

# UC Santa Barbara

## Perspectives and Resources for GIScience Education

### Title

Third International Symposium on GIS and Higher Education

### Permalink

<https://escholarship.org/uc/item/7n14d6r0>

### Authors

Towson State University

National Center for Geographic Information and Analysis (UCSB)

### Publication Date

1997-11-01

# GISHE97

[Background](#)

[The Program](#)

[Conference  
Summaries](#)

[Symposium  
Details](#)

[Committees](#)

[Scholarship  
Sponsors](#)

Participants List

## **The Third International Symposium on GIS and Higher Education**

**October 30 to November 2, 1997**  
Marriott Westfields Conference Center  
Chantilly, Virginia

---

This site contains a record of GISHE '97, including the final program, abstracts, and presentations, plus summaries of the working group and final plenary discussions.

---

---

Organized by:

**NCGIA**

and

 **Towson State University**

---

# GISHE97

## ***The Third International Symposium on GIS and Higher Education***

**October 30 to November 2, 1997**  
Marriott Westfields Conference Center  
Chantilly, Virginia

---

This site contains a record of GISHE '97, including the final program, abstracts, and presentations, plus summaries of the working group and final plenary discussions.

---

**Organized by:**

**NCGIA**

and



**Towson State University**

---

# GISHE97

## Conference Background

Following a successful [GISHE '96](#) held in Columbia MD in September 1996, the conference steering committee was asked to organize a third GISHE symposium in the fall of 1997. In order to make it easy for both US and foreign participants to attend, we have chosen a site close by Dulles International Airport and have scheduled the meeting for the weekend immediately following GIS/LIS '97.

The [GISHE '96 conference summary](#) provides the starting point for planning this year's workshops, papers, posters, demonstrations and discussion sessions. GISHE '97 will specifically address those critical strategic issues in GIS Higher Education which were identified last year. Structured with parallel paper sessions followed by directed discussion periods, this meeting will again culminate in a final plenary session at which a comprehensive conference statement and action item list will be formulated by all participants. Once again, a special one-day event will be scheduled for K-12 teachers who wish to meet with colleagues to discuss issues related to using GIS in their classrooms. A special track for Community College GIS educators will be organized and if sufficient interest is shown, sessions for other special interest groups will be included.

## Strategic Issues

The GISHE '97 theme is "***Building foundations for expanding GIS education locally and globally***". Once again, the symposium will focus on **strategic issues in GIS higher education**. These issues include:

- expanding partnerships between educators, private organizations and government agencies
- identifying GIS employment needs and linking these to educational opportunities
- building capacity in developing countries in support of GIS education and training

- enlarging networks for sharing ideas about instructional methods, materials and laboratory facilities
- improving GIS education for teachers
- teaching and learning through the Internet
- enhancing GIS professional education options
- identifying the key spatial concepts which should form the basis of GIS education
- articulation of courses and programs spanning the range of GIS education options

# GISHE97

## **Final Program**

**Last updated November 21, 1997**



*indicates a full text paper can be found at the link indicated.*

### **Thursday, October 30**

**4:00 - 7:00 - Registration**

**7:00 - 8:00 - Opening Plenary**

Chair: Karen Kemp

Welcome and Introductions  
GISHE '97 Steering Committee

The current state of GIS higher education  
**John M. Morgan III**  
Towson University

GIS in K-14  
**Steve Palladino**  
University of California Santa Barbara

UCGIS Education Priorities  
**Richard Wright**  
San Diego State University

Strategic issues for GIS in higher education  
**Karen K. Kemp**  
University of California Santa Barbara

---

### **Friday, October 31**

**8:30 - 10:00 - Parallel Session F1**

*F1.1 - Using the Web in traditional university courses*

Chair: Ken Foote

[Collaborative Curriculum Development in Geoprocessing Using](#)

[Distance Learning and The Internet](#) 

**Donald J. Leone**

The University of Hartford

**Daniel L. Civco**

The University of Connecticut

[Teaching GIS with ArcView and the World Wide Web at the United States Military Academy](#)

**Mike Hendricks**

West Point Military Academy

[The Analysis of the State of Vocational Training on Geoinformation Technologies in Siberia](#) 

**Nikolay G. Markov** (*ESRI Scholar*)

The Tomsk Polytechnical University, Tomsk, Russia

[Beyond Posting Lecture Notes on the Web: Examples of Three GIS Internet Courseware Initiatives and Our Lessons Learned](#)

**C. Peter Keller, Rosaline R. Canessa and Trevor J. Davis**

University of Victoria, Canada

*Discussion: What are effective strategies for bringing the Web into GIS instruction?*


**F1.2 - Teaching GIS across the curriculum, I**

Chair: William Sprinsky

[GIS Education for Hydrology and Water Resources Engineers](#)

**Josef Fürst, H.P. Nachtnebel and H. Holzmann**

University of Agricultural Sciences, Vienna, Austria

[Relieving stress with GIS: Integrating GIS with Stressed Stream Analysis](#) 

**Karl Korfmacher**

Denison University, Ohio

[A Spreadsheet Approach to Teaching Object Oriented GIS](#)

**Sam Cole and Emil Boasson**

University at Buffalo

*Discussion: How can GIS be included as both a relevant tool and a useful science in courses across the curriculum?*

**F1.3 - Panel: Community College Administrative GIS**

Chair: Randall Raymond

[Community College Administrative GIS: The First Step in a Community College GIS Enterprise](#) 

**Randall E. Raymond**

Urban Environmental Education in Detroit - Cass Technical High School

**Freda L. Brown**

Henry Ford Community College  
**Yichun Xie**  
Eastern Michigan University

Background on the project

Procedures and methodologies

An urban GIS model

*Discussion: How can other colleges initiate similar programs?*

**10:00 - 10:30 - Break**

**10:30 - 12:00 - Parallel Session F2**

*F2.1 - GIS education and the Internet*

Chair: Peter Keller

GIS in the Virtual Geography Department Project

**Kenneth E. Foote**  
University of Texas at Austin

Using the Web to Deliver Instructional Resources for GIS Teaching

**X. Mara Chen**  
Salisbury State University, MD

Teaching GIS incorporating the Internet

**Hui Xu**  
Frostburg State University, MD

*Discussion: What sorts of materials should be created for inclusion in a GIS instructional materials clearinghouse on the Web?*

*F2.2 - Teaching GIS across the curriculum, II*

Chair: Don Leone

Evaluation of a GIS-T Student Friendly Training Tool

**Peter van der Waerden**  
Eindhoven University of Technology, The Netherlands  
**Antonio Nelson Rodrigues da Silva**  
Universidade de Sao Paulo, Brazil

Geographic Information Systems - Educating the Civil Engineering User 

**Wm. H. Sprinsky**  
Pennsylvania College of Technology


Teaching GIS for Coastal Zone Management




**Malcolm C. Thomas**  
Pembrokeshire College, UK


*Discussion: What new tools and concepts are needed for including GIS across the curriculum?*

*F2.3 - GIS education in developing countries, I*  
Chair: Susan Nolen

[GIS Education in Developing Countries: Ecuador](#)   
**Jonathan Deckmyn** (*Intergraph Scholar*), **Kristof Scheldemans and Gwendolyn Verstraete**  
PROMAS - Universidad de Cuenca, Ecuador

[Partnership in GIS Education: Building Capacity in a Disadvantaged Society](#)   
**Tracey Morton** (*UniGIS Scholar*)  
Vista University, Soweto, South Africa

[Status of GIS Education in India](#)  
**P. Venkatachalam**  
Indian Institute of Technology

[The Need for GIS Education in Mauritius](#)   
**Jaishree Beedasy** (*Intergraph Scholar*)  
University of Mauritius

**12:00 - 1:00 - Conference Luncheon**


**1:00 - 1:30 - Luncheon Speaker**

[Rebuilding the Top of the Pyramid: Providing Technical GIS Education to Support Both GIS Development and Geographic Research](#)   
**Prof. Duane Marble**  
The Ohio State University

**1:45 - 3:15 - Parallel Session F3**

*F3.1 - Professional development and distance education*

Chair: Derek Thompson

[Perspectives on GIS Education for Professional Development](#)   
**Sarah Cornelius and Ian Heywood**  
Manchester Metropolitan University, UK

[Planning a GIS Certificate Program for Distance Delivery](#)  
**David DiBiase**  
The Pennsylvania State University

[Multimedia Learning for Professionals in Geographical Information: The Challenges for Courseware Development](#)

**Bruce Carlisle, Ian Heywood, Sarah Cornelius and Simon Kenton**

Manchester Metropolitan University, UK

**David Grimshaw**

University of Leeds, UK

[Multimedia Computer Based On-Line-Training in GIS and Remote Sensing](#) 

**Yuxian Sun and Wolfgang Kainz**

International Institute for Aerospace Survey and Earth Sciences (ITC), The Netherlands

*Discussion: Can distance education satisfy the growing market for GIS professional development?*

*F3.2 - Education partnerships*

Chair: Les Doak

[It's Not Plows, Cows, and Sows Anymore: Developing GIS Educational Partnerships with the Cooperative Extension Service](#)

**Scott A. Samson**

University of Kentucky

[GIS Partnerships and Service Learning](#)

**Christopher Semerjian and Lewis Rogers**

Gainesville College, GA

[Bridging the Gap between GIS Employment Needs and GIS Education and Training](#)

**Don Samuelson and I-Shian Suen**

Grays Harbor College, Aberdeen, WA

[Precision Agriculture Education Network Between K-12, Community Colleges and Universities](#)

**Terry Brase**

Hawkeye Community College, IA

*Discussion: What can be done to encourage community partnerships for GIS education generally?*

*F3.3 - GIS education in developing countries, II*

Chair: Christine Dunn

[GIS Projects and GIS Education in Russian Higher School](#)

**Alexander V. Simonov**

Pushchino Specialized Center for New Information Technologies, Russia

**Alexander D. Ivannikov**

Ministry for Education in the Russian Federation, Russia

[Development of a Training Centre for Environmental GIS Applications in Polish Universities](#)

**Joseph Fürst**

University of Agricultural Sciences, Vienna, Austria

**S. Ignar**

Agricultural University of Warsaw, Poland

[A Model GIS Laboratory for Higher Education in a Developing Country: The Example of the GIS Lab](#) 

**Olusegan Areola (*ESRI Scholar*), Sylvester Abumere and Bola Ayeni**

University of Ibadan, Nigeria

[The Geo Project: Introduction of GIS Culture in Higher Education](#) 

**Mirna Luiza Cortopassi Lobo**

Federal University of Parana, Brazil

**3:45 - 5:15 - Parallel Session F4**

*F4.1 - Designing GIS courseware*

Chair: David DiBiase

[The House Hunting Game: An Interactive Teaching Resource for Introducing Spatial Decision Making using GIS](#)

**Ian Heywood**

Manchester Metropolitan University, UK

**Roy Alexander**

University College Chester, UK

**John McKeown and John Castleford**

University of Leicester, UK

[The GIS Workbench: a Metaphor for Development of GIS Distance Education](#)

**Angelique Lansu and Rob Nadolski**

Open University of The Netherlands

**Truus Roesems**

Catholic University of Leuven, Belgium

[\(Joint paper by Vanneste, Lansu, Roesems, et al\)](#) 

[Demonstration of an multimedia introductory practical: the DTM module](#)

**Truus Roesems**

Catholic University of Leuven, Belgium

**Angelique Lansu**

Open University of The Netherlands

[\(Joint paper by Vanneste, Lansu, Roesems, et al\)](#) 

*Discussion: How can these lessons in the design of GIS courseware be passed on to other GIS educators considering similar projects?*

F4.2 - *Foundations for GIS education, I*  
Chair: Sarah Bednarz

[The Status of GIS Technology in Teacher Preparation Programs](#)

**Richard Audet**

Roger Williams University, Bristol, RI

**Sarah Witham Bednarz**

Texas A&M University

[Building Foundation for Spatial Analysis: The First Two Years](#)



**Shamim Naim** (*FGDC Scholar*)

Univeristy of Wisconsin at Waukesha

[GIS Education - Accessible to all Disciplines](#)

**Les Doak**

Cypress College, CA

*Discussion: What structural changes should be made to GIS education to address these issues?*

F4.3 - *Round Table: Capacity building in developing countries*

Chairs: Alex Simonov and Karen Kemp

[GIS Education for Developing Countries: Bringing about Desirable Change](#)

**Christine E. Dunn**

University of Durham, UK

[Round Table Discussion](#)

*How can the needs of developing countries with regards to improving GIS education be addressed by colleagues in developed countries? What programs exist to encourage partnerships between countries? What action should be taken now to develop such effective and productive partnerships?*

**5:30 - 7:00 - Exhibitor's Reception**

---

**Saturday, November 1**

**7:30 - 8:15 - K-12 Day Registration**

**8:15 - 8:30 - K-12 Day Welcoming Session**

**8:30 - 9:20 - Keynote**

[How We Will Learn](#)

Peter J. Denning

George Mason University, Fairfax VA

**9:30 - 10:30 - Parallel Session S1**

*S1.1 Panel: Improving GIS Education in Community Colleges*  
Chair: Denis Mudderman

[Promoting Community College GIS Workforce Relevant Course and Program Development](#)

**Denis E. Mudderman and William A. Dando**  
Indiana State University

*S1.2 Demonstration*  
Chair: Derek Thompson

[Learning with GIS - The Case of Urbanworld](#)

**Derek Thompson**  
University of Maryland

*S1.3 Panel: Data Sources for GIS Education*  
Chair: Barbara Poore

[The Role of Geographic Data in GIS Education](#)

**Barbara Poore**  
Federal Geographic Data Committee  
**Joe Sewash**  
West Virginia University

*S1.4 K-12 Day Poster and Vendor Session (continues through break)*  
Chair: Pat Cunniff

[Poster Session: High School Young Scholars GIS/GPS projects](#)

**Patricia Cunniff and Janet McMillen**  
Prince George's Community College, Largo MD

GIS Vendor Displays

**11:00 - 12:30 - Parallel Session S2**

*S2.1 - GIS in Community Colleges*

Chair: Michael Phoenix

[Relevance of Geographic Information Systems Technology in a Community College Curriculum](#)

**M.H. Akram, John Williams and N. Browning**  
Glennville Community and Technical College, WV

[NCGIA's Core Curriculum for Technical Programs](#)

**Stephen Palladino**  
University of California Santa Barbara

[GIS in Community Colleges - Where We Stand](#)

**Ann Johnson and Michael Phoenix**  
ESRI, Redlands, CA

*Discussion: What are the roles for community colleges in GIS*

*education?*

**S2.2 - Foundations for GIS education, II**

Chair: Richard Wright

[GIS Computer Laboratory Materials: Comparing Structural Approaches](#)

**Richard A. Scott**

Rowan University, Glassboro, NJ

[Identifying Key GIS Concepts - What the Books Tell Us](#)

**Susan M. Macey**

Southwest Texas State University

[A spatial information approach to introduce spatial analysis/statistics through GIS](#) 

**David Wong**

George Mason University, VA

[Scale - The Key Spatial Concept in GIS Education](#)

**Weihong Fan**

The Richard Stockton College of New Jersey

*Discussion: Do GIS curricula need to be redesigned to address these fundamental issues?*

**S2.3 - Teaching GIS in K-12, I**

Chair: Richard Audet

[Mountains: Interdisciplinary Curriculum That Actively Involves Students in Problem-Solving and Construction of Knowledge About Their World](#)

**Rebecca R. Head**

The University of Alabama

[GIS Project Planning Considerations for Educators](#)

**Bob Sharpe**

Wilfrid Laurier University, Canada

[GIS Meets K-12 Environmental Education at NC State University](#)

**Hugh A. Devine**

North Carolina State University

[GIS -- A Keystone Technology for Earth Science](#)

**Kathryn Keranen**

Thomas Jefferson High School for Science and Technology,  
Alexandria VA

*Discussion: How can the lessons from these projects be shared with other K-12 educators?*

K-12 Day Demo I (during lunch break)  
**Paul Van Zuyle**  
University of California Santa Barbara

**1:30 - 3:00 - Parallel Session S3**

*S3.1 - Education Programs of GIS Vendors*

Chair: Susan Macey

Intergraph's Education Programs  
**Susan Nolen**  
Intergraph, Huntsville AL

ESRI's Education Programs  
**Michael Phoenix**  
ESRI, Redlands CA

The Idrisi Project  
**Kevin St. Martin**  
Clark University

ERDAS's Education Programs  
**Chris Ogier**  
ERDAS, Atlanta GA

*Discussion: How can the GIS vendor community best assist GIS educators?*

*S3.2 - Problem solving and projects for GIS learning*

Chair: Derek Thompson

Teaching GIS Problem Solving with a Complex Site Allocation Case Study

**David G. Goldsborough & M. de Bakker**  
Van Hall Instituut, The Netherlands

The Use of Project Oriented GIS Education and Training in an Urban Setting

**Robert T. Aangeenbrug**  
University of South Florida

Preserving West Virginia's Heritage Using GIS

**J.M. Williams, C. E. Holt and M. H. Akram**  
Glenville State College, WV

*Discussion: How can other GIS educators initiate and share*

*experiences with similar projects?*

**S3.3 - Teaching GIS in K-12, II**

Chair: Robert Sharpe

[Enhancing General Professional Awareness of GIS by Improving Educational GIS Tools for Secondary School Teachers](#)

**Dominique Vanneste**

Catholic University of Leuven, Belgium

**Angelique Lansu**

Open University of The Netherlands

[\(Joint paper by Vanneste, Lansu, Roesems, et al\)](#) 

[The GeoSmart Project: Responding to the Need for a "Smart" Geography for Malaysia's New "Smart School" Initiative](#)

**Richard Dorall**

University of Malaya, Malaysia

*Cancelled - presenter unable to travel*

[CD-ROM on Estonian Geography as a GIS-based Contribution to the "Tiger's Leap" Programme](#)

**Juri Roosaare** *(UniGIS Scholar)*

University of Tartu, Estonia

*Discussion: What can higher educators do to assist K-12 teachers integrate GIS into their curricula?*

K-12 Day Demo II (during break)

**Paul Van Zuyle**

University of California Santa Barbara

**3:30 - 4:30 - Working Groups**

Participants will form several small working groups to discuss issues raised in the discussion sessions and to draft summary statements.

**4:30 - 5:30 - [Working Group Reports](#)**

Working groups will report on their discussions and identify items for action and further development during Sunday's working sessions.



## Sunday, November 2

### **9:30 - 12:00 - Closing Plenary and Working Groups**

Review of the conference

**Duane Marble**

The Ohio State University

### **Discussion and Working Groups**

Following Prof. Marble's review, conference participants will discuss and draft the conference summary and action statement for post-conference distribution. Plans for action on the issues raised will be discussed.

# GISHE97

## Conference Summaries

### Saturday Working Group Reports

### Sunday Focus Group Reports

---

## Announcing the publication of The GIS Educator newsletter

---

### Session Themes and Discussions:

*F1.1 - Using the Web in traditional university courses*

Discussion: What are effective strategies for bringing the Web into GIS instruction?

*F1.2 - Teaching GIS across the curriculum, I*

Discussion: How can GIS be included as both a relevant tool and a useful science in courses across the curriculum?

*F1.3 - Panel: Community College Administrative GIS*

Discussion: How can other colleges initiate similar programs?

*F2.1 - GIS education and the Internet*

Discussion: What sorts of materials should be created for inclusion in a GIS instructional materials clearinghouse on the Web?

*F2.2 - Teaching GIS across the curriculum, II*

Discussion: What new tools and concepts are needed for including GIS across the curriculum?

*F2.3 - GIS education in developing countries, I*

*F3.1 - Professional development and distance education*

Discussion: Can distance education satisfy the growing market for GIS professional development?

*F3.2 - Education partnerships*

Discussion: What can be done to encourage community partnerships for GIS education generally?

*F3.3 - GIS education in developing countries, II*

*F4.1 - Designing GIS courseware*

Discussion: How can these lessons in the design of GIS courseware be passed on to other GIS educators considering similar projects?

*F4.2 - Foundations for GIS education, I*

Discussion: What structural changes should be made to GIS education to address these issues?

*F4.3 - Round Table: Capacity building in developing countries*

Discussion: How can the needs of developing countries with regards to improving GIS education be addressed by colleagues in developed countries? What programs exist to encourage partnerships between countries? What action should be taken now to develop such effective and productive partnerships?

*S2.1 - GIS in Community Colleges*

Discussion: What are the roles for community colleges in GIS education?

*S2.2 - Foundations for GIS education, II*

Discussion: Do GIS curricula need to be redesigned to address these fundamental issues?

*S2.3 - Teaching GIS in K-12, I*

Discussion: How can the lessons from these projects be shared with other K-12 educators?

*S3.1 - Education Programs of GIS Vendors*

Discussion: How can the GIS vendor community best assist GIS educators?

*S3.2 - Problem solving and projects for GIS learning*

Discussion: How can other GIS educators initiate and share experiences with similar projects?

*S3.3 - Teaching GIS in K-12, II*

Discussion: What can higher educators do to assist K-12 teachers integrate GIS into their curricula?

# GISHE97

## **Symposium Structure**

The conference will begin on the evening of Thursday, October 30 with an opening plenary followed by a sponsored reception. Friday and Saturday will have a combination of plenaries and parallel sessions. Saturday's paper sessions will end with focus group discussions, followed by a brief plenary and a social event to give us a reward for our hard work. The meeting will conclude on Sunday morning with a breakfast buffet followed by small working groups and a final plenary to draft the conference summary and action items list. Workshops and demonstrations will be scheduled within the program or on Thursday and Sunday afternoons, depending on the offers we receive from potential presenters.

## **Special Events**

***K - 12 Day*** - Although the conference focus is higher education, K-12 teachers are again invited to attend a special one-day workshop. This special session will allow teachers to share their accomplishments in using and teaching GIS and to express their needs. Sessions on GIS education directions, the use of new technologies, and hands-on demonstrations and vendor feedback will be scheduled.

***Community College Track*** - a special track for Community College educators will be organized to allow discussion of problems unique to this educational sector.

***International Education Workshop*** - Plans are underway for a special workshop on International Education at which we will consider issues of particular importance to participants from developing or newly independent countries, but which will also be relevant to US participants who teach courses in foreign countries.

***Demonstrations*** - In addition to paper sessions, demonstrations of multimedia, on-line courseware, and other computer-based materials will be scheduled throughout the program.

## **Exhibit Information**

The conference will feature an exhibit area for commercial organizations offering products of interest to this international group of educators.

# GISHE97

## ***Steering Committee***

Karen Kemp, NCGIA, University of California Santa Barbara  
John Morgan, III, Towson State University  
Steve Palladino, NCGIA, University of California Santa Barbara

## ***Program Advisory Committee***

Sarah Bednarz, Texas A&M University  
Pat Cunniff, Prince George's Community College  
Bill Dakan, University of Louisville  
William Dando, Indiana State University  
Ken Foote, University of Texas Austin  
Michele Fulk, The IDRISI Project, Clark University  
Peter Keller, University of Victoria, Canada  
Brian Lees, Australian National University  
Susan Macey, Southwest Texas State  
Brian Mennecke, East Carolina University  
Susan Nolen, Intergraph Corp., Atlanta  
Mike Phoenix, ESRI, Redlands CA  
Barbara Poore, FGDC, Washington DC  
Susan Radke, Berkeley Geo-Research Group  
Alexander Simonov, Pushchino CNIT, Russia  
Josef Strobl, University of Salzburg, Austria  
David Unwin, Birkbeck College, London UK

# GISHE97

## Scholarship Sponsors

Several participants from developing and newly independent countries will receive scholarships which will permit them to attend this meeting. Funds to cover these scholarships for transportation, accommodation and participation in GISHE have been generously provided by the following sponsors:

- [UNIGIS, Manchester UK](#)
- [ESRI, Redlands CA](#)
- [Intergraph Corporation, Huntsville AL](#)
- [Federal Geographic Data Committee](#)
  
- Private Donors
  - Michael Phoenix

---

### *Confirmed GISHE International Scholars*

- [Juri Roosaare, Estonia](#)
- [Nikolay Markov, Siberia, Russia](#)
- [Tracey Morton, Soweto, South Africa](#)
- [Olusegun Areola, Nigeria](#)
- [Jonathan Deckmyn, Ecuador](#)
- [Jaishree Beedasy, Mauritius](#)

### *Confirmed GISHE College Scholar*

- [Shamin Naim, Wisconsin](#)
-

***Paper search by author's last name:***

**A B C D E F G H I J K L M N O P Q R S T U V W X Y Z**

**A**

[Aangeenbrug, Robert](#)  
[Abumere, Sylvester](#)  
[Akram, M. H. \(1\), \(2\)](#)  
[Alexander, Roy](#)  
[Areola, Olusegun](#)  
[Audet, Richard H.](#)  
[Ayeni, Bola](#)

**B**

[Bednarz, Sarah W.](#)  
[Beedasy, Jaishree](#)  
[Brase, Terry](#)  
[Boasson, Emil](#)  
[Brown, Freda L.](#)  
[Browning, N.](#)

**C**

[Canessa, Rosaline R.](#)  
[Carlisle, Bruce](#)  
[Castleford, John](#)  
[Chen, X. Mara](#)  
[Civco, Daniel L.](#)  
[Cole, Sam](#)  
[Cornelius, Sarah \(1\), \(2\)](#)  
[Cuniff, Pat](#)

**↑ Top of list**

**D**

[Dando, William A.](#)  
[da Silva, Antonio N. R.](#)  
[Davis, Trevor J.](#)  
[Deckmyn, Jonathan](#)  
[de Bakker, M.](#)  
[Denning, Peter J.](#)  
[Devine, Hugh A.](#)  
[DiBiase, David](#)  
[Doak, Les](#)  
[Dorall, Richard](#)  
[Dunn, Christine E.](#)

**E**

## **F**

[Fan, Weihong](#)  
[Foote, Kenneth](#)  
[Fürst, J. \(1\), \(2\)](#)  
[Fyans, Robert](#)  
[Fulk, Michele](#)

**↑ Top of list**

## **G**

[Grimshaw, David](#)  
[Goldsborough, David G.](#)

## **H**

[Head, Rebecca](#)  
[Hendricks, Mike](#)  
[Heywood, Ian \(1\), \(2\), \(3\)](#)  
[Holt, C.E.](#)  
[Holzmann, H.](#)

## **I**

[Ignar S.](#)  
[Ivannikov, Alexander](#)

## **J**

[Johnson, Ann](#)  
**↑ Top of list**

## **K**

[Kainz, Wolfgang](#)  
[Keller, C. Peter](#)  
[Kemp, Karen](#)  
[Kenton, Simon](#)  
[Keranen, Kathryn](#)  
[Korfmacher, Karl](#)

## **L**

[Lansu, Angelique](#)  
[Leone, Donald](#)  
[Lewis, Vaughn](#)  
[Lobo, Mirna](#)

## **M**

[Macey, Susan M.](#)  
[Marble, Duane \(1\), \(2\)](#)  
[Markov, Nikolay G.](#)  
[McKeown, John](#)  
[McMillen, Janet](#)  
[Morgan, John III](#)



[Morton, Tracey](#)  
[Mudderman, Denis E.](#)

**↑ Top of list**

**N**

[Nachtnebel, H.P.](#)  
[Nadolski, Rob](#)  
[Naim, Shamim](#)  
[Nolen, Susan](#)

**O**

[Ogier, Chris](#)

**P**

[Palladino, Steven \(1\), \(2\)](#)  
[Phoenix, Michael \(1\), \(2\)](#)  
[Poore, Barbara](#)

**Q**

**R**

[Ramsay, Bruce](#)  
[Raymond, Randall](#)  
[Roesems, Truus \(1\), \(2\)](#)  
[Rogers, Lewis](#)  
[Roosaare, Juri](#)

**↑ Top of list**

**S**

[Samson, Scott A.](#)  
[Samuelson, Don](#)  
[Scheldemans, Kristof](#)  
[Scott, Richard A.](#)  
[Semerjian, Chris](#)  
[Sewash, Joe](#)  
[Sharpe, Bob](#)  
[Simonov, Alexander V.](#)  
[Sprinsky, William](#)  
[Suen, Ivan](#)  
[Sun, Yuxian](#)

**T**

[Thomas, Malcolm C.](#)  
[Thompson, Derek](#)

**U**

**V**

[van der Waerden, Peter](#)

[Van Zuyle, Paul \(1\), \(2\)](#)

[Vanneste, Dominique](#)

[Venkatachalam, P.](#)

[Verstraete, Gwendolyn](#)

**W**

[Wilbrink, I.](#)

[Williams, John M. \(1\), \(2\)](#)

[Winnups, K.](#)

[Wong, David](#)

[Wright, Richard](#)

**X**

[Xie, Yichun](#)

[Xu, Hui](#)

**Y**

**Z**

[\*\*↑\*\* Top of list](#)

**GISHE97**



# GISHE97

## **Final Program**

**Last updated November 21, 1997**



*indicates a full text paper can be found at the link indicated.*

### **Thursday, October 30**

**4:00 - 7:00 - Registration**

**7:00 - 8:00 - Opening Plenary**

Chair: Karen Kemp

Welcome and Introductions  
GISHE '97 Steering Committee

The current state of GIS higher education  
**John M. Morgan III**  
Towson University

GIS in K-14  
**Steve Palladino**  
University of California Santa Barbara

UCGIS Education Priorities  
**Richard Wright**  
San Diego State University

Strategic issues for GIS in higher education  
**Karen K. Kemp**  
University of California Santa Barbara

**8-9 - No-host Reception**

---

### **Friday, October 31**

**7:30 - 8:30 - Continental Breakfast**

**8:30 - 10:00 - Parallel Session F1**

*F1.1 - Using the Web in traditional university courses*

Chair: Ken Foote

[Collaborative Curriculum Development in Geoprocessing Using Distance Learning and The Internet](#) 

**Donald J. Leone**

The University of Hartford

**Daniel L. Civco**

The University of Connecticut

[Teaching GIS with ArcView and the World Wide Web at the United States Military Academy](#)

**Mike Hendricks**

West Point Military Academy

[The Analysis of the State of Vocational Training on Geoinformation Technologies in Siberia](#) 

**Nikolay G. Markov** (*ESRI Scholar*)

The Tomsk Politechnical University, Tomsk, Russia

[Beyond Posting Lecture Notes on the Web: Examples of Three GIS Internet Courseware Initiatives and Our Lessons Learned](#)

**C. Peter Keller, Rosaline R. Canessa and Trevor J. Davis**

University of Victoria, Canada

*Discussion: What are effective strategies for bringing the Web into GIS instruction?*

*F1.2 - Teaching GIS across the curriculum, I*

Chair: William Sprinsky

[GIS Education for Hydrology and Water Resources Engineers](#)

**Josef Fürst, H.P. Nachtnebel and H. Holzmann**

University of Agricultural Sciences, Vienna, Austria

[Relieving stress with GIS: Integrating GIS with Stressed Stream Analysis](#) 

**Karl Korfmacher**

Denison University, Ohio

[A Spreadsheet Approach to Teaching Object Oriented GIS](#)

