Title
Introduction to the GIS Core Curriculum for Technical Programs

Author
National Center for Geographic Information and Analysis

Publication Date
2015

Peer reviewed

The NCGIA GIS Core Curriculum for Technical Programs

Introduction

In 1996, the National Center for Geographic Information and Analysis (UCSB) was awarded a two-year grant from the National Science Foundation Advanced Technological Education (ATE) Program to develop a core curriculum in GIS for two-year colleges (Award #DUE 9602348). The information contained in this introduction applies to the GIS Core Curriculum for Technical Programs (CCTP) as carried out in 1996–1999, under the direction of Steve Palladino (Michael F. Goodchild, Principal Investigator). Since then, GIS training programs have expanded significantly among community colleges in the United States. An excellent current source on the status of GIS training in community colleges is provided by the National Geospatial Technology Center of Excellence, known also as the GeoTech Center.

The sections that follow were prepared by Steve Palladino (CCTP Project Manager) and the CCTP Working Group, providing documentation on the process for developing the NCGIA GIS Core Curriculum for Technical Programs.

(Edited by Center for Spatial Studies, October 2015)

PROJECT SUMMARY (January 1997)

An increasing number of Geographic Information System (GIS) technician positions are being created by industry and public sector users of GIS. Community Colleges are attempting to create GIS programs that will meet this demand. This project addresses the need for a supporting resource for the GIS curriculum design and course-building activities taking place in a number of the two-year colleges. The National Center for Geographic Information and Analysis (NCGIA), in collaboration with a number of community colleges and current NSF Advanced Technological Education Projects, is developing a GIS Core Curriculum for Technical Programs (CCTP). This World-Wide-Web-based resource will support efforts to develop discipline-specific GIS materials by providing access to the fundamental elements of GIS theory and practice as they relate to efforts to provide GIS technician education in the community colleges. The CCTP will be patterned after the successful NCGIA Core Curriculum in GIS developed for university-level GIS curriculum development and will also draw from the experience of the current (1997) effort to update and create a World-Wide-Web version of the Core Curriculum in Geographic Information Science.

NCGIA and an Advisory Council, including GIS specialists from community colleges, the GIS industry, and the GIS user community, selected GIS educators from the community colleges to participate in a weeklong Work Session (August 12–18, 1996) in Santa Barbara, CA to create a framework for the CCTP. The framework outlines the essential units of material and a format for the CCTP. Following this session, each unit was assigned to an individual with expertise in the unit topic. The completed set of units will be compiled as a WWW resource and will be tested in a number of community colleges for GIS curriculum development and GIS instructional activities. Following a detailed evaluation from the sites testing the CCTP, the curriculum will be edited and made widely available via the WWW and CD-ROM.

CCTP WORK SESSION (November 1996)

In August, 1996 a Working Group of fourteen experienced GIS educators and specialists spent a week at the NCGIA Santa Barbara in an effort to create a framework for the development of the GIS Core Curriculum for Technical Programs.

A number of tasks were put before the Working Group. They included:

- Identify groups to be served by the CCTP
- Define the scope of the CCTP in order to serve those groups
- Identify specific needs of the using groups that should be met in the CCTP
- Review other curricula and support materials
- Determine the format of the CCTP
- Outline specific curriculum units for the CCTP
- Provide suggestions for unit structure and use of World Wide Web
- Review the evaluation procedure outlined in proposal

In the five full work days of the Work Session, the Working Group was able complete or at least begin most of the tasks. The breadth of the CCTP and the groups to be served were identified. A general format for the curriculum was developed and a comprehensive framework of CCTP units was drafted. Some effort was spent discussing the WWW structure for the CCTP and for individual units. This was also continued as a post-Work Session "home work" assignment. We did not get a chance to discuss the evaluation procedure outlined in the grant proposal.

