7) допустиме відхилення \_\_\_\_\_.

Other functions typical of an editor are *node snapping*, in which points that are close to each other and that should indeed be the same point, such as the endpoints of a line segment, are automatically placed into the graphic database with the identical coordinates; *dissolve*, when duplicate boundaries or unnecessary lines (e.g., the digitized edges of adjacent category-type maps) are eliminated automatically or manually; and *mosaicing* or ‘zipping,’ in which adjacent map sheets scanned or digitized separately are merged into a seamless database without the unnecessary discontinuities caused by the lack of edge matching of the paper maps. For example, a major road that crosses two map sheets does not need to be represented as two separated features in the final GIS database.

Another important editing function is the ability to deal with map *generalization*. Many digitizing modules of GIS systems, and certainly scanning, generate far more; points than are necessary for the use of the GIS. This extra detail can complicate data reformatting and display, slow the analysis process, and lead to memory problems on the computer. Many GIS packages allow the user to select how much detail to retain in a feature. Most will retain points that have a minimum separation and snap together all points within a fuzzy tolerance.

For point data sets, most GIS packages will eliminate or average duplicate points with the same coordinates. Some will allow *line generalization*, using any one of many algorithms that reduce the number of points in a line.

**Activity 9. Read the text and give a written translation into Ukrainian.**

More intricate and demanding are checks on the map data. Some GIS packages, which do not support topological structuring, do not enforce any restrictions on the map. Some simply check ranges. These systems run the risk of lacking a match between the attributes and the space they represent. No part of the map, for example, should fall into two separate areas—that is, the areas on a polygon map should not overlap or leave gaps. This happens when maps are captured at different scales or from inaccurate sources.

Topological GIS systems can check automatically to ensure that the lines meet at nodes and that the entire map area is covered by polygons without gaps or overlaps. Beyond simply checking, many GIS packages allow automatic cleaning of topology, snapping nodes, eliminating duplicate lines, closing polygons, and eliminating slivers. Some systems simply point out the errors and ask the user to eliminate them with the editor. Some go ahead and make the corrections without user intervention. The GIS user should be careful when using automatic cleaning, for the tolerances may eliminate important small features or move the features around in geographic space without accountability. A specific GIS package may or may not be able to deal directly with GPS data conversion, with survey-type data from COGO (coordinate geometry) systems, or with remotely sensed imagery. Some GIS packages have both functions – that is, they serve as GIS and image processing systems. Among these are Idrisi, GRASS, and ERDAS.

Essential to geocoding capabilities, because GIS allows maps from many sources to be brought into a common reference frame and to be overlaid, is the geocoding software's ability to move between coordinate systems and map projections. Most GIS packages accomplish these using affine transformations. Affine operations are plane geometry; they manipulate the coordinates themselves by scaling the axes, rotating the map, and moving the coordinate system's origin.

**Activity 10. Render the following sentences into Ukrainian. Use these sentences to summarize the information of Unit 7.**

- As GUIs became part of the operating system, GISs began to use the operating system's GUI instead of their own.
- PCs integrated GIS with the variants of Windows and other OSs.



- GIS features are known as functional capabilities.
- Functional capabilities fall into the ‘critical six’ categories.
- The critical six functional capabilities are data capture, storage, management, retrieval, analysis, and display.
- Some data capture functions are digitizing, scanning, mosaicing, editing, generalization, and topological cleaning.

## ***UNIT 8 GIS FUNCTIONAL CAPABILITIES: DATA STORAGE***

### **Active words and phrases:**

batching commands – команди для виконання пакетної обробки

storage – зберігання

high-density-storage – пам’ять (пристрій) з великою щільністю запису

resolution – роздільна здатність

user-friendliness – зручність для користувача

data access – доступ до даних

metadata – метадані

on-line data – оперативні дані

off-line data – дані, не встановлені на пристрій вводу-виводу.

### **Activity 1. Read and translate the text.**

Data storage within a GIS has historically been an issue of both spaces—usually how much disk space the system requires—and access, or how flexible a GIS is in terms of making the data available for use. The massive reductions in the cost of disk storage, new high-density storage media such as the CD-ROM, and the integration of compression methods into common operating systems have made the former less critical and the latter more so.

Current emphasis, therefore, is upon factors that improve data access. This has been a consequence also of the rise of distributed processing, the Internet, and the World Wide Web. As a result, many GIS packages are now capable of using *metadata*, or data about data, in an integrated manner. Metadata support might include a system for managing a single project as a separate entity, to managing many projects with multiple versions, to full support for exchangeable metadata stored in common formats and searchable through online “clearinghouses”. The USGS’s Global Land Information System, NASA’s master directory, and the Federal Geographic Data Committee’s Spatial Data Clearinghouse are all examples. Participation in the common library entails both standardizing the

metadata to make it searchable and agreeing to make the data available either on or offline.

Other larger issues around GIS use, most essential to the degree of user friendliness of the system, concern the mechanism for user interaction with the software's functionality. Virtually all GIS software allows user interaction via command lines and/or windows within a GUI. The GUI interface is tedious, however, without some way of *'batching'* commands so that they can be executed either at another time, as a background task while the user gets on with another job, or for design-loop editing to change minor aspects of the process. Most systems, therefore, also contain a 'language' for the user to communicate with the system. This allows users to add their own custom functions, automate repetitive tasks, and add features to existing modules. These languages are usually command-line programs or *macros*, but they can also be enhancements of existing programming languages such as Basic and Smalltalk.

**Activity 2. Answer the questions using the information from the text.**

1. What are many GIS packages now capable of using?
2. What might metadata support include?
3. What do most systems contain for the user to communicate with the system?

**Activity 3. Look through the text again and find the words that correspond to the following definitions.**

- 1) to put something together with something else so as to increase the size, number, amount etc. \_\_\_\_\_
- 2) the process of keeping information, etc. on a computer; the way it is kept  
\_\_\_\_\_
- 3) not very large, important or serious \_\_\_\_\_
- 4) a planned piece of work that is designed to find information about something, to produce something new, or to improve something  
\_\_\_\_\_
- 5) that can be exchanged \_\_\_\_\_

**Activity 4. Read and translate the key terms and definitions.**

Microcomputer – a small computer that contains a microprocessor  
metadata – data about data. Index-type information pertaining to the entire data set rather than the objects within the data set

batch – submission of a set of commands to the computer from a file rather than directly from the user as an interactive exchange

macro – a command language interface allowing a ‘program’ to be written, edited, and then submitted to the GIS user interface

address matching – address matching means using a street address such as *123 Main Street* in conjunction with a digital map to place the street address onto the map in a known location.

**Activity 5. Complete the sentences with the following words:**

*storage project exchangeable added minor  
metadata batching macros address matching microcomputer*

1. These may be some \_\_\_\_\_ changes to the schedule.
2. You must know everything about the \_\_\_\_\_ and retrieval of information.
3. We use these languages which are usually command-line programs or \_\_\_\_\_.
4. My friend has a \_\_\_\_\_.
5. These tokens are \_\_\_\_\_ for CD’s and cassettes only.
6. You need set up a \_\_\_\_\_ to computerize the library system.
7. The GIS interface is tedious without some way of \_\_\_\_\_ commands.
8. A new wing was \_\_\_\_\_ to the building.
9. \_\_\_\_\_ a mailing list would convert the mailing of characteristics of the places on the list.
10. \_\_\_\_\_ usually includes the date, source, map projection etc. as well as data about the format and structure of the data set.

**Activity 6. Fill in the gaps with the prepositions from the box.**

in-2    for    on-2    into    of-3    from
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Although disk storage is less critical than (1)\_\_\_\_\_the past it can still be a constraint. GIS software (2)\_\_\_\_\_a microcomputer can occupy tens (3)\_\_\_\_\_ megabytes even without data, and (4)\_\_\_\_\_ a workstation perhaps hundreds of megabytes. As data become higher resolution, as more raster layers are used, and as finer and finer detail becomes available, many GIS data sets can easily move (5)\_\_\_\_\_ the gigabyte range (6)\_\_\_\_\_ size.

This implies that not only is supporting multiple resolutions important — (7)\_\_\_\_\_ example, using coarse browse images as samples (8)\_\_\_\_\_ the real thing— but also that data compression should be supported. This can vary all the way (9)\_\_\_\_\_ partitioning data sets to meet constraints (such as a maximum number (10)\_\_\_\_\_ polygons) to supporting compressed data formats and structures such as JPEG, run-length encoding, or quadtrees.

**Activity 7. Learn the following words and word combinations. Find them in the text given below.**

- 1) data format – формат даних
- 2) topological structure – топологічна структура
- 3) three-dimensional – тривимірний
- 4) quadree – дерево квадрантів
- 5) convert – перетворювати
- 6) entity – (цілісний) об'єкт
- 7) vector – одновимірний масив.

Support for data formats is important to a GIS when data are to be brought in from outside (e.g., public-domain data from the Internet). Ideally, the GIS software should be able to read common data formats for both raster (DEM, GIF, TIFF, JPEG, Encapsulated PostScript) and vector (TIGER, HPGL, DXF, PostScript, DLG). Some GIS packages have import functions only into a single data structure, usually either an entity-by-entity structure or a topological structure.

For three-dimensional data, these systems usually support only the triangular irregular network. Others support only raster structures based on the grid, including the quadtree, and either convert all data into this structure or just ignore it. Some GIS packages continue to support only data in a proprietary format, available only at cost from the software vendor. A rather critical GIS function is the ability to convert between raster and vector data, an absolutely essential feature for the integration of multiple data sources such as GPS data and satellite images.

Of increasing interest in recent years has been the development of GIS functions that support data in standard exchange formats. At the national and international levels, several data transfer standards have now been developed, such as the Spatial Data Transfer standard and DIGEST. As these standards become mandated, and as the role of data exchange increases, led by the Internet, most GIS systems will develop support for inputting and outputting data in these standard

formats. The 2000 census, with its support for the federal information processing standard for data exchange, will probably drive GIS vendors to support this necessary next step for GIS.

**Activity 8. Read the text. Find the English equivalents to the following terms:**

- 1) система управління базою даних \_\_\_\_\_
- 2) набір програмного забезпечення \_\_\_\_\_
- 3) формат плоского файлу \_\_\_\_\_
- 4) осередки пам'яті \_\_\_\_\_
- 5) введення даних \_\_\_\_\_
- 6) функції пошуку \_\_\_\_\_
- 7) сортування даних \_\_\_\_\_.

Much of the power of GIS software comes from the ability to manage not just map data but also attribute data. Every GIS is built around the software capabilities of a database management system (DBMS), a suite of software capable of storing, retrieving selectively, and reorganizing attribute information. The database manager allows us to think that all the data are available, that the data are structured in a simple flat-file format, and that they constitute a single entity. In fact, the database manager may have partitioned the data between files and memory locations and may have structured it in any one of several formats and physical data models.

A database manager is capable of many functions. Typically, a DBMS allows data entry, and data editing, and it supports tabular and other list types of output, sometimes independent of the GIS. Retrieval functions always include the ability to select certain attributes and records based on their values. For example, we can start with a U.S. database, and select out all records for states containing cities with over one million inhabitants, forming a new database that is wholly enclosed by the original and that duplicates part of it. We can also perform functions such as sorting data by value, and retrieving a selected record by its identification, such as a name or a number.

**Activity 9. Read the text and give a written translation of it into Ukrainian.**

Address matching involves taking a listed street address, such as '123 Main Street', and using the GIS's existing data to match the address with a geographic region in the GIS. The key to this capability is usually the TIGER files from the U.S. Census Bureau, which contain a topologically connected street and block

network, referenced to house numbers. The address match finds the street and then moves along the street's individual blocks until the house number lies within the block and on the correct side of the street.

Many operations on data are very important from a mapping perspective. For example, very often maps captured from different sheets must be merged together, or sometimes a mask must be placed over the data to exclude features entirely from the GIS. Examples of masks are private lands within national parks, water bodies, or military bases. Similarly, sometimes data must be assembled in one way, by topographic quadrangle, and then cookie cut into another region such as a state or a city boundary. Even more complex, sometimes line features such as the latitude/longitude grid, a river, or a political boundary must be sectioned up or have points added as new features or layers are introduced. This feature, called dynamic segmentation can be done automatically by the GIS.

**Activity 10. Render the following sentences into Ukrainian. Use these sentences to summarize the information of Unit 8.**

- Storage functions are compression, metadata handling, control via macros or languages, and format support.
- Some data management functions are physical model support, the DBMS, address matching, masking, and cookie cutting.
- Some data retrieval functions are locating, selecting by attributes, buffering, map overlay, and map algebra.
- Some data analysis functions are interpolation, optimal path selection, geometric tests, and slope calculation.
- Some data display functions are desktop mapping, interactive modification of cartographic elements, and graphic file export.

***UNIT 9 GIS FUNCTIONAL CAPABILITIES:  
DATA RETRIEVAL, DATA ANALYSIS, DATA DISPLAY***

**Active words and phrases:**

retrieval – відновлення даних

single feature – окремий просторовий об'єкт

overlay – накладення, суміщення

polygon – багатокутник, (замкнута) лінія

cell – елемент

to multiply – множити

to sift – ретельно розглядати, аналізувати

basin – басейн (річки)/

### **Activity 1. Read and translate the text.**

Another major area of GIS functionality is that of data retrieval. As we saw a GIS supports the retrieval of features by both their attributes and their spatial characteristics. All GIS systems allow users to retrieve data—they wouldn't qualify as a GIS if they did not! Nevertheless, among systems some major differences exist between the type and sophistication of GIS functionality for data retrieval.

The most basic act of data retrieval for a GIS is to show the position of a single feature. This can be by retrieving coordinates as though they were attributes, or more commonly by displaying a feature in its spatial context on a map with respect to a grid or other features. For line features, the same goes, with the exception that line features have the attribute of length, and polygon features have the attribute of area. The GIS should be able to calculate and store these important basic properties as new attributes in the database. For example, for a set of counties we may want to take a polygon attribute such as an area of forest and divide it by the county area to make a percentage density of forest cover. Another common measurement we may want is to count features. For example, with the same database we could count the number of fire stations within the same counties by doing a point-in-polygon count from a separate database of municipal utilities and then relate the forest cover to the fire-prevention capabilities.