**Sam Cole and Emil Boasson**

University at Buffalo

*Discussion: How can GIS be included as both a relevant tool and a useful science in courses across the curriculum?*

*F1.3 - Panel: Community College Administrative GIS*

Chair: Randall Raymond

[Community College Administrative GIS: The First Step in a Community College GIS Enterprise](#) 

**Randall E. Raymond**

Urban Environmental Education in Detroit - Cass Technical High School

**Freda L. Brown**

Henry Ford Community College

**Yichun Xie**

Eastern Michigan University

Background on the project

Procedures and methodologies

An urban GIS model

*Discussion: How can other colleges initiate similar programs?*

**10:30 - 12:00 - Parallel Session F2**

*F2.1 - GIS education and the Internet*

Chair: Peter Keller

[GIS in the Virtual Geography Department Project](#)

**Kenneth E. Foote**

University of Texas at Austin

[Using the Web to Deliver Instructional Resources for GIS Teaching](#)

**X. Mara Chen**

Salisbury State University, MD

[Teaching GIS incorporating the Internet](#)

**Hui Xu**

Frostburg State University, MD

*Discussion: What sorts of materials should be created for inclusion in a GIS instructional materials clearinghouse on the Web?*

*F2.2 - Teaching GIS across the curriculum, II*

Chair: Don Leone

Evaluation of a GIS-T Student Friendly Training Tool

**Peter van der Waerden**

Eindhoven University of Technology, The Netherlands

**Antonio Nelson Rodrigues da Silva**

Universidade de Sao Paulo, Brazil

Geographic Information Systems - Educating the Civil Engineering User 

**Wm. H. Sprinsky**

Pennsylvania College of Technology

Teaching GIS for Coastal Zone Management

**Malcolm C. Thomas**

Pembrokeshire College, UK

*Discussion: What new tools and concepts are needed for including GIS across the curriculum?*

**F2.3 - GIS education in developing countries, I**

Chair: Susan Nolen

GIS Education in Developing Countries: Ecuador 

**Jonathan Deckmyn (*Intergraph Scholar*), Kristof Scheldemans and Gwendolyn Verstraete**

PROMAS - Universidad de Cuenca, Ecuador

Partnership in GIS Education: Building Capacity in a Disadvantaged Society 

**Tracey Morton (*UniGIS Scholar*)**

Vista University, Soweto, South Africa

Status of GIS Education in India

**P. Venkatachalam**

Indian Institute of Technology

The Need for GIS Education in Mauritius 

**Jaishree Beedasy (*Intergraph Scholar*)**

University of Mauritius

**12:00 - 1:00 - Conference Luncheon**

**1:00 - 1:30 - Luncheon Speaker**

Rebuilding the Top of the Pyramid: Providing Technical GIS Education to Support Both GIS Development and Geographic Research 

**Prof. Duane Marble**

The Ohio State University

**1:45 - 3:15 - Parallel Session F3**

*F3.1 - Professional development and distance education*

Chair: Derek Thompson

[Perspectives on GIS Education for Professional Development](#) 

**Sarah Cornelius and Ian Heywood**

Manchester Metropolitan University, UK

[Planning a GIS Certificate Program for Distance Delivery](#)

**David DiBiase**

The Pennsylvania State University

[Multimedia Learning for Professionals in Geographical Information: The Challenges for Courseware Development](#)

**Bruce Carlisle, Ian Heywood, Sarah Cornelius and Simon Kenton**

Manchester Metropolitan University, UK

**David Grimshaw**

University of Leeds, UK

[Multimedia Computer Based On-Line-Training in GIS and Remote Sensing](#) 

**Yuxian Sun and Wolfgang Kainz**

International Institute for Aerospace Survey and Earth Sciences (ITC), The Netherlands

*Discussion: Can distance education satisfy the growing market for GIS professional development?*

*F3.2 - Education partnerships*

Chair: Les Doak

[It's Not Plows, Cows, and Sows Anymore: Developing GIS Educational Partnerships with the Cooperative Extension Service](#)

**Scott A. Samson**

University of Kentucky

[GIS Partnerships and Service Learning](#)

**Christopher Semerjian and Lewis Rogers**

Gainesville College, GA

[Bridging the Gap between GIS Employment Needs and GIS Education and Training](#)

**Don Samuelson and I-Shian Suen**

Grays Harbor College, Aberdeen, WA

[Precision Agriculture Education Network Between K-12, Community Colleges and Universities](#)

**Terry Brase**

Hawkeye Community College, IA



*Discussion: What can be done to encourage community partnerships for GIS education generally?*

*F3.3 - GIS education in developing countries, II*

Chair: Christine Dunn

[GIS Projects and GIS Education in Russian Higher School](#)

**Alexander V. Simonov**

Pushchino Specialized Center for New Information Technologies, Russia

**Alexander D. Ivannikov**

Ministry for Education in the Russian Federation, Russia

[Development of a Training Centre for Environmental GIS Applications in Polish Universities](#)

**Joseph Fürst**

University of Agricultural Sciences, Vienna, Austria

**S. Ignar**

Agricultural University of Warsaw, Poland

[A Model GIS Laboratory for Higher Education in a Developing Country: The Example of the GIS Lab](#) 

**Olusegan Areola (*ESRI Scholar*), Sylvester Abumere and Bola Ayeni**

University of Ibadan, Nigeria

[The Geo Project: Introduction of GIS Culture in Higher Education](#) 

**Mirna Luiza Cortopassi Lobo**

Federal University of Parana, Brazil

**3:45 - 5:15 - Parallel Session F4**

*F4.1 - Designing GIS courseware*

Chair: David DiBiase

[The House Hunting Game: An Interactive Teaching Resource for Introducing Spatial Decision Making using GIS](#)

**Ian Heywood**

Manchester Metropolitan University, UK

**Roy Alexander**

University College Chester, UK

**John McKeown and John Castleford**

University of Leicester, UK

[The GIS Workbench: a Metaphor for Development of GIS Distance Education](#)

**Angelique Lansu and Rob Nadolski**

Open University of The Netherlands

**Truus Roesems**

Catholic University of Leuven, Belgium

[\(Joint paper by Vanneste, Lansu, Roesems, et al\)](#)



[Demonstration of an multimedia introductory practical: the DTM module](#)

**Truus Roesems**

Catholic University of Leuven, Belgium

**Angelique Lansu**

Open University of The Netherlands

[\(Joint paper by Vanneste, Lansu, Roesems, et al\)](#)



*Discussion: How can these lessons in the design of GIS courseware be passed on to other GIS educators considering similar projects?*

**F4.2 - Foundations for GIS education, I**

Chair: Sarah Bednarz

[The Status of GIS Technology in Teacher Preparation Programs](#)

**Richard Audet**

Roger Williams University, Bristol, RI

**Sarah Witham Bednarz**

Texas A&M University

[Building Foundation for Spatial Analysis: The First Two Years](#)



**Shamim Naim (FGDC Scholar)**

Univeristy of Wisconsin at Waukesha

[GIS Education - Accessible to all Disciplines](#)

**Les Doak**

Cypress College, CA

*Discussion: What structural changes should be made to GIS education to address these issues?*

**F4.3 - Round Table: Capacity building in developing countries**

Chairs: Alex Simonov and Karen Kemp

[GIS Education for Developing Countries: Bringing about Desirable Change](#)

**Christine E. Dunn**

University of Durham, UK

[Round Table Discussion](#)

*How can the needs of developing countries with regards to improving GIS education be addressed by colleagues in developed countries? What programs exist to encourage*

*partnerships between countries? What action should be taken now to develop such effective and productive partnerships?*

**5:30 - 7:00 - Exhibitor's Reception**

---

## **Saturday, November 1**

**7:30 - 8:15 - K-12 Day Registration**

**8:15 - 8:30 - K-12 Day Welcoming Session**

**8:30 - 9:20 - Keynote**

### How We Will Learn

Peter J. Denning

George Mason University, Fairfax VA

**9:30 - 10:30 - Parallel Session S1**

*S1.1 Panel: Improving GIS Education in Community Colleges*

Chair: Denis Mudderman

### Promoting Community College GIS Workforce Relevant Course and Program Development

**Denis E. Mudderman and William A. Dando**

Indiana State University

*S1.2 Demonstration*

Chair: Derek Thompson

### Learning with GIS - The Case of Urbanworld

**Derek Thompson**

University of Maryland

*S1.3 Panel: Data Sources for GIS Education*

Chair: Barbara Poore

### The Role of Geographic Data in GIS Education

**Barbara Poore**

Federal Geographic Data Committee

**Joe Sewash**

West Virginia University

*S1.4 K-12 Day Poster and Vendor Session (continues through break)*

Chair: Pat Cunniff

Poster Session: High School Young Scholars GIS/GPS projects  
**Patricia Cunniff and Janet McMillen**  
Prince George's Community College, Largo MD

GIS Vendor Displays

**11:00 - 12:30 - Parallel Session S2**

*S2.1 - GIS in Community Colleges*

Chair: Michael Phoenix

Relevance of Geographic Information Systems Technology in a Community College Curriculum

**M.H. Akram, John Williams and N. Browning**  
Glennville Community and Technical College, WV

NCGIA's Core Curriculum for Technical Programs

**Stephen Palladino**  
University of California Santa Barbara

GIS in Community Colleges - Where We Stand

**Ann Johnson and Michael Phoenix**  
ESRI, Redlands, CA

*Discussion: What are the roles for community colleges in GIS education?*

*S2.2 - Foundations for GIS education, II*

Chair: Richard Wright

GIS Computer Laboratory Materials: Comparing Structural Approaches

**Richard A. Scott**  
Rowan University, Glassboro, NJ

Identifying Key GIS Concepts - What the Books Tell Us

**Susan M. Macey**  
Southwest Texas State University

A spatial information approach to introduce spatial analysis/statistics through GIS 

**David Wong**  
George Mason University, VA

Scale - The Key Spatial Concept in GIS Education

**Weihong Fan**  
The Richard Stockton College of New Jersey

*Discussion: Do GIS curricula need to be redesigned to address these fundamental*

*issues?*

*S2.3 - Teaching GIS in K-12, I*

Chair: Richard Audet

Mountains: Interdisciplinary Curriculum That Actively Involves Students in Problem-Solving and Construction of Knowledge About Their World

**Rebecca R. Head**

The University of Alabama

GIS Project Planning Considerations for Educators

**Bob Sharpe**

Wilfrid Laurier University, Canada

GIS Meets K-12 Environmental Education at NC State University

**Hugh A. Devine**

North Carolina State University

GIS -- A Keystone Technology for Earth Science

**Kathryn Keranen**

Thomas Jefferson High School for Science and Technology, Alexandria VA

*Discussion: How can the lessons from these projects be shared with other K-12 educators?*

K-12 Day Demo I (during lunch break)

**Paul Van Zuyle**

University of California Santa Barbara

**1:30 - 3:00 - Parallel Session S3**

*S3.1 - Education Programs of GIS Vendors*

Chair: Susan Macey

Intergraph's Education Programs

**Susan Nolen**

Intergraph, Huntsville AL

ESRI's Education Programs

**Michael Phoenix**

ESRI, Redlands CA

The Idrisi Project

**Kevin St. Martin**  
Clark University

ERDAS's Education Programs  
**Chris Ogier**  
ERDAS, Atlanta GA

*Discussion: How can the GIS vendor community best assist GIS educators?*

*S3.2 - Problem solving and projects for GIS learning*

Chair: Derek Thompson

Teaching GIS Problem Solving with a Complex Site Allocation Case Study  
**David G. Goldsborough & M. de Bakker**  
Van Hall Instituut, The Netherlands

The Use of Project Oriented GIS Education and Training in an Urban Setting

**Robert T. Aangeenbrug**  
University of South Florida

Preserving West Virginia's Heritage Using GIS

**J.M. Williams, C. E. Holt and M. H. Akram**  
Glenville State College, WV

*Discussion: How can other GIS educators initiate and share experiences with similar projects?*

*S3.3 - Teaching GIS in K-12, II*

Chair: Robert Sharpe

Enhancing General Professional Awareness of GIS by Improving Educational GIS Tools for Secondary School Teachers

**Dominique Vanneste**  
Catholic University of Leuven, Belgium  
**Angelique Lansu**  
Open University of The Netherlands

(Joint paper by Vanneste, Lansu, Roesems, et al) 

The GeoSmart Project: Responding to the Need for a "Smart" Geography for Malaysia's New "Smart School" Initiative  
**Richard Dorall**

University of Malaya, Malaysia  
*Cancelled - presenter unable to travel*

CD-ROM on Estonian Geography as a GIS-based Contribution to the "Tiger's Leap" Programme

**Juri Roosaare** (*UniGIS Scholar*)  
University of Tartu, Estonia

*Discussion: What can higher educators do to assist K-12 teachers integrate GIS into their curricula?*

K-12 Day Demo II (during break)

**Paul Van Zuyle**  
University of California Santa Barbara

**3:30 - 4:30 - Working Groups**

Participants will form several small working groups to discuss issues raised in the discussion sessions and to draft summary statements.

**4:30 - 5:30 - Working Group Reports**

Working groups will report on their discussions and identify items for action and further development during Sunday's working sessions.

**6:00 - Buses depart for optional evening in Alexandria**

---

**Sunday, November 2**

**9:30 - 12:00 - Closing Plenary and Working Groups**

Review of the conference

**Duane Marble**  
The Ohio State University

**Discussion and Working Groups**

Following Prof. Marble's review, conference participants will discuss and draft the conference summary and action statement for post-conference distribution. Plans for action on the issues raised will be discussed.

## ***Accepted Abstracts***

---

### *Friday Luncheon Speech*

#### **Rebuilding the Top of the Pyramid: Providing Technical GIS Education to Support Both GIS Development and Geographic Research**

Professor Duane F. Marble  
Department of Geography  
The Ohio State University  
Columbus, Ohio 43210

It has been nearly a quarter of a century since the first formal courses in GIS appeared in a U.S. geography department. We strongly oriented these early courses toward the geography/computer science interface since the availability of GIS technology then was generally of the "if you want it, you must build it" variety. As a result, many geography students of that era were well equipped to make substantial contributions to the development of GIS technology as well as to the advancement of geographic research. This second element represents a critical and generally unrecognized aspect of geographic tool development: as we try to significantly improve our tools, our attention is often directed toward major theoretical problems that have been neglected or overlooked in the past. Examples in the GIS context include the explicit handling of temporal components within spatial models as well as the need to more clearly understand the dimensionality of our spatial analysis operations.

Over the ensuing years the focus of GIS education in geography has changed and, regrettably, the discipline is now turning its back upon its initial high-return focus in the GIS arena in favor of turning out "real" geographers who are often only capable - at best - of routinely manipulating GIS packages designed by others. This disciplinary posture is, I firmly believe, bad for geography as a research discipline, bad for the GIS industry and bad for the hundreds of thousands of individuals and organizations who are finally finding out that "geography really matters" through their exposure to highly useful GIS technology.

My presentation will develop these points within the context of the triangle diagram of GIS education that I first presented at the initial OSU meetings in GIS in Higher Education. Some suggestions for correcting the present imbalance in GIS education within geography will be set forth.

---

#### **The Use of Project Oriented GIS Education and Training in an Urban Setting.**

Robert T. Aangeenbrug



University of South Florida  
Tampa, FL 33620-8100

The GIS laboratory is used as a link to the employer/user community in our introduction to GIS class. A regular set of lectures and textbook are used for the course; a major part of this four credit program is the laboratory. Early in the semester a project discussion is held and examples from the past five years worth of class projects are discussed. Students are encouraged to submit a pre-proposal by the fourth week of the 14 week semester. By week eight an initial presentation outline is discussed and critiqued in class. The project is due one day before the final presentation. This is a fifteen minute presentation to a professional panel of jurors. They critique each presentation. The jury grades each project on five dimensions: presentation style and effect, clarity of purpose, documentation, cartographic quality and scientific merit. A sample of twenty five projects will be presented to frame a discussion of the scope and results from the project presentations.

---

### **Development of a Precision Agriculture Education Network Between K-12, Community Colleges and Universities**

Terry Brase  
Agriculture and Food Technology  
Hawkeye Community College  
1501 East Orange Road  
Waterloo, Iowa 50704

Precision farming, the application of GPS / GIS technology in agriculture, is becoming increasingly popular. However the education for precision farming has been slow in coming. Several universities, community colleges, and even K-12 schools have ventured into precision farming educational activities or curriculum, but for the most part, these have been independent.

Hawkeye Community College received a grant from the National Science Foundation to develop a 2-year Associate Degree in Agriculture Technologies, which it has implemented. A Phase II grant has been approved to disseminate this information to other schools. A network of community colleges linked to area K-12 schools and universities in 6 midwest states will be formed. Together these schools will develop a curriculum that is coordinated and articulated between the various educational levels, relying on current available curriculum materials.

The presentation would include the description of the current curriculum, the network

structure, and proposed outcomes. The presenter will require an overhead projector.

---

### **Mountains: Interdisciplinary Curriculum That Actively Involves Students in Problem-Solving and Construction of Knowledge About Their World**

Rebecca R. Head  
Teacher, Pinson Elementary School  
Doctoral Fellow, The University of Alabama

NGCE standards emphasize that students learn about their world through active participation in problem-solving. Interdisciplinary curriculum is a vehicle for meeting this goal. This presentation demonstrates interdisciplinary curriculum that is based in Geography Standards, The World in Spatial Terms and Places and Regions. A Hand-out includes lesson plans with objectives and hands-on activities for subjects taught in elementary classrooms. Lesson plans can easily be adapted to span grades K-5.

---

### **Building Foundation for Spatial Analysis: The First Two Years**

Shamim Naim  
Univeristy of Wisconsin at Waukesha  
1500 University Drive, Waukesha, WI 53188

The need to deliver the key spatial concepts which should form the basis for GIS education is recognized by academic and non-academic users of GIS technology. In a comprehensive university environment the educators make sure that their students get necessary information and training. The problem arises when a GIS curriculum is implemented on a two year campus or a community college. These institutions are serving increasing number of undergraduates in their first two years of college education. It is difficult for them to meet the demand because of staffing problems. Often one or two member departments have to make hard choices to deliver 'technique' courses at the expense of 'content' courses. To address this issue, undergraduate curricula could be redesigned and vertically integrated by introducing an introductory course that will serve as a prerequisite for other courses in geographic analysis series. An outline of such a course is presented as a step towards the inclusion of geographic

information sciences at the introductory level. This course, "A Survey of Geographic Techniques, Skills, and Applications", will serve as a prerequisite for additional courses in spatial analysis field.

---

## **Perspectives on GIS Education for Professional Development**

Sarah Cornelius and Ian Heywood  
UniGIS  
Department of Environmental and Geographical Sciences  
Manchester Metropolitan University  
John Dalton Building  
Chester Street  
Manchester  
M1 5GD, UK

Three areas of current interest in education are:

- the shift from once-only training and education to life long learning and continuing professional development;
- the increasing use of distance learning as a course delivery mechanism; and
- the development of electronic materials and means of support for learners.

UNIGIS, a worldwide network of Universities cooperating in the design and delivery of GIS courses, is well placed to investigate these issues with respect to GIS. UNIGIS students are mainly professionals, in employment, who undertake their studies by distance learning whilst continuing to work. The UNIGIS postgraduate Diploma/Msc in GIS makes extensive use of electronic media and students are required to have access to the Internet to obtain Web based materials, and are also provided with disk and CD based educational resources.

A survey of UNIGIS students has recently been undertaken to establish the education and training needs of geographical information professionals; to assess the strengths and weaknesses of the UNIGIS distance learning programme in GIS and to set a development agenda which meets the needs of GIS professionals into the 21st Century. Findings which will be presented here address issues such as motivating students to study, coping with changing technology, and the relevance of GIS skills for the working environment. The lessons learnt from this survey will be relevant for others developing life-long learning programmes, distance learning courses, or using electronic media for course delivery.

---

## **GIS in Community Colleges - Where We Stand**

Michael Phoenix, PhD  
ESRI Manager of University Relations  
380 New York St.  
Redlands, CA 92373

This paper will present an overview of the state of GIS education at two year colleges in the US & Canada. There are over 250 two year schools (in 45 states) that are doing something with GIS, up from only about a dozen 2 years ago.

This explosion in interest in GIS technology reflects a growing interest at the two year schools in providing high tech training and education. It also reflects the demand for continued professional education. This trend is shown by the fact that the majority of students in GIS classes at two year schools are professionals that already have four year degrees and jobs.

The importance of these facts to community colleges that are starting or planning to start a GIS program will be discussed. Information on related initiatives such as training or curriculum grants will also be presented.

---

## **Geographic Information Systems - Educating the Civil Engineering User**

Dr Wm. H. Sprinsky  
Pennsylvania College of Technology  
1 College Avenue  
Williamsport, Pa 17701

At Pennsylvania College of Technology, we believe in current, applications-intensive technical education. We recently received a National Science Foundation (NSF) Curriculum (ILI) grant. The major thrust of implementation reflects the revolution caused by technology in civil engineering and survey. We give each student not only the theory but actual experience with the projects and equipment that are the "bread and butter" of Civil Engineering practice.

In the area of Geographic information Systems (GIS), the merger of information from different sources, often in different formats, is the norm in civil engineering technology practice, using GIS-based systems. We have recognized and kept up with this trend. We

purchased the MGE Mapping and Geographic Information System (GIS) from the Intergraph Corporation, which we feel best suits our educational needs.

This presents course designers with balancing education in the basics with training in modern applications. We teach the use of the tool of GIS in the student's second semester in a course (CET122 Topographic Drawing and Cartography) with other tools required in later courses. Students learn about the State Plane Coordinate System after being introduced to Latitude/Longitude, Geodetic Datum and conformal projections. Concepts such as Scale (point and nominal) and convergence are covered, as well as transformations from geodetic to plane coordinates. Students' practical introduction to GIS technology draws on the common experience of a classic civil engineering project, that of widening a road in a built-up area.

---

### **The design and development of courseware on database design for international distance education**

Yuxian Sun, K. Winnups, and I. Wilbrink  
Department of Geoinformatics  
International Institute for Aerospace Survey and Earth Sciences (ITC)  
P.O.Box 6  
7500 AA Enschede  
The Netherlands

The development of multimedia and telecommunication technology has provided tremendous potential for changing the means and improving the efficiency in education. It is especially important in the international higher distance education environment. This paper describes the experiences in the design, development, and evaluation of a multimedia courseware produced at ITC. The subject of the courseware is database design and the target user group is mid-career professionals who work in geoinformation production or application organizations, mostly in developing countries. This courseware can be run both locally on CD-ROM and via World Wide Web on the Internet. The following major issues regarding this courseware production are discussed:

1. The advantages and disadvantages of this courseware comparing to the traditional lecturing/practical manner.
2. The importance of teaching database design to GIS major students and the relationship between the subject of database design and other GIS-related subjects.
3. The design considerations in structuring the contents of the courseware with special attention to the possibilities and limitations provided with authoring tools.
4. Special consideration in designing and developing the interface of the courseware for

the students who come from totally different cultural backgrounds, located all around the world.

5. The logistic and technical possibilities of integrating the courseware with World Wide Web.

The evaluation of the courseware among ITC students has indicated a favorable support to learning using computer courseware. However, interaction with a human lecturer is an essential element in an international distance education environment, and therefore proper telecommunication infrastructure must be established first to achieve good education result.

---

### **GIS Computer Laboratory Materials: Comparing Structural Approaches**

Richard A. Scott  
Department of Geography and Anthropology  
Robinson Hall  
Rowan University  
Glassboro, NJ 08028

This paper presents two approaches to organization of laboratory manual materials and examines their advantages and disadvantages. Both approaches use a "concept, workshop, problem" model of organization. Each laboratory unit explains the concepts to be learned, provides the student with a workshop designed to illustrate the concepts, and then requires the student to demonstrate mastery through successfully solving a GIS problem.

The first approach explains the concepts to be mastered, then leads the student through a detailed step-by-step workshop [click here, now press this key] that models how the software implements the concepts. After completing the workshop students solve a locational problem that is vsimilar to the problem used in the workshop.

The second approach combines explanation of each concept with explanation of how the software implements the concept. The workshop that follows the explanations presents a bare bones outline of the steps required to complete the workshop problem [overlay the flood prone layer with the landuse layer]. After completing the workshop students demonstrate mastery of the concepts and their implementation by solving a locational problem. Students evaluations and success in solving the laboratory problems indicate that although students feel more comfortable with the first approach, they seem to learn more deeply with the second.

## **The Status of GIS Technology in Teacher Preparation Programs**

Richard H. Audet  
Roger Williams University  
One Old Ferry Road  
Bristol, RI 02809

Sarah Witham Bednarz  
Department of Geography  
Texas A&M University  
College Station, Texas 77843-3147

---

Many educators advocate the inclusion of Geographic Information Systems (GIS) as a core technology in K-12 classrooms. Studies have identified barriers that to the implementation of GIS technology at these educational levels. One of the key barriers is the development of GIS skills among practicing teachers. If preservice teachers are taught with and about GIS during their teacher preparation programs, they will be ready to incorporate this technology into their curricula as they begin their teachers careers. Over 675 colleges and universities are members of the American Association of Colleges of Teacher Education (AACTE), the umbrella organization for teacher certification programs. This pool of schools, departments, and programs of education was surveyed to assess the extent to which Geographic Information Systems (GIS) software is incorporated into teacher education. Follow-up interviews were conducted to develop case studies of institutions using GIS.

The findings of the study indicate that: 1.) only a handful of teacher preparation programs intentionally expose preservice undergraduates to GIS technology, 2.) some preservice teachers encounter GIS in environmental science or geography courses, and 3.) there is considerable interest in incorporating GIS into teacher preparation programs. Preliminary conclusions regarding the conditions needed to implement GIS in teacher preparation are summarized.

---

## **Scale - The Key Spatial Concept in GIS Education**

Weihong Fan  
Natural Science and Mathematics  
The Richard Stockton College of New Jersey

126 Seminole Dr., Absecon, NJ 08201

As GIS increasingly being accepted by general public as a powerful tool in peoples decision making processes, it becomes GIS educators job to help general public understanding the geographic data and interpreting the results of a GIS application correctly. This task is very challenging because GIS educators face students with very different backgrounds (e.g. geographers, ecologist, foresters, managers, planners, business men, etc.) and knowledge levels (e.g. high school, undergraduate, graduate, etc. ). It is essential to identify the key spatial concepts that should and can be taught for the variety audience. This paper will present a preliminary research on one of the key spatial concepts -- scale -- and its education. A pedagogical model that intensifies the learning of baseline knowledge and skills, and increases student independence of thought in science will be discussed.

---

### **Relevance of Geographic Information Systems Technology in a Community College Curriculum**

John Williams, M. Akram, and N. Browning  
Glenville Community and Technical College  
Glenville, WV 26351-1292

Glenville State Community and Technical College is located in Central West Virginia. The area is characterized by low per capita incomes, a high rate of illiteracy, and predominantly rural based communities. Faculty in the Glenville State Community and Technical College have been working to meet the training needs of industry in the areas of business technology, environmental technology, forest technology, and land surveying since the early 1970's. These programs are evaluated annually to make them more responsive to changing socio-economic conditions of the community served by Glenville State College. A new program option was developed in 1997 to introduce geographic information systems (GIS) technology into existing associate degree programs.

A curriculum was developed to incorporate GIS technology in the areas of business technology, environmental technology, forest technology, and land surveying. Two courses were developed to introduce this technology to the students. First, an introductory course was designed to cover the fundamentals of GIS technology. Then, an intermediate level course was developed to encompass applications of this



technology to specific academic disciplines.

The applications of GIS technology were demonstrated in the above programs by providing students with an opportunity to work on a project relevant to their discipline using GIS technology as a decision making tool. Projects included: determining the feasibility of locating new retail and grocery stores for business technology; environmental impact assessment and water quality modeling in environmental technology; forest management and growth models for forest technology, and development of a pilot-scale land information system in land surveying. It is expected that the introduction of GIS technology in a community college curriculum will increase interest in associate degree programs and provide students with interactive opportunities to apply this technology across academic disciplines.

---

### **GIS Education for Developing Countries: Bringing about Desirable Change**

Christine E. Dunn  
Department of Geography  
University of Durham  
South Road  
DURHAM, DH1 3LE, UK

GIS is a product of the West and its development has been strongly influenced by the private sector. With the use of GIS in developing countries now steadily increasing there is an urgent responsibility to address issues of appropriate 'training transfer'. With many training programmes adopting a 'technology-led' approach, the need to avoid a 'blind' transfer of technical skills has been largely neglected.

This paper discusses an approach based both on *educating* students in the political, ethical and socio-cultural aspects of geographical information and on *training* them in the use of GIS for applications where change for the better in poorer countries can be brought about. Staff actively involved in development and/or GIS research have developed a postgraduate modular programme in 'Geographical Information for Development' at Durham University. The course not only considers the positive contributions which GIS can make to 'development', but also explores the potential pitfalls of adopting a technology which originated in industrialised countries and which is often promoted as a quick 'techno fix'. To this end, we focus on the concept of geographical data as social constructs, an idea which presents challenges for some of our students.

## **Collaborative Curriculum Development in Geoprocessing Using Distance Learning and The Internet**

Daniel L. Civco  
Department of Natural Resources Management and Engineering  
The University of Connecticut

Donald J. Leone  
Department of Civil and Environmental Engineering  
The University of Hartford

This paper documents the planning, delivery, and results of an experimental distance-based course -- Introduction to Geospatial Analysis -- in which lectures were delivered via interactive compressed video (ICV), with laboratory instructions and course syllabus accessible on our web site at The Center for Geospatial Analysis Technology and Education, or GATE. Students involved were seniors and first year graduate students in Civil and Environmental Engineering from the University of Hartford, and seniors in Natural Resources Management and Engineering from The University of Connecticut.

The syllabus for the course was divided into six main categories: maps, projections and coordinate systems; acquisition of digital geospatial data; remote sensing fundamentals; scanning and rectifying remote sensing imagery; raster and vector GIS operations; and decision support systems in GIS. Lectures were presented once a week using ICV technology. Support material developed by the authors was available on GATE, as well as through links to other geoprocessing-related sites. Background and instructions for laboratory procedures, with links to outside references, were also posted on GATE. Our experience has shown that ICV presentations need to be constructed and delivered carefully and need to involve the audience in some proactive way. Also, links to other sites need to be selectively chosen so that students are not overwhelmed by the sheer volume of Web-based information. Overall, through the blending of various electronic delivery technologies with traditional hands-on laboratory projects, the course proved very successful. Based on this positive distance education experience, the authors are designing a second course in the GATE curriculum.