The Work Session Schedule began with an orientation. This included an overview of GIS resources and applications as demonstrated by those present at the NCGIA; a summary of the status of other NCGIA Core Curriculum projects; and a review of WWW curriculum development options. After this orientation, the Work Group established basic parameters for the CCTP by approaching the issue of breadth and depth of content for this GIS curriculum for 2-year colleges. This was accomplished by forming three breakout groups. The first group examined this issue using the original NCGIA Core Curriculum in GIS as a guide. A second group synthesized various specific GIS curricula in use at community colleges into a master curriculum outline. A third group was the "Blue Sky" group, which sought to define the curriculum without dependence on existing examples.

It turned out that there was significant overlap between the findings of the three groups in content breadth and depth and in the nature of the CCTP format. The Working Group agreed that 2-year college GIS courses and programs varied widely in discipline focus (e.g., Computer Aided Drafting, Geography, Forestry, Computer Science, International Marketing, etc.) and in population served (transfer students, technical certificate students, and post-baccalaureate students). Therefore, the Working Group decided that the CCTP should be a broad resource, including general coverage of fundamental topics such as using spatial concepts and operation of computer systems. The group decided that individual units would include mastery level information so that college instructors would have a resource that could be used to create a number of challenging technically-based courses, rather than just a general introduction to GIS for technicians. They also wanted the GIS skill components of the curriculum to have a task focus ("How to do") rather than the knowledge focus ("what to know") of the academically oriented NCGIA Core Curriculum in GIS. This task focus in units would be built around real-world examples of technical uses of GIS.

This led to a merger of the findings of the three groups in order to create an outline of content sections for the CCTP. Once they came to agreement on the main topic areas of the CCTP, the participants broke into small groups to identify specific units in each of the topic areas. This effort dominated much of the rest of the Work Session. The final outcome was a draft topic list for the CCTP. It is from this resource that the project staff created a revised unit list for CCTP development. The units on this list will be developed by a number of Unit Editors and compiled into the preliminary CCTP that will be tested in college GIS programs and revised to create the official World-Wide-Web version of the CCTP.

The Working Group also made suggestions on how to format the information for access via the World-Wide-Web. A number of information structuring metaphors were discussed, but in the end a tree metaphor with core information in the trunk and general content information on the branches was agreed upon. The smallest bundle of information corresponding to a unit of information was likened to a leaf (or in the language used in the Work Session, leaflet). As the Working Group developed the unit framework, many types of ancillary resources useful to GIS instructors in 2-year colleges were identified. These included sample course outlines, lab exercises, articulation agreements, information on textbooks and other pedagogical resources for GIS, and sources of hardware and software. It was agreed that these resources could be accessed in the "root" structure of the CCTP tree. The project staff has used this metaphor to provide access to the CCTP.

Overall, the Working Group did an excellent job and accomplished the main task identified for the Work Session. Many of the Working Group members mentioned in their evaluations that we may have been able to achieve a similar amount of work in four rather than the five days if we had compressed the overview material of the first day and had better managed the use of break out group vs. whole-groups' sessions. At times the whole group sessions slowed progress due to premature attempts to come to whole group consensus. The small groups often were the most productive. Nonetheless, it was very helpful to have the experienced input of 14 leaders in the field serve as the basis of CCTP development. Currently this Working Group is serving in an advisory role for the remainder of the CCTP development. Some of these individuals are also representing the project at various professional conferences.

CCTP PARTICIPANTS (February 1997)

Project Staff

Dr. Mike Goodchild - Project Director

Mr. Steve Palladino - Project Manager

Dr. Karen Kemp - Project Consultant

Violet Gray - Web Site Manager

Independent Evaluator

Dr. Kenneth Foote - University of Texas, Austin

Working Group

The Working Group is composed of community college instructors and others with expertise in GIS instruction, curriculum design, and community college program development. These individuals participated in a one week Work Session in which a framework for the Core Curriculum for Technical Programs was developed. The Working Group continues to provide regular input on the structure and content of the CCTP.

Advisory Council

The Advisory Council is our consultative body for the entire project. These individuals' responsibilities include helping in the proposal-writing process, in the selection of working-group members, in reviewing the drafts of the CCTP, and in advising the project staff on the overall management of the project. They will continue in this role throughout the duration of the project.