We have seen that a GIS has the critical capability of allowing the retrieval of features from the database using the map as the query vehicle. One way, indeed the most basic way, of doing this is to support the ability to point at a feature, using a device such as a mouse or a digitizer cursor, to see a list of attributes for that feature. Again, the ability to select by pointing to a location virtually defines a GIS. If it cannot do this the system is probably a computer mapping system, not a GIS. Just as critical is the database manager select-by-attribute capability. This is normally a command to the database query language that generates a subset of the original data set. For example, we could find all houses in a real estate GIS that had been listed on the market in the last year. Similarly, we could find all houses built after 1990. All GIS systems and all database managers support this capability.

### **Activity 2. Answer the questions using the information from the text.**

1. What does a GIS support the retrieval of features by?
2. What is the most basic act of data retrieval for a GIS?
3. What defines a GIS?

**Activity 3. Look through the text again and find the words that correspond to the following definitions.**

1) to face or to be directed towards a particular direction \_\_\_\_\_

2) something important, interesting or typical of a place \_\_\_\_\_

3) to calculate the total number of people, things, etc. in a particular group \_\_\_\_\_

4) the act or the process of finding the size, quantity or degree of something \_\_\_\_\_

5) a question, especially one asking for information or expressing a doubt about something \_\_\_\_\_.

**Activity 4. Read and translate the key terms and definitions.**

Buffer – a zone around a point, line, or area feature that is assumed to be spatially related to the feature

map algebra – Tomlin’s terminology for the arithmetic of map combination for coregistered layers with rasters of identical size and resolution

sift – to eliminate features that are smaller than a minimum feature size

desktop mapping – the ability to generate easily a variety of map types, symbolization methods, and displays by manipulating the cartographic elements directly

multiply – to add a number to itself a particular number of times/

**Activity 5. Complete the sentences with the following words:**

*queries measurement pointing counting features  
map algebra sifted desktop mapping multiply*

1. The project is based on \_\_\_\_\_.
2. Our assistant will be happy to answer your \_\_\_\_\_.
3. GIS systems need to be able to perform \_\_\_\_\_ that is generating geographical and thematic maps so that they can be integrated with other functions.
4. The telescope was \_\_\_\_\_ in the wrong direction.
5. Accurate \_\_\_\_\_ is very important in science.
6. \_\_\_\_\_ 2 and 6 together and you get 12.
7. Dana Tomlin has classified the operations that are performed into a structure called \_\_\_\_\_.
8. He \_\_\_\_\_ the relevant data from the rest.
9. This polygon is a \_\_\_\_\_.



**Activity 6. Fill in the gaps with the prepositions from the box.**

of (x4) by (x2) for (x2) on (x2)

As we saw, GISs allow a set (1)\_\_\_\_\_ retrieval operations based (2)\_\_\_\_\_ using one or more map features as handles to select attributes (3)\_\_\_\_\_ those features. Although some (4)\_\_\_\_\_ them are very simple, these operations are also a real litmus test (5)\_\_\_\_\_ establishing whether or not a software package is a GIS. A GIS should allow the user to select a feature (6)\_\_\_\_\_ its proximity to a point, a line, or an area. For a point, this means selecting all features within a certain radius. (7)\_\_\_\_\_ a line or a polygon, we have used the term *buffering*. Buffering allows the GIS users retrieve features that lie within perhaps 1 mile of an address, within 1 kilometer of a river, or within 500 meters of a lake. Similarly, weighted buffering allows us to choose a no uniform weighting of features within the buffer, favoring close-by instead of distant points, for example.

The next form (8)\_\_\_\_\_ spatial retrieval is map *overlay*, when sets of irregular, no over-lapping regions are merged to form a new set of geographic regions that the two initial sets share. In the new attribute database it is possible to search (9)\_\_\_\_\_ either set of units. A GIS should be able to perform overlay as a retrieval operation since to support the many spatial analyses based (10)\_\_\_\_\_ map combination and weighted layer solutions.

**Activity 7. Learn the following words and word combinations. Find them in the text given below.**

- 1) option – вибір
- 2) pipe – труба
- 3) node – точка перетину
- 4) Boolean operation – логічна операція
- 5) municipal utilities – комунальні підприємства
- 6) saturated – насичений
- 7) sophisticated – складний, вдосконалений.

Another important set of retrieval options are those that allow networks to be constructed and queried. Typical networks are subway systems, pipes, power lines, and river systems. Retrieval operations involve searching for segments or nodes, adding or deleting nodes, redirecting flows, and routing. Not all GIS systems need these functions, but if the purpose is to manage a system usually abstracted as a network, such as a highway or rail system, a power supply system, or a service delivery system, obviously the GIS should then have this feature.

Dana Tomlin (1990) has elegantly classified the operations that a raster GIS can perform into a structure called *map algebra*. In map algebra, the retrieval operations used are Boolean, multiply, recode, and algebra. *Boolean* operations are binary combinations. For example, we can take two maps, each divided into two attribute codes ‘good’ and ‘bad’ and find a binary AND solutions layer where both layers are ‘good’. *Multiply* allows two layers to be multiplied together—for example, two sets of weights to be combined. In *recode* operations a range of computed attribute codes can be reorganized. Map *algebra* allows compute operations, such as map-to-map multiplication for a binary AND over the space of a grid.

Two truly spatial retrieval operations are the ability to *clump* or aggregate areas, and to *sift*. For example, all areas of saturated soils surrounding swamps could be added to the swamps and receded as wetlands, making a new, broader category of attribute. Sifting simply eliminates all areas that are too small, individual cells falling between two larger areas, or a tiny sliver polygon. Finally, some complex retrieval operations require the GIS to be able to compute numbers that describe shape. Common shape values are the length of the perimeter of a polygon squared, divided by its area, or the length of a “line” divided by the straight-line distance between the two endpoints.

**Activity 8. Read the text. Find the English equivalents to the following terms.**

- 1) настільне картографування \_\_\_\_\_
- 2) предметна карта \_\_\_\_\_
- 3) діаграма ліній рівня \_\_\_\_\_
- 4) діаграма поперечного перерізу \_\_\_\_\_
- 5) тривимірний \_\_\_\_\_
- 6) підходяща колірна схема \_\_\_\_\_
- 7) помилкова карта, карта з помилками \_\_\_\_\_.

Most of the display capabilities of GISs have been covered. GIS systems need to be able to perform what has become called *desktop mapping*, generating geographical and thematic maps so that they can be integrated with other functions. GISs typically can create several types of thematic mapping, including proportional symbol maps; and they can draw isoline and cross-sectional diagrams when the data are three dimensional.

Almost all GIS packages now either allow interactive modification of map elements moving and resizing titles and legends – or allow their output to be exported into a package that has these capabilities, such as Adobe Illustrator or

Corel Draw. A very limited few GIS packages include cartographic design help in their editing of graphics, defaulting to suitable color schemes, or notifying the user if an inappropriate map type is being used for the data. This would be a desirable feature for many of the GISs on today's market and could avoid many tasteless or erroneous maps before they were created.

**Activity 9. Read the text and give a written translation of it into Ukrainian.**

The analysis capabilities of GIS systems vary remarkably. Among the multitude of features that GIS systems offer are the computation of the slope and direction of slope (aspect) on a surface such as terrain; interpolation of missing or intermediate values; line-of-sight calculations on a surface; the incorporation of special break or skeleton lines into a surface; finding the optimal path through a network or a landscape; and the computations necessary to calculate the amount of material that must be moved during cut-and-fill operations such as road construction.

Almost unique to GIS, and entirely absent in other types of information systems, are geometric tests. These can be absolutely fundamental to building a GIS in the first case. These are described by their dimensions, point-in-polygon, line-in-polygon, and point-to-line distance. The first, point-in-polygon, is how a point database such as a geocoded set of point samples is referenced into regions. Thus a set of locations for soil samples, generated at random, could be point-in-polygon merged with a digitized set of district boundaries so that a sample list can be sent to each soil district manager. Other more complex analytical operations include partitioning a surface into regions, perhaps using the locations of known points to form proximal regions or Voronoi polygons, or by dividing a surface into automatically delineated drainage basins.

Some of the most critical analytical operations are often the simplest. A GIS should be able to do spreadsheet and database tasks, compute a new attribute, generate a printed report or summarize a statistical description, and do at least simple statistical operations such as computing means and variance, performing significant testing, and plotting residuals.

**Activity 10. Render the following sentences into Ukrainian. Use these sentences to summarize the information of Unit 9.**

- Many GIS functional capabilities are by-products of their particular data structure.
- Raster systems work best in forestry, photogrammetry, remote sensing, terrain analysis, and hydrology.

- Vector systems work best for land parcels, census data, precise positional data, and networks.
- Among the multitude of features that GIS systems offer are the computation of the slope and direction of slope on a surface.

## ***UNIT 10 GIS SOFTWARE AND DATA STRUCTURES. CHOOSING THE 'BEST' GIS: ArcGIS***

### **Active words and phrases:**

acceptable level – прийнятний рівень  
 software – програмне забезпечення  
 favored – кращий  
 to imply – мати на увазі  
 version – версія  
 geographic space – географічний простір  
 to support – підтримувати  
 extensive characterization – просторовий опис.

### **Activity 1. Read and translate the text.**

In the preceding discussion, the focus was on what functional capabilities the typical GIS offer. It should not be forgotten that many GIS features are predetermined by the GIS's particular data structure. As we saw at the very least the underlying data structure that the GIS uses, typically raster or vector but potentially also TIN, quadtree, or another model, such as object-based, determines what the GIS can and cannot do, how operations take place, and what level of error is involved.

In general, the driving force for the choice of structure should be not only what type of system can be afforded, but more critically, what model is most suitable to a particular application, what retrieval and analysis functions will be used most, and what is the acceptable level of resolution and error.

Some examples where particular structures are favored include extensive land characterization applications such as forestry, where detailed data are not required (favors raster); applications involving irregular polygons and boundary lines, such as political units or census tracts (favors vector); applications that require the ability to register all features accurately to ground locations (favors vector); applications making extensive use of satellite or terrain data (favors raster); or applications where image processing functions and analyses such as

slope and drainage analysis are to be conducted (favors raster). In many cases, the raster to vector conversion is done outside of the GIS in specialist conversion software, so that care can be taken to avoid the most common types of error, and so that the user can be brought in to resolve cases where the software is unable to solve a rasterization problem.

Increasingly, of course, many GIS systems allow the user to input and keep data in both raster and vector form. The GIS user should realize, however, that virtually all cross-structure retrieval and analysis requires one (or both) of the layers to change structure, and that this transformation often stamps itself irretrievably on the data's form, accuracy, and suitability for further use.

**Activity 2. Answer the questions using the information from the text.**

1. What is the driving force for the choice of the GIS's data structure?
2. What do many GIS systems allow the user to do?
3. What should the GIS user realize about the GIS's data structure?

**Activity 3. Look through the text again and find the words that correspond to the following definitions.**

- 1) something such as an object, a fact or a situation that shows, explains or supports what you say \_\_\_\_\_
- 2) an act of choosing between two or more possibilities something that you can choose \_\_\_\_\_
- 3) a quantity that has both size and direction \_\_\_\_\_
- 4) an organized set of ideas or theories or a particular way of doing something \_\_\_\_\_
- 5) the thing or person that people are most interested in \_\_\_\_\_.

**Activity 4. Read and translate the key terms and definitions.**

Meaningless – without any purpose or reason and therefore not worth doing or having

process – a series of things that are done in order to achieve a particular result

to automate – to use machines and computers instead of people to do a job or task

intuitive – obtained by using your feelings rather than by considering the facts

engineering – the activity of applying scientific knowledge to the design building and control of machines, roads, bridges etc.

**Activity 5. Complete the sentences with the following words:**

*focus choice example vectors system intuitive*  
*meaningless process automated engineering*

1. The entire manufacturing process has been \_\_\_\_\_.
2. He had an \_\_\_\_\_ sense of what the reader wanted.
3. Can you give me an \_\_\_\_\_ of what you mean?
4. The British educational \_\_\_\_\_ is very popular all over the world.
5. It was the main \_\_\_\_\_ of attention at the meeting.
6. We are in the \_\_\_\_\_ of selling our house.
7. The bridge is a triumph of modern \_\_\_\_\_.
8. We fill up our lives with \_\_\_\_\_ tasks.
9. Acceleration and velocity are both \_\_\_\_\_.
10. We are faced with a difficult \_\_\_\_\_.

**Activity 6. Fill in the gaps with the prepositions from the box.**

to with over of (x3) for in (x2) on
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The term ‘best’ is extremely subjective where GIS is concerned. Some systems have extremely loyal followings who advocate their system (1) others. A “best” system implies that one solution is best for all problems, which is of course largely meaningless. The following subset (2) \_\_\_\_\_ GIS systems, most available commercially, is intended to illustrate the breadth and depth (3) \_\_\_\_\_ systems (4) \_\_\_\_\_ the market today and some of the major and minor differences among these systems.

No endorsement is intended, and the list is provided (5) \_\_\_\_\_ further the GIS ‘consumer’s’ education. Research has shown that these ‘big eight’ packages account (6) \_\_\_\_\_ the majority (7) \_\_\_\_\_ those used in educational, and many professional, settings (8) \_\_\_\_\_ some cases, different GIS software packages are used (9) \_\_\_\_\_ combination or along (10) \_\_\_\_\_ other software for statistical analysis, graphical editing, or database management.