---

## **Multimedia Computer Based On-Line-Training in GIS and Remote Sensing**

Yuxian Sun and Wolfgang Kainz  
Department of Geoinformatics  
International Institute for Aerospace Survey and Earth Sciences (ITC)  
P.O.Box 6

7500 AA Enschede  
The Netherlands

This paper describes the design and development of two multimedia computer based training (CBT) packages on GIS and remote sensing. They are produced at ITC in the framework of the European Telematics Application Program project ET-1017 - PRONET (PROfessional NETwork). The main objectives of the RPONET project is to develop and demonstrate an integrated training and support service network for professionals who seek out and follow advances in their field in order to remain competitive. The design of the CBT templates ensures that it contains domain, learner, didactic and communication components. Besides learning the contents of the CBTs, users may also access, over the INTERNET or ISDN infrastructure, other services provided at each one of the three Access Service Points (ASP) - one in Greece, one in Spain and one in the Netherlands (ITC). These services include: Tutoring support - users may contact tutors for clarification or further discussion on the contents of the CBTs. The means of communication may be email, white board, text/audio/video conferencing etc. Information databases - users may access this on-line information databases for up-to-date information on the development of GIS and remote sensing technology and some services such as courses, literature, software etc. Special Interest Group - Each ASP will help to set up electronic discussion groups for the users who have interest on certain aspects of GIS and remote sensing. Currently the development of CBTs has completed and the other service infrastructures are in their later stage of implementation.

---

### **A Model GIS Laboratory for Higher Education in a Developing Country: The Example of the GIS Lab**

Sylvester Abumere, Olusegun Areola & Bola Ayeni  
Department of Geography  
University of Ibadan  
Ibadan, Nigeria

A major problem facing the development of GIS in higher education in developing countries of tropical Africa is the lack of foreign exchange to purchase the necessary hardware and software. Yet another problem is that of equipment maintenance and the purchase of necessary spare parts and consumables once the systems are set up. The GIS Laboratory at the Department of Geography, University of Ibadan, Nigeria provides a model of how these problems can be overcome through well-articulated bilateral agreements and relationships between institutions in developing countries and

those in developed countries. The laboratory has been set up and supported thus far through the Universities Development Linkages Program(UDLP) funded by the United States Agency for International Development(US AID). This Program(now discontinued since de-certification of Nigerian government by the USA) links four higher institutions in the state of Iowa, USA with four institutions based in southwestern Nigeria. The Iowa institutions comprise the University of Iowa, Iowa State University, University of Northern Iowa, and Des Moines Area Community College. The Nigerian institutions comprise the University of Ibadan, the Obafemi Awolowo University, Ile-Ife, the Nigerian Institute of Social and Economic Research and the Ibadan Polytechnic.

The establishment of the GIS Laboratory began with two full years of capacity building involving (1) awareness and training seminars locally to identify research priorities in the areas of spatial decision support systems and environmental monitoring and management and establish a need for GIS technology as a decision-making tool in a problem-solving environment; (2) training and refresher courses for local staff both locally and in the participating institutions in Iowa on hardware and software with a view to drawing up realistic configurations of both hardware and software and peripherals for the proposed GIS Laboratory - local staff had the opportunity to practise with various types of software and got briefings on the capabilities of individual systems and software; (3) the provision and adequate furnishing of laboratory space locally; followed by (4) actual purchase and installation of equipment. The choice of software is aimed at establishing a system that allows the integration of various software for both vector and raster data with import/export capability. This gives a full GIS capacity. The major installed software in this integrated system include ATLAS GIS, ArcCAD/AUTOCAD, IDRISI and ALEXANDER. Other software include MAPINFO, TRANSCAD, MAPTITUDE, and ArcView.

The potential for research is enhanced by the continuing cooperation of the eight institutions and the wide spectrum of research interests they represent. In order to ensure effective utilization of the facilities, the laboratory has embarked on the training of post-graduate students most of whom are drawn from government agencies and corresponding institutions in the private sector. In an environment where awareness is still rather low this is considered important to the adoption and development of GIS in both government and non-governmental agencies in Nigeria.

---

## **Bridging the Gap between GIS Employment Needs and GIS Education and Training**

Don Samuelson and I-Shian (Ivan) Suen  
Grays Harbor College  
1620 Edward P. Smith Drive  
Aberdeen, WA 98520-7599

Grays Harbor College has recently developed an Associated in Applied Science (AAS) degree in GIS and a GIS certification program. The main objectives of these programs are: (1) to prepare interested students for employment in the GIS field; and (2) to allow the person who is already in the GIS workforce, to upgrade his/her GIS knowledge and skills. To meet the challenge, GHC has undergone a DATA/DACUM process to link employment needs to its GIS program.

DATA means Develop A Task Analysis and DACUM means Develop A CurriculUM. The DATA/DACUM process is designed to:

- support information exchange between educators and employers.
- ensure students can perform required GIS competencies by providing relevant and up-to-date skill guidelines.
- assist faculty members to design and implement curriculum based upon industry-driven, applied GIS concepts and skill standards.
- provide business and industry with graduates who possess essential GIS skill levels that meet industry standards.

This paper will describe the DATA/DACUM process for GHC's GIS program, the outcomes generated by the process, and GHC's effort to integrate them into its GIS curriculum development.

---

## **What are beyond buffering and overlay when teaching GIS for Spatial Analysis?**

David Wong  
Geography & Earth Systems Science  
George Mason University  
Fairfax, VA 22030

An important component in a GIS (Geographic Information Systems) course or curriculum is teaching students to use GIS to perform spatial analysis. Most teaching materials on this topic tend to focus on rudimentary spatial analytical functions in GIS such as buffering and overlay, and the structure of the material is very much function-oriented. Very little emphasis is put on the fact that because most GIS capture pertinent spatial information required by most spatial analytical techniques and models, and therefore GIS can be powerful tools to perform spatial analysis. It is important to point out to students what are the pertinent and fundamental spatial information we can derive from GIS and how they can be used for spatial analysis beyond buffering and overlay. Thus, techniques in geostatistics and spatial statistics can be introduced to students in GIS courses logically. In this paper, I identify several key geographic information elements captured by most GIS. When these elements are explicitly stored

or captured by GIS, I demonstrate that these elements serve as the bases of a suite of spatial analytical procedures and statistics. Students in both GIS and quantitative methods courses should realize how these fundamental elements of spatial information can be utilized in spatial analysis.

---

### **Learning with GIS - The Case of Urbanworld**

Derek Thompson  
Department of Geography  
University of Maryland  
College Park, MD 20742

The demonstration will show the special pedagogic system, UrbanWorld, being created to improve undergraduate urban geography and planning education. Implemented as an ArcVIEW (TM) application, UrbanWorld has a customized GUI, tools for student productivity, electronic submission of assignments, a portfolio concept for student work, several learning units, prepared assignments, a knowledge base for visualization skills, metadata, spatial analysis tools, etc. It represents one, generalizable, attempt to exploit GIS as enabling technology for fostering affordable and effective active and authentic learning environments for undergraduate education involving geographic databases and spatial reasoning.

---

### **Identifying Key Geographic Information Systems Concepts - What the Texts Tell Us**

Susan M. Macey  
Southwest Texas State University  
Department of Geography and Planning  
Southwest Texas State University  
San Marcos, TX 78666

The recognition of the value of GIS as a tool in a variety of application areas has grown dramatically in the last decade. Concomitantly, there has been a rapid expansion in educational offerings to keep up with the demand for trained personnel. It has been

nearly a dozen years since the first widely recognized text on geographic information systems (GIS), Burrough's "Principles of Geographic Information Systems", was published in 1986. For several years, few books to rival this text were produced. The last five years has seen a marked growth in the number of GIS books that could be used as texts. Through an analysis of the contents of over two dozen of these books, this paper seeks to determine the key concepts their authors view as important to the field. Both a longitudinal and cross-sectional approach will be taken in the analysis. First, texts will be classified according to their orientation in terms of level (novice to expert), and approach - applied versus theoretical. Then the nature of the subject matter presented, in terms of depth and breadth of topic coverage, will be examined.

---

### **Abstract for Vaughn Lewis, Bruce Ramsay and Robert Fyans**

Vaughn Lewis and Bruce Ramsay  
University of Dundee  
Dundee, DD2 1NN  
Scotland, UK

Mr Robert Fyans  
Lineplan Ltd, Powerline Consultants  
Ruthvenfield Road  
Perth, Scotland, UK

GIS is rapidly developing as the necessary information manager for many organisations, and it is increasingly important that workers in various departments within an organisation become proficient in GIS. One of the main problems of implementing GIS has been the difficulty involved in customising it for different requirements.

Component software technology has been recently created to enable software developers to seamlessly, cheaply, and rapidly, develop complete software solutions by integrating different pieces of software, using minimal code. This technology can facilitate rapid developments of customised GIS environments and is particularly promising for use in educational institutions where funding for software development is very limited.

This presentation will show how component technology is being used to develop a GIS environment for the electricity supply industry, which may be used in a managerial context or for training. Current applications focus on asset management and system planning, with intended usage in an active industrial context and within a University based MSc programme in Electrical Power Engineering and Management. The package



is very flexible and can be customised for various applications by simply integrating appropriate software components into the environment.

---

### **Partnership in GIS Education: Building Capacity in a Disadvantaged Society**

Tracey Morton  
Department of Geographical Sciences  
Vista University  
Pvt Bag X9, Bertsham, 2103  
Soweto, South Africa

Previous experience of learning GIS applications demonstrated that working solely through the tutorials in the manual was unsatisfactory. Students need to do projects that involve the manipulation of data through the use of GIS applications and to be exposed to the theoretical aspects of GIS, so that GIS would be taught in a socially responsible manner. There were, however, severe logistical problems with introducing such a system, in terms of the availability of hard and soft ware, teaching hours and teaching staff. Thus, a programme was developed by myself, whereby, students would go out to businesses and government institutions currently using GIS applications to get "hands on experience". While this curriculum is still very much in the experimental phase, it is hoped that it proves to be of value, to students, the Geography Department and the various GIS users who participated. This paper outlines how the establishment of partnerships with various GIS users was undertaken and also includes a report back on the fruits of the partnership, from the perspectives of the students, the university teaching staff and the GIS users who took part in the programme.

---

### **GIS Partnerships and Service Learning**

Lewis Rogers and Chris Semerjian  
Division of Natural Sciences and Technology  
Gainesville College  
P.O. Box 1358  
Gainesville, Georgia 30503

Gainesville College in Gainesville, Georgia was recently awarded a grant from the National Science Foundation and Phi Theta Kappa for the development of Geographic



Information Systems (GIS) curriculum in two-year colleges. GC is the first two-year institution in the state to develop a GIS program of study. In the development of the program, GC has established service learning partnerships with local industry and government. Students are exposed to the power of GIS through real-world projects that address local problems and issues. Further, these projects are providing internships and possible future employment for GC students. Currently, service learning partnerships are established with the Elachee Nature Science Center, the Georgia Mountains Regional Development Center and the Hall County Board of Education. Future partnerships will include the United States Forestry Service and Jackson Electric Membership Corporation. Service learning is a natural in GIS education. It is a powerful learning experience that provides an obvious benefit for the community and prepares students for responsible citizenship and productive employment.

---

### **The Need for GIS Education in Mauritius**

Jaishree Beedasy  
Faculty of Engineering  
University of Mauritius  
- currently a Fulbright Scholar at:  
Department of Geography  
Pennsylvania State University  
University Park, PA 16802

Lack of trained personnel is a major problem facing the implementation of GIS in Mauritius. Situated 800 kilometers off the east coast of Madagascar, Mauritius has a land area of 1865 square kilometers and a population of one million. Rapid industrialization and economic growth have created considerable pressure on the provision of housing, transportation, community facilities and recreation. Many institutions have realized that the proper application of GIS technology would be of tremendous help in managing and monitoring resources to sustain the development of the island. The implementation of GIS in Mauritius is coming mainly from the outside, as foreign technical collaboration and aid. After the departure of the foreign consultants, the projects are 'orphaned' and are left at a standstill. In several institutions approved projects never even get started although costly hardware and software have already been acquired. These lie idle because of lack of trained personnel to work with them. The University of Mauritius does not run any GIS course yet and as a first step is considering to hold a seminar on GIS and a training session on ARC INFO with the help of foreign consultants. The University is developing its own physical and human resources to be able to run GIS courses to meet the country's need. Problems such as administrative barriers, lack of collaboration among institutions and a scarcity of organized spatial data are also discussed in this paper.

---

### **It's Not Plows, Cows, and Sows Anymore: Developing GIS Educational Partnerships with the Cooperative Extension Service**

Scott A. Samson  
Rural Sociology  
University of Kentucky  
Garrigus 500  
Lexington, Kentucky 40546-0215

The Cooperative Extension Service provides an outreach mechanism between a Land Grant university and the community. Traditional crop and livestock Extension programs at the University of Kentucky are complemented with community and economic development initiatives with the rural, farm and non-farm constituency. GIS educational opportunities in the University are linked with the Extension community development programs in several traditional and non-traditional forms. Some of these opportunities are: internships and graduate assistantships to assist with community planning; continuing education workshops for county agents, non-government/non-profit community development organizations, and local government agencies; training 4-H youth to compile community resource inventories; and implementation of a vocational education program with a local facility of the U.S. Bureau of Prisons. These outreach opportunities associated with GIS provide students with "real world" perspectives, assist in the development and/or refinement of university-level curriculum, and provide communities with another tool for local empowerment.

---

### **Enhancing general professional awareness of GIS by improving educational GIS tools for secondary school teachers**

Dominique Vanneste  
Institute for Social and Economic Geography  
Catholic University of Leuven  
de Croylaan 42  
B - 3001 Heverlee (Leuven)  
Belgium

In 1996 a survey (via questionnaire) has been executed as to have an insight in the way private firms in Belgium are handling their spatial data. One of the striking results is how little knowledge one has about the analytical possibilities of GIS (even when using some 'graphic' system), about the need of education of people working with GIS and the restraint in terms of budget and time, spend on a GIS. There seems to be a need for learning and teaching GIS outside the academic arena. Sought are new ways to enhance GIS education within secondary geography education to get both teachers and students acquainted with GIS.

One cut-and-dried solution for secondary GIS education was developed by the KULeuven. A package of complete lessons on city regions, human impact on the environment etc is offered containing e.g. didactic structuring of contents, FAQs and materials and data to be used. Another solution is found in the adaptation of a multimedia introductory GIS practical on CD-ROM, developed by e.a. OU and KULeuven and aimed at students in higher education. A tailor-made version of this self-tuition practical will be used in training of teachers in secondary education.

---

### **The GIS Workbench: a Metaphor for Development of GIS Distance Education**

Angelique Lansu, Truus Roesems, and Rob Nadolski  
 Open University of the Netherlands  
 Faculty of Natural Sciences  
 P.O. Box 2960  
 6401 DL Heerlen  
 The Netherlands

The GIS workbench: the computer working environment, consisting of GIS software, hardware, lifeware and connected to the outside GIS expertworld by Information- and communication technologies is an ideal metaphor by designing GIS education. To cope with diverse student groups by absence of sufficient GIS teachers, the idea of a workbench practical is linked to distance learning methods. The interactive GIS practical on CD-ROM described is developed to be studied at the student's own computer learning environment with access to Internet. The practical can be studied independently of place, time and pace of study, with tutoring designed within the material. The GIS practical teaches students the professional use of geographic information in various application fields. In addition, this computer based learning program will contact students with each other and the professional GIS world through computer conferencing and Internet. The didactic model followed in the course is a combination of embedded learning, collaborative learning, and discovery learning. The practical is designed by the Open university in cooperating with some GIS educational institutions of the Netherlands, Belgium and UK. The participants (authors) cooperate with means of specially developed authoring tools and computer conferencing. Manuscript versions of the modules are updated by FTP with access restricted to authors.

and editors.

---

### **Demonstration of an multimedia introductory practical: the DTM module**

Truus Roesems and Angelique Lansu  
Inst. Social and Economic Geography - KU.Leuven  
de Croylaan 42  
B - 3001 Heverlee (Leuven)  
Belgium

Demonstration of an educational module on Digital Terrain Models (DTM), developed as part of an international project to develop a multimedia introductory practical in GIS. The project Geo Information Systems: an introductory practical is part of the Consortium on the Innovation of Higher Education, founded by the Dutch and Flemish state departments of Education, partners are GIS educational institutions from Belgium, the Netherlands and UK. The modules (a.o. DTM, remote sensing, strategic decision making) of the computer-based learning (CBL) program are aimed to students in higher education to offer a self-tuition practical on CD-ROM with a hand-on training in GIS technology. The DTM module shows DTM concepts, illustrated with examples and exercises in IDRISI. The CBL program guides the students through the lessons on necessity of DTMs, DTM data models etc. and the Idrisi software to be used by didactic techniques as feedback (text and images) on the assignments, a hypertext glossary and hints.

---

### **Incorporating GIS into the Professional Work of the Agricultural and Forestry Technicians: the Columella Project**

Carlos Alvarez, Rafael Crecente & Urbano Fra  
Department of Agricultural and Forestry Engineering. EPS.  
Campus Universitario  
Lugo. 27002 Spain

The Columella Project, organized by the Escuela Politecnica Superior of the University of Santiago de Compostela, comes from the ADAPT initiative of the European Social Fund of the European Union. The ADAPT initiative tries to adapt and improve business

competitiveness through technician training within a global objective of a quality of life improvement.

The Columella Project aims specifically the agricultural, forestry and food sectors in the autonomous region of Galicia (NW of Spain). It seeks to train and update the knowledge of these professionals in new techniques, technologies and processes, so that through their activity they can influence this sector.

One of these technologies is the application of GIS to rural planning and management in the land field as well as in the business management. This paper reviews experiences and results of GIS training and work. Courses have been taught to professionals coming from the government, university and business sectors, for whom the use of this tool was something new.

Several applied GIS projects have been also developed, with examples as agricultural business management, land consolidation, distribution of raw resources and production collection.

---

## **GIS Education - Accessible to all Disciplines**

Les Doak  
Cypress College (NOCCCD)  
9200 Valley View  
Cypress, California 90630-5897

GIS education and training is becoming more accepted and wide spread throughout levels of academia. During this period of rapid expansion, teaching methods and learning styles have not had a thorough hearing or discussion. GIS courses currently are taught either to the content of a specific discipline or to a set series of lab exercises which are product or concept specific. These methods pose an access problem or an enrollment problem to newly established programs at all levels. Cypress College, in the North Orange County Community College District, has designed, over a six year period, a method of teaching GIS which addresses these potential problems. Utilizing active learning and SCANS methods, each Cypress College GIS course is fully accessible to students of any category, at any level, from any discipline. Students are encouraged to develop a semester project of their own choice, from personal, discipline, or work related interests, which will, when completed, demonstrate their technical and conceptual understanding and proficiency commensurate with the expectations of the specific course in which they are enrolled. Active Learning and SCANS methods will be reviewed, with specific applications to various levels of GIS education or training. Specific classroom and lab operating procedures will be discussed. Course organization and structure will be examined.

---

## **CD-ROM on Estonian Geography as a GIS-based Contribution to the "Tiger's Leap" Programme**

Juri Roosaare  
Institute of Geography  
University of Tartu  
46 Vanemuise St.  
Tartu EE-2400, Estonia

Last year an ambitious project of total 'computerisation' of Estonian schools, called "Tiger's Leap" was launched by Estonian President. It is supervised by Estonian Ministry of Education, is financed by different - both state and private - foundations and consists of several subprojects (<http://www.tiigrihype.ee>). For one among these, a team headed by the author is going to create for Estonian schools a vernacular tutorial CD-ROM on Estonian geography (EGCD) what will be in accordance with the official study program for schools. EGCD will be base to teach a concrete study subject (geography) in school with the help of computers what will be integrated step by step (teacher - a few enthusiastic pupils - group work - individual study en masse) into study process. Technologically the prototype of EGCD bases on ArcView. Final version will use ArcView Data Publisher or MapObjects LT, or other suitable ESRI's product. Didactically, the EGCD will be created as a multi-level product including:

1. READER'S LEVEL (a multimedia textbook of geography).
2. LEARNER'S LEVEL FOR GEOGRAPHY (additionally, one can exercise, solve basic to study program problems and find additional lessons)
3. LEARNER'S LEVEL FOR CARTOGRAPHY (additionally, one can learn how to make maps).
4. TEACHER'S LEVEL with methodical material and pedagogical advises.

---

## **GIS Education in Developing Countries : Ecuador**

Jonathan Deckmyn, Kristof Scheldemans, and Gwendolyn Verstraete  
PROMAS - Universidad de Cuenca  
CUENCA PO-BOX 01-01-1081

The Flemish Organization for Development and Technical Assistance (VVOB) has sent

during the last 4 years a group of GIS experts to different Ecuatorian universities. The idea of this collaboration was in the first place to improve the academic level regarding GIS related subjects. A side effect would be the implementation of GIS in both private as public projects. In both the Politecnica Nacional (Quito), the State University of Cuenca and the University of Loja, experience was gained on the collaboration regarding GIS in development countries with both academic personal as students of the faculties of agricultural engineers and/or system engineers.

Some first evaluations can be held concerning the situation of GIS at university level in third world countries. Topics for these evaluations are : preliminar knowledge of systems and agricultural engineers, hardware and software available at the universities, introduction and acceptance of new technologies, career perspectives of the new professionals, special interests.

The choice to send experts to the above mentioned faculties was determined by the interest from the Ecuatorian partners and the possibilites to achieve the mentioned goal, as thus both agricultural as informatic faculties were selected. Obviously the situation in both cases is quite different. In addition there were also differences between the support/collaboration given by the 3 universities. Nevertheless some general conclusions, remarks and advises can be made.

---

### **Promoting Community College GIS Workforce Relevant Course and Program Development**

Denis E. Mudderman and William A. Dando  
Department of Geography, Geology and Anthropology  
Indiana State University  
Terre Haute, IN 47809

The project "Advancing Geo-Technology Education: Providing GIS Skills for the Workforce of the 21st Century" is funded by the NSF Advanced Technology Education program. Since September 1995, the project, conducted from Indiana State University in partnership with over two dozen community colleges, has sought to promote and improve GIS instruction, courses, and programs in the United States. After Summer 1997, thirty-one community college instructors will have received intensive GIS training through two three-week institutes over two summers. During the 1996-1997 academic year these instructors returned to their home institutions and worked to incorporate GIS into existing classes, create new GIS courses, or established new GIS programs. Community college instructors also completed a survey of area GIS employers to begin making industry linkages and to understand the local employment market for their students. The work of community college instructors was supported with Internet-based resources, networking, and programs in distance learning. Panelists are community college instructors who have been participants in the project. Each



instructor will discuss the advances in GIS at their institutions through this project and then the panel will discuss the common insight gained in promoting community college GIS workforce relevant course and program development.

---

### **The GeoSmart Project: Responding to the Need for a "Smart" Geography for Malaysia's New "Smart School" Initiative**

Richard Dorall  
Department of Geography  
University of Malaya  
50603 Kuala Lumpur  
Malaysia

The Malaysian Government announced in 1995, and formally launched in 1996, the establishment of a Multimedia Super Corridor (MSC), an area some 15km by 40km encompassing the national capital, Kuala Lumpur, the new national administrative centre, the new international airport, as well as Malaysia's first Internet-linked, and fully-computer networked city, Cyberjaya. The MSC will be a multimedia catalyst centre for world-class multimedia computer companies to locate their business and R&D facilities to service the booming economies of Asia-Pacific.

Among the multimedia industries targeted for development in the corridor by year 2000 are "Smart Schools" for which software applications, curricula, courseware, teacher and staff training, and network infrastructure will have to be developed. Officially, the subjects selected for "Smart School" development include science, mathematics, English and the Malaysian national language.

This paper will describe initiatives being taken by the GeoSmart Project in the Department of Geography, University of Malaya, to develop multimedia content for a "smart" geography for not only Malaysian schools, but also for Malaysian colleges, universities, as well as for the private and public sectors which will be the beneficiaries of "smart" geography as they use more widely professional geographical information technologies such as geographical information systems, remote sensing, global positioning systems, etc.

---

### **Multimedia Learning for Professionals in Geographical Information: The Challenges for Courseware Development**



Ian Heywood, Sarah Cornelius, Bruce Carlisle and David Grimshaw  
Department of Environmental and Geographical Sciences  
Manchester Metropolitan University  
John Dalton Building  
Chester Street  
Manchester M1 5DG, UK

Simon Kenton  
School of Computer Studies  
The University of Leeds  
Leeds LS2 9JT, UK

Professionals updating their work related skills are an important group of GIS learners. With increasing emphasis on workplace learning, life long education and professional development, these learners are frequently unable, or unwilling to attend traditional courses, but prefer more flexible study. Distance learning and multimedia computer based resources are two opportunities for meeting the needs of this group of learners, empowering them with choice over learning speed, place and style.

Materials developed for this group of learners must address a number of conceptual and practical challenges:

- the chosen educational model must ensure that materials offer a flexible learning environment;
- the materials must motivate and satisfy learners from differing professional, cultural and intellectual backgrounds;
- the standards of presentation must be high, whilst remaining within resource constraints;
- devices to offer feedback must be included; and,
- simple updating of materials must be possible.

Work on two Modules for mature students on GIS related courses is presented in this paper. The Modules 'GIS in Business' and 'GIS and the Environment', are aimed at postgraduate students on non-GIS courses. The traditional learning strategies of professionals have been replicated in a digital environment to facilitate flexible learning. The basic framework for the materials includes conference presentations, short course attendance, case study work, site visits, trade journals and use of consultants. This paper illustrates some of the ways in which high quality professional development materials can be developed. The challenges, opportunities and specific difficulties of meeting the needs of professional development through multimedia distance learning are evaluated.

## **Development of a Training Centre for Environmental GIS Applications in Polish Universities**

S. Ignar  
Agricultural University of Warsaw, PL

J. Fürst  
Hydrology and Hydraulic Engineering  
Institute for Water Management  
University of Agricultural Sciences  
Muthgasse 18, A - 1190  
Vienna, Austria

In a cooperative effort of 9 Polish and 9 western European universities, as well as public authorities and private consultancies, a training centre for environmental GIS applications was established at the Warsaw Agricultural University (WAU). The activities included the initial installation of computer hardware and GIS software in the GIS laboratory at WAU. To achieve fast and wide dissemination of GIS technology in the country, a short intensive course on "Environmental GIS applications" was developed, targeted primarily at young teaching and research staff of the participating Polish universities and organizations, who were supposed to act as multipliers of the skills they learned in the courses. As accompanying measures, participants received copies of the software packages used in the courses and were eligible for staff mobility grants to further improve their skills at participating EU partner universities. The project is part of the "Structural Joint European Project" named "Joint Curricula Development for Soil and Water Resources Protection", in the framework of the EU TEMPUS PHARE program. It started in 1994 and will be completed in August 1997. This contribution will present the concept, structure, contents and accompanying measures of the course. The experiences and impacts after three years will be discussed, based on an evaluation among the participants, as well as lecturers and organizers.

---

## **GIS Education for Hydrology and Water Resources Engineers**

J. Fürst, H.P. Nachtnebel and H. Holzmann  
University of Agricultural Sciences  
Institute for Water Management  
Hydrology and Hydraulic Engineering  
Muthgasse 18, A - 1190  
Vienna, Austria

A course on "Application of GIS in hydrology and water management" was introduced into the study program of water resources at the University of Agricultural Sciences in Austria. To provide possibilities to upgrade their GIS knowledge also for professionals in the water management field, a 3-days short intensive course with a similar scope is offered. The objective of both courses is to develop and improve the understanding for the discipline-specific benefits and pitfalls of the application of GIS in water management and hydrology. For both target groups, only a basic experience with general computer applications can be assumed. One of the main challenges for the course development was therefore to cover the principles of GIS as well as the specific topics and problems in hydrology and water resources. The continuing success of both courses shows that a need for a GIS course with an emphasis on topics specific to water resources and hydrology existed and the feedback from participants justifies the concept and contents.

---

### **The House Hunting Game: An Interactive Teaching Resource for Introducing Spatial Decision Making using GIS**

Ian Heywood

Department of Environmental and Geographical Sciences

Manchester Metropolitan University

John Dalton Building, Chester Street, Manchester M1 5GD, UK

Roy Alexander

Department of Geography

University College Chester

Cheyney Road, Chester, CH1 4BJ, UK

John McKeown and John Castleford

CTI Centre for Geography Geology and Meteorology

Department of Geography

University of Leicester

Bennett Building, University Road, Leicester, LE1 7RH, UK.

The "House Hunting Game" is one of a suite of CAL products developed by the Teaching and Learning Technology Geography Consortium in the UK. The aim of the game is to introduce spatial decision making concepts using GIS technology without

the need to resort to the use of proprietary GIS software. The Game is designed to fill a single laboratory session at the start of a GIS course to raise awareness about a range of issues including sources of spatial data, analysis methods and data quality concepts. The game has been constructed using the Toolbook authoring language in conjunction with custom written C routines. A user centred interface guides students through the spatial decision making scenario of choosing a geographical location in which to live. Students are introduced to multi criteria analysis techniques in conjunction with more standard GIS procedures such as reclassification, distance operations and point in polygon routines. The Game also simulates the collaborative nature of spatial decision making by allowing the students to ^Ñcreate families^Ò and simulate their spatial decision making activities in searching for consensus on where to live. This paper will provide a demonstration of the game, consider the design issues involved in its construction and review feedback from its use in a range of teaching situations from undergraduate through to professional development programmes.

---

### **GIS Meets K-12 Environmental Education at NC State University**

Hugh A. Devine  
Campus Box 7106  
Computer Graphics Center  
North Carolina State University  
Raleigh, NC 27695-7106  
College of Forest Resources

For the past two years the GIS Research and Teaching Program at North Carolina State University has been cooperating with the NC Division of Environmental Management and EPA in bringing the combination of GIS and environmental science into the K-12 classroom. The NC State Sci-Link program, which is a network of master environmental science teachers, has developed an on-going consortium to bring spatial analysis into the curriculum. In year one, a group of about 25 classroom teachers came to the University campus to develop skills in the collection, analysis, and display of water quality data. By the conclusion of this one week workshop, each of the teachers had developed several GIS related projects to be implemented in their classes. Two weekend follow-up sessions were held during the academic year in which teachers received more GIS instruction and reported on their classroom implementation progress. The program was so successful that a second grant was secured and this summer (1997) two sessions are being held on campus; an advanced program for the original participants and an introductory course for a new set of teachers. This paper highlights the GIS curriculum, the teacher classroom projects, and the teacher evaluations of the project.

---

## **GIS Project Planning Considerations for Educators**

Bob Sharpe  
Department of Geography and Environmental Studies  
Wilfrid Laurier University  
Waterloo, Ontario, N2L 3C5

The purpose of this paper is to outline some of the major considerations faced by educators in designing a GIS-related project for the classroom. Its findings are based on observations of, and discussions with, inservice high school geography teachers in Ontario. When designing a GIS-related project teachers go through a challenging process of assessing their readiness, applying curriculum guidelines, and adjusting teaching methods. The paper elaborates on the requirements and options for each of these tasks. Throughout the process teachers want to know what GIS functions and operations are appropriate for different levels of readiness, curricula, and teaching methods. Using four categories, data input, manipulation, analysis, and output, a range of GIS functions are examined in terms of their appropriateness for educational projects. The functions are assessed in terms of their level of difficulty and in their requirements for computing power, data, and time commitments. Suggestions are given for several geography projects that range along a continuum of difficulty and resource requirements.