Editors and Writers

The first phase of CCTP development relies on the help of 11 section editors and 53 unit writers drawn from college and university faculty and GIS users in business, government, and the GIS industry.

Evaluators/Resource Developers

The second phase of CCTP development relies on a group of CCTP evaluators who will use the CCTP to create GIS educational materials.

PROJECT SCHEDULE (November 1996)

- **Winter-Spring 1996—Prefunding Activities**
  - Work with Advisory Council on preliminary list of Working Group candidates
  - Make initial contact with candidates
  - Preliminary planning for Work Session
- **Planning and Design Stage**
  - Summer 1996
    - Advisory Council selects and notifies Working Group members
    - Work Session Preparation
    - Begin developing WWW home page
    - Late summer one-week Working Group Work Session to outline unit writing topics and CCTP structure
    - Visit from Independent Evaluator
  - Fall 1996
    - Advisory Council and Project Staff review and edit draft CCTP framework from Work Session
    - Formalize guidelines for unit writing
    - Identify and select Unit Editors/Writers
    - Expand and officially "open" Web home page
- **Development Stage**
  - Winter-Spring 1997
    - Unit Editors/Writers prepare units
    - Begin to solicit CCTP testers via WWW, email, and conference presentations
  - Summer 1997
    - Clean up and convert units to World Wide Web pages
    - Package units as the preliminary WWW CCTP
    - Select formal CCTP Testers
    - Second visit from Independent Evaluator
- **Testing Stage**
  - Fall 1997
    - Working Group feedback on preliminary CCTP and final pretesting edits
    - Formal preliminary CCTP testing
    - Continue to solicit informal testers of preliminary CCTP, evaluation via WWW home page
    - Begin processing feedback from formal and unofficial testing
- **Dissemination Stage**
  - Winter-Spring 1998

- Edit preliminary CCTP on evaluations from testing stage
- Complete final edits with Advisory Council and Working Group input.
- Place final version on Web site (and master CD-ROM?)
- Dissemination via Web and CD-ROM (and hardcopy?)
- Independent Evaluator and project member summative evaluations

Working Group

- Dr. Joan Clemons - Visiting Professor, Community College Programs, GSE & IS University of California, Los Angeles.
- Mr. Les Doak - Instructor, Cypress College, Cypress, California.
- Dr. Vanik Eaddy - Research and Curriculum Specialist, Mississippi State University.
- Mr. Tom Holst - Emeritus Professor, Earth Science, Columbia Community College, Sonora, California.
- Ms. Susan Jampoler - Principal, GeoKnowledge, Leesburg, Virginia.
- Mr. Ross Miller - Program Head, Geographic Information Systems Department, British Columbia Institute of Technology, Burnaby, British Columbia.
- Mr. Ralph Moran - Instructor, School of Natural Resources and Ecological Sciences, Hocking College, Nelsonville, Ohio.
- Ms. Susan L. Nolen - Senior Manager, Intergraph Corporation, Huntsville, Alabama.
- Mr. JR Peay - Chairman, Computing & Information Technology Department, Community College of South Nevada, North Las Vegas, Nevada.
- Dr. Michael Phoenix - University Coordinator, Environmental Systems Research Institute, Redlands, California.
- Dr. Steven Reader - Department of Geography, McMaster University, Hamilton, Ontario.
- Mr. John Schaeffer - Assistant Professor, CADD/GIS Program, Central Oregon Community College, Bend, Oregon.
- Mr. Robert Slobodian - Instructor, Geography Department, Malaspina University-College, Nainaimo, British Columbia.
- Mr. Robert Welch - Program Director, Dept. of Geographic Resource & Environmental Technology, Lansing Community College, Lansing, Michigan.