**Activity 7. Learn the following words and word combinations. Find them in the text given below.**

- 1) long-lived – довговічний
- 2) full-function – повнофункціональний

- 3) mainframe – велика ЕОМ
- 4) data conversion – перетворення даних
- 5) data base management systems – системи управління базою даних
- 6) link – зв'язок
- 7) software tool – допоміжна програма/

ArcGIS, the latest version of Arc/Info, is a long-lived, full-function GIS package that has been ported to the microcomputer, the workstation, and the mainframe. Arc/Info and ArcGIS are used to automate, manipulate, analyze, and display geographic data, and the software incorporates hundreds of sophisticated tools for map; automation, data conversion, database management, map overlay and spatial analysis, interactive display and query, graphic editing, and address geocoding. The ArcInfo software includes a relational database interface for integration with commercial database management systems and a macro language called AML (ARC Macro Language) for developing customized applications. Since release 8, ArcGIS has instead used Visual Basic as its macro and programming language. ArcGIS uses a generic approach to geographic information systems that is not application specific, allowing the software to address virtually any geographic application. The software runs both on higher-end microcomputers and is available on several Unix workstations and for Windows NT.

ESRI is broadly accepted as a market leader in GIS, with many thousands of users in a variety of organizations worldwide. The software is used by federal, state, and local government organizations; and by businesses, utilities, and universities to address applications in planning, cartography, transportation, research, telecommunications, oil and gas, forestry, and many other disciplines. Release 8 of the program, in 1999, was a substantial modification of the program's user interface and functionality. Object-modeling capability and links to the Spatial Data Base Engine and other relational database management systems such as Oracle are included. With the latest versions of the software, the compatibility between ArcGIS and Arc View has been increased. The software uses the Windows COM component based software architecture, and is compatible with many other Window-based software tools.

**Activity 8. Read the text. Find the English equivalents to the following terms.**

- 1) система типу «робочий стіл» \_\_\_\_\_
- 2) виведення інформації на екран \_\_\_\_\_
- 3) метод візуального відображення \_\_\_\_\_

- 4) компоновка \_\_\_\_\_
- 5) набір інструментальних засобів \_\_\_\_\_
- 6) візуалізація даних \_\_\_\_\_
- 7) файл даних \_\_\_\_\_

Arc View is available for Windows, Macintosh, and a variety of Unix platforms. It is a desktop system for storing, modifying, querying, analyzing, and displaying information about geographic space. An intuitive graphical user interface includes data display and viewing tool. Support for spatial and tabular queries, “hot links” to other desktop applications and data types, business graphics functions such as charting, bar and pie charts, and map symbolization, design, and layout capabilities are supported. Geo-coding and address matching are also possible. The Spatial Analyst tool kit makes working with raster data such as terrain and DEMs possible. Other extensions permit network analysis; allow Web activation of Arc View maps, and support advanced display features such as three-dimensional data visualization. Arc View GIS since version 8 has been more compatible with ArcGIS.

ArcView is also a product of ESRI which makes ArcGIS. Compatibility exists between the two systems, with ArcView being more oriented toward map display than database management. Maps and data files are easily exchangeable between the formats used in the two systems, shape files, grid, images, and coverage's. Outdated versions of ArcView have been placed into the public domain and are available over the Internet.

**Activity 9. Read the text and give a written translation of it into Ukrainian.**

Autodesk Map is a GIS software suite built on the capabilities of the substantial AutoCAD software for automated drafting and design. Because this package is extensively used in planning, engineering, and architectural offices, many people can easily build upon their existing knowledge to enter the field of GIS. Autodesk Map uses AutoCAD 2002's drawing and plotting capabilities. Multiple data formats can be input, including those of AutoCAD (exchange format DXF and drawing format DWG) and also several other GIS packages. The software supports topology, query using Oracle and SQL, data management, and thematic mapping. The Autodesk Raster Design module supports grids and images and the Autodesk Onsite module handles all of the standard GIS data operations. There are extensive tools for coordinate conversion and specification, rubber-sheeting, and map editing and digitizing. The software uses the C++ programming language as a development tool. Output control and plotting support are strong, relying on AutoCAD's capability.



**Activity 10. Render the following sentences into Ukrainian. Use these sentences to summarize the information of Unit 10.**

- The driving force for the choice of structure should be: what model is most suitable to a particular application, what retrieval and analysis functions will be used most, what is the acceptable level of resolution and error.
- Arc/Info and ArcGIS are used to automate, manipulate, analyze, and display geographic data, and the software incorporates hundreds of sophisticated tools for map
- The software uses the Windows COM component based software architecture, and is compatible with many other Window-based software tools.
- Arc View is a desktop system for storing, modifying, querying, analyzing, and displaying information about geographic space.

### ***UNIT 11 CHOOSING THE 'BEST' GIS: GRASS, IDRISI. SELECTING SOFTWARE***

#### **Active words and phrases:**

public-domain software – безкоштовне програмне забезпечення

image processing – обробка зображень

shell – командний процесор

source code – вихідний текст, вихідна програма

to integrate – об'єднувати в єдине ціле

to select – відбирати

to determine – визначати

to date – зд. на даний момент

peripheral device – зовнішній, периферійний пристрій.

#### **Activity 1. Read and translate the text.**

**GRASS.** The U.S. Army Construction Engineering Research Laboratories (CERL) developed a public-domain software called the Geographic Resources Analysis Support System (GRASS). GRASS is raster based, was the first Unix GIS software, and has been considerably enhanced by the addition of user contributions—for example, in hydrologic modeling. The Web site states that GRASS is an open source, free software GIS with raster, topological vector, image processing, and graphics production functionality that operates on various

platforms through a graphical user interface and shell in X-Windows. The source code for the program is available under the GNU General Public License. The latest version, 5.0.0, the development version 5.1, and most prior versions are available free over the Internet. Many users run GRASS on PCs under the Linux version of Unix, although a Windows port is now complete. Since 1985, CERL has released upgrades and enhancements to GRASS and provided technical user support. However, CERL terminated GRASS-related work in the spring of 1996. Public domain user support has been very strong, and highly international.

**IDRISI.** The IDRISI GIS software has been developed, distributed, and supported on a not-for-profit basis by the Idrisi Project, Clark University Graduate School of Geography. To date, there are many thousands of registered users of IDRISI software in almost every country in the world, making it the most broadly used raster GIS in the world. IDRISI is designed to be easy to use, yet provide professional-level GIS, image processing and spatial statistics analytical capability on both DOS- and Windows-based personal computers. It is intended to be affordable to all levels of users and to run on the most basic of common computer platforms. Expensive graphics cards or peripheral devices are not required to make use of the analytical power of the system, which is designed with an open architecture so that researchers can integrate their own modules.

**Activity 2. Answer the questions using the information from the text.**

1. What is GRASS?
2. What has the IDRISI GIS software been developed on?
3. When was INDISI for Windows first released?

**Activity 3. Look through the text again and find the words that correspond to the following definitions.**

- 1) not difficult; done or obtained without a lot of effort or problems \_\_\_\_\_
- 2) an area of land that has or used to have its own government and laws \_\_\_\_\_
- 3) a person or thing that uses something \_\_\_\_\_
- 4) an institution at the highest level of education where you can study for a degree or do research \_\_\_\_\_
- 5) the process or method of building or making something, especially roads, buildings, bridges, etc. \_\_\_\_\_.

#### Activity 4. Read and translate the key terms and definitions.

Technical – connected with the practical use of machinery, methods etc. in science and industry

aspect – a particular part of future of a situation, an idea, a problem etc.; a way in which it may be considered

fact – one of several things that cause or influence something

training – the process of learning the skills that you need to do a job

trade-off – the act of balancing two things that you need or want but which are opposed to each other.

#### Activity 5. Complete the sentences with the following words.

*user    construction    university    easy    country    technical*  
*aspect    factor    training    trade-off*

1. We offer free \_\_\_\_\_ support for those buying our software.
2. The closure of mine was the single most important \_\_\_\_\_ in the town's decline.
3. Please enter your \_\_\_\_\_ user name.
4. Few candidates had received any \_\_\_\_\_ in management.
5. He didn't make it \_\_\_\_\_ for me to leave.
6. There is a \_\_\_\_\_ between the benefits of the drug and the risk of side effects.
7. Work has been begun on the \_\_\_\_\_ of the new airport.
8. She didn't know what life in a foreign \_\_\_\_\_ would be like.
9. This was one \_\_\_\_\_ of her character he didn't see before.
10. Is there a \_\_\_\_\_ in this town?

#### Activity 6. Fill in the gaps with the preposition from the box.

in (x2)    of (x4)    for    with    on (x2)    by    into
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Selecting the best GIS (1)\_\_\_\_\_ use involves many other aspects than simply the technical capabilities (2)\_\_\_\_\_ the software package. It could be argued that very little difference actually exists between GIS packages other than their user interfaces and their data structures. Conversely, many (3)\_\_\_\_\_ the issues that determine how satisfied we are (4)\_\_\_\_\_ the GIS we choose relate to how we

acquire the software, how easily it installs itself (5)\_\_\_\_\_ our computer, whether or not it is flexible enough to run (6)\_\_\_\_\_ a given computer system, and how satisfied we are when the software is up and running.

Obviously, cost is an important factor. Although the cost (7)\_\_\_\_\_ basic GIS packages has fallen remarkably (8)\_\_\_\_\_ recent years, cost can still be significant, especially when the hidden costs are taken (9)\_\_\_\_\_ account. For example, GIS companies may charge not only a software purchase fee, but also include a maintenance fee, a fee (10)\_\_\_\_\_ upgrades, a per call support cost, and sometimes other fees.

**Activity 7. Learn the following words and word combinations. Find them in the text given below.**

- 1) project deadline – граничний термін проекту
- 2) installation – встановлення
- 3) requirement – необхідна умова
- 4) manual – керівництво
- 5) time-consuming – трудомісткий
- 6) implementation – реалізація
- 7) purchase – покупка, придбання.

Training is another important factor. Few GIS packages can be used by a novice right out of the box. The user may need help from a systems expert, may have special installation requirements, and may require the user to get some formal GIS training. Of course, this book can go a long way toward helping the user to understand GIS, but there is a great deal of straightforward technical information as well. Many GIS users take technical training from one of the GIS vendors or from other sources. These vary from one- or two-day workshops to entire college semester classes. They can also be rather expensive and time-consuming. Many GIS implementations, although well thought out and organized, fail for the lack of one or two people with the right technical expertise at the right time.

Once technical training ends, the real GIS use begins. At this stage, late on a Friday evening with a project deadline looming, the usual sole self-help mechanism is the GIS system manual. Again, these vary considerably in readability, comprehensiveness, and user-friendliness. Some are excellent, others poor. The user should ask to see documentation before making a major GIS purchase, as users will spend many hours poring over these pages.

**Activity 8. Read the text. Find the English equivalents to the following terms.**

- 1) технічне забезпечення \_\_\_\_\_
- 2) електронна пошта \_\_\_\_\_
- 3) рядок підказки \_\_\_\_\_
- 4) довідкове керівництво \_\_\_\_\_
- 5) супровід програмного забезпечення \_\_\_\_\_
- 6) бути оновленим \_\_\_\_\_
- 7) розширені (оновлені) версії \_\_\_\_\_.

Regardless of the GIS's self-help capabilities, sooner or later almost all GIS users will eventually call a help line or interact in some way with the GIS vendor's technical support staff. In most cases this is done exclusively by telephone, but increasingly companies use fax. E-mail and network conference groups as help facilities. Help lines can involve being placed on hold for long periods, or worse, waiting to be called back after leaving a phone number. E-mail is far better and gets around the time-zone problem of phone lines. When contacting a help line, a concise statement of the problem and a full set of information, usually including the serial number and date of purchase of the software, will greatly speed up your call. In general, using the reference manual or user guide until there is no other means of finding information is far preferable to calling a help line. Remember, if all else fails, read the manual!

Software maintenance can be another major consideration. For example, most software is updated by complete version upgrades, which require a new installation, or by "patches" a self-contained fix for a specific problem in the software. Maintenance is more of a consideration for large and networked systems, but every user needs to be concerned about too many large files and about how critical data are to be backed up in case of emergency. A GIS should also not be seen as a static entity, but rather one that will grow and evolve. A system that is big or powerful enough for a small prototype project today will probably not be able to deal with the follow-up project. Fortunately, as time passes the hardware becomes faster and faster, the disks get bigger and bigger, and the cost actually remains the same or falls.

**Activity 9. Read the text and give a written translation of it into Ukrainian.**

Picking a GIS is obviously a complex and potentially confusing process. The most productive approach to the problem is to adopt the attitude of someone about to purchase a new car. First, the GIS user should assemble all the available

details about the system requirements, the functional capabilities, the system constraints, and so on. The car buyer could, for example, determine a need for four doors, power steering, at least 14 cubic feet of luggage space, and front-wheel drive. Next, these should be matched against the systems available. Perhaps a trade-off is necessary between capabilities. Next comes the visit to the car dealership, followed by a test drive. Many demonstration versions of GIS packages are available to give a flavor of the system use before the purchase. Some demo versions can be downloaded free over the Internet or are given away at GIS conferences. One such demonstration version of Arc View is included with this book.

Finally, ‘You pay your money and you take your choice.’ After the fact, however, the car will need to be maintained and perhaps repaired. One day it may be traded in for a new car. Every one of these issues should be considered. Although every vehicle will probably allow you to get home from the dealership, fundamental differences exist between a sports car and a Sports Utility Vehicle. To summarize: Before you choose, research, select, test, and question. Fortunately for the new GIS user, the early days of GIS failures are now over. Technically, today a GIS is much like a reliable automobile. Where and how you drive, however, is still entirely up to you!

**Activity 10. Render the following sentences into Ukrainian. Use these sentences to summarize the information of Unit 11.**

- Eight GIS systems form the hulk of operational CIS in professional and educational environments.
- There are some significant differences among these ‘big eight’ systems.
- A variety of issues should be considered in system selection:
  - cost
  - upgrades
  - network configuration support
  - training needs
  - ease of installation
  - maintenance
  - documentation and manuals
  - help-line and vendor support
  - means of making patches
  - workforce.
- Selecting a GIS can be a complex and confusing process.
- The intelligent GIS consumer should research, select, test, and question systems before purchase.