---

## **Passport to the Future: The new GIS Program at the Faculty of Technology, University of Qatar**

Steven Rose  
GIS Program  
Computer Technology Department  
Faculty of Technology  
University of Qatar

There are currently over 100 people (mostly expatriates) working in GIS in Qatar and this number is expected to at least double over the next few years. The new GIS Program at the Faculty of Technology, University of Qatar is a two and a half year

technology program designed to train Qatari citizens to fill many of these exciting GIS career opportunities -- their passport to the future. The paper identifies the GIS Program's objectives and describes the curriculum and state-of-the-art GIS facilities designed to meet these objectives.

---

### **Abstract from Malcolm Thomas**

Malcolm C. Thomas  
Coastal Zone Resources  
Pembrokeshire College  
Haverfordwest, Pembrokeshire  
Wales, U.K  
SA61 1SZ

Recognition that the coastal zone must be managed on multisectoral principles has generated demand for integrated coastal zone management plans. An important requisite for these plans is development and use of a range of management tools, one of which, G.I.S., is increasingly seen as a powerful tool in the decision making process, particularly its ability to integrate often diverse, spatially referenced datasets. Development of G.I.S. teaching and learning strategies for future coastal zone managers is challenging. Initial methods require exploration of the range and limitations of available coastal environmental datasets. These are often dispersed in a variety of agencies, in a format not readily usable in G.I.S. Subsequent training is required to understand fundamental G.I.S. functionality, through investigation of a range of proprietary software packages. Managers are then presented with a range of datasets and encouraged to integrate and then derive new parameters from which decisions can be made. G.I.S. Modelling is undertaken to portray a range of management scenarios involving environmental problems particularly oil spill analysis. Interrogation techniques are undertaken to evaluate strengths and weaknesses of coastal databases and guidance given on database design and implementation.

---

### **Beyond Posting Lecture Notes on the Web: Examples of Three GIS Internet Courseware Initiatives and Our Lessons Learned**

C. Peter Keller, Rosaline R. Canessa and Trevor J. Davis  
Department of Geography and Spatial Sciences Laboratories

University of Victoria  
Victoria, BC, Canada  
V8W 3P5

This presentation will outline our experiences with the design, development and delivery of three digital GIS courseware initiatives. We will introduce G-HELP, a digital tutor designed to help with hands-on GIS, as well as an introductory INTERNET distance education course covering "Fundamentals of Geo-Information" and a second INTERNET course covering "Introduction to GIS" which includes laboratory exercises. The remainder of the presentation will highlight what we have learned when developing and teaching with these digital courseware initiatives. We will comment on budgetary and time commitments invested in this courseware, talk about students' reactions, share recommendations we have made to senior administration concerning INTERNET based curriculum development and delivery, and conclude by posing a number of questions for discussion.

---

### **Evaluation of a GIS-T Student Friendly Training Tool**

Peter van der Waerden  
Urban Planning Group  
Eindhoven University of Technology  
P.O. Box 513 (postvak 20)  
Eindhoven, The Netherlands

Antonio Nelson Rodrigues da Silva  
Universidade de Sao Paulo  
Escola de Engenharia de Sao Carlos - Departamento de Transportes  
Av. Dr. Carlos Botelho, 1465  
13560-250 Sao Carlos - SP - BRAZIL

Last year the authors developed a so-called GIS-T Student-Friendly Training Tool with the aim of supporting the GIS education of transportation planning students. The tool is primarily based on the GIS-package TransCAD and is developed as a self-teaching tool. With the objective of getting insight into the suitability of the training tool for students with little or no experience in transportation planning, a detailed checking and evaluation study has been developed and applied during the course. Those students who participate in the class were asked to fill in partial questionnaire, without looking to

their course material. A comprehensive questionnaire has been carried out at the end of the course. The main goal of the checking part of the questionnaire was to get insight into the topics the students have learned during the course. In the evaluation part of the questionnaire, students were asked to state their opinion about the provided material. In January of 1997 the first group of students at Eindhoven University started to use the training tool. Around 25 students attend the course and filled in an evaluation form after each part of the course. This paper describes the results of the checking and evaluation process.

---

## Teaching GIS Problem Solving with a Complex Site Allocation Case Study

David G. Goldsborough & M. de Bakker  
Van Hall Instituut  
P.O. Box 17  
9700 AA Groningen  
The Netherlands

Since 1991 the basic principles of GIS are taught to students at the Van Hall Instituut in a 160 hour introductory module 'GIS in Agriculture and Environment'. Each academic year this module is offered two or three times in Dutch to our own students and once in English to visiting foreign students and Dutch students seeking an international label on their diploma. Foreign students come from several European countries and occasionally from the U.S.A. and all students have a background in environmental or agricultural science. As a final assignment the students (in pairs) are required to tackle a complex site allocation problem: suggesting 2 suitable locations for new nature reserves. The working material that the students receive for this 'Nature Management' case study includes information on: GIS and nature management, theoretical background on nature management, an example (in the form of a slide-show) of solving a comparable nature management problem with GIS, and an elaborate description of the available data. Although students have very different backgrounds, ranging from very little knowledge on nature management to being very knowledgeable, all students are able to reach the objectives of the case study. These include: translating a spatial problem into GIS terms, displaying the solution to this problem conceptually by means of a flow-diagram and manipulating a large data-set containing data on different scales and with different coverages. Our structured approach enables the students to experience all aspects of the problem solving procedure: from data evaluation to presentation and description of the final result. Several evaluation points are included in our procedure; thus enabling the lecturers to prevent students from losing track of where they are going. As a result all students always fulfil the main assignment i.e. assigning new nature reserves. The final results produced by students are very diverse: ranging from very good GIS work based



on sound ecological principles to relatively poor GIS work based on little expertise. In discussing the final result with students we focus on four aspects. Firstly the approach they selected including an explanation and motivation of all assumptions, available data and supporting knowledge. Secondly their flow-diagram, including a description, is evaluated based on clarity and reproducibility. Thirdly the final map, including a description in words on contents and interpretation, they produced is evaluated. And finally their conclusions on the intermediate and final result, with emphasis on uncertainty, reliability and value of end map, are critiqued. We feel that this complex site allocation case, including our step by step procedure, is a very effective tool for confronting students with all aspects of the GIS problem solving procedure.

---

### **Preserving West Virginia's Heritage Using GIS: Fort Moore**

C. E. Holt, M. H. Akram, and J. M. Williams  
Glennville State College  
Glennville, West Virginia 26351

Fort Moore, Gilmer County's most important Civil War site, is in a state of deterioration, along with the surrounding emplacements and the Old Glennville Cemetery. The fort was used as a stockade and to defend the city of Glennville until it was burnt by Confederate forces in 1864. Surrounding the fort, the cemetery dates back to the 1840's. The fort and the cemetery adjoin the Glennville State College campus and is used for instructional purposes by various academic units. The faculty at Glennville State College developed a collaborative project utilizing resources from the Divisions of Land Resources and Social Sciences. This effort has involved historical research, surveying of the Fort Moore area including the cemetery, and developing a database of various sites using GIS. In addition, construction of a walking trail by the students has facilitated public access to both the cemetery and Fort Moore. This collaborative effort has provided students from various disciplines to interact, to learn from each other, and to participate in a practical project. Eventually, this effort may lead to the development of a heritage park.

---

### **The Analysis of the State of Vocational Training on Geoinformation Technologies in Siberia**

Nikolay G. Markov

Cybernetic Center  
The Tomsk Politechnical University  
84 St. Sovetskaja Street  
Tomsk, 634034, Russia

As Siberia is rich with natural resources, there is a great need for the experts, being masters of modern GISs in the sphere of geology and oil&gas extracting, wood and ground cadastres.

The analysis of the state of training in GISs in Siberia is done. It is revealed, that the best material base and high level of teaching are in the State and the Politechnical universities of Tomsk and in the Academy of geodesy and cartography in Novosibirsk. The specialty "Geoinformation systems" is open in the Tomsk Politechnical University on the faculty of automatics and computer engineering. For training of students both post-graduate students of the University and number of Siberian universities, and also for conversion training of the engineers of the petroleum companies of Siberia the WWW- server with geoinformation contents is created. Training within the framework of remote training, including use of Internet, is begun. The preparation of experts on GISs is conducted under the individual plans in the Tomsk State University on the faculty of computer science. In all universities the students study well self recommending GISs MapInfo (USA), Arc/INFO and ArcView (USA).

The list of educational rates investigated in the universities, their methodical maintenance etc. are analyzed in detail. Results of foreign experience use, in particular, in USA universities, are considered.

---

### **GIS in the Virtual Geography Department Project**

Kenneth E. Foote  
Department of Geography  
University of Texas at Austin  
Austin, TX 78712-1098

The Virtual Geography Department Project was begun in 1996 as a clearinghouse for high-quality educational materials in the Worldwide Web. Contributors to the clearinghouse have organized into working groups to cultivate new materials in a wide variety of subfields spanning the entire field of geography. A GIS, remote sensing, and spatial analysis working group was formed in 1996 and is being led by Brian Klinkenberg of the University of British Columbia. Eugene Turner of the California State University, Northridge is coordinating the work of the cartography working group formed in 1997.

The GIS working group is seeking to build a collection of exercises, notes, and datasets that will be keyed to the new Core Curricula in GIScience and Remote Sensing. The point is to provide an easy means for instructors to pool and share materials they develop for their classes. In this way instructors can save time and share ideas as they develop exercises and tutorials for different software systems matched to the units of the Cores. This paper will explain how the clearinghouse is organized and how instructors can use and contribute to the collection of materials now being compiled.

---

### **Using the Web to Deliver Instructional Resources for GIS Teaching**

X. Mara Chen  
Dept. of Geography and Regional Planning  
Salisbury State University  
Salisbury, MD 21801

The NCGIA GISCC has provided guidance on the substance of GIS teaching in higher education, but training-oriented instructional resources are needed to meet in-class teaching demands. Hands-on GIS teaching with commercial software requires detailed instructional materials that need to be updated often. The Worldwide Web can be used by instructors to pool and share such materials and thereby to promote a more effective and active teaching-and-learning process.

The GIS and remote sensing working group of the Virtual Geography Department Project (VGDP) is in the process of creating a web-based clearinghouse for GIS and remote sensing instructional materials. This paper argues that GIS teaching should integrate knowledge-based education with skill-oriented training, and that web-based instructional materials can play a central role in this integrated approach. It also describes how to design web-based lab instructional modules for GIS teaching and learning.

---

### **Teaching GIS incorporating the Internet**

Hui Xu  
Department of Geography  
Frostburg State University  
Frostburg, MD 21532-1099

This paper presents results of a summer project for teaching improvement, work partly supported by the Frostburg State University and further inspired by the summer 1997

Virtual Geography Department Workshop at the University of Texas.

"Introduction to GIS" is offered by the Department of Geography every semester as one of its Geographic Technique courses. The course seeks to balance the teaching of GIS fundamentals and principles of GIS against training in the use of the technology and software. The goal of the improvement project is to develop Internet programs that help achieve this balance more effectively.

Course materials are revised to go on-line, including lecture notes and instructions for laboratory exercises. Students can study them for comprehension before or after class, rather than being forced to copy from the board during lecture. Linking to other Internet sites provides the students with additional learning resources. Each student is required to complete a final project with GIS applications, the best of these being displayed on the Internet. Use of the Internet acts as an incentive for better performance. It also provides students with computer skills of value in the real world. The project is conceived as an experiment, as a means to recognize problems, and to provide a prototype for other faculty to follow.

---

### **The Role of Geographic Data in GIS Education**

Barbara Poore  
Federal Geographic Data Committee  
U.S. Geological Survey  
590 National Center  
Reston, VA 20192

Joe Sewash  
West Virginia University  
Department of Geology and Geography  
425 White Hall, POI 6300  
Morgantown, WV 26506

Increasingly, teachers of courses in geographic information science recognize the need for students to explore geographic data and to understand their nature and limitations. The issues range from theoretical data models, to technical challenges of analysis and representation, to organizational and institutional questions of why and how data are produced. The way data producing organizations deal with these issues influence the structure, quality and availability of data for classroom use. The National Spatial Data Infrastructure (NSDI), is a national initiative that encourages federal, state, and local

governments, academia and private industry to share geographic data. By encouraging data documentation, electronic data clearinghouses, data standards, and a basic framework of geographic data for multiple applications, the NSDI will make higher quality, better documented data available for citizens to use.

This session will describe the NSDI, focusing on its potential relevance to K-16 educators. A recent project at the University of West Virginia, funded by the Federal Geographic Data Committee (FGDC) will demonstrate how NSDI ideas can be used to enhance student comprehension of the theoretical, technical, and organizational aspect of GIS and geographic data. Finally, a representative of the FGDC will describe federal funding programs that may be of interest to educators. The audience will be invited to discuss how the education community can contribute to the development of the NSDI.

---

## **GIS Projects and GIS Education in Russian Higher School**

Alexander D. Ivannikov  
Center on Informatization  
Ministry on Education of Russian Federation

Alexander V. Simonov  
Pushchino Specialized Center for New Information Technologies  
Ministry on Education of Russian Federation

The GIS Development as the separate direction (subprogram) within the framework of Russian Ministry on Education (RF MoE) Research Program on Regional Informatization is accepted. It is implemented by the System of Regional and Specialized Centers on Information Technologies which are organized in Russian universities (near 90). There are four main directions in GIS Development Subprogram. They are (1) development of standards on GIS terminology, documents describing and regulating GIS projects and GIS education and training materials, methodical recommendations etc., (2) development of networking in field of GIS Education and GIS Project implementation on the RUNNet (Russian Universities Network) basis using GIS-oriented Web-sites, (3) development of different GIS projects (in cooperation with regional and local institutions and administrations), (4) development of education and training materials for System on GIS Continuing Education Courses (in cooperation with branch and territorial administrations).

The Subprogram is strong oriented on the regional geoinformation resources and potentialities since it is connected with development of active regional policy in field of natural resources management, regional planning, environment protection and other spatial problems. Its final purposes are not only to develop GIS education and but also to explore, estimate and harmonize regional geospatial data as well as to increase the

role of universities in regional informatization and computerization.

---

### **Planning a GIS Certificate Program for Distance Delivery**

David DiBiase  
Department of Geography  
The Pennsylvania State University  
University Park PA 16802

The U.S. higher education industry is increasingly competitive. Some institutions, including Penn State, are developing expanded continuing and distance education programs to create new markets among professional adult learners who are unable to pursue traditional resident degree programs. This year, Penn State launched a "World Campus" initiative involving development of several new certificate programs for distance delivery beginning in 1998. Among these, the Department of Geography was selected to create a program in Geographic Information Systems. This presentation will outline market strategies, educational objectives, curriculum content and structure, and personnel requirements involved in designing and producing a 4-course sequence for asynchronous distance delivery via the Internet, CD-ROM, and print media. The talk will focus in particular on the relationship between the distance education program and the Department's existing geographic information science curriculum for resident education. An instructional design model will be presented which accommodates both distance and resident delivery for GIS education.

---

### **Teaching GIS with ArcView and the World Wide Web at the United States Military Academy**

Mike Hendricks  
CPT, U.S. Army  
Assistant Professor  
West Point Military Academy

The use of hands-on practical exercises with GIS software is a critical component of an undergraduate introduction to GIS Course. However, getting students familiar with a fully functional GIS software package is time consuming and can overshadow the learning of GIS concepts. Historically, a traditional textbook is used to address these concepts, and the software is learned through instructor produced handouts. The Geographic Information Systems (GIS) course offered by the Department of Geography and Environmental Engineering at the United States Military Academy underwent major course design change in

the spring of 1997 to address these problems. The changes were initiated to increase student active learning, and were made possible by recent hardware and software upgrades. The major components of these changes were: the use of ArcView 3.0, with the Spatial Analyst extension, the utilization of the "Getting to Know ArcView" training book in lieu of a course text, and the heavy use of web based resources. This paper will highlight the justification, method of utilization, and effectiveness of teaching an introductory undergraduate level GIS course with these components.

---

### **Community College Administrative GIS: The First Step in a Community College GIS Enterprise**

Randall E. Raymond

Urban Environmental Education in Detroit - Cass Technical High School

Freda L. Brown

Henry Ford Community College

Yichun Xie

Eastern Michigan University

Geographic information system (GIS) technology is rapidly expanding in government, industry, and the business sectors. However, the societal utility of GIS in community development is to be exploited yet. Community colleges can play a significant role of disseminating this evolving technology to grass-root communities and work forces. Henry Ford Community College (HFCC), in collaboration with Eastern Michigan University and Cass Technical High School, is developing a national urban model for community-based GIS education. The first step is to demonstrate to the college how GIS can be deployed to assist administrative decisions. 16,300 student records at HFCC were geo-referenced to 1995 TIGER street networks. The census demographic and economic data were then joined. As a result we were able to apply various statistical analyses to look into issues such as student patron areas, and their social, political, and economic well-beings. Mapped spatial information, in particular, can provide easy digestible information to assist administrators in their management routines. GIS can be used to track student enrollment against political entities such as house and senate districts for the purpose of funding and support from legislators. The presentation will include the analysis conducted on HFCC student enrollment and the strategies and methodologies used so those interested can reproduce the analysis procedure at their home institutions. GIS is an intriguing technology that educational institutions can benefit administratively, in addition to its profound values in education, research, and training.

---

### **Integrating GIS with Stressed Stream Analysis**

Dr. Karl Korfmacher

Environmental Studies Program



Denison University  
Granville, OH 43023

Stressed stream analysis (SSA) is an approach that identifies impacted subbasins and streams within a watershed and assesses the sources, extent, effects, and severity of pollution (Makarewicz, 1993). Assessing the relative impacts of point and non-point sources of pollution within a watershed is a complex problem for students. For many, this is their first experience addressing a large spatial problem. SSA methodology is easily integrated into a GIS, expanding the quantitative analyses students can perform. Such analyses include identifying "hot spots" based on land use change, incorporating terrain analysis results into the SSA, and creating pollutant loading models with the SSA monitoring data. At Denison University, students in two environmental studies courses will be using SSA and GIS to assess the environmental health of two watersheds near the school. Clay Run is almost entirely contained within the boundaries of the school's 350 acre biological reserve. Clear Run, which contains the Clay Run watershed, drains a mixture of land uses and land covers, including agriculture, pasture, forests, residential areas, urban build-up, and wetlands. Land around the biological reserve is steadily being converted from farmland to residential, with great potential for altering water quality. This paper discusses the integration of SSA and GIS as a multidisciplinary teaching tool and a framework for teaching environmental science.

---

### **Status of GIS Education in India**

P. Venkatachalam  
Centre of Studies in Resources Engineering  
Indian Institute of Technology  
Powai, Bombay 400076, INDIA

Geographic Information System is becoming one of the major decision making tools in the area of resources management. Integration of remote sensing technology with Geographic Information System has enhanced the capabilities of both these emerging technologies and the application areas are increasing dramatically. Geographic Information Systems are often seen as a multipurpose technology which can satisfy the needs of a variety of users. The process of transferring this technology from laboratory to real world organization is a massive complex task. The target audience varies from high level administrators and professional scientists to application oriented personnel, technicians and computer specialists. Also the implementation of GIS is considered as a highly resource intensive activity. The last decade has witnessed a steady increase in the number of training programmes and post graduate courses being offered in GIS by the educational institutes and R & D organizations all over the world. Also with the availability of low cost computer systems and software to process the spatial data, it is becoming increasingly possible for the user departments to take



advantage of these emerging technologies.

India is one of the few countries in the world which has made remarkable progress in space technology. India has launched a series of operational remote sensing satellites providing high quality remote sensing data to several parts of the world. Integrating remote sensing and GIS methodologies, India has carried out several operational level projects in the areas of natural resources planning and management. Understanding the need for the trained manpower, several universities in India are offering post graduate degree programmes such as M.Tech, M.Sc.Tech, M.Phil and PG Dip. in Remote Sensing where GIS is offered as a subject. As a partial fulfillment of the degree, most of the students carry out their research projects in GIS applications. Taking into consideration, the interdisciplinary nature of the areas, students of varied backgrounds are admitted to these degree programmes. In addition, doctoral level research programmes are pursued in GIS and its applications in a number of universities and Indian Institutes of Technology. Anna University, Tamil Nadu, India has started a 4 year under-graduate degree programme in Geo-informatics covering photogrammetry, remote sensing, GIS and computer applications. Geography departments in the Colleges and Universities have taken initiatives to introduce GIS as a core or elective subject in their UG and PG degree programmes in Geography. Although different levels of courses can be offered starting from basic introductory level to advanced application level, there is a continuous demand from decision makers, inservice personnel and university teachers to undergo short training programmes in these areas. To meet these demands the academic institutes, R & D Centres and industries are conducting GIS training programmes of varied durations. This paper presents an overview on the status of GIS education in India. It gives a summary of different levels of courses being offered in GIS, curriculum adopted, the books followed and also the availability of infrastructure. Status of GIS education in the post graduate and doctoral level research programmes is brought out. The framework adopted for conducting short term continuing education programmes on GIS is summarised. Attempts being made in the development of indigenous GIS software packages for promoting GIS education and training is presented. The paper also brings out the upcoming trend in introducing GIS technology in higher education in India.

---

## **GIS -- A Keystone Technology for Earth Science**

Kathryn Keranen

Thomas Jefferson High School for Science and Technology  
Alexandria, VA

Demonstrations and lessons will be shown that link point data to GIS software. Earthquakes, volcanoes, weather, EPA data, a peak flow of streams will be obtained from the web, brought into a GIS and analyzed. Lessons will be provided on how to incorporate this into an earth science curriculum. In addition to data found on the web, students can create their own databases and incorporate them in local GIS datasets. This technology is a keystone

technology in Fairfax County, VA's new Geosystems class taught at the junior/senior level.

---

## **A Spreadsheet Approach to Teaching Object Oriented GIS**

Sam Cole and Emil Boasson  
NCGIA and Departments of Planning and Geography  
University at Buffalo, Hayes Hall, NY14214

Our paper will explain how object oriented mapping may be carried out in spreadsheets, using simple user-created maps and macros. The method has uses for teaching, research, and policy. The advantage over current add-in mapping is that the macros can be written by students and other users with basic spreadsheet skills, the procedures are relatively fast, custom maps may be drawn or imported, and the macros can be adapted to a variety of applications such as real-time animation, or used in planning situations where time is of the essence. The paper raises a number of issues as to the inflexibility of some GIS modeling capabilities and the rapidly evolving capability of spreadsheet mapping. The approach will be illustrated for Quattro Pro for Windows and Excel with Visual Basic, using classroom and planning applications. The authors will review their experiences as teacher and student with the approach.

## THE ANALYSIS OF THE STATE VOCATIONAL TRAINING ON GEOINFORMATION TECHNOLOGIES IN SIBERIA

*Nikolai G. Markov*

Tomsk Polytechnical University  
84, Sovetskaja Street, Tomsk, 634004, Russia

Siberia occupies the big territory and gives the significant contribution to the economy of Russia. Siberia is divided into Western Siberia and Eastern Siberia (figure 1) and includes the territories of 19 subjects of Russian Federation. Siberia is rich by natural resources, which today are intensively developing, and it needs for experts who can operate with modern GISs in geology, oil and gas producing, wood and earth cadastres.

First of all, we'll show the results of the analysis of GIS-education in Siberia. Here and then we'll speak about training not users but the developers of software and hardware. The analysis is fulfilled on the basis of data, received from five cities, which are scientific and educational centers of Siberia -- Novosibirsk, Tomsk, Barnaul, Krasnoyarsk and Irkutsk (figure 1). These cities were chosen because of their successful training of bachelors, engineers and masters on computer science in Siberia. Tomsk and Novosibirsk are in the first group of cities because they have a big number of students and teachers. Barnaul, Krasnoyarsk and Irkutsk, in spite of the fact that they are large industrial and scientific cities, are included into the second group. The quantity of students and computer science teachers in these cities is in 3 times less than in each city of the first group.

Table 1 and table 2 show the data about computer training in Tomsk (the representative of the first group) and in Barnaul (the representative of the second

group). Today the percentage of students, who are studying the geoinformation systems and technologies to the general number of the students, who studying the computer science, is not big. On the figure 2 you can see that it is from 4.7% up to 9.6%. The diagrams on the figure 3 demonstrate the share of 1997 graduates who have received the specialization in geoinformational systems. It changes from 3.7% up to 8.3% on cities. The analysis of the diagrams shows that there is some growth of the number of students who are studying on geoinformation systems.

**Table 1. The Data About the Computer Training in Tomsk**

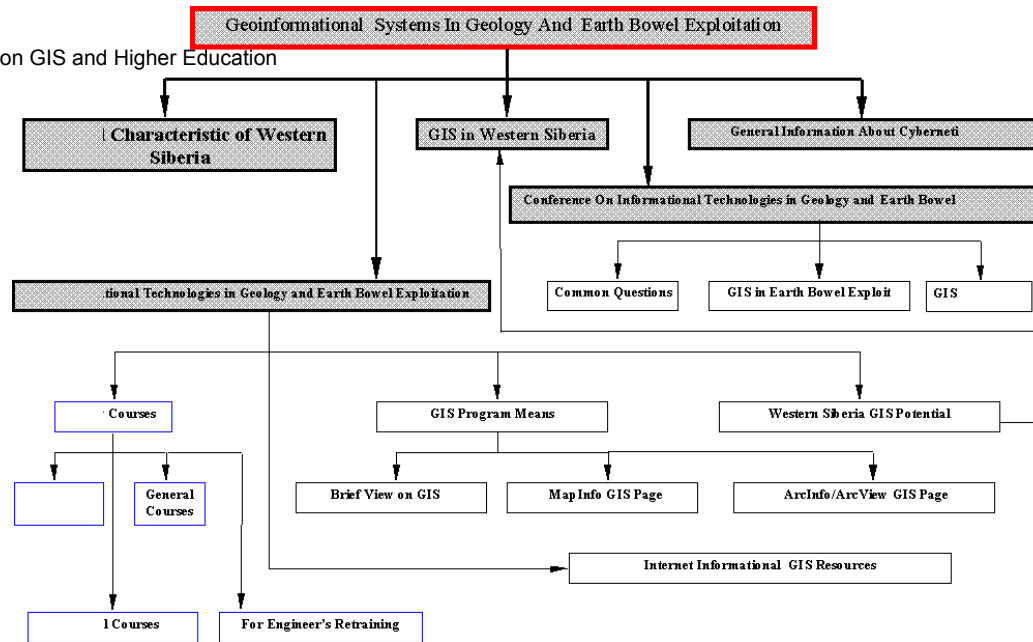
?	University	The Number of Students and Teachers						
		Current Students	Graduates of 1997	Enrollment	Post-graduates	Professors	Associate Professors	Assistant Professors
1	Tomsk Polytechnical University	892	224	255	36	11	75	15
2	Tomsk State University	697	136	200	51	13	71	8
3	The Tomsk State University of Control Systems and Radio Electronics	901	136	280	35	14	51	14
	Summary							

**Table 2. The Data About the Computer Training in Barnaul**

N	University	The Number of Students and Teachers						
		Current Students	Graduates of 1997	Enrollment	Post-graduates	Professors	Associate Professors	Assistant Professors
1	Altay State University	156	36	75	12	2	15	6
2	Altay State Technical University	530	103	198	12	8	44	3
	Summary							

The analysis has demonstrated that Tomsk State University, Tomsk Polytechnical University and Novosibirsk Academy of Land-Surveying and Cartography have the best material base (presence of software and hardware of GIS), a modern methodical maintenance and high teaching level of geoinformation technologies among all educational institutions in Siberia. The courses «Geoinformation», «Digital Cartography», «Methods of Geoinformation Systems Design», «Database Theory» and so on are studied in this Universities and the Academy. Students are studying well-known

GISs like MapInfo (MapInfo Corporation, USA), ArcInfo and ArcView (ESRI, USA), WinGIS (firm ProGis, Austria). It is necessary to note that these systems are widely used in Russian



**Fig.5 The Structure of GIS Web-site**

This site is used to study the bases of GIS by other Siberian universities and also by engineers of oil and gas producing enterprises: East Petroleum Company, Surgutneftegas etc. In 1997 Tomsk Politechnical University started preparing of experts on GIS with the help of remote training. CASE-technology and Internet are applied.

We are carrying out two projects for effective training activity via our Web-site. Software of the first project will allow to make maps according to any client's needs.

Dr. Wm. H. Sprinsky, Associate Professor,  
Pennsylvania College of Technology  
1 College Avenue, Williamsport, Pa. 17701

## **Geographic Information Systems - Educating the Civil Engineering User**

William H. Sprinsky, Ph D, Associate Professor, [Pennsylvania College of Technology](#)

### Abstract

At [Pennsylvania College of Technology](#), we believe in current, applications-intensive technical education. We recently received a National Science Foundation (NSF) Curriculum (ILI) grant. The major thrust of implementation reflects the revolution caused by technology in civil engineering and survey. We give each student not only the theory but actual experience with the projects and equipment that are the "bread and butter" of Civil Engineering practice.

In the area of Geographic Information Systems (GIS), the merger of information from different sources, often in different formats, is the norm in civil engineering technology practice, using GIS-based systems. We have recognized and kept up with this trend. We purchased the MGE Mapping and Geographic Information System (GIS) from the Intergraph Corporation, which we feel best suits our educational needs.

This presents course designers with balancing education in the basics with training in modern applications. We teach the use of the tool of GIS in the student's second semester in a course ([CET122 Topographic Drawing and Cartography](#)) with other tools required in later courses. Students learn about the State Plane Coordinate System after being introduced to Latitude/Longitude, Geodetic Datums and conformal projections. Concepts such as Scale (point and nominal) and convergence are covered, as well as transformations from geodetic to plane coordinates. Students' practical introduction to GIS technology draws on the common experience of a classic civil engineering project, that of widening a road in a built-up area.

---

## **Geographic Information Systems - Educating the Users**

William H. Sprinsky, Associate Professor, [Pennsylvania College of Technology](#)

At Pennsylvania College of Technology, we believe in current, applications-intensive technical education. Our portfolio of technical programs includes a two-year [Civil Engineering Technology \(CT\)](#) Program, with an emphasis in surveying, a two-year Surveying Technology degree and a new four year [Civil Engineering Technology \(BCT\)](#) degree. Our

Civil Engineering Technology (CET) and [Surveying Technology \(SU\)](#) Associate degree programs follow the Accreditation Board for Engineering and Technology (ABET) standards and are accredited. A recent National Science Foundation (NSF (ILI)) grant allowed us to change the thrust of the programs to reflect the revolution in civil engineering and survey technology caused by electronics, satellite positioning, and computer power. Accurate measurements never before possible are now the accepted norm. Measurements over large distances allow accuracies on the order of one part in one million. Concurrent with improved measurements is an increase in productivity. The new technologies do not require rights-of-way to be cut for line-of-sight measurement. They do not require large technical crews to do standard measurements. They bring the cost of surveying and land documentation to a level that will greatly augment and improve the quality of civil projects.