Original Task List for Technical Programs Developed by the CCTP Working Group in Santa Barbara, August 13-17, 1996

1. USING SPATIAL CONCEPTS

- 1.1. The world in spatial terms
  - 1.1.1. human cognition of the spatial world
  - 1.1.2. asking geographic questions
- 1.2. Spatial description
  - 1.2.1. location
  - 1.2.2. distance
  - 1.2.3. direction
  - 1.2.4. scale and geographic detail
  - 1.2.5. physical space
  - 1.2.6. psychological space
- 1.3. Spatial distribution
  - 1.3.1. pattern
  - 1.3.2. density
  - 1.3.3. concentration(dispersion)
- 1.4. Spatial interaction
  - 1.4.1. connectivity
  - 1.4.2. spatial hierarchies
- 1.5. Space and time
  - 1.5.1. flow and diffusion
- 1.6. Spatial systems
  - 1.6.1. classification(boundaries)
  - 1.6.2. regions
  - 1.6.3. systems
- 1.7. Landscapes
  - 1.7.1. natural(physical)
  - 1.7.2. cultural
- 1.8. What is GIS?
- 1.9. What does GIS do?

2. MAPPING THE EARTH

- 2.1. Representing the earth
  - 2.1.1. map types
  - 2.1.2. map accuracy and resolution
  - 2.1.3. map projections
  - 2.1.4. coordinate systems

- 2.2. Describing the earth
  - 2.2.1. measurement
  - 2.2.2. position on the earth
    - 2.2.2.1. the shape of the earth
    - 2.2.2.2. georeferencing (i.e., postal codes)
    - 2.2.2.3. latitude/longitude/time
- 2.3. Cartographic representation
  - 2.3.1. symbols
  - 2.3.2. images
  - 2.3.3. variables (choropleth)
  - 2.3.4. points, lines, areas, fields, 3D
  - 2.3.5. processes and time (temporality)
  - 2.3.6. documentation(metadata)
- 2.4. Interpreting maps
  - 2.4.1. legends
  - 2.4.2. scales
  - 2.4.3. symbols

3. ACCESSING DATA SOURCES

- 3.1. Identify data sources
  - 3.1.1. demographic data
  - 3.1.2. transportation networks
  - 3.1.3. land records
  - 3.1.4. natural resources
  - 3.1.5. terrain
  - 3.1.6. local, regional, national, global data
- 3.2. Identify geographic data structures
  - 3.2.1. rasters
  - 3.2.2. vectors
  - 3.2.3. TINs
  - 3.2.4. objects
- 3.3. Convert data
  - 3.3.1. data exchange
    - 3.3.1.1. open GIS
  - 3.3.2. data conversion
  - 3.3.3. transfer standards
    - 3.3.3.1. interoperability
  - 3.3.4. transformation
- 3.4. Generate data from existing data
  - 3.4.1. CAD
  - 3.4.2. GPS coordinates
  - 3.4.3. address matching

3.4.4. remotely sensed data
3.4.5. CoGo
3.4.6. calculate new fields from existing attributes

4. OPERATING COMPUTER SYSTEMS AND SOFTWARE

4.1. Create and implement directory structures
4.2. Write batch files to set operating parameters
4.3. Write batch files to automate file processes
4.4. Configure program properties and working directory(windows)
4.5. Install and configure software programs (for pc)
4.6. Utilize common operating systems
4.7. Utilize internet to access data and information
4.7.1. use FTP to transfer data
4.7.2. use Telnet to connect to other computer systems
4.8. Perform data backups
4.9. Transfer digital data between different formats, systems and software
4.10. Exhibit knowledge of graphic file formats
4.11. Utilize ascii editors and word processors
4.12. Perform common spreadsheet functions
4.13. Utilize database management programs to sort, manipulate, etc.
4.13.1. non-spatial database models
4.13.2. data modeling
4.13.3. database theory and practice
4.14. Hardware for GIS systems
4.14.1. configure a digitizer
4.14.2. configure a scanner
4.14.3. configure a plotter
4.15. Fundamentals of computing systems
4.15.1. computer networks--able to describe common types of networks
4.15.2. database administration - access and security issues