**UNIT 12 INTRODUCING GIS IN ACTION.**  
**GIS LIGHTS THE GYPSY MOTH**

**Active words and phrases:**

case study – характерний приклад, ілюстрація  
to monitor – вивчати  
data structure – структура даних  
grid – координатна сітка  
annual – річний  
extreme breadth – гранична ширина  
application – застосування, використання  
to spread – поширювати, розширювати  
broader-scale – більш широкомасштабний.

**Activity 1. Read and translate the text.**

As much as knowledge and understanding of the principles behind GIS are critical to getting started with GIS, the technology's true strength is and will always be in the power of its applications. In this chapter, some GIS case studies are presented. Each is unique in its own way, and the reader should pay attention to differences in data structures, software, procedures, and directions as the GIS systems we have discussed in theory now move out into the real world. What is also impressive is the extreme breadth and versatility of these applications. GIS is a tool that crosses disciplinary and professional boundaries with ease. Nevertheless, each field of expertise has an angle on GIS use and brings to the application a fresh set of approaches. The applications cover oceans, rural, suburban, deserts, and urban areas, they encompass forestry, geology and ecology, public health concerns and insects, storms and runoff, and mysterious rocks, and also how GIS assisted at the site of the tragedy in the nation's worst terrorist attack. These applications do not pretend to be comprehensive. Each has been contributed by the GIS experts in question as a summary of a broader-scale work that they have either completed or that remains in progress. Nevertheless, these applications are a perfect starting point from which to examine GIS in action.

**Activity 2. Answer the questions using the information from the text.**

1. What does each field of expertise have?
2. What do applications cover?
3. What has each application been contributed by?

**Activity 3. Look through the text again and find the words that correspond to the following definitions.**

- 1) being the only one of its kind \_\_\_\_\_
- 2) to show or offer something for other people to look at or consider \_\_\_\_\_
- 3) the practical use of something, especially a theory discovery \_\_\_\_\_
- 4) a thing that helps you to do your job or to achieve something \_\_\_\_\_
- 5) the earth with all its countries, peoples and natural features \_\_\_\_\_

**Activity 4. Read and translate the key terms and definitions.**

Desert – a large area of land that has very little water and very few plants growing on it

coast – the land beside or near to the sea or ocean

suburb – an area where people live that is outside the centre of a city

population – the people who live in a particular area city or country

native – connected with the place where you were born and lived for the first year of your life.

**Activity 5. Complete the sentences with the following words.**

*application      present      unique      world      tools*  
*desert      coast      suburbs      population      native*

1. Which is the largest city in the \_\_\_\_\_?
2. One third of the word's \_\_\_\_\_ consumes two thirds of the word's resources.
3. The new invention would have wide \_\_\_\_\_ in industry.
4. It's a long time since he has visited his \_\_\_\_\_ Poland.
5. Somalia is mostly \_\_\_\_\_.
6. They live in the \_\_\_\_\_.
7. We walked along the \_\_\_\_\_ for five miles.
8. The computer is now an invaluable \_\_\_\_\_ like questionnaires.
9. The committee will \_\_\_\_\_ its final report to Parliament in June.
10. Everyone's fingerprints are \_\_\_\_\_.



**Activity 6. Fill in the gaps with the proposition from the box.**

of for (x3) in (x2) on by to at
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The Entomology Spatial Analysis Laboratory (1)\_\_\_\_\_ the Department of Entomology (2)\_\_\_\_\_ Michigan State University is devoted (3)\_\_\_\_\_ the spatial analysis of insect pests and the assessment of risk to Michigan's forests, among other projects. The laboratory is directed (4)\_\_\_\_\_ Dr. Stuart Gage, who has conducted research (5)\_\_\_\_\_ the spatial distributions (6)\_\_\_\_\_ forest and crop pests (7)\_\_\_\_\_ \_\_\_\_\_ over 25 years. Dr. Bryan Pijanowski is an ecologist, and an associate in the laboratory. He has specialized (8)\_\_\_\_\_ the use of GIS, such as Arc/Info and IDRISI, to model insect and human populations. The laboratory currently contains several Pentium computers, four Sun workstations, and a Silicon Graphics workstation (9)\_\_\_\_\_ visualization of spatial data. The staff uses Arc/Info, IDRISI, ERDAS, ER-Mapper, and Atlas, GIS (10)\_\_\_\_\_ research.

**Activity 7. Learn the following words and word combinations. Find them in the text given below.**

- 1) gypsy moth – непарний шовкопряд
- 2) resource management – управління ресурсами
- 3) pest – вредитель, паразит
- 4) designated locations – зазначені, позначені місця
- 5) caterpillar – гусениця
- 6) multitude – безліч
- 7) frass – екскременти комах.

The use of GIS to study the gypsy moth in Michigan provides an excellent example of the applicability of this tool in the biological sciences and for resource management. The gypsy moth is an introduced forest pest that consumes the leaves and needles of nearly 300 woody plants. The insect was first discovered in the state 40 years ago, and outbreaks of the pest have been occurring in Michigan since the mid-1980s. Severe defoliation (i.e., loss of leaves) of oaks, aspens, and other tree species preferred by gypsy moth caterpillars has occurred throughout the northern Lower Peninsula, and populations continue to expand into southern Michigan and into the state's Upper Peninsula. Defoliation has increased from 2800 hectares in 1984 to over 280,000 hectares in 1992.

Unlike many native forest insects, the gypsy moth is a problem in both urban areas and forests. Multitudes of large, hairy caterpillars, abundant frass

(fecal material), and loss of leaves on shade and ornamental trees create much annoyance for people in wooded residential and recreational areas. Management of the gypsy moth is carried out by aerial spraying of a biological insecticide called *Bacillus thuringiensis* (Bt) from helicopters or planes. This biological insecticide kills only moths and butterflies that eat the Bt from tree leaves and it degrades in the environment in a few days.

**Activity 8. Read the text. Find the English equivalents to the following terms:**

- 1) використання феромона \_\_\_\_\_
- 2) приманочна пастка з феромонами \_\_\_\_\_
- 3) тендер-пастка \_\_\_\_\_
- 4) число місць, ділянок \_\_\_\_\_
- 5) поширення організму-носія \_\_\_\_\_
- 6) масове поїдання листя комахами \_\_\_\_\_
- 7) протилежність \_\_\_\_\_.

In 1985, a statewide gypsy moth monitoring program was implemented to characterize this pest's population dynamics. Because the male is attracted to the female through the use of a pheromone that is emitted by the female, populations of male moths have traditionally been monitored through the use of pheromone-baited traps. A small pesticide strip is placed at the bottom of these traps to kill the moths once they enter. The statewide program entails the monitoring of 3 000 pheromone traps placed in a grid-like design with a 6-mile intertrapping distance. Several agencies have been involved in this monitoring effort, including the Michigan Department of Agriculture, Michigan Department of Natural Resources, the USDA-APHIS, Animal and Plant Health Inspection Service, and USDA Forest Service. Funding for the project has come from the Michigan Department of Agriculture.

Every year, these pheromone-baited traps are placed in designated locations in the spring. In the fall, trap tenders visit each location and record the number of moths contained in the trap. Trap catch data are recorded on specially designed forms and are sent to the state survey coordinator at Michigan State University for data entry and management. Trap locations are geocoded at Michigan State University's Entomology Spatial Analysis Laboratory by linking permanent site numbers to geographic coordinates. Data are then placed into a geographic information system for spatial analysis and association with other information, such as previous years' moth estimate, host distribution, and tree defoliation.

Once the data are brought into a GIS, the numbers of moths captured per year, initially represented as point data, are converted to a raster format using various interpolation methods. The most common interpolation method that is used is the inverse distance squared (IDW) method, which is available in both IDRISI and Arc/Info.

**Activity 9. Read the text and give a written translation of it into Ukrainian.**

The use of GIS to assess risk to Michigan's forests from the gypsy moth is one example of a case study that has special interest to both resource analysts and to biologists interested in studying the interaction of insects and forests. The main objective of this study, partly funded by the Michigan Department of Agriculture, is to determine areas where the most susceptible tree species, oak and aspen, may undergo defoliation. We approached this study by developing annual gypsy moth population-size category coverage. Annual high-risk population coverage, which we determine to be 400 moths or more are created as simple binary maps; a '1' is coded as the presence of 400 or more moths and a '0' as locations of the state that contain fewer than 400 moths for that year. Susceptible forest data were obtained from a statewide 1-km resolution forest-type map (dominant tree species only) that was developed from a multitemporal analysis of AVHRR data and various forest cover maps from the Michigan Department of Natural Resources.

This forest cover map contains information for several classes of forests (e.g. oak-hickory; spruce-fir); we used GIS to extract only susceptible forest types (i.e. oak and aspen forests) from this database. To perform the final analysis, we coded all oak forests with a '2' and all aspen forest-with a '1' and multiplied the high-risk population coverage with the susceptible forest coverage.

**Activity 10. Render the following sentences into Ukrainian. Use the sentences to summarize the information of Unit 12.**

- In Michigan, GIS has been used by Michigan State University to monitor the spread of the gypsy moth.
- The gypsy moth has spread over the state from the north and east and defoliates trees.
- Information from the monitoring program, via a GIS in Arc/Info and IDRISI, is used to direct spraying trees with Bt.
- Statewide gypsy moth infestations are interpolated using inverse distance squared weighting and are mapped.

- An overlay of tree species data is then used to map the trees at risk of defoliation and therefore to be sprayed.
- Results are used in resource management, policy development, and are posted for information on the WWW.

***UNIT 13 GIS AT THE WORLD TRADE CENTRE  
AFTER SEPTEMBER 11, 2001.  
THE CHANNEL ISLAND GIS***

**Active words and phrases:**

protection system – система захисту

benefit – перевага

motor vehicle – автомобіль

query – запит (на пошук певних даних)

collision – зіткнення

team – команда, група, бригада

viewing environment – робочі умови для відображення (спостереження)

to indicate – показувати

public-use version – загальнодоступний варіант.

**Activity 1. Read and translate the text.**

CODES stand for Crash Outcome Data Evaluation System and Connecticut is one of 20 U.S. states participating. CODES evolved from a national need to report on the benefits of regulations requiring automotive protection systems like seat belts and bicycle helmets. States are funded by the National Highway Traffic Safety Administration (NHTSA) to link motor vehicle crash data with medical outcome data to develop a better picture of the problem of motor vehicle injury and the effectiveness of protection systems. The linked database is the primary product of a CODES project, and a public-use version of the database is also required by NHTSA. In addition, CODES projects are allowed to develop state-specific products. The Connecticut CODES GIS is an example.

The purpose of the Connecticut CODES GIS is to create a viewing environment for the linked motor vehicle crash records so that users can find collisions of interest and obtain data on their attributes and locations. CODES users can easily display, query, and map data. These capabilities are especially important for the public-use version of the databases, with which the GIS works. The CT CODES GIS is a combination of Microsoft Access databases and an ESRI

Arc View application modified with Avenue scripts to create a GIS specifically for the project. Users can search the CODES databases by WHAT and by WHERE. In Access, users can perform detailed queries to identify what collisions are of interest, report them, and add them as a user-defined collision data layer in the GIS to see where the collisions occurred. In the GIS, users can find where a place of interest is, and then identify and report collision attributes to find out what kinds of collisions occurred in that place.

**Activity 2. Answer the questions using the information from the text.**

1. What is the purpose of the Connecticut CODES GIS?
2. What can CODES users do?
3. What is the CI CODES GIS?

**Activity 3. Look through the text again and find the words that correspond to the following definitions.**

- 1) a thing that is used for transporting people or goods from one place to another, such as a car or lorry \_\_\_\_\_
- 2) the intention, aim or function of something \_\_\_\_\_
- 3) the act of protecting somebody/something \_\_\_\_\_
- 4) to make a physical connection between one object, machine, place, etc. and other \_\_\_\_\_
- 5) to recognize somebody/something and be able to say who or what they are \_\_\_\_\_.

**Activity 4. Read and translate the key terms and definitions.**

to assist – to help somebody to do something

to destroy – to damage something so badly that it no longer exists, works

health – the conditions of a person's body or mind

uphill – sloping upwards.

**Activity 5. Complete the sentences with the following words:**

*uphill      destroyed      protection      identified*  
*health      assist      purpose      vehicle      linked*

1. The \_\_\_\_\_ of the book is to provide complete money.

2. He asked to be put under police \_\_\_\_\_.
3. Exhaust fumes are bad for your \_\_\_\_\_.
4. The building was completely \_\_\_\_\_ by fire.
5. Are you the driver of this \_\_\_\_\_?
6. The last part of the race is all \_\_\_\_\_.
7. The video cameras are \_\_\_\_\_ to a powerful computer.
8. The bodies were \_\_\_\_\_ as those of two suspected drug dealers.
9. We'll do all we can to \_\_\_\_\_ you.

**Activity 6. Fill in the gaps with the prepositions from the box.**

in (x3)	of (x3)	on	by	into	to
---------	---------	----	----	------	----

September 11, 2001 saw the greatest peacetime tragedy (1) \_\_\_\_\_ the recent era, the combined suicidal attack (2) \_\_\_\_\_ the twin towers of New York City's world trade center (WTC) and the Pentagon (3) \_\_\_\_\_ four hijacked planes. At Hunter College's CARSI (Center for the Analysis and Research (4) \_\_\_\_\_ Spatial Information) laboratory, GIS was put to immediate and effective use (5) \_\_\_\_\_ dealing with the aftermath. Fortunately, Geography Professor Sean Ahearn was ready and able to assist, having worked on the NYCMap, New York City's comprehensive GIS. The CARSI played a critical role, partly because the permanent New York City Emergency Operations Centre had been located (6) \_\_\_\_\_ the WTC complex, and was destroyed. This case study is dedicated to all of those who helped, but also to those who died, and especially (7) \_\_\_\_\_ Geographer Robert LeBlanc (8) \_\_\_\_\_ the University of New Hampshire who was on United Flight 175 on the way to a Geography conference (9) \_\_\_\_\_ Santa Barbara when it was crashed (10) \_\_\_\_\_ the WTC's south tower.