Students in the program are provided opportunities for hands-on experiences and real problem-solving using industry standard equipment. Laboratories in cartography, photogrammetry, surveying, and civil engineering design were upgraded to include experiences in these new technologies. Students are currently required to respond to a competence based curriculum where they demonstrate ability in the use of essential pieces of equipment and the related supportive technologies.

As course designers, the problem we now face is how to give each student not only the theory but actual experience with the projects and equipment that are now the "bread and butter" of civil engineering practice. The solutions should be performed on modern equipment with techniques used in today's practice. In addition, the common student experience of "fragmentation" into coursework specific to surveying, highway design and land use needs to be overcome. Improvements and integration include analytical instead of analog plotting techniques, improved synthesis/integration of multiple source data through application of Geographic Information System (GIS) technology, and improved survey measurement precision. Above all, we need to integrate these technologies so that students understand how to use information and data bases to find solutions for engineering and surveying problems.

We plan to use Geographic Information Systems (GIS) to facilitate this integration in coursework in much the same way the industry uses GIS in the workplace. The merger of information from different sources, such as surveying, GPS and Photogrammetric activities, often in different formats, is the norm in civil engineering practice. Such information is used in the design of subdivisions, location of parks, design of transportation networks, and the husbandry of the environment. Labor-intensive practices, often used to integrate information from government and private sources, are not competitive with new technology. Most government and private engineering entities have or are switching to GIS-based systems and our educational institutions must recognize and adapt to this trend. In this manner, integration of data using manual techniques previously measured in person-years can often be reduced to person-weeks.

Our first step in this integration process was to use Intergraph's Modular GIS Environment (MGE) as part of a mapping project performed by all students (Sprinsky 1997). The student-constructed map, a byproduct of a Digital Terrain Model (DTM), coordinated in Pennsylvania State Plane (1983) North Zone 3701, is the unifying project of their first two-semester experience in Surveying. Based on after-the-fact comments of students and evaluation of their product as compared to previous student work, this has been an unqualified success.

We are teaching the use of the tool of GIS in the student's second semester in a course ([CET122 Topographic Drawing and Cartography](#)) in which we teach the use of other tools required in later courses. In this course, students learn about the State Plane Coordinate System after being introduced to Latitude/Longitude, Geodetic Datums and conformal projections. Concepts such as Scale (point and nominal) and Convergence are covered, as well as transformations from geodetic to plane coordinates. Learning the use of GIS fits in nicely with other newly learned concepts.

We believe that entry-level employees will be involved with construction and use of GIS before they are required to have any extensive knowledge of data base manipulation. This is the manner in which we teach the use of the GIS tool. Discussion of data base concepts, schemas and design are theoretical. Students' practical introduction to GIS technology draws on the common experience of a classic civil engineering project, that of widening a road in a built-up area. In our discussions of theory, we brainstorm from the engineer's and of the municipality's viewpoint as to what data we would collect. In this project, students learn to use data of different types, to update data bases already in existence, to form queries and to interpret the results of the execution of those queries.

For the project we use a fairly extensive example of a municipal database from Knoxville, TN, that supports a project to widen a street named Ray Mears Bv, recorded in the database in a number of segments. This data was supplied by Intergraph. [Figure 1](#) (42K graphic) shows a Microstation-95 design file with the transportation features for the area in red and the parcel information superimposed upon them. Students first identify Ray Mears Bv segments by the segment name, the students' first experience with querying. They are also required to note the nature of the data that this street has as a part of its record and we compare these findings to our brainstorming session results ([see figure 2](#)) (41K graphic). Once identified, they go through the steps to link database segments through a Topological file and form the second query, to identify all parcels located within 150 feet of the centerline of the target street. Once formed, they execute the query and display it graphically in a design file that contains both the transportation network and the parcel outlines ([see figure 3](#)) (43K graphic).

In addition, students use an Intergraph report-writing utility to produce an ASCII file and hardcopy query results including parcel owner, area, assessed value and street address ([see figure 4](#)) (24K graphic). This gives students a practical understanding of spacial and attribute data, by example, rather than just in theory. From other courses they are familiar with the concepts of mailmerge and ASCII file use, so students understand the utility of this report in notification of property owners about interruptions in utilities services. To illustrate the maintenance and update capabilities of the GIS, students then query the database for a specific parcel, change the owner's name to their own and the assessed value of the parcel to \$1,000,000, see [figures 5a](#) (36K graphic) and [5b](#) (33K graphic). This activity reinforces instruction on data maintenance and integrity, previously discussed in class. Rather than repeating the steps leading to the second query, they recall and re-execute the same query referring to distance from the centerline, reinforcing in their minds the linking nature of the database function and what they have just changed. The hardcopy from this segment is at [figure 6](#) (24K graphic).

Ever greater quantities of information must be integrated to provide civil engineers, planners, and others with enhanced predictive and planning capacities. Our students must understand



that the information upon which decisions are based will have multiple and correlated inputs. This will improve the efficiency of designs, identify long-term problems, and reduce costs. The capacity to integrate large quantities of information can greatly reduce the cost of major building and construction projects. By shortening the time required for planning, development and construction, front end costs are reduced. Information systems can greatly enhance speed and accuracy of development and ensure that design expectations are more fully met. Our students must appreciate the advantage of flexibility in design and construction provided by the GIS--ability to supply rapid responses to "what if" alternatives. After this experience, they do.

---

#### REFERENCE

Sprinsky, W. H., 1997, Surveying Education in the '90s - something Old and Something New. 1997 ASEE Annual Conference Proceedings.

---

## GIS Education in Developing Countries : Ecuador

Jonathan Deckmyn (1), Kristof Scheldeman (2), Gwendolyn Verstraete & Yves Van Gijssel (3)

(1) *PROMAS - Universidad de Cuenca*  
*P.O.BOX 01-01-1081*  
*CUENCA, ECUADOR*

(2) *UNISIG - Escuela Politecnica Nacional de Quito*  
*QUITO, ECUADOR*

(3) *CINFA - Universidad Nacional de Loja*  
*LOJA, ECUADOR*

### ABSTRACT

The Flemish Association for Development Cooperation and Technical Assistance (VVOB) has, during the last five years, sent a group of GIS professionals to different Ecuadorian universities. The idea of this cooperation is primarily to improve the academic standard regarding GIS related subjects. A complementary benefit, however, is the implementation of GIS in both private and public projects. Experience was gained in the field of GIS applications in collaboration with academic staff and students within the faculties of civil, agricultural and/or computer engineering of the National Polytechnical School (Quito), the University of Cuenca and the National University of Loja.

From these experiences some conclusions can be drawn regarding the situation of GIS at university level in third world countries. Topics are: the general and preliminary knowledge of computer and agricultural engineers, the availability of hardware and software at universities, the introduction and acceptance of new technologies and the career perspectives of GIS-trained professionals and their special interests.

The mentioned universities were chosen because of their interest and the likelihood of reaching a desired goal. A collaboration with the faculties of civil, agricultural and/or computer engineering within these universities was considered the most likely to achieve success. Obviously the academic / scientific situation is quite different for each one of them. Moreover the support and collaboration offered by the local partners is characterized by its heterogeneity, due to political and financial differences. Nevertheless some general conclusions, remarks and suggestions can be made.

### Introduction : Ecuador, VVOB, development aid, GIS

#### Ecuador (1996)

- republic with a democratic government headed by a president (Fabian Alarcon);
- 11 million inhabitants (60% urbanized); high emigration;

- total area of 283350 km<sup>2</sup> divided over three geographical regions (Coastal Lowlands, Andean Mountain Range, Amazon Basin); very heterogeneous climate with wet and dry seasons; very high biodiversity; ecological problems of deforestation (280000 ha yearly in 1996, 150000 ha yearly in 1982) and desertification (32670 km<sup>2</sup> in 1996, 25000 km<sup>2</sup> in 1982, 30% of soils in the interandean region are lost through erosion);
- primary export sectors : oil, banana and shrimps
- annual inflation of 25.3%
- elementary education of 6 years is mandatory but desertion is high (26% leave school before reaching 6th grade) and 10.2 % of 15-years old are still illiterate; 33 universities / technological colleges (202683 students)
- 30.000 internet users, 10 internet providers ; the main problem is still the slow and completely undersized telephone network.

## VVOB

The "Vlaamse Vereniging voor Ontwikkelingssamenwerking en Technische Bijstand" (Flemish Association for Development Cooperation and Technical Assistance), is a development organization, supported by the Flemish federal government (Belgium), whose aims are to organize, stimulate and coordinate the transfer of knowledge between the Flemish community and foreign countries, mainly through projects in secondary schools and universities. The organization is active in Asia (Thailand, China, Vietnam), Africa (Kenya, Zambia, Zimbabwe, Botswana, Rwanda and Burundi) and Latin America (Ecuador, Surinam and Chile).

## Development Aid

A few years ago some press releases on failures in development programs started a profound discussion in Belgium about development aid: Where should we work? What should we do? How should we work? ...

Recently the tendency seems to be to concentrate efforts both spatially and thematically. The spatial concentration means that only a few countries receive development aid from Belgium. The choice of these countries is based upon previous experiences and upon the probability of a successful intervention, which is often related to the degree of corruption, the presence of organizational frameworks and in general the ripeness for cooperation. The thematic concentrations intend to focus the efforts on existing needs in fields of health, agriculture, infrastructure and other primary needs.

## So, why GIS ??

In recent years computer tools such as geographic information systems (GIS) have become fundamental for environmental assessment, regional planning, ecosystem conservation and natural resource management. Also in developing countries there exists a growing interest in these tools, both in the public and private sector. GIS offer a wide range of possibilities in the fields of **inventory making, planning and decision making**. With GIS one can store and manage geographical data, integrate different types and analyze relations between data themes, perform spatial modeling, etc. . The results are displayed visually on maps to help decision-makers better understand and solve problems.

GIS is an interdisciplinary tool. Therefore it receives attention from various disciplines such as agricultural engineering, civil engineering, computer science, sociology, etc. . This is positive in a way, for indeed it is necessary that all the involved disciplines become partners in the process of implementation of the GIS, on the other hand it also complicates the situation because each one of them tends to neglect the global picture. A sociologist does not worry about projection systems, an agricultural engineer does not see the need of a neatly structured database, a computer scientist does not understand the final goal of his new toy, ... and each one of them wants to have or to be himself "the" GIS specialist.

## **Experiences of VVOB GIS professionals in Ecuador**

### **Cuenca**

#### *Context :*

The Program for Land and Water Management (*Programa para el Manejo del Agua y del Suelo* - PROMAS) of the University of Cuenca is being executed by an interdisciplinary team of local engineers, economists and sociologists and 3 foreign experts (some 12 persons in total). . It is the only location where a GIS professional sent by the VVOB works in a "program", clearly defined as interdisciplinary. This team is active in research projects, teaching and consulting. The need for a GIS expert was expressed by the team and VVOB sent this reinforcement in November 1996.

(Cuenca is the third city of Ecuador with its 300000 inhabitants.)

#### *Current situation :*

PROMAS has been working several years with GIS, acquiring thus a good working knowledge of the system. Currently the main ongoing actions are to structure and divulge this knowledge, to fill the gaps (on precision, error, decision making, ...) and to clean and organize the extensive dataset. This work is being done within the different research projects, by organizing seminars, by lectures and through the guidance of thesis students from different faculties (civil, agricultural and computer engineering).

The experience with this group of last-year students and recently graduated collaborators shows the success such an interdisciplinary group can have due to the complementary character of its members. These young people demonstrate a lot of enthusiasm to learn new skills and often prove to be good in acquiring these fully autonomously. Unfortunately the different scientific branches of the university use to be isolated from each other. The lack of interfaculty contact prevents a rapid improvement of the academic level in general and especially with regard to GIS. The knowledge of computer sciences is very low in the agricultural faculty, more acceptable amongst the civil engineers, and very application oriented in the school of computer engineers. The knowledge of geography is limited amongst both the agricultural and civil engineers and nonexistent amongst the computer engineers. Hydrology, soil sciences, topography, computer science, ..., are all different disciplines taught by different professors in the different faculties without any form of discussion or interrelationship between the disciplines.

As a result of this situation, GIS took off in the school of computer sciences, at that time

computers were not even available in the other faculties. ArcINFO was bought and installed on one of the first workstations of the university. A few collaborators participated in some ESRI courses and started digitizing and storing maps. This work was done by computer engineers with a very limited knowledge (if any) of projection systems, scale, error propagation, cartography, ... . As a later stage GIS became a course in the school of computer sciences, naturally dictated by a computer engineer. Only recently have other faculties shown an interest to incorporate GIS in their curriculum. The main problems here are the almost complete lack of fundamental computer knowledge, the unavailability of an adequate infrastructure and in some cases the stubbornness of colleagues.

Last year a series of seminars was organized which demonstrated that the students throughout the whole university generally have not developed a sufficiently critical and analytical mind. Apparently the reasons for this phenomenon should be sought in the low level of education before university and the learning system which is based on memorizing.

The main inhibitor for a rapid improvement of the current situation is lack of cooperation and the poor divulgence of knowledge between faculties and departments. At least three other groups in the university are interested in and working with GIS (IDRISI, ArcInfo, ArcView, GRASS, MapInfo, Microstation), but unfortunately the contact between these groups is restricted because of political or even strictly personal problems. The same problem occurs with other schools and institutions in the same city also working with GIS.

### **Loja :**

#### *Context :*

The Center for Agricultural Computer Science (*Centro de Informática Agropecuaria - CINFA*) was created in 1994 at the Faculty of Agricultural Engineering of the National University of Loja by a local soil conservation specialist and two VVOB experts. The center's main goal is to introduce computer science in the fields of agronomy, irrigation and forestry, at university level as well as in local governmental and non governmental organizations.

#### *Current situation :*

Between developed and developing countries there exists an increasing technology gap. In a similar way, due to centralisation, the remote places within developing countries obtain new technologies at a slower pace than the bigger cities. In Loja, one of the smaller and remotest cities of Ecuador (100.000 inhabitants), only during the last few years have computer sciences been reaching a larger scientific public. Although the computer is mainly employed for word processing, in some cases it is used to run spreadsheets and CAD-systems, but only in exceptional situations an interest in GIS is shown. Therefore the principal activities are teaching and advising about GIS and Remote Sensing.

Presently GIS-education is not included in the curriculum of any of the faculties of the National University of Loja. The process of bringing the curricula up to date with the technological and scientific advances is very retarded because of the conservatism existing in Loja. Often professionals seem to lack curiosity, an open-minded attitude, initiative, imagination, an analytical mind, ingenuity, and planning capacity.

Moreover the infrastructure for GIS courses is still very limited as the basic needs of the university and the educational tools for the principal departments (eg chemistry, physics, biology, ...) are attended to in the first place.

## **Quito**

### *Context:*

At the *Escuela Politécnica Nacional*, the department UNISIG (*Unidad de Inteligencia Artificial y Sistemas de Información Geográfica*) was founded three years ago. The aim of the department is to organize courses of Artificial Intelligence, GIS and Remote Sensing and to participate in GIS related projects formulated in other faculties of the university. The team of professionals working at UNISIG consists of two foreigners (an agricultural engineer and a computer engineer), a local computer engineer and an electrical engineer. Because the department UNISIG is part of the 'Faculty of Computer Sciences', most of the students which are doing their thesis are future computer engineers.

(Quito, the capital of Ecuador has about 1 million of inhabitants.)

### *Current situation:*

Most of the teams time is dedicated to education ; lecturing at pre- and postgraduate level, seminars about geostatistics, remote sensing, ... . The follow-up of thesis students is another major activity. Most of the thesis students are dealing with GIS-database management applications in areas such as hydrology, irrigation, tourism, city planning and natural resources management. There are contacts with other faculties and private organizations in order to start GIS related projects. Although it seems there is a lot of interest, funding usually is hard to find. Another problem is that UNISIG was created within the Faculty of Computer Sciences, and therefore lacks the multidisciplinary contact which is needed within a GIS-workgroup. UNISIG has to contact and make agreements with other institutions which complicates the work.

## **Other projects regarding GIS education in Ecuador :**

### **MAG (ministry of agriculture)**

At this moment of group of consultants is analyzing different commercial GIS. By the end of this year a report is to be published with the results of this study and from January the training of personal with the selected software/hardware is expected to start.

At this moment there are two groups that have already started working with GIS : DINAREN (*Dirección Nacional de Recursos Naturales*) and INEFAN (*Instituto Nacional de Forestación de Áreas Naturales*). The main tools they use are ArcInfo, ArcView, IDRISI and PCI.

The training of staff is still a critical point. Only a very limited number of people have had any form of training at all and if there was any training, this training generally is limited to the use of one or another commercial GIS. This can be quite harmful as the underlying knowledge of projections, error assessment, scale, ... is completely neglected.

### **Other universities**

The "Universidad de Azuay" has been working on a GIS for the city of Cuenca. Unfortunately this effort resulted, so far, only in a prototype.

The "Escuela Politecnica del Ejercito" (ESPE) is the only university where a Faculty of Geographical Engineers exists. It is probably one of the best equipped institutes in Ecuador, both in hardware and software. In addition they have privileged contacts with the CLIRSEN (*Centro de Levantamientos Integrados de Recursos Naturales por Sensores Remotos*).

The Flemish Interuniversity Council (VLIR) is currently working with the "Escuela Politecnica del Litoral" (ESPOL) in a project "Monitoring the Guayas Estuary using GIS".

In the "Universidad Tecnica Estatal de Quevedo" (UTEQ), a former collaborator of the CINFA (Loja), a center for agricultural computer sciences has been created. Next year VVOB will send a GIS-expert to support this center.

### **Commercial organizations**

In Ecuador the vendors of GIS software provide very little user's support. ESRI is giving some introductory courses in Quito and TNTMips has been starting to divulgate his GIS and to organize courses.

### **Main problems**

Most of the problems in developing countries also occur in developed countries but become more critical in these economically weak countries.

The development cooperation and technical assistance organizations must contribute to diminish the technology gap. Their principal means are education and transfer of knowledge. But this is not altogether easy because of the following obstacles :

- (a) The basic knowledge of mathematics, statistics, geography and other base sciences is limited, a situation which originates from primary and secondary education and which is not sufficiently corrected at university level.
- (b) The knowledge of English is also quite rudimentary and prevents often reading GIS related literature and obtaining fellowships.
- (c) The low wages for university professors sometimes cause a competition for the knowledge in the new "high-tech" fields and are in some cases the reason why the transfer of knowledge to colleagues or students is limited.
- (d) Generally one can state that the employment opportunities for GIS professionals in Ecuador are still limited. Companies are not yet aware of the full possibilities of GIS technology and therefore did not create the corresponding job positions. The main possibilities at this moment are governmental institutions and universities. Regarding the employment opportunities in universities, one has to consider that these are usually not very attractive because of the low appreciations and salaries and the limited resources for research.

(e) GIS equipment for education is still very expensive, especially with reference to wage levels (eg. a university professor earns  $\pm$  400 US\$ a month). Universities are also subject to the national economic pressures.

The task of education and transfer of knowledge will take a long time, but can be sped up through small development centers with a catalytic function and which serve as examples.

### **The future ?**

The growing interest from both foreign development aid organizations and local institutions to apply GIS to a huge variety of, still largely unexplored, problems, should be guided by well trained personnel. Foreign professionals can have an important role in this as they can support and/or organize courses. These courses should be organized around a well-thought GIS curriculum.

As it is rather hard to believe that the existing faculties will create the space for such a complete GIS curriculum within their program, one should try to create introductory GIS courses within the given structure and extend these with a specialization post-graduate course.

To achieve a high standard of local GIS expertise, a national GIS forum should be created, international contacts should be made enduring and research projects using GIS - in a scientifically responsible way - should be supported.

As in the developed countries, it is necessary that the government takes positions on data standards, data policy and recognizes GIS training centers / degrees.

As stated above, the problems, needs and possibilities for GIS are quite similar in developing countries and in developed countries. Though, there are differences in economical possibilities, the stage in the development cycle, and the specific needs.

Only if they are fully aware of these differences, the presence of foreign experts can have a positive impact in these countries.



## PARTNERSHIPS IN GIS EDUCATION: BUILDING CAPACITY IN A DISADVANTAGED SOCIETY

Tracey Morton  
Department of Geographical Sciences  
Vista University  
Soweto  
Pvt Bag X9, Bertsham, 2103, South Africa

### ABSTRACT

*Previous experience of learning GIS applications demonstrated that working through solely through the tutorials in the manual was unsatisfactory. Students need to do projects that involve the manipulation of data through the use of GIS applications and to be exposed to the theoretical aspects of the technology, so that GIS would be taught in a socially responsible manner. There were, however, severe logistical problems with introducing such a teaching system, in terms of the availability of hard and soft ware, teaching hours and teaching staff. Thus, a programme was developed by myself, whereby, students would go out to businesses and government institutions currently using GIS applications to get "hands on experience". Teaching time that was freed by this system, was used to give students an opportunity to be exposed to the various theoretical debates surrounding the use of GIS and remote sensing technology. While this curriculum is still very much in the experimental phase, it is hoped that it proves to be of value, both to the students, to the Geography department of Vista University, Soweto and to the various GIS users who were involved. This paper outlines how the establishment of partnerships with various GIS users was undertaken and also includes a report back on the fruits of the partnership, from the perspectives of the students, the university teaching staff and the GIS users who took part in the programme.*

### INTRODUCTION

In order to overcome the logistics of teaching GIS at a historically disadvantaged university, a programme was devised to firstly give students access to a GIS in a practical form, and secondly, to introduce them to theoretical issues. One of the central problems with teaching GIS at Vista is the lack of sufficient computers. The department only has seven, even though there are over 60 students who need to use them. Another significant problem is that the software is out-of-date (IDRISI for DOS), which means that anything that the students learn on the system is very unlikely to be used in the GIS community, thus disadvantaging them in the job market. Thus, a programme was developed whereby students would be sent off to GIS users and vendors in the hope that they would be exposed to the various uses of a GIS, as well as, gain some operational experience. This programme was launched by Vista, Soweto at the beginning of 1997. This programme is, therefore, still new and the various advantages, disadvantages and logistical problems are currently being encountered and being dealt with. Most of the students and many of the GIS partners were, however, very impressed with the project and enthusiastic about being part of it.

## THE COURSE OUTLINE

The GIS course at Vista is structured into sets of 3, 6 week teaching blocks, consisting of 3 hours per week. The previous syllabus consisted of introducing students to what a GIS is and the various applications that it can be used for. Then, the students would move onto a basic introduction to the practical aspects of a GIS, using IDRISI for DOS. It was decided to radically change the syllabus, for several reasons: Firstly the current system did not adequately teach theoretical important GIS concepts, nor did it give students sufficient amount of time to learn a GIS system. Secondly, logistically, the GIS facilities on campus, consisting of 7 computers, only one of which has a hard drive and only 3 hours scheduled per week, the system would have been unable to cope with over 60 students. Thus, in terms of the time available; the shortage of computer equipment and the outdated technology, the best case scenario would have been that the students being taught GIS totally inadequately. The worse case scenario would have been that the course ended up being meaningless. Under such conditions, it was obvious that changes would have to be made. The options were to either abandon the course altogether, or update and increase the number of computers available to students, or radically change the way in which GIS was taught at Vista. It was decided that it would have been unfair to our students to abandon the GIS course, as having knowledge of a GIS was fast becoming a job requirement.

While an obvious solution to our logistical problems would have been to upgrade the computer laboratory by installing new computers, with hard drives and large memories, as well as, obtaining new updated software, financially and time wise, this option would have been impossible. Thus, a new syllabus was introduced. While the students would be introduced to the software, the theoretical aspects of the course we done in far greater detail and more depth. Additional topics such as the problems that can be encountered in doing GIS analysis, GIS and remote sensing, GIS as an appropriate technology for the third world, critiques of GIS, the politics embedded in mapping, the role of GIS in reinforcing power structures, as well as, how a GIS can be used to overturn or subvert systems of authority and power were included along with discussions on what raster and vectors are etc.

Once the theoretical aspects of GIS were dealt with, the students were to be given a brief practical introduction to the software, using IDRISI for DOS. Once with was completed, the students were then sent out to various GIS users or vendors in the Greater Johannesburg area. While in the businesses, they would observe a GIS first hand and also get some experience in using the software in a work situation if possible. This would give them some real work experience, which many of the students lack (and so are disadvantaged in the job market because of it). It was also hoped that the experience would stand the students in good stead should they wish to do any post-graduate studies. Finally, it was hoped that the students would enjoy the practical experience, meet people who could turn out to be vital business contacts, and possibly decided to make a career out of GIS. The project also appealed to the Soweto Geography Department, as it was the only way in which GIS could be offered to the students in the short term. It was felt that the students who were sent out to the various GIS businesses, would also promote Vista within the GIS community and Geographic circles generally within Greater Johannesburg. It was hoped that such an awareness would encourage GIS users to support or employ our students. Finally it was felt that the project could be used to promote Geography on the Soweto campus, as it offered hands on, practical experience in a

rapidly expanding field.

### ONE STEP FORWARD, TWO STEPS BACK! BUILDING THE PARTNERSHIPS

It soon turned out, however, that solving one problem, just created others! For now there was an urgent need to locate businesses who were using GIS and persuade them to take our students on for a period of eight weeks. It was decided that the best way to do this was the "sell" the concept to them, by pointing out the benefits for the company. Thus, an emphasis was placed on the companies been able to have an input on how GIS was taught at Vista, thus making Vista graduates more useful to the people who employ them. Dealing with the students would also enable the businesses to see if the students were in a position to contribute to the companies once they graduate, a better assessment method than appointing someone solely on the basis of their curriculum vitae.

As it turned out, the real problem was not persuading businesses to take part in the project, but in finding a sufficient number of businesses using GIS in the Greater Johannesburg area. Most of the GIS users are located in Pretoria, as Pretoria is the seat of government and so most of the government departments and parastatals are based there. The government agencies and departments are often the source of major GIS contracts and so many GIS vendors/users are located there in order to be close to their customers. Those that did fall under the scope of Greater Johannesburg, were, in fact located on the northern periphery, en route to Pretoria. This meant that even businesses who were within Greater Johannesburg, far from Soweto, were most of the students live. As all the students but one, rely on public transport, meant that getting to such peripheral locations turned out to be difficult, expensive and time consuming (see table 1).

Once businesses were identified and approached, the vast majority of them were very willing to participate, and most did so purely on philanthropic grounds. Those that did not participate, did so because they were either too busy to spend time with the students or because they had various logistical problems of their own that they were currently sorting out. A few refused to participate on the grounds that they were dealing with sensitive information and did not want unauthorised people working on their systems. A contact person was identified within each establishment, who would deal with the students and liaise with other members of the organisation and Vista for the duration of the project. Due to problems experiences in locating GIS firms, only 17 companies took part. This would have meant that three students would have been allocated to each business. Unfortunately this turned out to be impossible. Firstly all the companies indicated that they could only cope with two students at a time and, secondly, all of them insisted in having students that were of a sufficiently high enough academic standard to cope with their GIS. The result was, after lengthy departmental debates, that those students who had not managed to pass the whole third year course to date, would remain on campus and do further GIS practical work in the computer laboratory. In the end this system worked out rather well, as the weaker students were able to get more individual attention from the lecturer and many of them were able to successfully complete the GIS practical course.

### POSSIBLE HICCUPS!

There is always a possibility that such a project can be a failure, no matter how much time,

effort and pre-planning is put into it. As there is always a possibility that the students will have learnt nothing from the experience. This could be because the people within the businesses were too busy to actually work with the students, or that too little time allocated to allow any real learning to take place. For the students, the project required a great deal of investment, in terms of time (to get to the firms and back), financially (they had to pay to get to the firms and back) and planning (they had to sort out how to get there, as well as organise times to work with the employees of the firms). For Vista, student behaviour was a concern: How would students conduct themselves? How seriously would they take their visits to the GIS partners? How could the students be assessed? It would have been impossible for the lecturer to go around to every firm on a weekly basis in order to ascertain what the students are learning. So, it was decided to set a test at the end of the project. The test covered cover issues such as the practical problems of implementing and running a GIS in South Africa and then, their own experiences in the firms. The companies would also be asked to provide Vista with details of how the students performed while with the firms.

### THE PARTNERSHIP IN ACTION

The students began visiting the various GIS partners at the beginning of August in 1997, with the aim of spending time with them at least one afternoon a week. Naturally, there were mishaps with some students finding it difficult to make contact with the partners, while other students arrived to discover that the partner had decided to withdraw from the project at the last minute! For the students learning began from the moment they had to make telephonic contact with the GIS partner and get details of where they were located. For many of the students it was the first time that they had had to liaise with business people and develop business conversation skills (pers. observation; pers. comm W. B. Makhaya & F. M. Khaile).

The students had to then organise to get themselves to the various GIS partners and most of them had to rely on public transport to do so. For many of the students this turned out to be one of the most difficult and expensive aspects of the project. This was especially true for those students who were allocated to GIS partners located far away from Soweto, at such places as Rivonia, Midrand and Strathavon. The fact that the students are disadvantaged not just because of their low income status, but also because of the spatial legacy of apartheid was clear. Under the apartheid regime, black people had been confined to urban peripheral areas, with Soweto being the largest of these (see Figure 1). While urban apartheid legislation was totally dismantled by 1991, many black people are still confined to areas such as Soweto because of financial and social constraints. Furthermore, the apartheid state deemed these black areas to be residential zones only, so there are few commercial enterprises located in black areas or even near by. Thus, most

Soweto residents face severe spatial constraints in terms of getting to industrial and commercial areas. This was no different for the Vista students. As Figure 1 shows, Soweto is located on the southern periphery of Greater Johannesburg, while the GIS partners were mainly located on the northern fringes of the city. Traditionally the northern Johannesburg suburbs have been sought after in terms of residential and now industrial and commercial location. With decentralisation to the northern periphery, few businesses remain in the central city. So some students, therefore,

Figure 1: THE PERIPHERAL LOCATION OF SOWETO WITHIN GREATER

## JOHANNESBURG (not included in draft version)

ended up travelling up to 2 hours (one way) in order to get to the GIS partners (see Table 1). This was not because of distance alone, but also due to their reliance on public transportation, which is slow and erratic (another legacy of apartheid). While on average the students travelled one hour to get to the GIS partners, some were luckier than others and were allocated to partners that were located in the inner city or closer to Soweto. In the future, it is unlikely that the pattern of urban development in Greater Johannesburg will reverse, in fact, with the current trend of decentralisation, it is most likely that even the GIS partners that are currently located in the central city, will decamp to the northern suburbs (pers.comm M. Reed of Anglo American Geophysics). This means that any future projects will have to take this factor into account.