5. PROGRAMMING FOR GIS

5.1. Customize user interfaces
5.2. Enhance software using macro and programming languages
5.3. Write computer programs using high level languages (e.g. VB, C++)
5.4. Utilize scripting languages and operating system utilities to perform spatial data handling tasks (e.g. AWK)
5.5. Describe fundamental concepts of object orientation

6. CREATING DIGITAL DATA

6.1. Digitize a map

- 6.2. Scan images and maps
- 6.3. Build tabular databases
- 6.4. Acquire coordinate geometry information
- 6.5. Use CAD to create a map
- 6.6. Collect global positioning system (GPS) Data
- 6.7. Recording metadata

7. MANAGING DATA

- 7.1. Edit Data
  - 7.1.1. attributes
  - 7.1.2. spatial data
  - 7.1.3. topology
- 7.2. Validate data (Q/A)
  - 7.2.1. accuracy
  - 7.2.2. handle uncertainty
    - 7.2.2.1. storing uncertainty information
    - 7.2.2.2. error propagation
    - 7.2.2.3. visualization of uncertainty
    - 7.2.2.4. decision making under uncertainty
  - 7.2.3. generalization guidelines
- 7.3. Manipulate database files
  - 7.3.1. link
  - 7.3.2. sort
  - 7.3.3. expanding databases (i.e., adding new attributes)
- 7.4. Managing digital libraries

8. ANALYZING DATA

- 8.1. Perform buffering operation
- 8.2. Overlay maps
- 8.3. Measure distance and connectivity
- 8.4. Characterize "neighborhoods"
- 8.5. Apply statistical analysis
- 8.6. Create new layers from existing layers
- 8.7. Reclassify maps
- 8.8. Perform spatial analysis functions
  - 8.8.1. Boolean search
  - 8.8.2. map algebra operations
  - 8.8.3. surface derivative operations
  - 8.8.4. appropriate generalization
  - 8.8.5. shortest path analysis
  - 8.8.6. hydrological modeling

8.8.7. location/allocation
8.8.8. terrain modeling

9. REPORTING INFORMATION

9.1. Visualization and cartography
9.1.1. apply sound cartographic fundamentals to map products(3)
9.1.2. apply sound principles of graphic design(3) to reports
9.1.3. select appropriate digital output options(3)
9.2. Plot and print maps, tables, charts, in hard and soft copy
9.2.1. produce maps to local, state/provincial, federal, and agency standards
9.2.2. develop templates for standardizing output products
9.3. Prepare and present digital presentations
9.4. Prepare data for export to other graphic formats (Corel draw, postscript)

10. IMPLEMENTING AND MANAGING GIS

10.1. Plan a project
10.1.1. needs analysis
10.1.2. develop a budget
10.1.3. prepare a cost recovery projection
10.1.4. system evaluation
10.1.5. specifying a GIS
10.2. Implement a project
10.2.1. pilot project
10.2.1.1. scope
10.2.1.2. database design
10.2.2. project documentation
10.2.3. full implementation
10.3. Legal and ethical issues
10.4. Describe the industry
10.4.1. history and trends
10.4.2. current products and services
10.4.3. careers in GIS
10.5. Market the data
10.5.1. transfer standards
10.5.2. national and international data infrastructures
10.5.3. marketing strategy
10.5.4. legal issues
10.5.5. WWW and digital libraries
10.5.6. create metadata

11. APPLICATION AREAS AND CASE STUDIES

11.1. resource management
11.2. urban planning and management
11.3. cadastral records and LIS
11.4. facilities management
11.5. transportation applications - a network application
11.6. emergency response and E911 - a network application
11.7. environmental health
11.8. environmental modeling
11.9. ecological modeling
11.10. scientific research
11.11. studying and learning geography
11.12. business and marketing
11.13. real estate
11.14. recreation

12. LEFTOVERS

12.1. Teaching GIS
- 12.1.1. curriculum design for GIS descriptor
- 12.1.2. teaching and learning GIS in laboratories

12.2. Statistical analysis
- 12.2.1. dimensionality
- 12.2.2. spatial variation
- 12.2.3. classification of data
- 12.2.4. measurement levels
- 12.2.5. error - sources, types
- 12.2.6. spatial data models - vector, raster - included in 2.5.2, 3.2 ???