**Activity 7. Learn the following words and word combinations. Find them in the text given below.**

- 1) operational – працюючий
- 2) imagery – зображення, образи
- 3) inaccessible – недоступний
- 4) outline – контур
- 5) to pile – навантажувати
- 6) kernel – суть, сутність
- 7) rescue workers – рятувальники.

The call came at 4 p.m. on September 11, 2001. It was from Alan Leidner, head of New York City GIS, ‘Get your staff together and start creating maps, your lab is the only operational GIS Centre in town, everything else is destroyed or inaccessible, I’ll be there within the hour.’ Everyone who didn’t live in Manhattan had gone home except me. I called up the only two people on my staff from Manhattan, Ji Ding and Jeffery Bliss and they rushed over to the CARSI Lab at Hunter College. Leidner showed up soon after.

Maps of ground zero were needed for command and control of the operation. Rescue workers from around the country would be pouring in and they would all need detailed site maps. Fortunately New York City had recently created a ‘base-map’ called NYCMaP, consisting of 30 cm resolution orthophotography and planimetric map data with an absolute spatial accuracy of half a meter. NYCMaP has over two dozen geographic map features including building outlines, curb lines, street centerlines, parks, subway stations, rails, towers, and so on. Over the next four hours, the Hunter College team worked to create a baseline set of maps using just the planimetric data and maps showing the orthophotographs with planimetric overlays.

At about 10: 30 p.m. on September 11, Leidner and Bliss headed downtown to the Emergency Operations Centre (EOC) on 21st Street with armfuls of maps of the WTC site. The city virtually empty, the next morning at 7:00 a.m. the Hunter team piled three computers loaded with the NYCMaP database into the back of a police car and sped down to the EOC. The data on these machines was to form the kernel of what would become a twenty-four hour a day, seven days a week operation involving over fifty GIS professionals and lasting for over two months. The full range of mapping science technologies would be deployed: GIS, GPS, and remote sensing. Cartographic representation of data would prove to be critical in an environment in which the consumers of maps (such as firefighters and rescue workers) had never seen the likes of the data that we would be providing, including thermal imagery and Light Detection and Ranging (LIDAR).

**Activity 8. Read the text. Find the English equivalents to the following terms:**

- 1) берегова система \_\_\_\_\_
- 2) раціональне природокористування \_\_\_\_\_
- 3) цифрова база даних \_\_\_\_\_
- 4) засоби (методи) просторового аналізу \_\_\_\_\_
- 5) батиметричні дані (про глибину) \_\_\_\_\_
- 6) накопичення коштів \_\_\_\_\_
- 7) нове розуміння, уявлення \_\_\_\_\_.

Viewing the coastal system of California as an ecosystem that includes both marine and terrestrial inputs and outputs allows managers to take account of the composition, structure, and function of the entire range of processes influencing the area's environmental health. Environmental management in the rapidly growing coastal areas of Southern California is controlled by a unique set of political and scientific challenges that can partially be met through a combination of field data collection, spatial modeling, and information technologies. In particular, digital databases, remote sensing data, and spatial analysis tools embedded in a GIS allow analysis of relations among the environmental variables. In addition to scientific challenges, coastal regions involve management by multiple agencies with distinct disciplinary and jurisdictional interests.

As a resource management tool, the CIGIS provides information on flora and fauna (for example, kelp, sea grass, harbor seals, seabird colonies, shellfish), location of sensitive archeological sites, location and dimensions of sea caves, shipping lanes, oil platforms, bathymetry, geology, vegetation cover, soils, and topography. In response to the multiple roles it serves, CIGIS is customized to meet the needs of individual users. The master database is in Arc/Info and Arc View (Unix and PC version), while users receive versions with data relevant to the mission of the agency. For example, Arc View versions now reside at a field station and on a boat. Experience with multiple users shows that by promoting cooperation among agencies it is possible to create a database substantially more useful to the group as a whole than to have only emphasized the disciplinary or jurisdictional needs of an individual group. In addition, through pooling of resources, each agency has benefited from access to the entire database rather than only data explicitly related to their management mandate.

Success has been measured not by the size of the database, but rather by the new insight gained through spatial analysis of the environmental layers. Through analysis of a time series of Landsat remote sensing data from 1972 to the present. Dr. Mertes and her collaborators have analyzed the characteristic patterns at the surface of the coastal waters of the Santa Barbara Channel.

**Activity 9. Read the text and give a written translation of it into Ukrainian.**

The Racetrack Playa, at an elevation of 1131 meters, is a pluvial lake within the Panamint Range of Death Valley National Park, California. As the topographic low of the Racetrack Basin, rocks of various sizes tumble onto the dry lakebed from abutting cliffs and surrounding alluvial fans. Since the beginning of the twentieth century, prospectors, park rangers, and geologists have noted and described evidence of dynamic traction events that apparently occur once the rocks



are deposited on the playa. Recessed furrows, up to two centimeters deep, suggest that rocks glide along the surface, a near-perfectly horizontal plane; in fact, rocks skid slightly uphill since most rocks are found on the ends of trails closer to the 5-centimeter-higher northern ‘shore.’ Trails are defined by lateral ridges, similar to scaled-down river levees, suggesting that the surface is saturated and pliant when the rocks move. Some trails exhibit evidence of splash marks, wakes, and bow waves, indicating that the rocks are propelled at speeds of about 2 meters per second, or even more. The longest trail, over 800 meters, is fairly straight, but others record extremely chaotic activity. The largest boulders are estimated to have masses up to 320 kilograms and contrary to logic, their trails are by no means the shortest. To date, no one has witnessed the rocks in motion.

Having reached full operational capacity in April 1995, the global positioning system (GPS) provides surveyors with a new non-impact tool for constructing highly accurate maps in little time. Differential correction of GPS data can achieve centimeter-level accuracy for point and line features. The exact locations of all rocks and precise plans of all trails on the 667 hectare playa were captured by a field crew of two in July, 1996, requiring only ten days’ time. Data were exported to ArcView GIS, and analyzed using a variety of spatial and statistical methods.

With no smoking gun there were still many questions left unanswered. The GIS did present some spatial patterns worth investigating. It seemed that straighter, longer trails were concentrated on the eastern margin of the playa, but those near the playa’s centre were sinuous or chaotic. Analysis of the surrounding terrain, using the USGS digital elevation model (DEM), provided the clue that had remained hitherto elusive: The slope and aspect of the basin directs airflow along specific vectors. Direct measurements of the wind conducted with handheld anemometers revealed that wind speeds up to six times faster, and up to 50 degrees deviant in heading occurred synchronously at locations only 400 meters apart. Therefore, the nature of a trail has more to do with the location of the rock that inscribed it than to the physical characteristics of the rock itself. Follow-up visits to the Racetrack confirm these conclusions, since the rock that has slid farthest since the 1996 survey (‘Diane’) is the one that previously carved the longest trail (881 meters).

**Activity 10. Render the following sentences into Ukrainian. Use these sentences to summarize the information of Unit 13.**

- In Connecticut, a GIS has been developed to track automobile accidents.
- A key element in the GIS has been linking spatial data and maps showing locations of accidents with hospital information about injuries.

- The disaster relief effort was supported by a GIS operation involving over 50 GIS professionals that operated around the clock for two months.
- The GIS was built by collaborative efforts from several agencies, and included database assembly by both undergraduate and graduate students.
- Studies of the mysterious Sliding Rocks of Racetrack Playa in Death Valley have been conducted using GIS and field GPS.
- Research on the rocks dates back to the 1950s, with a leading theory being related to ice flow.

## ***UNIT 14 THE FUTURE OF GIS***

### **Active words and phrases**

Distribution – розподіл, розповсюдження

catch up (with) – управляти, схоплювати, розуміти

immense – обмежений

obstacle – перешкода

timely – своєчасно

disaster – лихо

glimpse – деяке уявлення.

### **Activity 1. Read and translate the text.**

The theme of this book has been an examination of the value that GIS brings to the workplace as a tool for understanding geographic distributions, and for describing and predicting what will happen to these distributions in the real world. History has shown just how powerful GIS can be as a new mechanism for managing information. From humble origins, a set of simple ideas and some rather inefficient software. GIS has grown into a sophisticated, multibillion-dollar industry in only half the length of a human career. GIS's dual role as a mainstream technology for the management of geographic information and as an effective tool for the use of resources is no longer a promise, but a reality.

So why bother to discuss the future of GIS? Quite simply, why speculate? The future always seems to catch up with the present at an alarming rate. In only 3 years, for example, GIS and GPS technologies have met and merged in a seamless way without the slightest hitch. Why not just wait and let the technology deliver our dreams and speculations if they are realistic enough to come into being? The blood of a GIS is the digital map data that runs through its' software veins and hardware body. The future holds immense promise for new types of data, more

complete data, higher-resolution data, and more timely data. Once the major obstacle to GIS development, data have now become GIS's greatest opportunity. Some of the types and sources of GIS data have already been described in detail in this book. The years ahead will bring us even more new types of data, and vast revisions of the existing types. As such, this summary of future data can be only a glimpse of what is still to come.

**Activity 2. Answer the questions using the information from the text.**

1. What has history of GIS shown?
2. What has GIS grown from humble origins into?
3. What is the blood of a GIS?

**Activity 3. Look through the text again and find the words that correspond to the following definitions.**

- 1) extremely large or great \_\_\_\_\_
- 2) a plan, thought or suggestion, especially about what to do in a particular situation \_\_\_\_\_
- 3) the red liquid that flows through the bodies of humans and animals \_\_\_\_\_
- 4) the act of looking at or considering something very carefully \_\_\_\_\_
- 5) to say that something will happen in the future \_\_\_\_\_
- 6) a single entity that composes part of a landscape \_\_\_\_\_.

**Activity 4. Read and translate the key terms and definitions.**

Significant – large or important enough to have an effect or to be noticed  
theme – the subject or main idea in a talk, piece writing or work of art  
technology – machinery or equipment designed using technology  
revolution – a great change in conditions, ways of working, beliefs, etc. that affects large number of people  
the Internet – an international computer network connecting other networks and computers from companies, universities, etc.

**Activity 5. Complete the sentences with the following words:**

*examination    predict    theme    idea    Internet*  
*technology    immense revolution    significant    blood*

1. There is still an \_\_\_\_\_ amount of work to be done.
2. All got the information from the \_\_\_\_\_.
3. It's impossible to \_\_\_\_\_ what will happen.
4. It might be an \_\_\_\_\_ to try again later.
5. Careful \_\_\_\_\_ of the ruins revealed an even earlier temple.
6. The naked male figure was always the central \_\_\_\_\_ of Greek art.
7. The company has invested in the latest \_\_\_\_\_.
8. A \_\_\_\_\_ in information technology is taken place.
9. Your work has shown a \_\_\_\_\_ improvement.
10. He lost a lot of \_\_\_\_\_ in the accident.

**Activity 6. Fill in the gaps with the preposition from the box.**

of (x4)    for (x2)    from    through    to    in
--

Hardware for GIS has gone (1) \_\_\_\_\_ at least four revolutions (2) \_\_\_\_\_ the last decade: the workstation, network, microcomputer, and mobility revolutions.

Each one (3) \_\_\_\_\_ these has already had a profound impact on computer hardware and will influence the future of GIS significantly.

The first of these – the workstation revolution – has given GIS an operating platform that has all of the necessary power and storage to work with massive databases. In the space of just a few years, the capability of a \$15,000 workstation has gone (4) \_\_\_\_\_ megabytes (5) \_\_\_\_\_ gigabytes of storage, while increasing the size of RAM beyond 64 megabytes and the processor speed well above and beyond the capabilities (6) \_\_\_\_\_ most mainframe computers. Examples are Sun's Sunblade, DEC's DecStation, and Silicon Graphics workstations. Along with the expansion of the workstation has been the spread of Unix, the TCP/IP communications protocol, and graphical user interfaces such as Sun's OpenLook, Motif and MIT's X-Windows. The more powerful systems of the future and the falling price of workstations seem to make this the preferred GIS work environment (7) \_\_\_\_\_ large-scale projects, although Windows, Macintoshes, Linux, and even DOS remain for low-end systems, small projects, and for education.

The network capabilities built into workstations have broadened include many other types (8)\_\_\_\_\_ computers, including microcomputers. Many computers are now connected to the Internet and can use network search tools such as Windows Explorer and Netscape to ‘surf’ the World Wide Web (WWW). Already, the Internet has become a primary means (9)\_\_\_\_\_ data exchange and information search and retrieval. Many GIS packages, including Arc/Info, GRASS, and IDRISI, have support services on the Internet’s network conference groups. The national spatial data infrastructure, a linked distributed database (10) public GIS information with common metadata, is being built upon the capabilities of the Internet and the WWW.

**Activity 7. Learn the following words and word combinations. Find them in the text given below.**

- 1) to predominate – переважати
- 2) abbreviated – скорочений
- 3) system management – координація роботи системи
- 4) flavor – особливість
- 5) digitizer – пристрій введення графічної інформації
- 6) track ball – куля трасування
- 7) light pen – світлове перо.

A review of GIS software trends of recent years is in order if we are to speculate in a similar way about where GIS software is going in the future. Several themes suggest themselves.

The first major trend over the last few years has been in operating systems. In the 1970s, complex mainframe operating systems predominated, and system interaction was limited both by the inflexibility of the user interface and by the nature of the early time sharing of systems. The first minicomputer operating systems were little better, with the exception of Unix, a simple and much abbreviated set of instructions for doing file and systems management that has proven very flexible and long lived. Today, operating systems can ‘multitask,’ working on two problems at once, with ease. Microcomputer operating systems now also have this capability.