While a few of the students felt that getting to the GIS partners was difficult and time consuming, others felt that it was also dangerous, due to the levels of taxi violence that prevail in Johannesburg. As almost all of them had to rely on the taxis, such concerns are understandable. More, serious, however, was the cost to the students of the trips. As table 1 demonstrates, some students were paying up to R 27.20 (return) per session, to get to their GIS partners. This constituted a large part of the average student's budget. Most of the Vista students are unable to find part-time work during the term time (usually due to time constraints and lack of access to available jobs, as well as the general high unemployment rate in South Africa). This means that most rely on financial support from their parents or extended families. As most of these families are low-income, such high transportation costs had a serious impact on the family budget (pers. comm R.W.Mashawana; B.H.Zulu & K.Magodiello). Expecting families to make such sacrifices in the interests of ones education is common among black people in South Africa, but clearly some students and their families found the burden heavy to bear.

## ASSESSING THE VALUE OF THE PARTNERSHIP

Despite the obvious problems that were encountered in both the implementation and the running of the project, it was felt, by the GIS partners, Vista Geography Department, and the students themselves, that the partnership was a success. While criticisms were made, all participants felt that , once the problematic issues were addressed, the project should continue next year.

LOCATION OF FIRM	COST TO GET THERE - average*	TIME TAKEN- average**
CENTRAL JHB	R 5.70***	1 hour 5 minutes
PARKTOWN	R 10.00	1 hour 45 minutes
BOOYSENS	R 9.00	1 hour
RANDBURG	R 10.00	1 hour

MIDRAND	R 23.80	1 hour 20 minutes
RIVONIA	R 13.00	1 hour 40 minutes
ROSHERVILLE	R 8.00	50 minutes
STRATHAVON	R 17.00	2 hours

Table 1: The table shows the area that the students had to travel to, the time that it took them and the cost of the journey.

\*The cost of the journey refers to return trips and clearly shows that the students who were allocated to GIS partners who were located on the northern periphery of Greater Johannesburg (Midrand, Rivonia & Strathavon) paid far more than those who only had to travel to the central city and its environs.

\*\* The time taken for students to get to the business reflects one way journeys and times varied according to distance, volume of traffic and the number of taxi changes necessary. Again it was those students who had to travel to the northern periphery who took the longest to get to the firms and had the most traffic and taxi changes to contend with.

\*\*\* At the time of writing the Rand/US Dollar exchange rate was R 4.705 = \$1.00.

### The GIS Partners

Personal communication with various members of the GIS partners indicated that the project was well received. Some, Rob Taylor & Associates; Intertech Systems and GIMS, expressed their disappointment with being unavailable for students at certain times due to deadline constraints. Such problems are understandable, however, as company business would have to take precedent over teaching students. Most of the partners, such as Anglo American Geophysics; Maps & Data and the various municipalities that took part, were impressed with the dedication and capabilities of the students. Several of the GIS partners were (and are!) interested in establishing a more permanent relationship with the Vista Geography Department in order to upgrade the teaching of GIS on the Vista Soweto campus. Some were willing to come into Soweto and run courses (Susan Pruet), others were willing to employ some of the Vista geography students on a part-time basis during the annual vacation (Maps & Data; GIMS; Randburg and Midrand municipalities). Others were willing to donate computer equipment (Anglo American Research Division) or allow students to come and use their systems on weekends should they wish to (Transnet). GIMS, Anglo American Geophysics and the Gauteng Provincial Government, were willing to use their financial resources and business contacts to help the Vista Geography Department upgrade the GIS laboratory. As one of the students, O.S.Mvula, indicated, his experience of the GIS community, obtained during the project, proved how essential it is for Vista to upgrade its GIS facilities. Thus, the current plans to upgrade the GIS facilities on campus is seen as important by most of the project participants. Overall, the partners felt that the programme was a success and indicated their willingness to participate in any future projects. It was clear that they were interested in working with Vista to upgrade skills training and help

disadvantaged students.

### The Students

Most of the feedback received from the students was positive. Some felt that the exercise had helped them improve their computer skills generally, thus giving them vital computer experience and ensuring that they were computer literate (pers.comm R.W.Mashawana; W.B.Makhaya; T.GSekwati; M.E.Hlongwane; M.S.Tshehla & A.Mofolo). Others, such as R.W.Mashawana and E.S.Mahlaba were made aware of the practical use of geography outside of the academic world. Other skills that the students felt that they had acquired because of the project were:

1. How to interact with strangers (especially white people) and business people especially.
2. How to work as a team, in terms of collaborative work and assisting colleagues.
3. Basic draughting.
4. How to collect information and do primary research, such as liaising with the Deeds Office.
5. How to work with people generally in terms of interacting with them and accepting criticism. # Learning that office environments have particular codes of behaviour that need to be adhered to.

The students appreciated the general work skills and other information that they learnt, such as how businesses function; that one must be punctual; that business demand hard work, dedication, good service provision and work to tight deadlines and, finally, that education is essential in the post-industrial economy. More important, however, was their acquisition of GIS skills. Students learnt how to:

1. Apply GIS technology to South Africa issues.
2. Operate GIS packages such as ArcView, ArcInfo, MapInfo, ReMap and Regis.
3. Operate scanners and digitizers.
4. Input, store, overlay and retrieve data.
5. Convert vector based information into raster format.

Several students indicated that they had experienced some problems with some of the partners, such as employees being too busy to work with students; that some of the employees were unable to be effective teachers; that on some occasions, there were no computers for the students to use, due to deadlines and work loads in the firms; that some GIS systems broke down regularly or that the time that they spent at the firms was too short (pers.comm N.Nsibande; T.C.Vilikazi; D.H.Dube, S.R.Zulu; M.G.Gama). Despite this, most felt that the project was worthwhile, as they had learnt a great deal and several of them indicated that they were interested in following a career in GIS (pers.comm M.E.Hlongwane; N.Nsibande & O.M.Baloyi). Even those who did not want to pursue a career in GIS said that they enjoyed the chance to do practical work and apply their geographical knowledge. They felt that the project had given them a better understanding of how the business world functions, that given them valuable work experience, and new insights into the world of GIS.

For those students who were unable to go out to the GIS partners, due to their poor academic performance, the project was also helpful. This was because they were taught a practical GIS

course on campus using the IDRISI for DOS. Had the majority of the students not being sent out to the businesses, there would have been no possibility that any of the students would have received any GIS training. As the majority of the class was off campus, however, it was possible to fit the remaining students into the computer laboratory (providing that they shared computers). The smaller group also meant that the students were given a great deal more individual attention, and so most were able to complete the course successfully. While it was most certainly a pity that they were unable to attend sessions at the various GIS partners, most accepted the situation and were happy with the GIS course.

### The Vista Geography Department

The department was pleased with the results of the pilot project. Although the project took a great deal of time and effort to set up and had some hiccups, it ran reasonably smoothly. Partnerships with the business community is obviously a method that can be used to solve the lack of capacity in a disadvantaged community. For the students, the department felt that they learnt a great deal, not just in terms of GIS but also in terms of crucial work related skills. For the department, the exercise also ensured that the plight of disadvantaged students was brought to the attention of the GIS community and the result was that several of the partners are actively working to improve the situation on campus. While the university is currently developing a plan to enlarge the computer laboratory, and purchase more computers, various GIS partners have pledged to help further upgrade the facility in terms of acquiring hard drives, additional memory and installing GIS software such as ArcInfo and Regis. It is hoped that the problems experienced in the pilot project can be ironed out and that the programme can run again in 1998. The aim is to identify additional GIS partners, attempt to select partners that are located closer to Soweto and hopefully get funding from sponsors to assist those students who cannot afford the high cost of transport to the businesses.

### **CONCLUSION**

It is clear that such a project can be of a great deal of value, for all of the parties concerned. The GIS partners agreed that they felt that they could have input into the teaching of GIS in South Africa, which they had not had before. Other firms felt that the students, once trained, ended up assisting the firm. Many students felt that they had gained a great deal in terms of learning how a company operates, as well as, learning aspects of GIS, such as digitizing, that they would not have learnt had they stayed on campus. In fact, the students received a high degree of exposure to GIS, which they would never have received had they remained on campus. For the Vista Geography Department, it was felt that, in a world where education budgets are constantly being cut and yet more and more students are registering for courses, this was a definite option that could ensure that graduates have a theoretical knowledge of GIS as well as practical experience. The establishment of partnerships with the private sector is being acknowledged worldwide as a way of ensuring that graduates are well educated and employable. Other tertiary institutions may want to implement this option. There are several preconditions, however. The department needs to be innovative and willing to take a risk on such a venture and be prepared to put a great deal of time and effort into establishing partnerships with GIS firms. The department also needs to be located near to an established GIS community. One also needs students who are keen to learn, interested in GIS and understand the importance of practical experience, so as to ensure that they are willing to make the sacrifices necessary to guarantee that the project works.



# **The Need for GIS Education in Mauritius**

**Jaishree Beedasy**

**University of Mauritius, Mauritius  
Faculty of Engineering**

\*currently a Fulbright Scholar at:  
Department of Geography  
Pennsylvania State University  
University Park, PA 16802

## **Abstract**

Lack of trained personnel is a major problem facing the implementation of GIS in Mauritius. Situated 800 kilometers off the east coast of Madagascar, Mauritius has a land area of 1865 square kilometers and a population of one million. Rapid industrialization and economic growth have created considerable pressure on the provision of housing, transportation, community facilities and recreation. Many institutions have realized that the proper application of GIS technology would be of tremendous help in managing and monitoring resources to sustain the development of the island. The implementation of GIS in Mauritius is coming mainly from the outside, as foreign technical collaboration and aid. After the departure of the foreign consultants, the projects are 'orphaned' and are left at a standstill. In several institutions approved projects never even get started although costly hardware and software have already been acquired. These lie idle because of lack of trained personnel to work with them. The University of Mauritius does not run any GIS course yet and as a first step is considering to hold a seminar on GIS and a training session on ARC INFO with the help of foreign consultants. The University is developing its own physical and human resources to be able to run GIS courses to meet the country's need. Problems such as administrative barriers, lack of collaboration among institutions and a scarcity of organized spatial data are also discussed in this paper.

## **Background**

Situated 800 kilometers off the east coast of Madagascar, Mauritius is an island with a land area of 1865 square kilometers and a population of one million. Rapid industrialization and economic growth have created considerable pressure on the provision of housing, transportation, community facilities and recreation. The dense population has increased demands on the public infrastructure. There have been changes in land-use as more and more agricultural land has been converted to urban, commercial and tourism oriented uses. Much of the country's economy is built upon manufacturing industries, agriculture (sugar production) and tourism that in turn depend upon the balance between natural and built-up environment

being sensitively managed.

The need for GIS technology is being felt by several departments. The latter have realized that the proper application of GIS technology would be of tremendous help in managing and monitoring resources to sustain the development of the island.

## **GIS Implementation in Mauritius \***

In Mauritius a shortage of trained people, no strategy and lack of spatial data are hindering the development of GIS. The implementation of this technology which is new to the country, is coming mainly from the outside, as foreign technical collaboration and aid. After the departure of the foreign consultants, the projects are 'orphaned' and are left at a standstill. In several institutions approved projects never even get started although costly hardware and software have already been acquired. These lie idle because there is a lack of trained personnel to work with them.

### ***GIS Projects***

The objectives of institutions/departments owning or considering to develop a GIS are shown in Appendix A. Most of them have some ties with international organizations and they sometimes work in collaboration with these organizations or benefit from their technical or financial support. Several of these departments have acquired GIS hardware and software but have not proceeded any further (Appendix B). Even in those places where the GIS is operational, its use is very limited. It is either an automated cartographic mapping system or else a database. There is practically no spatial analysis being carried out.

The Mauritius Sugar Research Institute (MSIRI), the Water Resources Unit and the Marine Sciences Unit have GIS that are mostly in the early stages of operation.

The Mauritius Sugar Research Institute is among the first to have acquired a GIS. It was initiated a couple of years back with the help of foreign technical support. Now the institute has two trained local staff, one in remote sensing and the other in GIS. Several other technical staff have received in-house training and attended seminars carried out by foreign experts to help them with the software (ARC INFO) and hardware. The GIS is being used for sugar cane land indexing.

The Marine Sciences Unit at Albion has started a marine conservation project using GIS. The software used for this project is MapInfo. The data for the base map was obtained from aerial photographs and GPS receivers were used for ground 'truthing'. Most of the setting up is being carried out by the Canadian International Development Agency (CIDA) technicians. Two members of staff are being trained as the project progresses. They will have to eventually take over the project.

Water Resources Unit has acquired a customized hydrological GIS. This was developed by GEOLAB (France). The local staff still works with the French technical support to operate the GIS. They intend to model the water resources in Mauritius and use it as a management tool.

## ***GIS Committees***

The question most often raised is how to proceed to develop GIS technology in the country. There is no well-defined strategy for the implementation of GIS. Two national committees have been set up to look into GIS and remote sensing issues, the National Land Information System (LIS) committee and National Remote Sensing committee. No effective plan of action seems to have emerged from the work of these two committees. Members of these committees are representatives of the institutions embarking or envisaging to embark on GIS projects. There is no collaboration between these institutions, and sharing of information and know how are rare. Each project is an isolated one and each group is trying to solve its problems on its own.

The LIS committee is chaired by the representative of the Ministry of Land and Housing. This ministry advocated that the introduction of a Land Information System could provide the government and possibly other users with up-to-date spatial digital data apart from producing and updating maps and statistics. Once fully operational besides providing up to date information to planners for decision making it would lead to savings on staff costs and time. The project was to be launched by 1996 with the technical support of the World Bank. Partly because the necessary resources were not available and partly because some officials could not perceive the utility of the system the project did not start.

The Remote Sensing committee brings together the representatives of government departments and institutions that are potential users of data from the Remote Sensing Center. This center is under the aegis of the Ministry of Agriculture and Natural Resources and is being set up with the financial help of the Indian Government and technical support of the Indian Space Research Organization (ISRO). There are plans for the acquisition of satellite images captured by the ISRO to be sent to Mauritius. The image processing will be done by the local staff at the Remote Sensing Center. Scientists and technicians from ISRO have already installed most of the equipment. In 1996 they also held a seminar and a couple of technicians were sent for a few weeks to ISRO in India for further training. Such short preparations are not sufficient for these technicians to operate the center and therefore the resources at the center are lying idle.

The projects are not operational mainly because of lack of adequate planning and follow up actions. The results are unprofitable investment in hardware and software and set objectives not being attained.

## **Equipment and Spatial Data**

Several institutions are already equipped with GIS hardware and software. Financial support from international organizations and the diminishing costs of electronic equipment have made them more accessible. In most cases the systems were acquired without any structured evaluation of the needs of the organization. Most of these systems remain unutilized (Appendix B). The reasons put forward are lack of data or lack of qualified people to operate the system.

There is very little spatial digital data available. Departments are relying on the LIS project

and Remote Sensing Center for their spatial data requirements. A few departments have started with their own data collection and initiated their projects with the financial and technical help of international organizations. Yet there is rarely any data sharing or exchange. The bureaucratic barriers to the exchange of data and technological know how has been eliminated. This will avoid unnecessary duplication of data collection. Simultaneously other sources of data have to be investigated. An accessible source of data these days is from satellites. The collaborative work with ISRO will enhance the acquisition of satellite data. As mentioned previously the problem is that the processing of the data is beyond the present capabilities of the local staff.

## **GIS Training Requirements in Mauritius**

To operate a GIS correctly, there is a need for competent personnel. Appendix C shows the human resources available and/or required by the departments. It is observed that there is a shortage of adequately trained people. Local technicians require further preparation in the theoretical and practical aspects of the technology. The GIS software are not very user friendly and require several months of intensive training. The competence of the local scientists is not increasing at the rate of the technology transfer. It is a fact that some projects have been started but these have been done with the help of foreign experts. Maintaining the GIS operational after the departure of these experts is a major problem.

The theoretical base in GIS and remote sensing has yet to be built in Mauritius. An educational program needs to be developed to alleviate the problem. The educational institutions in Mauritius are facing the challenge of setting up such programs. Presently no training centers in Mauritius offer GIS courses. The Faculty of Engineering and the Faculty of Science at University of Mauritius (the sole university on the island) are interested in setting up facilities to enhance the development of GIS. Hardware and software have already been acquired with funds from a World Bank program. The University is planning to develop its own physical and human resources before it can run GIS courses.

Trained local people will understand both the technological and socio-economic context in which the system has to operate. The technology can then be adapted to the needs and capabilities of the particular situation in which it is to be used.

## **Developing GIS Technology in the Country: A Proposed Strategy**

There is no doubt that the application of GIS will benefit the country. Planning, environmental management and resource allocation decisions are extremely critical in an island setting like Mauritius. State-of-the-art planning tools such as GIS could bring solutions to these complex problems hence the need to explore and research these techniques. Some departments are conscious of the growing importance of the use of computerized tools for resource management and spatial data analysis and decision making yet they do not have access to data or the adequate human resources to make use of the data. To provide solutions to these problems a well-defined strategy has to be adopted.

## ***Well Structured Approach***

The introduction of GIS in the country has to be seen from a national perspective. All the sectors concerned with GIS technology, private and public, have to put their efforts together for mutual benefits. In the first instance a national GIS program has to be laid down. Only one national committee is sufficient to monitor GIS development. There is no necessity for a national committee for each major project. The committee can consist of representatives of departments or institutions involved in GIS activities. The representative need not be the administrative head of the department as (s)he is rarely very familiar with the details of the project. (S)he is not able to discuss its problems and priorities. The project leaders of proposed or operating GIS projects will be more appropriate delegates. The educational institutions planning GIS training programs will also be represented by people actively involved in such plans.

The main objectives of the committee will be to

- to coordinate the activities of the different departments and institutions.
- to promote the capacity building efforts
- to see to it that the technology and the technology transfer involved in GIS implementations satisfy defined goals and meet local conditions.

To be able to accomplish all the above the committee need to have certain powers such as access to information and right to monitor the projects. The chairperson will have to be a dynamic and resourceful person convinced of the benefits of GIS.

To meet its objectives the committee can come up with a well-defined plan of action by

- identifying the needs in terms of data, infrastructure and know how
- identifying existing and potential data sources
- setting up and maintaining an inventory of data, hardware and software and expertise available
- setting up specifications for information (metadata) about the data
- acting as a mediator for data exchanges - all data requests being channeled through the committee which would then send a request to any department having such data
- acting as a facilitator and investigating the problems of any project which is not progressing according to schedule or not meeting the specified goals.
- setting up and monitoring a capacity building program with the collaboration of the University of Mauritius and training centers.

Some of the key issues for an effective training program are discussed in the next section.

## ***GIS Capacity Building Program***

GIS training will have to take place in different ways and at different levels by :

### **\* Creating awareness**

To exploit GIS technology successfully awareness must be created at the level of planners, administrators, engineers and technicians. These people must realize the potentials and the benefits to be derived from the technology.

As a first step the Faculty of Engineering (with the collaboration of different departments) is considering to hold a seminar on GIS and a training session on IDRISI and ARC INFO software with the help of foreign consultants. The optimum would be to hold different awareness sessions for each target group. These sessions have to be of varying duration and at different levels of details depending on the audience.

**\* Organizing training sessions run by experts.**

This has already started but not in a systematic coordinated manner. Experts from France (GEOLAB), South Africa, India (ISRO) and Canada (CIDA) have been running some workshops and seminars. The training programs has to include a follow up action as not only has the theoretical and practical aspects of GIS to be built but it has to be reinforced gradually. The competence of the people has to be increased progressively as more advanced technology is introduced. It would be ideal for all those working on GIS projects or setting up GIS infrastructure to benefit from such programs.

**\* Sending people to an educational institution abroad where the expertise and equipment are available.**

Both the Faculties of Engineering and Science have sent a couple of staff on training programs and seminars abroad to acquire further knowledge. Other educational institutions can also engage in such capacity building efforts. Local expertise has to be built to enable the implementation of courses in GIS. The local trainers have to be competent enough to eventually take over the work started by the foreign experts. This type of training is essential but expensive. Financial support from international institutions is very beneficial for such training.

An interesting recommendation made by The International Institute for Aerospace Survey and Earth Sciences of the Netherlands is that for GIS technologies to be successful, minimum personnel training should comprise the following groups: (Bernhardsen 1992)

- Decision makers and planners, including, officials and administrators who need a general understanding of the practical possibilities and limitations of GIS as a decision making tool.
- Leading personnel in institutions, public management agencies and private companies, who need sufficient technical knowledge to coordinate the introduction of GIS.
- Technicians responsible for the operation and maintenance of equipment and programs
- Research workers knowledgeable in GIS and with expertise in applications development and in GIS as an analytical tool.
- Instructors responsible for training and teaching the various categories of personnel and knowledgeable in GIS technologies and their practical applications
- School pupils and University Students

The above recommendation can prove to be very helpful while planning awareness and training programs.

It is not claimed that this is the only strategy or the optimum one for the implementation of GIS in Mauritius. Nevertheless it can be a good starting point for further discussions to arrive at a more effective strategy.

## Conclusion

Mauritius has to learn from its own experiences and that of other countries in implementing GIS technology. A review of the experience of others is useful especially when a new technology is implemented. This helps to minimize wastage of precious resources - time and money. Most of the projects have not taken off or failed to operate in Mauritius because of unavailability of expertise. So priority should be given to capacity building. There is a pressing need for the setting up of an appropriate training program which will foster the implementation and exploitation of GIS technology in the country.

## References

Beedasy J . (1996) Survey on GIS Projects and Resources in Mauritius.

Bernhardsen, T.(1992), Introductory Readings in Geographic Information Systems. Asplan Viak IT a.s./Norwegian Mapping Authority.

---

### Appendix A - Departments contemplating to operate or operating GIS Projects

<b>Institutions/ Departments</b>	<b>Objectives</b>	<b>Collaboration &amp; Technical/Financial Support</b>
Ministry of Housing Survey - Division Land Information Unit Cartography Unit	Surveying and preparation of maps of Mauritius and Rodrigues	Technical aid and commercial relationships: Ordnance Survey (UK) Institut Geographique National (France)
Ministry of		Financial aid: Government of India Technical

Agriculture et Natural Resources Remote Sensing Center	Remote sensing and image analysis	assistance/collaboration: Indian Space Research Organization(India) Regional Center for Remote Sensing (Nairobi) European Space Agency(Rome)
Mauritius Sugar Industry Research Institute Land Resources Division	Agricultural Land indexing with emphasis on sugar cane plantations	Collaboration: Mauritius Sugar Producers Association(MSPA) Ministry of Agriculture SIGMA, SIFB, FSC
Ministry of Energy and Water Resources Water Resources Unit	Evaluation and management of water resources.	Technical /Financial Assistance by La Cooperation Francaise. Consultant:GEOLAB (France)
Ministry of Environment and quality of Life Department of Environment	Management of Environment and EIA	Financial/Technical support : World Bank, UNEP Collaboration : Other Ministries
Meteorological services	Weather Forecasting	WMO (World Meteorological Organization)  Australia
Ministry of Fisheries and Marine Resources Marine Science Division	Marine and Coastal research	Technical Assistance : CIDA (Canadian International Development Agency)
Ministry of Rodrigues Cartographic Division	Preparation of detailed maps of Rodrigues	Technical support : FED Fonds Européens de Développement
University of Mauritius Faculty of Engineering Faculty of	Providing tertiary education to meet the social, administrative, agricultural, scientific and technological needs of Mauritius.	Financial aid : World Bank



Science		
Central Statistical Office(CSO) Housing and Environment Section Cartography Section	Statistical Analysis of National Data Preparation of Demographic Maps	Collaboration: Ministry of Housing Cartography Unit Dept of Environment

### Appendix B - GIS Hardware and Software

Institutions/ Departments	Software and Hardware	Status
Ministry of Housing Survey - Division Land Information Unit Cartography Unit	A GIS system ( Hardware/software and technical support) is planned for under the LIS project. Digitizer PCs (AutoCAD)	Utilized for cartographic purposes
Ministry of Agriculture et Natural Resources  Remote Sensing Center	Sun Sparc Workstation PCs Light tables Mirror stereoscope Planimeter Ground Truth Radiometer Scriber ERDAS/Imagine - Image processing ARC/INFO (Work Station)	Center not fully functional
Mauritius Sugar Industry Research Institute  Land Resources Division	PCs Digitizers Color Printer Plotter GPS receiver ARC INFO (PC) ArcView	In Operation
Ministry of Energy and Water Resources  Water Resources	PCs(Pentiums) notebook plotter color printer scanner digitizer	In Operation

Unit	Atlas GIS (AutoCAD) Custom made GIS by GEOLAB	
Ministry of Environment and quality of Life  Department of Environment	1 PC 1 Digitizer IDRISI	No GIS in operation
Meteorological services	PC IDRISI	No GIS in operation
Ministry of Fisheries and Marine Resources  Marine Science Division	Pentium desktop Digitizing Table( 36"x 48") CD ROM writers Color Scanner Ink Jet Printer - size A3 Plotter - size E ( 36"X 7ft) 2 notebooks 2 GPS units ( interfaced to the notebooks) 1 Eliminator 1 Zip drive- portable ( for back-up) MapInfo ArcView	In Operation
Ministry of Rodrigues  Cartographic Division	PC (Pentium) Digitizing table Plotter format A1 Color Printer GPS receiver (to be acquired) (AutoCAD)	To be used for Cartographic purposes
University of Mauritius  Faculty of Engineering  Faculty of Science	Photogrammetric Equipment Sun Work Station (143 MHz SPARC processor) o/s :Solaris 2.5.1 Plotter Scanners Digitizer PCs ARC/INFO 7.0 IDRISI ARC INFO(PC) ARC View	For research and educational purposes.  Not fully functional.
Central Statistical Office(CSO)  Housing and	Digitizer ATLAS GIS	Not Used

Environment Section		
Cartography Section		

## Appendix C - Human Resources

Institutions/ Departments	Human Resources
Ministry of Housing  Survey - Division Land Information Unit  Cartography Unit	Two persons trained for one year in UK. One transferred to another Ministry (his GIS skills are not relevant to the job).  6 to 8 technicians will have to be trained under the LIS project
Ministry of Agriculture et Natural Resources  Remote Sensing Center	Three people have followed short courses in India. One of them is at posted at the Remote Sensing Center. In 1996 a two-week intensive course was run by ISRO scientists in Mauritius. Longer term and more advanced training is required for the potential cadres or recruitment of professionally trained personnel is necessary for the center to become functional.
Mauritius Sugar Industry Research Institute  Land Resources Division	Two people have followed courses in UK and the United States. Four other technicians have been trained by foreign experts and by these two local scientists.
Ministry of Energy and Water Resources  Water Resources	One person has been following the setting up of the project by the GEOLAB experts. Two other local staff are also involved. They require further training to operate the GIS effectively on their own.

Unit	
Ministry of Environment and quality of Life Department of Environment	Two members of staff were sent for short courses in Australia and Nairobi. They are not involved in any GIS work. Their skills are not adequate to implement a GIS project.
Meteorological services	One person was sent for training for a short period and but his skills are not sufficient to set up or operate a meteorological GIS.
Ministry of Fisheries and Marine Resources Marine Science Division	Six technicians followed a short course by the CIDA team who are developing the Marine GIS. This group was reduced to three in the second follow-up short session. It is planned that one of them will be given more advanced training in Canada.
Ministry of Rodrigues Cartographic Division	Five people are being trained to use the system by the French expert. This is an automated cartography project.
University of Mauritius Faculty of Engineering Faculty of Science	Three people have followed courses in Europe. One is presently reinforcing her knowledge in the States. Further training is required for the potential trainers and for technicians.
Central Statistical Office(CSO) Housing and Environment Section Cartography Section	The only person who was sent to follow a course in GIS passed away. There is need for skilled personnel.

\* The data contained in this paper was collected and compiled during a survey that the author carried out in 1996 before leaving Mauritius for the United States.

## **Rebuilding the Top of the Pyramid: Structuring GIS Education to Effectively Support GIS Development and Geographic Research**

Professor Duane F. Marble  
Department of Geography  
The Ohio State University  
Columbus, Ohio 43210

### **Introduction**

It has been a quarter of a century since the first formal courses in GIS appeared in a U.S. geography department. These initial courses were strongly oriented toward the geography/computer science interface since the availability of GIS technology then was generally at the "if you want it, you will have to build it" level. As a result, most of the GIS students of that era emerged well equipped to make substantial contributions not only to the ongoing development of GIS technology, but also to the new areas of geographic research that were opening up as this technology slowly became available.

Over the ensuing years the focus of GIS education in geography has shifted significantly, but unfortunately this shift has not been one that permits many of today's geographers to take full advantage of the burgeoning capabilities of the technology. As GIS technology has become generally available, as well as more user-friendly, an erroneous notion developed in some quarters that these changes mean that the technology can be mastered by almost anyone with only a minimal investment of intellectual effort. This has led a number of academic units to structure their programs so that only an introductory course in GIS (and often one that concentrates only upon the details of operating a specific, off-the-shelf software package) is all that is considered necessary to fully make use of this now powerful tool. This is much like using statistical software without knowing much about statistics!

Hand in hand with this dilution of GIS education has also gone the notion that individuals in the discipline with an interest in the further technical development of GIS are somehow not doing "real geography." This represents an aberrant attitude in which we see a supposedly scientific discipline rejecting not only participation in the further development of a powerful tool of widely demonstrated utility, but also ineffectively training its students in making use of the tool as currently structured.

This shift in focus has led to the creation of a generation of geographers, and many others interested in the application of GIS technology, who are, at best, able to apply perhaps 10% of the power of the technology, and this often incorrectly. The present attitude, if it is allowed to continue, will turn out to be unfortunate for the discipline of geography, for the GIS industry and for those hundreds of thousands of individuals and organizations who are finally finding out that "geography really matters" through their exposure to the highly useful products of GIS technology.

### ***GIS and Geographic Research***

The application of GIS technology is rapidly changing the spatial structure of society as well as the way that individuals live and work in a spatial-temporal context. Failure to recognize this, together with the notion being put forward by some individuals that GIS technology is somehow "wrong," lies at the root of the present problem. As geographic researchers we are generally failing to advantage of the substantial increase in scope provided by the widespread availability of GIS technology. Not only are new analytic capabilities now possible, but the volume of detailed spatial data available to us has increased by several orders of magnitude. The situation in spatial analysis today is much like that of traditional cartographers suddenly confronted the tools of modern color graphics -- a common response is just to ignore the massive increase in scope and to continue to do very much what was done before. The need in spatial analysis today is not for further polishing of existing tools and ideas, but rather to realize that we can now move on to a host of exciting new research areas that GIS technology makes possible. I suggested some years ago that GIS technology would have a significant impact upon the definition and execution of research problems in geography and the other social sciences (Marble, 1990), but this change has yet to gather significant momentum. One reason for this is the low level and non-technical nature of the GIS education that is currently available.