Task List for Technical Programs' Editors and Unit Authors

Units that were not completed are in italics.

1. Accessing Spatial Data Sources

1.1 Acquiring existing digital data
Acquiring digital data requires the use of digital data exchange techniques and knowledge of data exchange formats. These are largely technical computer skills.

1.1.1 Acquire data (UNIT 1)
Using ftp, telnet, Internet browsers, etc.
Ordering tapes, disks, other media
Unpacking data, import/export files, zip, tar, etc.
Interoperability (java, activeX, etc.)

1.2 Locate data
Finding and preparing data for use in a GIS is often the preliminary task performed by the GIS technician. Data can be located in a variety of ways; most data types are formatted in specific ways which are peculiar to that data type. In addition, most data types can be located in a relatively small set of libraries, archives and government offices. Focusing on the specific type and geographic domain of data can narrow the search to those specific places which house a particular type of data. Understanding the characteristics of local, regional, national, and global data archives can improve the efficiency of data searches. Similarly Internet data searches can be improved by knowing where data can be found.

1.2.1 Locate demographic data (UNIT 2)
What is demographic data used for?
What is demographic data (link to core and other resources)?
Where can demographic data be found?
What are the standard formats for demographic data?
What is the set of tasks required to locate demographic data?

1.2.2 Locate transportation networks (UNIT 3)
What is transportation data used for?
What is transportation data (link to core and other resources)?
Where can transportation data be found?
What are the standard formats for transportation data?
What is the set of tasks required to locate transportation data?

1.2.3 Locate land records (UNIT 4)
What is land record data used for?
What are land records (link to core and other resources)?
Where can land record data be found?
What are the standard formats for land records?
What is the set of tasks required to locate land record data?

1.2.4 Locate natural resources data (UNIT 5)

What natural resource data used for?
What is natural resource data (link to core and other resources)?
Where can natural resource data be found?
What are the standard formats for natural resource data?
What is the set of tasks required to locate natural resource data?
1.2.5 Locate terrain data (UNIT 6)
What is terrain data used for?
What is terrain data (link to core and other resources)?
Where can terrain data be found?
What are the standard formats for terrain data?
What is the set of tasks required to locate terrain data?

1.3 Assessing data

Understanding the quality of the data which has been located or created is an important step in spatial data handling. Issues such as scale, data quality, temporal issues, etc. are important in evaluating alternative data sets and selecting the most appropriate materials.

1.3.1 Use and interpret metadata (UNIT 7)
data structure
spatial documentation
thematic documentation
1.3.2 Check for errors (UNIT 8)
Reducing and controlling for errors
Estimating spatial error
Estimating thematic error

1.4 Converting data

Converting data requires knowledge of one's own working environment and the requirements of the local computing system. It also requires a general understanding of the broad range of spatial data formats available, and the use of compatible transfer formats.

1.4.1 Convert digital spatial data between formats, systems, and software (UNIT 9)
Converting between spatial data models
Preparing import and export files
Spatial data formats- headers, gif, tif, bmp, vector export files, etc.
1.4.2 Project data (UNIT 10)
Selecting a projection
Projecting unprojected data
Reprojecting data
1.4.3 Register and conflate data (UNIT 11)
Using control points
Rubbersheeting
Conflation

2. Creating Digital Spatial Data

Creating Digital Spatial Data is often required when appropriate data do not exist. This involves automating analog data through digitizing or scanning or using digital GPS, COGO, or CAD data to create explicit spatial data.