Early systems were somewhat poor at user interaction, yet the revolutionary Apple Macintosh system, followed by the various flavors of Windows and X-Windows, led to a significant improvement in user simplicity and comprehensiveness. Standardization was an additional unseen improvement: that is, every application could use a standard and commonly understood set of menus

instead of making its own flavor. Most recently, operating systems that run on multiple platforms have flourished, including Unix. The ability to divorce standard operations such as printing and digitizer communication from the GIS led to some major improvements. Similarly, commonly accepted industry standard formats and languages, such as PostScript, led to another level of standardization, this time for hardware devices such as printers and plotters.

The computer era has seen radical changes in the very nature of both the computer and GIS user interfaces. Early systems used only the screen and the keyboard to communicate to the user. Systems now have these same functions, but also a mouse, pointing devices such as a track ball or light pen, multiple windows on the screen, sound, animation, and many other options.

**Activity 8. Read the text. Find the English equivalents to the following terms.**

- 1) ступінь проникнення \_\_\_\_\_
- 2) складні завдання предмета обговорення \_\_\_\_\_
- 3) на рівні практики \_\_\_\_\_
- 4) все більш і більш поширений \_\_\_\_\_
- 5) право на секретність (таємницю) \_\_\_\_\_
- 6) вкрай необхідне питання для обговорення \_\_\_\_\_
- 7) наукове уявлення \_\_\_\_\_.

Assuming that GIS is now only a few years away from this degree of permeation into the economy, if it is not already there, it is a good idea to finish this chapter, and indeed the entire book, with a glimpse at the issues and problems we are likely to face with the future of GIS. How well we as a user community react to the challenges of the issues will play a major role in the future of GIS. As a person now introduced to the possibilities, it is you, the reader, who will have to deal with these issues at a practical level.

An issue that raises itself again and again as GIS databases become more and more widespread is that of personal privacy. We very often take our right to privacy for granted, yet all the time, by the use of telephones, credit cards, mail order, and the like, we are constantly revealing to other people what can be personal property. Facts we consider of the greatest privacy – our personal income, information about the family, our health record, and employment history – are all tucked away in somebody's database. GIS offers the integration of these data through their common geography. Although it is to the public benefit, for example, to build a link between environmental pollution and health, the more local and individual the link, the more the issue of personal privacy arises. Even

the federal census, with its highly general information about groups of individuals, has strict restrictions on availability of information that can identify specific people, holding such data private for over 70 years before releasing it.

A critical issue for the future of GIS is the degree to which the systems become integrated with those new parts of computer graphics and cartography most suitable for GIS applications. The entire field of scientific visualization is an example. Scientific visualization seeks to use the processing power of the human mind, coupled with the imaging and display capabilities of sophisticated computer graphics systems, to seek out empirical patterns and relationships visible in data but beyond the powers of detection using standard statistical and descriptive methods.

### **Activity 9. Read the text and give a written translation of it into Ukrainian.**

To summarize, we have covered in this chapter some speculations and some predictions about the future of GIS. Clearly evident is that new issues will arise and will have to be resolved as GIS matures into a mainstream science rather than a new approach. In the preceding section we discussed these in detail. Here we focus on the shorter-term problems that are being confronted as this book goes to press.

First, the impact of standards has become clear. The spatial data transfer standard has already led the way in confronting such issues as accuracy, file transfer, terminology, and definitions. The same standards groups in the United States, led by the federal Geographic Data Committee, have now set forth metadata standards. Other standards, especially for the WWW are now being formulated, such as GeoVRML and GML.

A good analogy to this effort is that of the catalog systems used by libraries. If each library is allowed to design and use its own system, there is little or no possibility for libraries to work together. For example, imagine an Intel-library loan request from one library that files its books by size to one that files its books by the color of the cover! Metadata standards are to digital cartographic and geographic data what the Library of Congress catalog system is to a library. Standardization is essential, not necessarily for a single library but certainly for a network of libraries. As GIS enters the era of the Internet and the World Wide Web, such standardization is the foundation upon which all later work will build. The free exchange of data will lead to massive savings in duplication and in incompatible and unmatched direct data equivalents.

**Activity 10. Render the following sentences into Ukrainian. Use these sentences to summarize the information of Unit 14.**

- The theme of Getting Started with Geographic Information Systems has been GIS's place in understanding geographic distributions and their mapping and prediction in the real world.

- Acquiring data for a new GIS is no longer a major problem.

- Digital map images such as scanned maps and air photos are often used as a background image for cross-layer registration and update.

- The microcomputer has allowed GIS to be applied to new fields and has improved GIS education

- Improvements in the user interface have substantially altered GIS's 'look and feel'.

- Data ownership will remain critical to GIS, with a delicate balance between public and private GIS data.



## SUPPLEMENTARY READING

### PERSONAL COMPUTING

In 1952, a major computing company took a decision to get out of the business of making mainframe computers. They believed that there was only a market for four mainframes in the whole world. That company was IBM. The following year they reversed their decision.

In 1980, IBM decided that there was a market for 250,000 PCs, so they set up a special team to develop the first IBM PC. It went on sale in 1981 and set a world-wide standard for IBM-compatibility which, over the next ten years, was only seriously challenged by one other company, Apple Computers. Since then, over seventy million PCs made by IBM and other manufacturers have been sold. Over this period, PCs have become commodity items. Since IBM made the design non-proprietary, anyone can make them.

The history of the multi-billion dollar PC industry has been one of mistakes. Xerox Corporation funded the initial research on personal computers in their Palo Alto laboratory in California. However, the company failed to capitalize on this work, and the ideas that they put together went into the operating system developed for Apple's computers. This was a graphical interface: using a mouse, the user clicks on icons which represent the function to be performed.

The first IBM PC was developed using existing available electrical components. With IBM's badge on the box it became the standard machine for large corporations to purchase. When IBM were looking for an operating system, they went initially to Digital Research, who were market leaders in command – so based operating systems (these are operating systems in which the users type in commands to perform a function). When the collaboration between IBM and Digital Research failed, IBM turned to Bill Gates, then 25 years old, to write their operating system.

Bill Gates founded Microsoft on the basis of the development of MS/DOS, the initial operating system for the IBM PC. Digital Research have continued to develop their operating system, DR/DOS, and it is considered by many people to be a better product than Microsoft's. However, without an endorsement from IBM, it has become a minor player in the market. Novell, the leaders in PC networking, now own Digital Research, so things may change.

The original IBM PC had a minimum of 16K of memory, but this could be upgraded to 512K if necessary, and ran with a processor speed of 4.77MHz. Ten years later, in 1991, IBM were making PCs with 16Mb of memory, expandable to 64Mb, running with a processor speed of 33MHz. The cost of buying the hardware has come down considerably as the machines have become commodity items.

Large companies are considering running major applications on PCs, something which, ten years ago, no one would have believed possible of a PC. In contrast, many computers in people's homes are just used to play computer games.

The widespread availability of computers has in all probability changed the world for ever. The microchip technology which made the PC possible has put chips not only into computers, but also into washing-machines and cars. Some books may never be published in paper form, but may only be made available as part of public databases. Networks of computers are already being used to make information available on a worldwide scale.

**Answer these questions on the text**

1. How many mainframes did IBM think it was possible to sell in 1952?
2. How many PCs have now been sold?
3. Who paid for the initial research into PCs?
4. Which company later used the results of this research to develop their operating system?
5. What are command-based operating systems?
6. DR\DOS is an acronym. What does it stand for?
7. Since the invention of the IBM PC, many of its features have been improved. Which of the following features does the text not mention in this respect?
  - A memory
  - B speed
  - C size
  - D cost.

## **OPERATING SYSTEMS**

**Before reading the text, try to answer the following questions:**

1. What is an operating system and what is its purpose?
2. Where is an operating system stored and how is it transferred to internal memory?
3. List some tasks typically performed by an operating system.

**Now read the text and check your answers.**

## OPERATING SYSTEMS

An operating system is a master control program which controls the functions of the computer system as a whole and the running of application programs. All computers do not use the same operating systems. It is therefore important to assess the operating system used on a 5 particular model before initial commitment because some software is only designed to run under the control of specific operating systems. Some operating systems are adopted as 'industry standards' and these are the ones which should be evaluated because they normally have a good software base. The reason for this is that software houses are willing to expand resources on the development of application packages for machines functioning under the control of an operating system which is widely used. The cost of software is likely to be lower in such circumstances as the development costs are spread over a greater number of users, both actual and potential.

Mainframe computers usually process several application programs concurrently, switching from one to the other, for the purpose of increasing processing productivity. This is known as multiprogramming (multi-tasking in the context of microcomputers), which requires a powerful operating system incorporating work scheduling facilities to control the switching between programs. This entails reading in data for one program while the processor is performing computations on another and printing out results on yet another.

In multi-user environments an operating system is required to control terminal operations on a shared access basis as only one user can access the system at any moment of time. The operating system allocates control to each terminal in turn. Such systems also require a system for record locking and unlocking, to prevent one user attempting to read a record whilst another user is updating it, for instance. The first user is allocated control to write to a record (or file in some instances) and other users are denied access until the record is updated and unlocked.

Some environments operate in concurrent batch and real-time mode. This means that a 'background' job deals with routine batch processing whilst the 'foreground' job deals with real-time operations such as airline seat reservations, on-line booking of hotel accommodation, or control of warehouse stocks, etc. The real-time operation has priority, and the operating system interrupts batch processing operations to deal with real time enquiries or file updates. The stage of batch processing attained at the time of the interrupt is temporarily transferred to backing storage. After the real-time operation has been dealt with, the interrupted program is transferred back to internal memory from backing storage, and processing recommences from a 'restart' point. The operating system also copies to disk backing storage the state of the real-time system every few minutes (periodic

check points) to provide a means of 'recovering' the system in the event of a malfunction.

An operating system is stored on disk and has to be booted into the internal memory (RAM) where it must reside throughout processing so that commands are instantly available. The operating system commands may exceed the internal memory capacity of the computer in which case only that portion of the OS which is frequently used is retained internally, so other modules being read in from disk as required. Many microcomputers function under the control of a disk operating system known as DOS.

### **Answer these questions on the text**

1. Why is it important to assess the operating system on a computer before buying it?
2. What is multiprogramming?
3. The text gives some examples of real-time processing. Can you think of some examples of batch-processing?

### **ONLINE SERVICES**

I'm frequently asked which online service is 'best', but the answer is there is no best. Rating a particular service over another is entirely subjective. Price is important to some people, while the number of files available for download is important to others. Because of these and so many other different judgments, there can be no absolute. It all comes down to individual needs and preferences.

Still, users tend to be fiercely loyal to their 'home' online service – which is usually the first online service they ever used. They tend to judge all other online services based on this first service – often preventing themselves from seeing the advantages of a specific service. For my part, I like all the services I use and I'm on two dozen. Each offers one or more products or features that either do not exist elsewhere or are superior to the same features on other services. And I've a really subjective reason for being on one service – I use it to send monthly articles to magazines in Japan. So, the real answer to the question is simple: the best online service is the service that has what you want and is easy for you to use. The point? Keep an open mind when checking out an online service. Judge it based on what it offers and how it meets your needs -not in comparison to what you're used to using. (It takes a couple of sessions to shake preconceived notions of what an online service 'should' be.) Eventually, we're all going to be interlinked, no matter which service we use, in what DIALOG'S Richard Ream calls a 'network of networks'. Until then, most of us have to go to more than one service to find everything we need.

And now, the news...

### **What's new on-line**

#### **BIX**

TAB Book Clubs Online: You've probably seen magazine ads for The Computer Book Club and The Computer Professionals' Book Society. These are sponsored by TAB Books. This division of McGraw-Hill (BIX's parent company) is now online on BIX, taking orders and answering questions from members and prospective members. The club conference is moderated by Tammy Ray and Jeanette Shearer. You can check them out by typing JOIN TAB.BOOK.CLUBS.

#### **CompuServe**

Dell Computer Forum: Dell Computer Corporation has opened a product support area on CompuServe. The Dell area is part of the PC Vendor D Forum. Type GO DELL or GO PCVEND to take a look.

#### **Minitel Link to CompuServe**

CompuServe bolstered its position in Europe by making some of its services available via France's national Minitel system in July. French Minitel users have access to an extra-cost service that is essentially a 'limited edition', English-language version of CompuServe. Among the services available are software and database downloads. E-mail and message-base posting are not available to Minitel users.

#### **DELPHI**

Hobby Group Expands: DELPHI's Hobby Shop special-interest group continues to expand its areas of interest. The most recent additions to the database and group topics are Antique Auto, which focuses on classical vehicles, and Autotech, where you can learn about new cars and technology. Type Go GROUP.

**Decide whether the following statements are true (T) or false (F) in relation to the information in the text. If you think a statement is false, change it to make it true.**

1. Most people choose an online service because of the price or the number of available files.
2. Everybody has one service which he/she likes more than all the others.
3. You should judge each service according to whether it is better or worse overall than the service you are currently using.
4. Eventually, all services will be accessible from the service you are using.
5. McGraw-Hills is owned by BIX.
6. Tammy Ray and Jeanette Shearer think the BIX service is average.

7. French Minitel users have free access to an English-language version of CompuServe, although they cannot use the e-mail facility.

8. DELPHI's Hobby Shop now has two special-interest areas: one on classic vehicles, and one on new cars and technology.

## COMPUTER SOFTWARE

In the magazine article which follows, a number of software developers express their opinions on the future of software technology. Read the article and identify which opinions are expressed by the speakers.

### Opinions

1. In general, customers are getting what they want. \_\_\_\_\_
2. In general, customers are not getting what they want. \_\_\_\_\_
3. Software is too complex. \_\_\_\_\_
4. Software is not complex enough. \_\_\_\_\_
5. Software developers know what users want. \_\_\_\_\_
6. Software developers don't know what users want. \_\_\_\_\_.

## COMPUTER SOFTWARE

I chose four well-known software developers and asked each to talk about current and future trends in software technology. Their comments reveal some common and diverse themes. I began by asking them if they thought that software purchasers are getting what they need. What should developers be doing differently to give purchasers a better product?