The traditional lack of effective tools for handling large volumes of complex spatial data has led traditional spatial analysts to make substantial simplifications in the spatial problems that they addressed (see, for example, the comments in Marble, 1998). An obvious example may be seen in the one-dimensional assumptions that implicitly underlie much of our current work: it seems that while distance matters, direction does not. This reduction in the spatial dimensionality of the analysis (not to mention the important missing temporal component) reflects the analyst's perceived need for simplicity when faced with a highly complex spatial-temporal world. Yet another major problem area is encountered when we examine the question of the scale at which many geographic analyses take place. The common use of larger instead of smaller analysis areas again represents an attempt by the analyst to avoid complexity through the assumption of areal homogeneity when such an assumption is highly doubtful (e.g., research based upon Census tracts when comparable block group data is available).

The existence of GIS technology does not instantly "solve" these analytic problems, but it does provide an available framework that will permit geographic researchers to eliminate outdated approaches and to significantly increase the scope of our work. The result, if we make use of our new tools and improved spatial data correctly, will be a significant advancement in our understanding of the spatial and temporal structure of society.

### ***GIS Education and the GIS Workforce***

The rapidly increasing use of GIS technology in nearly all segments of society has placed substantial stresses upon the industrial base responsible for development of the technology and upon those organizations, both public and private, who are rapidly making it an integral part of their day to day operations. Not only are there tens of thousands of new users to be trained, but the technology development process itself requires the presence of many individuals with substantial skill levels in both geography and computer science. Geographers without computer science and computer scientists without geography are no substitute for the type of invaluable, cross-disciplinary education and training that has served so well in the past. However individuals with this combination of skills are becoming increasingly difficult to identify in today's job market.

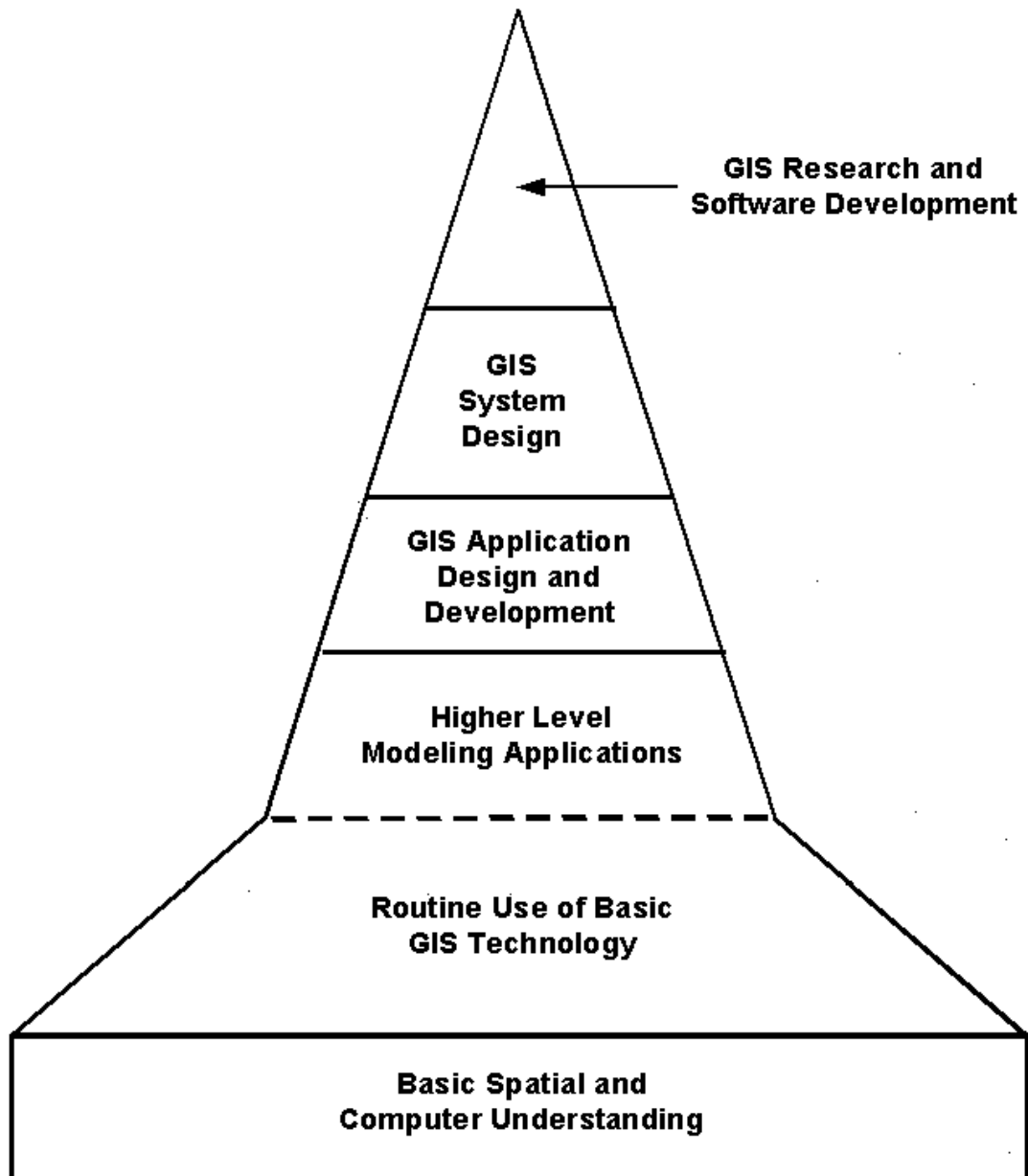
A recent study by the Information Technology Association of America notes that one job in ten in the general information technology (IT) area is currently going unfilled (ITAA, 1977; and Oracle, 1997). I would suggest, based on my experience, that of those that are filled, at least two of these represent less than optimal hiring decisions. I am also quite certain that conditions in the GIS industry, because of its specialized requirements, are even worse than what ITAA reports for the overall IT industry. There is clearly a very strong and increasing demand for individuals who are educated to a level where they can effectively work with, and continue to develop, modern GIS technology. It is also clear that today most geography departments are not graduating students with these capabilities.

I believe, and so do others in both academia and industry, that we must move to rectify the present dangerous situation by immediately revitalizing what has become a diminishing segment of GIS education. The basis for accomplishing this is to encourage a much stronger melding of geography and computer science. If this occurs, then we will be able to meet the rapidly growing need for well-educated geographers in the world outside of academia and, at the same time, significantly improve the quality of geographic teaching and research in our colleges and universities.

### **An Outcome-Oriented Model of GIS Education**

What needs to be done? Before elaborating on this let me establish a little context by examining my personal view of GIS education. For some years I have used a simple, outcome-oriented model of GIS activities. First I ask the individual the question "what do you want to do in geography and GIS?" and then I place their response within the context of my simple model. From this I can then suggest appropriate paths leading to the level of competency desired. The model is shown in graphic form in Figure 1. I have used a pyramid form (yes, it is really 3-D in order to accommodate the many building blocks that make up the more detailed view) and a look at the general levels of this pyramid will establish a context for my subsequent suggestions..

## An Outcome Oriented Model of GIS Education



Duane Marble

December-1997

**Figure 1**

### *Basic Elements: The Foundation*

At the bottom of the pyramid we see a foundation of basic elements. These represent the items that the individual must have in hand before he or she can successfully venture into the realm of GIS. Here we encounter such items as basic cartography (e.g., notions of scale, projections, elements of map design, etc.), basic spatial analysis (including statistics), computing (programming concepts, methods of data organization,

etc.) and the development of what I call "thinking spatially." This latter element is one of the most critical building blocks and refers to the ability of the individual to identify the active spatial components of any given problem. Many people are never able to do this and strangely some disciplines (even those with an explicit spatial component) do not seem to develop it in their students. Geography departments teach tens of thousands of students from other disciplines each year but commonly fail to develop this critical facility in these individuals. Failure to acquire a basic understanding of all of these components leads to subsequent errors and inefficiency in the individual's use of GIS technology.

### ***The First Operational Level: Routine Uses of GIS Technology***

Just above *Basic Spatial and Computer Understanding* we encounter the initial operational level labeled *Routine Use of Basic GIS Technology*. Here the individual is expected to have a working grasp of the foundation materials and also to know enough about GIS to make effective use of basic components of GIS technology and to use GIS applications created by others. An example might be a social science researcher who is using, say, ESRI's ArcView to create simple overlays or to make a fairly standard map. For individuals who routinely perform at this level we would expect that if an operation is accessible from the interface tool bar, then the individual should be able to handle it -- *and understand it* -- without too great an effort.

Regretfully, I encounter many people working at this level who have skipped over some of the fundamentals and, as a result, make stupid mistakes in their work. Indifference to critical scale considerations represents a common example of this type of error. Producing really awful, and sometimes misleading, maps is yet another. Failing to realize that there is far more that can be done with GIS technology is by far the worst! Beyond mastering the elements contained in the *Basic Spatial and Computer Understanding* level, a good, semester-length introduction to GIS course with substantial laboratory work is the most common entry requirement to this level of my pyramid. A critical component of this initial course must be the development of a working knowledge of the full scope of GIS technology.

### ***The Second Level: A Major Increase in Competence is Required***

Above the *Routine Use ...* level we encounter a bold, dashed line in the diagram. This line represents the presence of a really significant amount of education and training that must be undertaken before any effective approach to the upper portion of the applications use level (*Higher Level Modelling Applications*) is possible. To rise above my dashed line, the individual must be prepared to make a substantial investment in learning about formal approaches to spatial analysis and his or her ability to "think spatially" must be highly developed. Also, to operate effectively at this level, the individual needs a good grasp of basic computer programming (C, C++ and Visual Basic are common languages today) as well as at least an introductory understanding of database systems. I would expect individuals capable of operating routinely at this level to be able to structure and operate complex models using Tomlin's Map Algebra, intelligently utilize the routing and service area assignment models found in GIS extensions such as ESRI's Network module, devise and implement their own models within the scope of "off-the-shelf" GIS technology, etc. This level of competence will, of course, require perhaps two or more intermediate courses in the GIS area.

Beyond basic GIS and modeling competence, the individual who expects to routinely operate at this level must also be capable of undertaking, and understanding, within the context of their own problems, analyses of the type that Peter Fisher (1993) carried out so well for viewshed algorithms. This implies not only a knowledge of algorithms in general, but also of the way in which they are implemented within the GIS. A good course on algorithms with particular emphasis on GIS algorithms and data structures is clearly a must. This, with the two applications-oriented courses noted above, represents over a year of work specifically in the GIS area.

### ***The Third Level: Creating Applications Instead of Using Them***

The next higher level of the pyramid addresses *GIS Application Design and Development*. At this level, over and above all the basic uses of GIS technology, including routine modeling, the individual must be able to develop and implement sophisticated GIS applications that may involve substantial spatial analysis and modeling components. At this level a number of computer science elements such as programming, software engineering and advanced database systems are drawn upon quite heavily as well as other significant elements from geography and spatial analysis. Programming skills at the professional level are required. The level of



knowledge of existing GIS technology must be at a comparable level; this does not necessarily imply additional GIS course work but certainly substantially more depth can be developed thru project work. Professional level skills in modeling and spatial analysis are required in some cases (e.g., when working with complex logistics applications) and are certainly needed by anyone contemplating going on to higher levels of the pyramid.

#### ***The Fourth Level: Placing GIS Technology in a New Context***

The next level of the pyramid deals with *GIS System Design*. Here we find individuals who are trained in high-level system analysis and whose primary professional concern is with the implementation of GIS technology in complex situations where it has not been previously utilized. Work at this level is most often encountered in non-academic settings (universities seldom generate problems of suitable magnitude). The elements of systems analysis and GIS design should be taught to all GIS students who plan to work above the most routine levels although relatively few institutions currently do so. The professional GIS system analyst must be highly competent at everything contained in the first two levels and must fully understand all that goes on in the third level although his or her programming skills may not be at a professional level. It should be explicitly noted that the development of GIS design methodologies is an area of considerable academic research interest.

Individuals wishing to operate at this level need intensive work in all forms of systems analysis and design, including database design and the design of user interfaces. I have found that there is no substitute for including a real world project as part of the "GIS design studio." This project should address nearly all levels of GIS design (see Marble, 1995) and, if possible, be complemented by a subsequent course where a moderately complex system is actually implemented (as suggested by Mike DeMers of New Mexico State University).

#### ***The Tip of the Pyramid: Research and New Tool Development***

Finally we reach the top of my pyramid! Here we find a relatively small group of individuals deeply immersed in GIS and geographic research and development activities. Highly trained in geography, spatial analysis and computer science they are capable of creating new analytic approaches and algorithms and/or implementing them as part of powerful software tools for subsequent GIS application. These individuals who are working at the top of my conceptual pyramid must be capable of understanding and, if necessary, carrying out any activities normally associated with the lower levels of the pyramid. They are in exceedingly short supply today and their contributions are critical to the continued growth and development of the GIS industry. I would also argue that they are perhaps the only major group who are capable of fully integrating GIS technology into much of geographic research and of using this integrated technology to make major advances in our knowledge of the spatial structure of society.

#### **Some Observed Structural Problems**

As noted at the beginning of these remarks, the general emphasis in GIS education has shifted significantly over the last two decades away from a relatively close integration of computer science and geography. This has led to the great majority of persons who are "educated" in GIS attaining competence only at the very lowest operational level of my pyramid. Little or no attention is being paid in most programs to the education of individuals who desire to reach the higher levels of the pyramid. Even worse, many of these students are not even being made aware that more powerful manifestations of the basic tool exist!

Today, many institutions are offering little beyond an introductory course in GIS, often taught by individuals whose competency level is only modestly higher than that of the students in their class and who mistakenly focus upon software training rather than critical concepts and skills. The base of the pyramid has been widening at an explosive rate while the upper levels have been permitted to crumble. This situation, if allowed to continue, will certainly be disastrous to the future of the GIS industry and to the reputation and intellectual content of the discipline of geography.

Hand in hand with this myopic focus on the lowest level of the pyramid we are also finding an increasing amount of sand in the foundations. We need to find a better way of preparing individuals who are not initially seeking great depth in their encounter with GIS technology. Somehow we must encapsulate the critical items that are now spread over several courses and make them more readily available. Pragmatically, if we tell people that they cannot "do" GIS without first taking several courses then I suspect they will simply ignore us. The

solution here appears to be to devise a rigorous yet useful first course that will provide a sound initial foundation for individuals who want to learn GIS and that also makes extensive use of GIS technology in its presentation. Those individuals who have or subsequently develop a desire for deeper engagement with GIS can then be encouraged to seek out the more extensive, traditional basic courses in parallel with further work in GIS.

### **Rebuilding the Top of the Pyramid**

Clearly, we must significantly raise our current level of GIS education and we must do so with some haste if we are to keep pace with the rapid pace of technological advancement. First, we must *in all GIS education programs* firm up our presentation of both fundamental concepts and of the full scope of the technology. We must cease confusing mastery of software commands with attaining a grasp of critical intellectual concepts. We also must insure that those who teach our introductory GIS courses are competent professionals who fully understand the substantive structure of the technology.

With respect to the critical upper levels of the pyramid, we must immediately reestablish the strong role of computer science education within GIS and at the same time restructure all of our GIS educational activities so that this greater competence in computing is fully integrated into the structure of these activities. This clearly implies that there will be advanced, and highly technical, courses offered in GIS and that our notion of a curriculum in this area will advance beyond attempts to specify the content of one or two introductory courses to a full-fledged examination what spectrum of courses is required to make up an adequate GIS education at each level of the pyramid. We need to have a firm idea of what specific sequence of courses should be taken by a variety of individuals. For example:

- An undergraduate student in geography who desires a career in the GIS industry after graduation.
- A computer science/computer engineering undergraduate major who seeks a geography minor relevant to a career in GIS.
- A terminal, and most likely non-thesis, masters program that can be entered by a geographer or other disciplinary specialist having only basic computer science skills who is seeking a position in the GIS industry.
- A terminal, and most likely non-thesis, masters program that can provide GIS education for students with an undergraduate computer science/computer engineering degree seeking to obtain a strong grasp of GIS before seeking a position in government or industry.
- A graduate student in geography who is looking forward to a research career in the discipline.

The work of Bennion, et al (1997) is clearly a step in the right direction but within the U.S. context I believe that it would be quite helpful to have in hand a structured document somewhat comparable to those that have been produced by the Association for Computing Machinery (e.g., ACM, 1991a & 1991b). A joint academic-industry working group will be considering this matter early in 1998 and it is my hope that a well-developed plan of action will emerge from these discussions.

### **References**

- Association for Computing Machinery, 1991a. *ACM Curricula Recommendations Volume I: Computing Curricula 1991*. New York: Association for Computing Machinery.
- \_\_\_\_\_, 1991b. *ACM Curricula Recommendations Volume II: Information Systems*. New York: Association for Computing Machinery.
- Bennion, Frank, Barry Capper and David Unwin, 1997. *Professional Development for the Geographic Information Industry*. London: Association for Geographic Information. [Draft]
- Fisher, Peter F., 1993. "Algorithm and implementation uncertainty in viewshed analysis," *International Journal of Geographical Information Systems*, vol. 7, no. 4, pp. 331-347.

Information Technology Association of America, 1997. *Help Wanted: The IT Workforce Gap At the Dawn of a New Century*. Arlington, VA: ITAA.

Laurini, R. and D. Thompson, 1992. *Fundamentals of Spatial Information Systems*. London: Academic Press.

Marble, Duane F., 1990. "The potential methodological impact of geographic information systems on the social sciences," in Allen, Zubrow and Green (eds.), *Interpreting Space: GIS and Archaeology*. London: Taylor & Francis, Ltd.

\_\_\_\_\_, 1994. "An introduction to the structured design of geographic information systems," in David Green and David Rix (eds.) *The AGI Source Book for GIS*. London: Association for Geographical Information and John Wiley & Sons.

\_\_\_\_\_, review of Longley and Batty (eds.), 1998. *Spatial Analysis: Modelling in a GIS Environment*, forthcoming in the *International Journal of Geographical Information Science*.

Oracle Corporation, 1997. *Oracle<sup>®</sup> Academic Initiative: The IT Shortage*. An Oracle White Paper.

Worboys, Michael, 1995. *GIS: A Computing Perspective*. London: Taylor & Francis.

# Perspectives on GIS Education for Professional Development

**Sarah Cornelius**, Free University of Amsterdam

**Ian Heywood**, Manchester Metropolitan University

## Perspectives on GIS professional development

- Perspectives on GIS professional development
- UNIGIS survey
- Issues for professional development

## Perspectives

- National:
  - Beyond Chorley
  - UCGIS
- International:
  - EU
  - OPENGIS foundation

## Educators' responses

- development of continuing professional development programmes
  - (e.g. Edinburgh/Kingston/)
- increasing use of distance learning for course delivery
  - (e.g. GeoInformation/UNIGIS)
- development of electronic materials and support mechanisms for students
  - (e.g. Geographers Craft/NCGIA)

## The dilemma

- most programmes/products developed from educators perspective
- what do professionals need from GIS education and training?
- traditionally academic institutions have been poor at conducting market research for products

## UNIGIS survey

- aims:
  - to understand educational needs of GIS professionals
  - to help set development agenda for UNIGIS
- questions asked:
  - respondents background
  - motivation and communications
  - attitudes to professional development
  - course evaluation
  - future of GIS

## UNIGIS

- international consortium of Universities
- launched in 1992
- delivers postgraduate Diploma/MSc in

### Geographical Information Systems

- correspondence courses
- aimed at professionals in GI employment
- <http://www.unigis.org>

### Respondents

- 80 responses (approx 25% response rate)
- 86% European residents
- almost 20% UNIGIS graduates
- employment

### Respondent profile

- funding:
  - 66% completely or partly self funding
- motivating factors:
  - 39% Job/career development issues
  - 35% Useful/interesting materials
- prevented from studying by:
  - 36% Family commitments
  - 31% Work pressures and commitments
  -

### Respondents: likes/wishes

- likes
  - quality of modules
  - interaction with students and staff
  - range of topics covered
- wishes
  - more exposure to commercial software
  - more on implementation and intro. of GIS
  - awareness raising for senior management

### Relevance: course to work

### Relevance: course to career

### UNIGIS issues: users

- work for government/commercial orgs and consultancy
- will fund their own studies
- have access to email and internet, use email to contact tutors
- motivated to study by job and career development issues and an interest in the topic area

### UNIGIS issues: needs

- high quality materials
- interaction with staff
- materials on data and organisational issues

### exposure to commercial software

- awareness raising for senior management and IT staff to secure support for GIS projects
- WWW based resources

**Strategic development issues:**

**A new perspective?**

- accreditation and professional development
- overview/case study courses
- links with vendors
- more international courses
- improved student interaction
- better use of WWW
- awareness raising
- ....new UNIGIS?

**<http://www.unigis.org>**

# **A MODEL GIS LABORATORY FOR HIGHER EDUCATION IN A DEVELOPING COUNTRY: THE EXAMPLE OF THE GIS LAB., UNIVERSITY OF IBADAN, NIGERIA**

by  
Sylvester Abumere, Olusegun Areola & Bola Ayeni  
Department of Geography  
University of Ibadan  
Ibadan, Nigeria

## **Introduction**

As with most areas of modern technology, tropical Africa is lagging behind in the development and utilization of information technology. Poor telecommunication facilities, erratic electricity supply and the generally poor maintenance and management of public facilities have slowed down the entry of these countries into the international information highway. These are in addition to the almost herculean task of obtaining the necessary hardware and software. With particular reference to geographical information systems(GIS), a major problem facing its development and use generally and specifically in higher education in the developing countries of tropical Africa is the lack of foreign exchange to purchase the necessary hardware and software. Yet another problem is that of equipment maintenance and the purchase of necessary spare parts and consumables once the systems are set up. A further huddle is the training of the trainers at the local level to keep them abreast of developments in the field, especially, in a situation of rapid development of new software packages and of the continuous upgrading of existing ones. The GIS Laboratory at the Department of Geography, University of Ibadan, Nigeria provides a model of how these problems can be overcome through well-articulated bilateral agreements and relationships between institutions in developing countries and those in developed countries.

The aim of this paper is to describe the project under which the laboratory was set up and the institutions involved as well as the different stages and processes involved in the setting up of the laboratory and in its operation since then. The goal is to show how the problems highlighted above were solved and a functional GIS laboratory was established. The procedures adopted could become a model for other institutions in tropical Africa and elsewhere for the acquisition and development of GIS and other information technology.

## **The Iowa/Nigeria University Development Linkages Project**

The United States Agency for International Development(USAID), in 1992, embarked on a programme by which universities in the United States can develop and implement a variety of long term, sustainable relationships with institutions in development countries. The purpose of the University Development Linkages Project(UDLP) according to USAID is to promote and support the collaboration of US colleges and universities with developing country institutions of higher learning to (1) further the internationalization objectives of US

universities, and (2) strengthen developing country institutions to more effectively meet the development needs of their societies. The USAID made fifteen UDLP awards in 1992 one of which was the Iowa/Nigeria five-year university development linkages project which links four institutions in Iowa State, USA with four institutions in western Nigeria.

The consortium of Iowa institutions of higher learning consists of The University of Iowa, at Iowa City, Iowa State University at Ames, The University of Northern Iowa at Cedar Falls, and the Des Moines Area Community College at Ankeny and Des Moines. These institutions were meant to use the UDLP to build upon and extend linkages with four Nigerian institutions, The University of Ibadan at Ibadan, Obafemi Awolowo University at Ile-Ife, The Nigerian Institute of Social and Economic Research (NISER) at Ibadan, and The Polytechnic at Ibadan. The Iowa/Nigeria UDLP has developed a sustainable programme of faculty, staff and student exchange which complement a number of activities including collaborative research and academic programmes. By taking advantage of faculty development assignments, sabbaticals, and staff development leaves, a regular flow of resource persons among the participating institutions has been assured.

The purpose of the Iowa/Nigeria UDLP is to strengthen institutional capacities for research and training in several key areas of development planning, management and analysis. The goals of this programme may be summarized as follows:

1. to strengthen faculty and institutional capacities for research and training/education in seven priority areas of development policy analysis and development management and planning so as to respond better to national and community development needs;
2. to develop the capacity of seven inter-institutional, multidisciplinary cross-cultural development support teams in areas of development support communications, small-scale enterprises, indigenous knowledge, environmental monitoring, participation/ decentralization in development, women in development, and spatial decision support systems to conduct development project design, implementation and evaluation assignments in an effective and efficient manner; and
3. to provide opportunities for Iowa faculty to participate in development-oriented activities in Nigeria leading to further internationalization and diversification of existing course curricula in Iowa institutions.

The areas of research activity were selected to take advantage of the complementary strengths of the participating institutions and reflect faculty research interests and institutional commitment, an essential aspect of sustainability. The organization and implementation is vested in the University of Iowa (at the Center for International and Comparative Studies (CICS)) as the lead institution for the Iowa consortium and the University of Ibadan (at the Department of Geography) serves as the lead for the Nigerian institutions.

The planning and implementation of activities has been based on and greatly facilitated by a series of Development Advisory Team (DAT) training workshops and seminars held in both



Iowa and Nigeria. The purpose of these DAT workshops is to train multidisciplinary development support teams consisting of US and Nigerian professionals with a full range of project planning, management, implementation, monitoring and team performance skills. More specifically, each research team used the workshops for project identification, design and implementation, as well as the needed institutional capacity building in the participating Nigerian institutions. It was in the course of these workshops that two of the teams, Environmental Monitoring and Management(EMM), and Spatial Decision Support Systems(SDSS) decided to merge and build their activities around a common technology, geographical information systems(GIS). The EMM group was concerned with monitoring and evaluating environmental aspects of development projects, including the development of efficient strategies for collecting and managing environmental data which would lead to the establishment of an environmental information system based on GIS and remote sensing technologies. The SDSS team focuses on the development and implementation of a research and training programme based on GIS/spatial decision support systems to facilitate locational analysis of essential services and the establishment of a GIS laboratory at the Department of Geography, University of Ibadan.

### **Setting Up the GIS Laboratory at Ibadan**

The preparation of the GIS laboratory, the compilation of the list of hardware and software and peripherals and the phasing out of the laboratory development process were carefully worked out between counterpart faculty in Iowa and Nigeria. In November 1993, two members of the SDSS and two members of the EMM teams from Nigeria visited the Universities of Iowa, Iowa State University and the University of Northern Iowa to familiarize themselves with the range of hardware and software desirable in an SDSS/EMM computer laboratory.

The University of Ibadan signified commitment to the Iowa/Nigeria UDLP on the one hand and to the building of the laboratory on the other voting nearly 100,000.00(\$ = 22.00) for the provision of air-conditioning equipment, and burglar proofing to the doors and windows of the room(a converted physical geography workroom) provided by the Department of Geography for this purpose. The USAID Office in Nigeria also provided a grant of 110,000.00(or \$5,000.00) to decorate and furnish the laboratory.

The establishment of the GIS Laboratory at Ibadan occupied nearly two academic years of capacity building locally. This entailed in the first instance, development advisory team workshops to raise awareness and to provide avenues for Nigerian participants to identify research priorities in the areas of spatial decision support systems and environmental monitoring and management and establish a need for GIS technology as a decision-making tool in a problem-solving environment. Secondly, the UDLP sponsored training and refresher courses for Nigerian faculty both locally and in Iowa on the latest computer hardware and GIS software with a view to drawing up realistic configurations of hardware, software and peripherals for the proposed GIS Laboratory. The Nigerian faculty had the opportunity of hands-on practice with various types of software mainly in laboratories at Iowa State University in Ames but also at the University of Iowa. The provision and adequate furnishing of laboratory space and a commitment on the part of the Nigerian faculty to make effective use of the laboratory facilities was well established before actual commitment to equipment purchase. The actual purchase and installation of equipment in 1994/1995 were finalized and

implemented through the collaborative work of Professor Duane Shinn of the Department of Community and Regional Planning, Iowa State University, the UDLP Project leader, Professor Michael McNulty of the University of Iowa, and Professors Bola Ayeni and Olusegun Areola both of the Department of Geography, University of Ibadan. The equipment and the software came in stages, the last set were installed in July 1996.

## **The Installed Hardware and Software**

The main laboratory hardware comprise four 486 66DX desktop computers. Two of these are APEX computers with 16MB RAM and 540MB hard disk, 31/2" diskette drive, backup tape driver and CD ROM. The other two computers are Gateway 2000 Intel:Pentium with 16MB RAM, CD-ROM and 1.6GB hard disk and 24 bit colour display. There are three digitizing tablets two of which are small templates while the third, on loan from UNICEF Ibadan, is an A0 class Calcom Drawing Board III. The three available printers are all Hewlett Packard inkjet printers one of which prints in colour. A battery operated global positioning system, the Trailblazer with a 30m. positional accuracy, and capable of linking up with up to seven satellites is used for fieldwork purposes.

The complement of software is aimed at establishing a system that allows the integration of various software for both vector and raster data with import/export capability between the different software packages. This gives a full GIS capacity. The major installed software in this integrated system include AtlasGIS, ArcCAD/Autocad, Idrisi for Windows and Alexander. ArcCAD is a vector based GIS based on an integration of Autocad mapping capability with the analytical capabilities of Arc/Info. ArcView 2 and ArcCADTrainer are two related software packages which are installed to complement the ArcCAD system. AtlasGIS is a vector based package that is easy to use for thematic mapping with good import/export and map projection capabilities. Idrisi is a raster based package with import/export capability and raster modelling strengths. Idrisi bridges the interface between GIS and remote sensing. It comes with a tutorial package which is easy to learn and master. Alexander is the windows version of the former RISC-based Archimedes software package for digital image processing and analysis. Other installed software designed mainly for use in spatial decision support systems include TransCAD, Maptitude, and MapINFO.

Apart from these core equipment and hardware, there are three other computers installed by other research groups within the UDLP, notably the Development Support Communications (DSC) and the Small-Scale Enterprises(SME) groups. The computers are loaded mainly with software packages for wordprocessing, desktop publishing, database management, statistical analysis and graphics. Also, an e-mail facility has been installed which serves basically as a mail receiving and distributing node.

## **Effective Operationalization of the GIS Laboratory**

Effective occupation of the laboratory and utilization of the facilities has been promoted in several ways. The University of Ibadan appointed a B.Sc. Computer Science graduate as a systems analyst for the laboratory who has proved highly competent in keeping the equipment going and has interacted very well with both the local and visiting Iowa faculty. Equipment maintenance and the supply of spare parts and consumables such as ink cartridges for the

printers, network, printer and system interface cables, and UPS has been made very easy by the linkage with Iowa institutions and faculty. The transportation of these materials from Iowa, USA to Nigeria is made possible by the regular flow of UDLP participants between the two countries.

Every summer, and sometimes during the Christmas break in December/January, groups of UDLP faculty from Iowa institutions come for periods ranging from 4-6 weeks to run hands on training workshops. For instance, for two years now, the DSC group has staged workshops on "Connecting Nigeria to the Internet" aimed at developing awareness and actual development of e-mail facilities in Nigeria. The workshops are run by Professor Eric Abbott of the Department of Mass Communication and Journalism supported by Professor Dale Grosvenor of the Department of Computer Science both at the Iowa State University, Ames. In 1995, Professor Duane Shinn and Mr. Michael Miller ran a month-long training workshop on AtlasGIS and ArcCAD/Autocad for twenty Nigerian faculty drawn from the four participating Nigerian institutions. The 1996 training GIS workshops by Professor Duane Shinn and Mr. Leonhard Blesius have focused on these two software packages and the additional newly installed Idrisi and Alexander packages. Mr. Blesius developed the original Archimedes version of Alexander.