- 2.1 Digitizing
    - 2.1.1 Plan a digitizing project (UNIT 12)
    - Selecting materials to digitize
    - Preparing the materials for digitizing
    - Selecting a digitizing mode
    - Estimating time requirements
    - Creating metadata
    - 2.1.2 Digitize maps (UNIT 13)
    - Digitizing a network
    - Digitizing polygons
    - Digitizing points
    - Digitizing contours
    - 2.1.3 Digitize on-screen (UNIT 14)
    - Tracing maps
    - Interpreting digital airphotos
    - Delineating/tracing satellite images
    - 2.1.4 Label data (UNIT 15)
    - Adding labels
    - Entering attributes interactively while labeling
    - Adding annotation
- 2.2 Scanning
    - 2.2.1 Plan a scanning project (UNIT 16)
    - Selecting materials to scan
    - Preparing the materials for scanning
    - Selecting a spatial resolution
    - Estimating time requirements
    - 2.2.2 Scan maps (UNIT 17)
    - Preparing the map for scanning
    - Selecting a spatial resolution
    - Using a scanner
    - Post scan processing
    - 2.2.3 Scan airphotos (UNIT 18)
    - Preparing for scanning
    - Selecting a spatial resolution
- 2.3 Creating tabular data
    - *2.3.1 Plan a tabular database (UNIT 19)*

Designing for versatile use of the data
Creating a record number system for spatial referencing
Compound variables, coding systems
2.3.2 Use text editors (UNIT 20)
Generic functions of text editors
GUI text editors
command line text editors (UNIX, DOS)
2.3.3 Use spreadsheets (UNIT 21)
Generic functions of spreadsheets
Math and Statistical functions
Character vs. Numeric data
Using organizational functions (sort, select, etc.)
2.3.4 Merge tabular data with spatial data (UNIT 22)
Spatial referencing using coordinates
Spatial referencing using spatial objects(i.e. counties)
Using Join and Relational operators
2.4 Creating maps with CAD (UNIT 23)

Using CAD data to create data layers
Registering spatial data in CAD systems

2.5 Using GPS data
2.5.1 Collect GPS data (UNIT 24)
What is GPS (link to main core and other resources) GPS accuracy
2.5.2 Use GPS coordinates to register spatial data (UNIT 24)
using control points
rubbersheeting
2.5.3 Create a spatial database using GPS data (UNIT 24)
downloading points and attributes
2.6 CoGo (Editor 6) (UNIT 25)
Engineering survey techniques.
Using CoGo attributes.
Using survey charts.

3. Managing Spatial Data

Spatial data is usually stored, manipulated, and used over long periods of time by multiple individuals. Protecting the integrity of a spatial database is an important and difficult task given the ease with which spatial data can be altered, often in irreversible ways.
3.1 Edit spatial data
3.1.1 Edit point data (UNIT 26)
Adding points
Moving points
Editing point attributes

Reorganizing point data (sorting, renumbering)
Protecting data and documenting alterations
Adding annotation
3.1.2 Edit linear data (UNIT 27)
Adding arcs and nodes
Extending arcs
Removing or repairing spatial errors
Editing nodes
Building topology
Using dissolve operators
Editing arc node attributes
Protecting data and documenting alterations
Adding annotation
3.1.3 Edit polygon data (UNIT 28)
Creating polygons
Removing sliver polygons
Using dissolve operators
Adding and removing nodes and vertices
Removing dangling arcs and nodes
Editing polygon attributes
Adding, moving and renumbering polygon labels
Building and protecting topology
Protecting data and documenting alterations
Adding annotation
3.1.4 Edit raster data (UNIT 29)
3.2 Validate databases (UNIT 30)
3.2.1 Formal evaluation of data accuracy

Why is this done
What are the tasks

3.3 *Manage database files (UNIT 31)*
3.3.1 Adding and deleting attributes
3.3.2 Organizing and retrieving database files
3.3.3 Using sort operators
3.4 Manage digital libraries (UNIT 32)
3.4.1 Tiling data layers
3.4.2 Building a library
3.4.3 Retrieving data from a library

4. Analyzing Spatial Data

4.1 Use buffering operators (UNIT 33)
4.1.1 buffering points

- 4.1.2 buffering polygons
- 4.1.3 buffering arcs
- 4.1.4 creating and using uniform buffers
- 4.1.5 creating and using variable buffers