Mary Evans 'In general, I think people are getting what they want -there are a lot of creative things being done with paint software, word processing, DTP (desktop publishing) systems, and the like. Do users want more? Of course! Users will always want more. The computer is an incredibly powerful tool, and any software that makes it easier, faster, more creative, or more cost-effective will inevitably be in demand. But I'm generally optimistic about the way things are going at the moment. I think most of the major software manufacturers are able to read the market quite well.

Gerry Harper 'I'm afraid I completely disagree with Mary. I just don't think that software purchasers are getting the technical support they need. While the products are getting more and more complex, and more and more expensive, it seems that support is starting to be thought of as an additional business opportunity. More generally, I've thought for some time that applications are getting too big, and that they're trying to do too much. Yes. They're versatile and

powerful, but they're also often overwhelming. I think what we need are simple little programs that are easy to understand and use, and that work together to accomplish more complex tasks.'

Matt Andrews 'I really can't agree with that. To imagine we can just go back to "simple little programs" just ignores the complex needs of many of today's software users. No, I'm sure that you can't stop progress. Suppliers know what their customers want - they just can't supply it quickly enough. I've studied the market very closely, and I've found that purchasers' needs seem always to exceed the capability of the available software by a constant time-frame of about six to twelve months.

Bob Bolton 'I think users are getting what they want, provided that their needs fit the off-the-shelf application. Specialized software is usually so specific that it should be written in-house for businesses. Developers should add features that the customer needs, not what they think customers want. Some effort should be made to get feedback from the users before making an upgrade so that the proper features are added.

## **COMPUTER NETWORKS**

**Read quickly the text below, then match each paragraph with the appropriate summary.**

1. Network uses, past and present
2. How distributed systems work
3. Networks and the future
4. What networks are and how they operate
5. The growth of networks, past and present.

Computer networks link computers by communication lines and software protocols, allowing data to be exchanged rapidly and reliably. Traditionally, networks have been split between wide area networks (WANs) and local area networks (LANs). A WAN is a network connected over long distance telephone lines, and a LAN is a localized network usually in one building or a group of buildings close together. The distinction, however, is becoming blurred. It is now possible to connect up LANs remotely over telephone links so that they look as though they are a single LAN. Originally, networks were used to provide terminal access to another computer and to transfer files between computers. Today, networks carry e-mail, provide access to public databases and bulletin boards, and are beginning to be used for distributed systems. Networks also allow users in one

locality to share expensive resources, such as printers and disk-systems. Distributed computer systems are built using networked computers that co-operate to perform tasks. In this environment each part of the networked system does what it is best at. The high-quality bit-mapped graphics screen of a personal computer or workstation provides a good user interface. The mainframe, on the other hand, can handle large numbers so of queries and return the results to the users. In a distributed environment, a user might use his PC to make a query against a central database. The PC passes the query, written in a special language (e.g. Structured Query Language - SQL), to the mainframe, which then parses the query, returning to the user only the data requested. The user might then use his PC to draw graphs based on the data. By passing back to the user's PC only the specific information requested, network traffic is reduced. If the whole file were transmitted, the PC would then have to perform the query itself, reducing the efficiency of both network and PC.

In the 1980s, at least 100,000 LANs were set up in laboratories and offices around the world. During the early part of this decade, synchronous orbit satellites lowered the price of long-distance telephone calls, enabling computer data and television signals to be distributed more cheaply around the world. Since then, fibre-optic cable has been installed on a large scale, enabling vast amounts of data to be transmitted at a very high speed using light signals.

The impact of fibre optics will be considerably to reduce the price of network access. Global communication and computer networks will become more and more a part of professional and personal lives as the price of microcomputers and network access drops. At the same time, distributed computer networks should improve our work environments and technical abilities.

## **DATABASE MANAGEMENT SYSTEMS**

**Before reading the text, match the following words with their definition**

- |                               |   |
|-------------------------------|---|
| 1) logical record             | a the collection of data transferred as a         |
| unit                          |   |
| 2) field                      | b the user's permitted view of the data           |
| 3) physical record            | c the logical design of the databases             |
| 4) internal schema an address | d an item of data such as a number, a name        |
| 5) external schema            | e the way that the data is physically held        |
| 6) conceptual schema          | f the collection of data relating to one subject. |



**Now compare your answers with the information in the text.**

Databases are used within a medical context for many purposes. For example, they are used to hold patient details so they can be accessed from anywhere within a hospital or network of hospitals. With the recent improvements in image compression techniques, X-rays and scan output can also be held in databases and accessed in the same way.

These multi-user databases are managed by a piece of software called a database management system (DBMS). It is this which differentiates a database from an ordinary computer file. Between the physical database itself (i.e. the data as actually stored) and the users of the system is the DBMS. All requests for access to data from users – whether people at terminals or other programs running in batch – are handled by the DBMS.

One general function of the DBMS is the shielding of database users from machine code (in much the same way that COBOL shields programmers from machine code). In other words, the DBMS provides a view of the data is that is elevated above the hardware level, and supports user-requests such as 'Get the PATIENT record for patient Smith', written in a higher-level language.

The DBMS also determines the amount and type of information that each user can access from a database. For example, a surgeon and a hospital administrator will require different views of a database.

When a user wishes to access a database, he makes an access request using a particular data-manipulation language understood by the DBMS. The DBMS receives the request, and checks it for syntax errors. The DBMS then inspects, in turn, the external schema, the conceptual schema, and the mapping between the conceptual schema and the internal schema. It then performs the necessary operations on the stored data.

In general, fields may be required from several logical tables of data held in the database. Each logical record occurrence may in turn, require data from more than one physical record held in the actual database. The DBMS must retrieve each of the required physical records and construct the logical view of the data requested by the user. In this way, users are protected from having to know anything about the physical layout of the database, which may be altered, say, for performance reasons, without the users having their logical view of the data structures altered.

**The steps below show how a DBMS deals with an access request. Find the relevant section in the text, and then put the steps in the correct order.**

The DBMS:

- 1) inspects the mapping between the conceptual schema and internal schema
- 2) checks for syntax errors
- 3) inspects the external schema
- 4) receives the request
- 5) performs operations on the stored data
- 6) inspects the conceptual schema.

## **PROGRAMMING AND LANGUAGES**

**Before reading the text, try to fill in the gaps in these sentences.**

1. A \_\_\_\_\_ is a program written in one of the high-level languages.
2. A program written in a high-level language must be interpreted into \_\_\_\_\_ before the computer will read and process it.
3. A program designed to perform a specific tasks is called an \_\_\_\_\_.
4. The \_\_\_\_\_ or \_\_\_\_\_ is the program produced when the original program has been converted into machine code.
5. A \_\_\_\_\_ is a program that converts a high-level language into machine code.
6. The systems program which fetches requires systems routines and links them to the object module is known as the \_\_\_\_\_.
7. The \_\_\_\_\_ is the program directly executable by the computer.

**Now read the text to check your answers.**

## **PROGRAMS AND PROGRAMMING LANGUAGES**

Computers can deal with different kinds of problems if they are given the right instructions for what to do. Instructions are first written in one of the high-level languages, e.g. FORTRAN, COBOL, ALGOL, PL/I, PASCAL, BASIC, or C, depending on the type of problem to be solved. A program written in one of these languages is often called a source program, and it cannot be directly

processed by the computer until it has been compiled, which means interpreted into machine code. Usually a single instruction written in a high-level language, when transformed into machine code, results in several instructions. Here is a brief description of some of the 10 many high-level languages:

**FORTRAN** acronym for FORmula TRANslation. This language is used for solving scientific and mathematical problems. It consists of algebraic formulae and English phrases. It was first introduced in the United States in 1954.

**COBOL** acronym for COmmon Business-Oriented Language. This language is used for commercial purposes. COBOL, which is written using English statements, deals with problems that do not involve a lot of mathematical calculations. It was first introduced in 1959.

**ALGOL** acronym for ALGOrithmic Language. Originally called IAL, which means International Algebraic Language. It is used for mathematical and scientific purposes. ALGOL was first introduced in Europe in 1960.

**PL/I** Programming Language I. Developed in 1964 to combine features of COBOL and ALGOL. Consequently, it is used for data processing as well as scientific applications.

**BASIC** acronym for Beginner's All-purpose Symbolic Instruction Code. Developed in 1965 at Dartmouth College in the United States for use by students who require a simple language to begin programming.

**C** developed in the 1970s to support the UNIX operating system. C is a highly portable general-purpose language.

Other such languages are APL (developed in 1962), PASCAL (named after Blaise Pascal and developed in 1971), and LISP and PROLOG, both of which are used for work in artificial intelligence. LOGO is a development of LISP which has been used to develop computer-based training (CBT) packages.

When a program written in one of these high-level languages is designed to do a specific type of work such as calculate a company's payroll or calculate the stress factor on a roof, it is called an applications program. Institutions either purchase these programs as packages or commission their own programmers to write them to meet the specifications of the users.

The program produced after the source program has been converted into machine code is referred to as an object program or object module. This is done by a computer program called the compiler, which is unique for each computer. Consequently, a computer needs its own compiler for the various high-level languages if it is expected to accept programs written in those languages. For example, in order that an IBM RS/6000 may process a program in FORTRAN, it needs to have a compiler that would understand that particular model and the FORTRAN language as well.

The compiler is a systems program which may be written in any language, but the computer's operating system is a true systems program which controls the central processing unit (CPU), the input, the output, and the secondary memory devices. Another systems program is the linkage editor, which fetches required systems routines and links them to the object module (the source program in machine code). The resulting program is then called the load module, which is the program directly executable by the computer. Although systems programs are part of the software, they are usually provided by the manufacturer of the machine.

Unlike systems programs, software packages are sold by various vendors and not necessarily by the computer manufacturer. They are a set of programs designed to perform certain applications which conform to the particular specifications of the user. Payroll is an example of such a package which allows the user to input data - hours worked, pay rates, special deductions, names of employees - and get salary calculations as output. These packages are coded in machine language (0s and 1s) on magnetic tapes or disks which can be purchased, leased, or rented by users who choose the package that most closely corresponds to their needs.

**These are the answers to the questions on the text. Write the questions.**

1. No, it is quite wordy so it is used for commercial purposes.
2. To support the UNIX operating system.
3. An applications program.
4. It is done by the compiler.
5. It fetches required systems routines and links them to the object module.
6. No, they are also sold by other vendors.

## **INFORMATION SYSTEMS**

**Before reading the text, try to decide which of the following definitions best describes a management information system:**

- a** a system for supplying information to management
- b** a system for managing information
- c** a system which supplies information about management.

**Decide whether these statements are true (T) or false (F), then read the passage to check your answers.**

1. All businesses are interested in more or less the same information, regardless of the nature of their operations.
2. The managing director of a company needs a lot more detailed information about the day-to-day operations than his executives do.
3. Functional management requires up-to-the-minute information so that they can take action to control events as they happen.
4. Information systems are usually computerized.
5. Transaction processing systems are usually the first systems to be installed.

### **Information Systems**

The objective of information systems is to provide information to all levels of management at the most relevant time, at an acceptable level of accuracy, and at an economical cost.

Individual businesses require information according to the nature of their operations. A car manufacturer is particularly interested in the extent of competition from overseas manufacturers in the home market and competition from other home-based manufacturers. A tour operator is concerned about purchasing power and its effect on holiday bookings and the political situation prevailing in the various countries.

As a general guide, the detail contained in reports containing information varies according to the position of the recipient in the hierarchical management structure. The chairman and managing director of a company require details of operations which are broad in scope and which concentrate on key factors pinpointing economic and financial trends. Functional management require information relating to the departments they are responsible for in sufficient detail to enable them to apply whatever measures are required to bring situations into line with requirements. They require information relating to events as they occur so that appropriate action can be taken to control them.

Information systems are often computerized because of the need to respond quickly and flexibly to queries. At the bottom level in the information hierarchy are the transaction processing systems, which capture and process internal information, such as sales, production, and stock data. These produce the working documents of the business, such as invoices and statements. Typically, these are the first systems which a company will install. Above the transaction-level systems are the decision support systems. These take external information – market trends

and other external financial data – and processed internal information, such as sales trends, to produce strategic plans, forecasts, and budgets. Often such systems are put together with PC spreadsheets and other unconnected tools. Management information systems lie at the top of the hierarchy of information needs. The MIS takes the plans and information from the transaction-level systems to monitor the performance of the business as a whole. This provides feedback to aid strategic planning, forecasting, and/or budgeting, which in turn affects what happens at the transactional level.

## **PORTABLE COMPUTERS**

FOR THE LAST GENERATION, Silicon Valley and Tokyo have been working to design computers that are ever easier to use. There is one thing, however, that has prevented the machines from becoming their user-friendliest: you still have to input data with a keyboard, and that can require you to do a lot of typing and to memorize a lot of elaborate commands.

Enter the clipboard computer, a technology that has been in development for the last 20 years but took hold in the mass market only this year. Clipboard PCs - which, as their name suggests, are not much bigger than an actual clipboard - replace the keyboard with a liquid crystal display (LCD) screen and an electronic stylus. Users input data by printing individual letters directly on the screen.

There are two technologies at work in a clipboard PC: one allows raw data to get into the computer and the other allows the computer to figure out what that data means. The first technology relies principally on hardware and varies depending on the particular computer. In one system, marketed under the name GRIDPad the computer's LCD screen is covered by a sheet of glass with a transparent conductive coating. Voltage is sent the glass in horizontal and vertical lines forming a fine grid; at any point on the grid, the voltage is slightly different. When the stylus - which is essentially a voltmeter - touches the screen, it informs the computer of the voltage at that point. The computer uses this information to determine where the stylus is and causes a liquid crystal pixel to appear at those coordinates. The position of the stylus is monitored several hundred times a second, so as the stylus moves across the glass, whole strings of pixels are activated.