4.2 Using overlay operators

- 4.2.1 Perform pre/post overlay tasks (UNIT 34)
  Evaluating slivers and eliminating spurious polygons
- 4.2.2 Perform overlay operations (UNIT 34)
  Using Boolean operators
  Performing overlay operations
- *4.2.3 Perform point in polygon operations (UNIT 35)*
- *4.2.4 Perform line in polygon operations (UNIT 35)*

4.3 Use distance and connectivity operators (UNIT 36)

- *4.3.1 Measuring distances in raster data*
- *4.3.2 Measuring distances in vector data*
- *4.3.3.Using shortest path operators*
- *4.3.4 Understanding distance measures*

4.4 Characterizing spatial neighborhoods or regions

- *4.4.1 Data compression (UNIT 37)*
  Using field mathematical operators to derive raster regions
  Deriving vector regions
- *4.4.2 Data expansion (UNIT 38)*
  Using multiple fields/layers to derive new fields/layers
  Combining attributes to calculate new attributes
  Creating and using constant variables

4.5 Perform statistical analyses (UNIT 39)

- 4.5.1 Aspatial attribute statistics
- 4.5.2 Spatial attribute statistics

4.*6 Use reclassification operators (UNIT 40)*

- *4.6.1 Clustering*
- *4.6.2 Generalizing using an attribute (dissolve operator)*
- *4.6.3 Density slicing*
- *4.6.4 Using spatial filters*

4.7 Use Boolean search techniques (UNIT 41)

- 4.7.1 Query writing
- 4.7.2 Using relate operators
- 4.7.3 Using reselect operators

4.8 Use map algebra (UNIT 42)

- 4.8.1 map algebra operators
- 4.8.2 preparing data for map algebra (recoding)

4.9 Use derivative surface operators (UNIT 43)

- 4.9.1 Types of surface operators
- 4.9.2 Using surface functions

4.9.3 Using terrain models
4.10 Use hydrologic models (UNIT 44)
4.10.1 Flow and accumulation functions
4.10.2 Delineating watersheds and basins
4.10.3 Stream ordering
4.11 Use location/allocation operators (UNIT 45)
4.11.1 What is location allocation
4.11.2 Understanding location/allocation models
4.12 Perform address matching (UNIT 46)
4.12.1 Using address matching to generate greater thematic and spatial resolution

5. Reporting on Spatial Data

5.1 Visualizing and Representing Spatial Data
5.1.1 Prepare materials for on-screen visualization (UNIT 47)
Reselecting data for visualization
Selecting effective symbols for CRT plotting
Setting display environments (canvas colors, symbol sets etc.)
5.1.2 Design products for printing (UNIT 48)
Selecting an appropriate map type for your data.
Using cartographic primitives (lines, symbols, colors).
Understanding the use of text on maps
Documenting printed products (metadata).
Using computer graphic systems for finish design (Corel, Adobe, etc.)
5.2 Plotting and Printing Spatial Data
5.2.1 Operate plotter/printer hardware (UNIT 49)
Understanding pen plotters, ink jets, laser, etc.
Configuring and operating a plotter
Configuring and operating a printer
5.2.2 Operate plotter/printer software (UNIT 50)
Formatting plot files
Scaling maps for plotter formats
Preparing postscript files
5.3 Prepare digital presentations (UNIT 51)
5.3.1 Writing demonstration macros
5.3.2 Caption and text writing

6. Implementing and Managing GIS

6.1 Manage a project (UNIT 52)
6.1.1 Equipping and maintaining a GIS lab
6.1.2 Determining client specifications
6.1.3 Time and manpower budgets

- 6.1.4 Bid preparation
- 6.1.5 Defining deliverables
- 6.1.6 Quality control
- 6.1.7 Scheduling
- 6.1.8 Packaging a GIS project

6.2 Communicate about and distribute GIS products (UNIT 53)

- 6.2.1 Advertising
- 6.2.2 Presenting demonstrations
- 6.2.3 Providing training and support