'What we do is sort of connect the dots,' says Jeff Hawkins, the creator of GRIDPad. 'Users can then write whatever they want on the screen with a kind of electronic ink.'

Making that writing comprehensible to the computer, however, requires the help of some powerful software. When the stylus is being used, the computer is programmed to look for moments when the tip does not touch the screen for a third of a second or more. Every time this happens - and it happens a lot when somebody is printing -the software assumes that one letter or number has been written. The pixel positions of this fresh character are then passed on to the computer's pattern recognition software, which no instantly identifies the letter or number written.

The software does this by first cleaning up the character -smoothing out crooked lines and removing errant dots. The remaining lines and curves are then compared with a series of templates in the computer's memory that represent hundreds of thousands of different versions of every letter in the English alphabet and all ten numerals. When the computer finds the closest match, it encodes the character in memory and displays it on the screen as if it had been typed. The entire process takes just a fraction of a second. To delete a word, you simply draw a line through it. To move to the next page, you flick the stylus at the bottom of the screen as if you're flicking the page of a book.

There are a handful of clipboard computers now on the market, including GRIDPad, which is sold in the US; Penvision, manufactured by NCR and sold around the world; and Sony's Palmtop and Canon's AI Note, both sold only in Japan. IBM and Apple are also pouring millions of dollars into the technology.

In addition to this hardware, a variety of software is also making its way to the market. Depending on the power of the computer and the sophistication of the software, clipboard systems can be programmed to understand the particular quirks of a particular user's printing; this is an especially useful feature in Japan, where elaborate kanji characters make up most of the written language. Improvements in software may soon allow machines sold in the US to understand not only printing but continuous script as well.

Given such flexibility, the designers of clipboard computers are predicting big things - and a big market - for their products. 'There's no doubt about it,' says an optimistic Hawkins. 'You're going to own one of these things in the not-too-distant future

**Decide whether the following statements are true or false in relation to the information in the text. If you think a statement is false, change it to make it true.**

1. The Americans and the Japanese are working together to produce user-friendlier computers.

2. The clipboard computer was first sold twenty years ago.
3. On a clipboard, an electronic pen replaces the traditional keyboard.
4. In the GRIDPad system, when the pen touches the screen, it informs the computer and a liquid crystal pixel appears at that point.
5. The software decides that one character or number is complete if the tip of the stylus is not in contact with the screen for more than half a second.
6. The whole process of recognizing letters or numbers and printing them on the screen takes very little time.
7. There are many clipboard computers sold today which are all available everywhere in the world.
8. Clipboard systems can be made to understand any kind of writing.

**Look back in the text and find the reference for the words in italics.**

- 1) from becoming *their* user-friendliest
- 2) *one* allows raw data to get
- 3) *it* informs the computer
- 4) Every time *this* happens
- 5) *which* instantly identifies
- 6) *it* encodes the character in memory
- 7) *this* is an especially for *their* products.

## COMPUTER VIRUSES

**Before reading try to answer the following questions.**

1. What is a computer virus?
2. How does a virus work?

**Match the words and definitions listed below**

- |                |   |
|----------------|---|
| 1) a detonator | <b>a</b> a protective device  |
| 2) an infector | <b>b</b> to remove all traces of something                                  |
| 3) to boot     | <b>c</b> a device used to set off an explosion or other destructive process |
| 4) to trigger  | <b>d</b> to discover or recognize that something is present                 |
| 5) to erase    | <b>e</b> to set a process in motion   |
| 6) pirated     | <b>f</b> something which transmits a disease or virus                       |
| 7) a shield    | <b>g</b> stolen, obtained without owner's consent                           |
| 8) to detect   | <b>h</b> to load the operating system into memory.                          |



## **How computer viruses work**

A computer virus – an unwanted program that has entered your system without you knowing about it – has two parts, which can be called the infector and the detonator. They have two very different jobs. One of the features of a computer virus that separates it from other kinds of computer program is that it replicates itself, so that it can spread (via floppies transported from computer to computer, or networks) to other computers.

After the infector has copied the virus elsewhere, the detonator performs the virus's main work. Generally, that work is either damaging data on your disks, altering what you see on your 25 computer display, or doing something else that interferes with the normal use of your computer.

Here's an example of a simple virus, the Lehigh virus. The infector portion of Lehigh replicates by attaching a copy of itself to COMMAND.COM (an important part of DOS), enlarging it by about 1000 bytes.

So let's say you put a floppy containing COMMAND.COM into an infected PC at your office -that is, a PC that is running the Lehigh program. The infector portion of Lehigh looks over DOS's shoulder, monitoring all floppy accesses. The first time you tell the infected PC to access your floppy drive, the Lehigh infector notices the copy of COMMAND.COM on the floppy and adds a copy of itself to that file. Then you take the floppy home to your PC and boot from the floppy. (In this case, you've got to boot from the floppy in order for the virus to take effect, since you may have many copies of COMMAND.COM on your hard and floppy disks, but DOS only uses the COMMAND.COM on the boot drive.)

Now the virus has silently and instantly been installed in your PC's memory. Every time you access a hard disk subdirectory or a floppy disk containing COMMAND.COM, the virus sees that file and infects it, in the hope that this particular COMMAND.COM will be used on a boot disk on some computer someday.

Meanwhile, Lehigh keeps a count of infections. Once it has infected four copies of COMMAND.COM, the detonator is triggered. The detonator in Lehigh is a simple one. It erases a vital part of your hard disk, making the files on that part of the disk no longer accessible. You grumble and set about rebuilding your work, unaware that Lehigh is waiting to infect other unsuspecting computers if you boot from one of those four infected floppies. Don't worry too much about viruses. You may never see one. There are just a few ways to become infected that you should be aware of. The sources seem to be service people, pirated games, putting floppies in publicly available PCs without write-protect tabs, commercial software (rarely), and software distributed over computer bulletin board systems (also quite rarely, despite media misinformation). Many viruses have spread through pirated –

illegally copied or broken – games. This is easy to avoid. Pay for your games, fair and square. If you use a shared PC or a PC that has public access, such as one in a college PC lab or a library, be very careful about putting floppies into that PC's drives without a write-protect tab. Carry a virus-checking program and scan the PC before letting it write data onto floppies.

Despite the low incidence of actual viruses, it can't hurt to run a virus checking program now and then. There are actually two kinds of antivirus programs: virus shields, which detect viruses as they are infecting your PC, and virus scanners, which detect viruses once they've infected you.

Viruses are something to worry about, but not a lot. A little common sense and the occasional virus scan will keep you virus-free.

Remember these four points:

- Viruses can't infect a data or text file.
- Before running an antivirus program, be sure to cold-boot from a write-protected floppy.
- Don't boot from floppies except reliable DOS disks or your original production disks.
- Stay away from pirated software.

**Decide whether the following statements are true (T) or false (F) in relation to the information in the text. If you feel a statement is false, change it to make it true.**

1. Viruses cannot be spread through a computer network, only via floppies transported from computer to computer.
2. The virus will spread as soon as you put the infected floppy in your PC.
3. The infector works by interfering in some way with the normal use of your computer.
4. The detonator in Lehigh works by altering what you see on your screen.
5. Most viruses spread through pirated games.
6. You should run an antivirus program every time you use your computer.
7. There are not very many viruses in circulation.
8. Virus shields are more effective than virus scanners.

## **COMPUTERS IN THE OFFICE. VISIONS OF TOMORROW**

First, safety. Radiation screens are available, and have been for some years. Most of them place an emissions barrier between you and the front of your display,

while others encase the entire monitor, protecting you from side and rear emissions as well. Many offices already have these screens available for their workers.

The paperless office is still a dream, but the basic tools are in place. We receive mail in two basic forms: on paper in an envelope, or electronically on our computers. Most of us have access to e-mail in one form or another. That's half the battle won. The other half is a bit more difficult, but it can be, and is being, done. All mail can be opened in the mail room and scanned into the computer using optical character recognition (OCR). Then a document-image-processing program takes over and lets you accomplish electronically what you would normally do with paper. Various personal computer products are available for this purpose. Pen-based computing is coming into its own. Pen-input capabilities are beginning to show up in hardware, applications, and operating systems. You can't take notes that will go directly into your computer, and the technology wouldn't know what to do with your doodles, but it would know that a doodle isn't a valid word. And that's a start – a good one.

Multimedia really needs no explanation. There are many packages that help you 55 create multimedia presentations, and the tools to create customized multimedia training programs are also plentiful. CD-ROM disks, such as Ziff-Davis's Computer Select and Microsoft's Bookshelf, let you access mountains of information with ease.

Computers are already much smaller than they used to be, and you can't go to an industry show these days without finding some company promoting its 'small footprint'. When you start talking about laptops, notebooks, and palmtops, the question becomes, 'How small is too small?' FAX capabilities are already available on boards that you can plug into your computer. When you combine the technologies present in internal modems with voice recognition, the basics for having your computer replace your phone-voice line are in place.

Voice recognition is another technology that may appear limited in its present form, but it shows great promise for the future. Current voice-recognition systems can handle speaker-dependent continuous speech or speaker – independent discrete speech. Speaking to your computer will be a major factor in the office of the future. In some locations, it is already a major factor in the office of today. Stock is traded in some brokerage houses by verbal command from the broker to the computer. So, you ask your computer a question, and it answers you – verbally. Depending on the rate of speech sampling used and the resolution the A/D converter uses for each sample, we can already create a credible approximation of human speech with digitized sound.

Large display screens? You can get screens of up to 35 inches now, and between Barco and Mitsubishi competing for the honor of having the largest

monitor, it's hard to predict just how big they will get in the future. As for color, some companies offer upwards of 16 million. Somewhere in that number must lay the perfect color for reducing eye-strain.

The real disaster that most of us still have to deal with is the traditional keyboard, which is the cause of much pain and suffering in the form of carpal tunnel syndrome and other repetitive-strain injuries. Wrist rests are available to alleviate the problem, and new designs for strange-looking keyboards, Star Trek-style, are moving from the drawing board to the factory. Enterprise networks are proliferating almost as fast as LANs did just a year or two ago. Public data networks are ripe for the dialling up and signing on. And the Internet already exists, with several of the research and educational facilities on its membership rolls.

Worldwide connectivity is already available in the enterprise networks of some major corporations (e.g. DEC'S DECnet and IBM's Systems Network Architecture). Admittedly, these are proprietary networks, but they are living proof that the concept can and does work.

## 24-BIT COLOR

**Before reading the text, try to answer these questions.**

1. How many distinct shades of color can the human eye see?
2. What is:
  - a pixel?
  - a bit?
  - a byte?
3. Roughly how many different color shades can be generated from 24-bit color?
4. If your machine has 24-bit color and one million-pixel display, how much memory will you need to drive the screen?

**Now read the text and check your answers.**

Short explanation:

If your computer has 24-bit color, then it can display photographic images in color on its screen that have natural-looking tones.

Long, long explanation:

In principle, there is an infinite number of shades available between a solid color and pure white. In practice, the human eye can detect somewhere between

150-200 distinct shades, so as long as you've got more than this, you can produce an undetectably smooth progression of shades (there are exceptions, but they're not worth going into here).

Cheapo computer monitors can't display shades – you get solid black or white and nothing else (in many cases you get black or green). It is possible to fake shades on one of these monitors by a sort of poor man's halftone process called dithering, but this is useless for serious image viewing and retouching.

What you need is a computer that can show true shades on its screen. A computer builds up a picture from a series of building blocks called pixels. Each pixel is a square (normally) of a single color.

The more pixels you can divide the picture into, the higher the resolution of the complete image. The computer organizes itself by describing each pixel that it wants to display as a code in the binary mathematical set (numbers built up from a series of Os or Is). Each 0 or 1 is called a bit.

Computers are generally structured to work in groups of eight bits (called a byte). These eight numbers can be used to count up to 256, and so can describe 256 shades of grey from black to white, which is more than enough to satisfy the eye.

A computer which can assign eight bits to describe each pixel will produce perfect black and white photographs on its monitor. A monitor that can show all these shades is called a greyscale display.

Now your eye can detect those 150-200 shades in all three of the colors it can see: red, green, and blue. If you use eight bits to describe color, you only get 256 colors, which isn't enough – you get a mildly posterized effect, although the dithering process can simulate more colors at the expense of quality. To get the full color photographic effect on a computer monitor, you need to be able to generate 256 shades for each color. This takes eight bits of information per color, giving a total of 24 bits. This is the 24-bit color that you keep reading about in computer magazines. If you take all the possible variations of 256 shades of three colors, you end up with a possible 16.7 million color shades.

Some computers, such as the Macintosh, offer 32-bit color: the spare eight bits can be used to control transparent overlays of color – you get 256 levels of transparency.

You only really need 24-bit color if you are going to do color photographic retouching on-screen or similar 'painting' on-screen. For linework and picture placing, an 8-bit color monitor is perfectly adequate, as you can still define colors for print even if you can't show them on the screen.

Naturally, there's a bottom line in all this, or everyone would be using 24-bit color. To start with, you need special circuit boards which plug into your computer and drive the monitor. An 8-bit board is cheaper than a 32-bit one.

You also need plenty of memory. A typical high resolution color monitor can display about a million pixels. The 24 bits that your computer uses to describe each pixel can also be described as three bytes. To describe a million pixels takes three million bytes. In other words, a hefty three megabytes of your computer's memory is assigned to driving the screen. With 8-bit color, you only need one Mb.

Generally, 24-bit color boards include extra memory and processors to speed up the display performance.

**Decide whether the following statements are true (T) or false (F) in relation to the information in the text. If you think a statement is false, change it to make it true.**

1. If a computer can generate more than 200 distinct shades of color, the human eye will see a perfectly smooth progression of shades.
2. Everybody should have a computer that can show true shades on its screen.
3. A group of eight binary numbers is called a byte.
4. Under certain circumstances, 8-bit color can provide more than 256 colors.
5. 32-bit color offers 256 times as many shades of color as 24-bit color.
6. To run 24-bit color, you need three times as much memory to drive the screen as you do to run 8-bit color.

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