In addition to the faculty, the trainees in the 1996 workshop series have included the first set of students admitted into the one calendar year M.Sc. Degree course in GIS at the Department of Geography, University of Ibadan. Most of these students have come from government agencies and corresponding institutions in the private sector. In an environment where awareness is still rather low, this is considered important to the adoption and development of GIS and other information technology in both government and non-governmental agencies in Nigeria. The graduates of this programme are expected to promote the utilization of GIS technology in decision making in various fields of management and planning in Nigeria. The M.Sc. degree programme covers the functional elements of geographical information systems with courses dealing at some depth with data structures, spatial statistics, spatial decision support systems, maps and map projections and GIS/remote sensing applications in different areas of the human and natural environments.

The programme requires that a student develop a working knowledge of at least two of the installed GIS software and to carry out a project based on at least one of them.

The teaching programme is benefitting from a short-term collaborative agreement with the UNICEF Office, Ibadan, as indicated above. There is the possibility of a much longer term agreement after this experimental phase. The laboratory also is exploring the possibility of reaching mutually beneficial working relationships with several other national and international bodies based in Nigeria including the Sustainable Ibadan Project of the United Nations Environment Programme, the United Nations Economic Commission for Africa's Regional Centre for Training in Aerial Surveys, Ile-Ife, the National Population Commission and the Federal Survey Department.

One of the remaining hurdles to cross in the operationalization of the laboratory is to get a good base map with a good projection that can be digitized in Autocad/ArcCAD and which can then be moved back and forth between the different software packages. Already, a base map of Nigeria has been imported into Atlas from the National Population Commission but it is not very suitable for thematic mapping. The problem of base maps is felt at all levels of

mapping in the country. The cooperative agreement with UNICEF is for one of their consultants to work on a pilot project concerned with getting a good digital base map for one of the local government areas of Ibadan city using the facilities in the laboratory.

## **Problems and Challenges**

The sustainability of the system already in place hinges very much on the establishment of a vigorous programme of research. This is because the USAID award which was for 5 years in the first instance with the possibility of a renewal, was terminated before the end of the initial five year period as a result of the political problems between Nigeria and the United States governments. The Iowa/Nigeria UDLP has subsisted on the fund provided to wind down the project since 1995. Thus, more than ever before, there is urgent need to develop a vigorous programme of research and advisory services that would generate income for the running of the facility. Indeed, this is the greatest challenge facing the development and effective utilization of GIS technology in Nigeria as in other developing countries.

The potential for research is enhanced by the continuing cooperation of the eight institutions and the wide spectrum of research interests they represent. Also, there are great prospects for offering consultancy and advisory services to governmental departments and non-governmental institutions in the private sector. At this initial stage, much of the request for assistance has been in relation to the digitizing of maps, but proposals have been developed also on the establishment of geographical information systems for industrial pollution monitoring and for urban housing and tenement rate collection. At the moment, the organizations where there is substantial awareness of the value and possible uses of GIS in Nigeria include the oil companies, the Federal Environmental Protection Agency, the National Population Commission and the Federal Survey Department which plans to digitize all of its topographic maps. The prospects for early collaborative works on GIS are brightest and worth exploring with these organizations. Plans have been finalized for a series of awareness seminars and training workshops for policy makers in government departments, non-governmental organizations and the private sector. The objective is to bring these top and middle level operatives in the decision making apparatus in government and private sector institutions for short term intensive workshops which apart from dealing with the functional elements and applications of GIS will also highlight practical matters pertaining to the choice, design and setting up of geographical information systems and the cost, policy and legal implications.

A major problem with most organizations is getting the top management staff to accept the huge initial costs of setting up a geographical information system. The scarce foreign exchange in the country is partly responsible for this as it constitutes a serious bottleneck to the acquisition of the necessary computer hardware and software. Fortunately, in Lagos at least, there are now many local vendors selling computer hardware and software and peripherals. There also are a few computer services units providing excellent equipment repair and maintenance services.

Erratic electricity supply still constitutes a major problem to the smooth running of computer outfits. The installation of uninterruptd power supply(UPS) and power surge protectors is standard for any serious computer unit. But these do not take care of the frequent and sometimes prolonged power cuts experienced in many areas. The solution is to install

generators with a capacity high enough to carry all the systems in a computer laboratory. Such additional equipment make setting up and operating a geographical information system that much more expensive than would otherwise have been the case. An institutional environment such as is provided by a university or multinational organization with its own standby electricity generating set, is still the most ideal for operating a GIS establishment in a developing country such as Nigeria.

## **Conclusion**

The computer technology that has revolutionized teaching and research in American and European institutions of higher learning until recently has eluded universities in Nigeria and other tropical African countries. Yet, under the on-going structural adjustment programmes in Nigeria and elsewhere, the demands on the universities to engage in meaningful research and training programmes relevant to the needs of the local environment and natural resources have increased rather than decreased. These demands require the kinds of revolution in information handling, analysis and management made possible by the UDLP initiative. Perhaps, the UDLP initiative has proved to be the most result oriented approach to capacity building that Nigerian universities have witnessed in a long time. The outcome justifies its being presented as a possible model for other institutions of higher education in tropical Africa to follow. Foreign countries and organizations looking for cost effective and result oriented ways of building research capacity in African universities may well find the UDLP initiative worthy of adopting. The UDLP has met the original objective of the funding agency in providing a method by which higher education institutions in America and elsewhere can develop and implement a variety of long term, sustainable relationships with developing country institutions. The Iowa/Nigeria linkage, as exemplified by the GIS laboratory project, has been based on the implementation of well defined objectives with time-specific accomplishments for each objective.

The existence of a well-trained and highly-experienced research team in the Department of Geography, University of Ibadan has been crucial to the development of the UDLP in general and the GIS laboratory specifically. For many years before the UDLP, this department had developed linkages with a number of American universities, indeed the relationship with the University of Iowa dates back to the late 1960's. Also there has been a long history of faculty exchanges and collaborative research between the universities in Iowa and Ibadan which dates back to a Rockefeller Institutional Development Grant in the early 1970's. These links were maintained through the years and the exchange relationship was formalized in 1988 with a linkage programme funded in part by a United States Information Agency(USIA) University Affiliation Programme grant. The UDLP has merely built upon and expanded existing relationships. Such high levels of cordial working relationships and commitment to the achievement of set objectives are necessary for the implementation of any programme of capacity building in African universities by counterpart institutions in the developed countries.

# THE GEO PROJECT:

## INTRODUCTION OF GIS CULTURE IN HIGHER EDUCATION

**Mirna Luiza Cortopassi Lobo**  
**ICGS-Integrated Center of Studies in GIS**  
**Federal University of Paraná**

### 1. Introduction

The Federal University of Paraná at Curitiba, Capital of Paraná State, Southern Brazil, has over 20000 students and offers a variety of undergraduate and graduate programs in different areas.

One of them, the GIS program, started in 1990 as an interdisciplinary project and its main objective was to introduce the GIS culture into the university. The first diagnosis of compatibility between the GIS program and other programs identified 147 compatible courses in 29 programs.

A pilot project was then developed and implemented, with the participation of an interdisciplinary team and it was oriented towards urban planning, accessing land records and definition of land use. The following step was the creation of the Integrated Center for GIS Studies - CIEG - which started its activities in November/1992, oriented to teaching, research and extension.

Several projects currently developed by the CIEG are based on the needs of state-owned companies, which provide services to the community and planning agencies.

### 2. GIS in Higher Education

There are two basic approaches concerning GIS in higher education:

- GIS as a science
- GIS as an environment

The first approach, considering GIS as a science, will place GIS education in a very specific context. The related courses must prepare *scientists* to develop and integrate technologies. We think that this should happen in Graduate programs, based mostly in research activities.

GIS as an environment has a totally different concept: an environment to handle spatial data in order to solve managerial, planning, and political problems. This concept requires a reevaluation of the undergraduate level programs and the substitution of the traditional teaching methodologies by a specific methodology that considers spatial analysis. GIS environment impacts the courses schedules, and the class support materials and the courses expected results must be organized in much advance and very clearly in order to allow the students to reach the targets.

Till the present, CIEG' experience is the offer of an Graduate program linked to the Architecture and Urban Planning Department at the university. It is an interdisciplinary 750 hours certificate program with an operation approach to solve real problems trough the capacitation of new professionals in GIS environment.

The students are mainly with engineering, architecture, geology, geography, computer science, and agronomy backgrounds. There are students from the social and human areas as well. Most of them come from state-owned companies and agencies. CIEG is very proud of its program, which will be offered for the 6th consecutive year. All former students achieved good employment placement, a very difficult situation in emerging countries, due to the high unemployment rates. This certifies the quality of CIEG' education.

### **3. The Context of GIS in Brazil**

In Brazil, GISs are still in the earlier stages. Brazilian authorities are not used to making decisions based on spatial analysis or GIS models. This is particularly relevant when it comes to defining the professional profile of an urban planner whose education must be directed to fulfill the country's emerging needs. There is a great demand for qualified urbanists in GIS, and a stupendous amount of work to be done. As an example, the periphery of Curitiba, a city whose life quality standards are considered high in the national context, grows 4% a year and must be supplied with basic infrastructure.

Urbanization is a core issue in Brazil. The scenario of Brazilian urban growth is as follows: in 1940 only 51 of the country's cities had more than 50 thousand inhabitants; in 1991 the number increased to 478, and the population in cities of this size increased from 3 million in 1940 to 85 million in 1991.

Despite the increased number of cities, massive growth is still more evident in the megalopolis: the ten largest cities grew the equivalent to 42% of the country's demographic growth, and back in the '70s the municipality of São Paulo alone had a demographic growth equivalent to the whole northeastern region (Martine 1993).

In 1991, 42 million people lived in the nine Brazilian metropolitan regions which had an increase in the '80s (although smaller than in the '70s) of 7.8 million people, a figure slightly higher than Austria's population (Martine 1993).

The urban planner who are now entering the labor market are involed in such complex dynamics which demand a shift in scientific thinking. It is precisely whitin this scenario that GIS plays a fundamental role in helping understand the complex dynamics that support the decision making process.

Introducing GIS in the future urbanists'curriculum is how the University contributes for the development of society, and for local management, preparing professionals who are skilled and qualified to do their job in an environment made available by technology.

### **4. GIS in the Architecture and Urbanism Curriculum - Federal University of Paraná at Curitiba**

Curitiba is a city with 1.6 million people, and its metropolitan area is 2.5 million. The city's

highlights are its planning and excellent infrastructure for both urban services and leisure. Curitiba's urban planning is well known throughout the country and internationally.

The city's major urban planners attended the School of Architecture and Urbanism at the Federal University of Paraná. In this school, the enrolled students must fulfill a 5010 hour curriculum. With the new 1996 curriculum, GIS became the foundation for urbanism teaching.

GIS in the Architecture and Urbanism programming was first experienced at the university in 1995. It represented a methodological approach to the introduction of GIS in undergraduate programs as part of the teaching/learning process. The experience is, therefore, worthwhile to share.

Teaching and research labs had a subsidiary or elective role in graduate and undergraduate programs, in which GIS was seldom included in the regular curriculum in a systematic manner. The experience's challenge was to include GIS in the curriculum, proposing solutions and establishing a new methodology for both teaching and using a new technology to solve real world's problems. The students response then suggested that this was the right track.

Senior Architecture and Urbanism students were already minimally familiar with CADs. Minimally is stressed because not earlier than 1998 the subject will be included in the regular curriculum. ArcCAD was chosen as the working environment because it is close to AutoCAD, the most widely used CAD for drawing.

The chosen theme was a review of Matinhos' urban plan. Matinhos is a city on the coast of Paraná state, with a regular population of 120 thousand people. However, this population increases tenfold on the summer months. Due to high occupation densities there is a lack of proper public services and in the rain season (coincident with the summer season) it is particularly affected by floods.

CIEG's lab, with an infrastructure of microcomputers and workstations, was used to develop the work. The students were divided in eight teams, each one assigned to a workstation with the above mentioned software. The database was always the major problem, since for urban planning it requires urban records bases. The database considered included a cartographic base drawn from 1:2000 maps (which belongs to the State Sanitation Company), alphanumerical data from the municipality's tax records, and census data available at the Brazilian Geography Institute - IBGE,

Since the urban area was very extensive lengthwise, it was chosen to have the maps digitized by the teams, who have added information collected in field surveys. Initially, the idea was to create a geographical base using the teams' work. The survey included different collection areas. Such as the existing trees cover, the urban equipment, and the type of occupation, among others.

A common symbol library was developed and adopted because of two main reasons: first, there was a tremendous difference among the students concerning their knowledge of computer science and CAD, and, second, there were too many holidays during the academic year, reducing the subject hourload.



Initially, the students had to be trained in CAD, and later in ArcCAD. The university has recently acquired ArcCAD and there is still a lack of local training expertise. In spite of all these difficulties, there was an overwhelming interest level of the 20 student class.

This experience led into a new methodological approach, consisted on selecting a team of students who were more familiar with computer environments and who were observed by the other teams while developing the GIS work.

## 5. Conclusion

The objective of this experience was to show that as much as the GIS environment is proposed to be used as part of the teaching/learning process, a radical methodological adjustment will be necessary, including a change in courses' hourload as well. This is not an oversimplified rationale, in which computer drafting is just another technological tool or a sort of refined electronic draft table, with an added alphanumerical database. It is a new didactic methodological culture, which can undoubtedly be efficient and totally applied not only in urban planning, but in other courses in graduate and undergraduate levels.

From the experience it was found that the sooner can learn computer drafting, the better they will be able to work in environments with more variables to solve equations and problems.

Spacializing such variables will enable the students to better visualize the world we live, and to interact with this world by overlaying its multiple aspects. In these times of globalization, local problems have global implications. The concept of development is intimately linked to the integrated view of the world, and the sustainability of such development now lies in the capability of the professionals to deal with it, along with the broader political problems of our society.

---

## References

Martine, George(org) - **População, Meio Ambiente e Desenvolvimento** - Editora da Unicamp, 1993.

Lobo, Mirna Luiza Cortopassi - **Urbanização, Desenvolvimento Sustentado e Sistemas de Informações** - Proceeding of VI National Seminar of Applied Geography - GOI, 1996.

---

ICGS - Integrated Center of Studies in GIS - Federal University of Paraná  
Address: Centro Politécnico - Jardim das Américas  
Caixa Postal 19076  
CEP 81530-900  
Curitiba, Paraná, Brazil

## **Designing novel educational GIS tools in secondary and higher education to enhance professional awareness**

*Dominique Vanneste<sup>1</sup>, Angélique Lansu<sup>2</sup>, Truus Roesems<sup>3</sup>, Rob Nadolski<sup>4</sup> and Thérèse Steenberghe<sup>5</sup>*

*Catholic University of Leuven (KU Leuven), Belgium*

*Institute for Social and Economic Geography (1, 3),*

*Lab. for Experimental Geomorphology (3)*

*& Ground for GIS (1,5)*

*De Croylaan 42, 3001 Heverlee, B;*

*and*

*Open University of the Netherlands (OUNL), Heerlen, The Netherlands*

*Faculty of Natural Sciences (2)*

*& Expert Centre of Educational Technology (4)*

*PBox 2960, 6401 DL Heerlen, NL*

### *0 Introduction*

gis technology is emerging with enormous rapidity into the professional world of research, policy and management. The last decade the processing of spatial or geographical information is strongly computerised. Nowadays digital geo-referenced data like postcode bounded socio-demographic data sets, satellite imagery, street maps and cadastral information are broadly available on CD-ROM and Internet. The spatial data will no longer be used only in geographical/geo-science applications by gis specialists but also in new application fields by a broad group of gis users.

With the introduction of a new technology like gis and a larger awareness of this tool in the professional field, there is the common need for hands-on training by the traditional users of geo information. This need can easily be satisfied, because this is a relatively small and well-known target group. Courses can consist of in-company training programmes, courses provided by the system distributor and individual sessions with help of extended user's guides and demos. Academic level education is provided as short specialist academic programmes or as part of (the few) geo-oriented academic disciplines such as agronomy, geography, etc.

But the spread of gis technology into the professional world of research, policy and management has brought a large new group of potential GIS users. As a result, there is a crying need for gis education and training, both by students of the regular educational institutions, by new groups of professionals, and even by the older educational staff, who have had their training before this GIS-era. With traditional forms of education, this need can not be solved by the available group of teachers in GIS. In this article we direct to new ways of non-traditional education in GIS and novel educational GIS tools to be able to cope with the growing need in training and education.

Firstly, we describe in this article the major trends in gis education in the Netherlands and Belgium, to determine the starting points to take into account within the design of the educational materials. We recall attention to the fact that these trends in gis education are clearly derived from more common trends in education and in the emerging of information- and communication technologies.

In the second part of this article we describe two examples of educational GIS projects, both meant to solve the need in gis education. The first project, the development of instant tools for secondary education, is started by the Catholic University of Leuven (Belgium), and is directed to both teachers and students (Vanneste, 1997). The second project, the development of distance learning material in gis, is initiated by the Open University of the Netherlands (OUNL). This joint international project, in which several authors of eight institutions participate, is aimed at the broad and diverse group of potential gis users. Both the educational design of the project and the design of the developmental and authoring process are modelled according to a GIS workbench as metaphor (Lansu, 1997).

After the starting points, the aims and the experiences of these educational projects have been described and discussed, the next section shows the resulting product. This educational module on digital terrain models is developed by the OUNL and KU Leuven (Roesems and Govers, 1997; Roesems, 1997). The module, consisting of self-contained lessons and cases in DTMs is part of a multimedia introductory practical in GIS.

At the end of this article we compare the results of those projects to the trends in gis education mentioned

in paragraph 1. This close encounter between pedagogic experiences and technological trends will indicate new ways of solving the need of GIS education and enhancing professional awareness in the future as effective as possible. A virtual GIS workbench may solve the lack of experienced teaching tools in secondary and higher education in future.

## 1 Trends in GIS education

### 1.1 designing GIS education

The usage of geo information systems has expanded to various GI systems (including desktop mapping) and many new application fields. According to this shift, the attention of the GIS educators has to be changed from the GIS specialists' training programmes towards courses directed to potential GIS users. These potential GIS users have dissimilar professional backgrounds or application areas and divergent knowledge of spatial concepts. At the same time, the students and the teaching staff of the regular educational streams have to be confronted with the new GIS possibilities within a context of spatial information processing and spatial analysis.

Obviously, the number of GIS educators, to be recruited out of the booming and attractive GIS business, is too small to satisfy the need by traditional, instructional face-to-face (teacher-student) education. The design and development of instant educational tools, with instruction and guidance within the material can be a possible solution in this tight labour market to meet the demand for instructors. The diversity of the target groups asks for a "tailor-made" approach of this problem. If we want to be able to reach these groups of GIS users optimally, we have to analyse their views and opinions about the GIS tools as well as their aims and goals in order to take these into account the educational design of the materials to be developed.

The design of educational materials is an integrated educational product in which several factors are considered (Huisman *et al.*, 1995):

- (1) the *professional contents*, e.g. which subject is part of the course,
- (2) *didactic means*, e.g. how to offer the subject ,
- (3) *educational considerations*, e.g. the various ways of learning and teaching,
- (4) *logistics*, e.g. is there a need to attend scheduled meetings, and
- (5) *financial affairs*, e.g. how many students can be expected.

These factors play a role in both the development and exploitation of the educational materials.

In the next paragraph we describe some key trends in reference to the factors *professional contents* and *educational considerations* in GIS education. These trends in the professional fields of education and GIS are of important influence on both the structure and contents of the two given examples of educational GIS tools (see next sections). With the appropriate didactic means and effective use of logistical and financial means, these mix of factors will lead to a well-considered didactic design, optimally dedicated to the aimed target groups.

### 1.2 Trends in the professional contents

#### **Tools & techniques**

At the moment we observe a rapid spread of "tools & techniques" among users in business, policy and education. Main causes are the increasing processing power of personal computer systems, the user friendliness of new software and the diminishing prices of hard- and software. This "digital emancipation" of tools and techniques makes geo information systems from a specialists' secret to the users' shareware. The spread of GIS desktop mapping software is a clear example (for example the

mapping module of Excel).

### **Professional awareness**

The present-day school population forms the decision makers, managers, researchers, urban planners and marketers of tomorrow. They should be aware of the notice of GIS as a marvellous spatial information tool. At the same time they need to have some insight in spatial analysis to be able to ask the right spatial questions to obtain the expected geographical information.

This notice of spatial information is not yet sufficiently available among the present generation of actors in the field of spatial information. A recent investigation was carried out to identify the nature of "using" spatial data in Belgium (Vanneste & De Wilde, 1996). The survey shows that firms handling and/or producing spatial data, often stick to a low level spatial analysis. It is clear that many of them are not aware of the strengths of a GIS or do not take full profit out of the spatial analytical capabilities of their GIS.

### **Life-long learning**

The flexible and dynamic labour market asks more and more for generalists with an overview on complex matters who are ready to start a life-long learning (or "éducation permanente" along the White Papers of

the former EU commissioner Jacques Delors). This has its effect on education by paying more attention on learning how to learn than on teaching facts and figures. In GIS we see a re-orientation from GIS courses of distributor's training programmes directed at the ins and outs of a specific GIS software, towards more problem oriented education, with GIS as a tool in decision-making, independently from the software.

### **New technologies in an integrated environment**

The computer-environment of the GIS users' working place, the so called GIS workbench, consists essentially of digital spatial data. The other parts of the workbench are the soft-and hardware, the methods used to solve the researched problems and the human procedures and contacts of the GIS users. Often, this GIS workbench is not standing on its own, but it is an integrated part of the information department of the firm or the institution.

Because of the computerised nature, the new information and communication technologies can be integrated in the digital heart of the GIS workbench. These new technologies give new possibilities in linking GIS with other tools (models, multivariate analysis, dynamic simulation), and a cheap and easy gate-way to information (clearinghouse, metadata) and communication (with internal and external GIS professional expertise) on its own GIS application field.

To be able to speak of a successfully integrated environment, there should be a minimal condition of acceptance by and integration within the organisation. Therefore, even colleagues and people in charge need knowledge about GIS (Aronoff, 1993).

### **Visualisation of complexity**

Present society, and in particular society's decision makers, researchers and planners, copes with complex problems with many variables (climate change, human health, planning of infrastructure). In search for solutions they have to process large databases of different sources and multidimensional (spatial and time depending) data.

Digital image processing techniques play an important role in the analysis of complex problems. These techniques combine the present intensive computer technology with the unique human ability to visualise complexity and to interpret these images. This particular combination leads to quick creative solutions for complex problems. In this way, digital image processing techniques (as used not only by GIS, but also by remote sensing, medical scans, and in telecommunication) are essential in policy-making, research and education on complex problems.

## 1.3 Educational considerations

### **Secondary education: students**

*Professional awareness of users and decision-makers of spatial information about the possibilities of GIS and spatial analysis does not start by vocational training of potential GIS users. To enlarge the professional awareness, the awaking of the qualities and possibilities of a geo-information system has to grow and to be supported by a broad public. For stimulating professional awareness, the level of secondary education is an ideal start to learn about spatial information with GIS tools.*

*When comparing to other data management tools, gis has the advantage of presenting the results of the analysis and processing of large data sets, not only as a table or a graph, but also as (two- or three-dimensional) maps. For this, GIS is an ideal medium to visualise complexity. Moreover "visual" education like GIS education corresponds to the experiences and actual practice of the present generation of students, who are used to visualised information and to information processing by (multimedia) images.*

*In addition to the trend to incorporate the ideas of life-long learning or "éducation permanente" in secondary school education, the final learning objectives of secondary education are subject to drastic changes in the nearby future. For example the structure of secondary education in the Netherlands will be changed as from 1998 (Min. van OCW, 1997). A choice is made for a new pedagogic approach with more self study and assessment by means of practical tasks and essays. Together with this switch from teaching by teachers to learning by students, the contents of the subjects are reviewed and renewed, with more attention payed at tools & techniques like GIS and remote sensing.*

### **Secondary education: teachers**

Because of the above described increase of GIS education in secondary schools, teachers of subjects like geography, science and information technology, are considered to have knowledge of GIS and to be able to teach the handling of spatial information by GIS tools. The present-day teachers have not been confronted with GIS in their own education and there is a huge necessity for teaching-the-teacher programmes. In addition, "instant" educational GIS tools are needed to be used in programmes both for teachers and for secondary school students. The tight GIS labour market with shortage of GIS educators does intensify this need for well-equipped teachers. In section 2 an example is given of such an integrated package.

### **Individual (higher) education: the non-specialists**

With the rapid spread of "tools & techniques" among users in business, policy and education, we observe a growing need in GIS education among non-specialists. The professional awareness asks for another approach of education in form and contents. The potential GIS user needs education on a problem-oriented approach and dedicated to the individual study-environment: with full freedom of place, time and pace of study. The contents of the education programme should be more oriented to spatial data for the decision-making process in her/his discipline, with GIS as one of the tools. The GIS users should be able to learn about the process of analysis of spatial information, with its sources, methods and actors, instead of becoming technician, specialised in the use of one specific software package.

This asks for personalised study materials, with incorporated guidance like distance education courses. *The information- and communication technologies* could provide an integrated environment consisting of this mix of personalised approaches as part of the real-world GIS workbench, with authentic materials, tasks and contacts among in-firm and ex-firm colleagues and GIS experts. The distance learning practical described in section 3 is an example of individual competence-based GIS education, directed to the starting GIS user.

## **2 Enhancing general professional awareness of gis by improving educational gis tools for secondary school teachers**

### **2.1 A cut-and-dried solution for secondary gis education in Belgium**

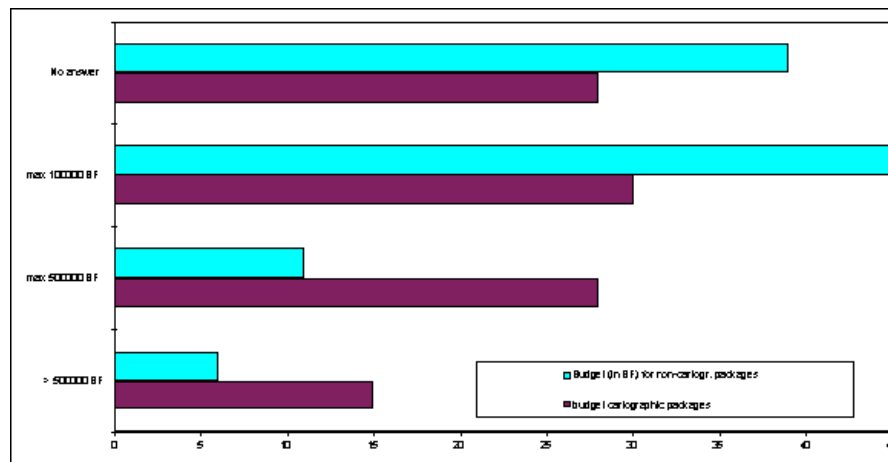
Since 1997, the Catholic University of Leuven, Belgium (D. Vanneste and Th. Steenberghen) has been organising GIS training for secondary school teachers, based on a cut-and-dried package. The evaluation of previous training sessions had taught that a detailed demonstration of the possibilities of several

software packages, although suitable for and oriented to a secondary school situation, was not said to be fully satisfactory because of the following:

- The teachers felt unable to judge how far and in what manner they could use an instrument such as GIS within a classroom situation in spite of or because of the plenitude of information.
- Most of the software (even desktop mapping) was too expensive for most schools.
- Schools were not prepared to invest much in a GIS training for a teacher (in casu the teacher of geography); only a limited budget was made available to pay a maximum of one day's training.

This is not a specific situation for the educational sector. A recent survey among Belgian private firm using spatial data showed that, even when considering spatial data of strategic importance, firms were only prepared to spend a limited budget (in terms of time and money) at GIS training (D. Vanneste, 1996).

Figure 2.1 Budget available for GIS training (results of an inquiry of Belgian private firms) (Vanneste & De Wilde, 1996).



Therefore, the training session was reoriented towards a set of lessons, linked explicitly towards the content and logic of the secondary school curriculum, structured within a didactic lay-out to be used by the teacher in a classroom environment and executable with the cheapest software. In addition, all cartographic material and statistical data were put in digital form on a floppy disk and added to the training package. Material (maps, schemes, lists and tables) that might be useful to show the students by means of an overhead projector was added on paper for copy on transparency.

The entire preparation as needed by the teacher was worked out for each lesson: integration in the school curriculum, literature that was used for the lesson and that can be consulted by the teacher, a list of didactic tools, the initial stage of knowledge and experience of the pupils, the general, affective and practical aims, the scheme of the lesson divided in several "educational moments".

This way of putting the GIS lessons in place does not differ from any other lesson the teacher has to prepare. In addition an extensive appendix describes how the teacher (or the student) can use and manipulate the software so as to obtain the results for each of the "educational moments" and to reach the goals.

The annex for the teacher therefore has a different structure as compared to a traditional user manual. The "manual" is not structured according to a list of functionalities but according to the didactic path of the teacher and the technical way of creating the information needed to answer the didactic questions of that moment.

The price of this training (incl. the material on paper and floppy disk) is kept very low in order to solve the obstacle of a very restrained budget.

## 2.2 The choice of contents

The choice of the contents depends on several aspects:

1. the time available for GIS within the geography program and the level of maturity of the students,
  2. the demand to avoid any tie with a particular software by elaborating a spatial topic that can be handled with almost all kinds of desktop GIS,
  3. the requirement to maximise the illustrative value
    - by combining a subject in the field of physical as well as socio-economic geography, with links towards other disciplines such as environmental sciences, planning etc.
    - by integrating as much basic handling and manipulation of data with GIS as possible, within a logical order,
    - by maximising the use of existing source material of different types (statistical data, images and raster documents),
    - by covering different study areas and structures on a different geographical scale,
1. the intent to offer a few profound examples rather than many less elaborate ones.

The subject of the lesson *Belgian urban regions: an exploratory survey of their distribution, their impact on Belgian space and population and their micro-scale internal structure* seemed to offer many possibilities to respond to the conditions pointed out before. The lesson is based on MapInfo and stresses elements such as thematic mapping and exploratory search activities. At the same time, students have the opportunity to get acquainted with census data and their importance for a socio-economic survey of space.

On the other hand, a lesson was attributed to *the European environment via a survey of the impact of human activities from a macro-scale perspective* by focusing on the mapping possibilities of the latest release of Excel as well as ArcExplorer. Because existing cartographic material (made available by the services of the EU) is structured in layers, the students can explore the effects of combining information layers and quantifying spatial relationships.

Both subjects are part of the official secondary school curriculum for the fifth year within the Belgian secondary school system, together with the topic "cartography and GIS". This offers a far-reaching integration of technical issues and the compulsory content within the program of the same year.

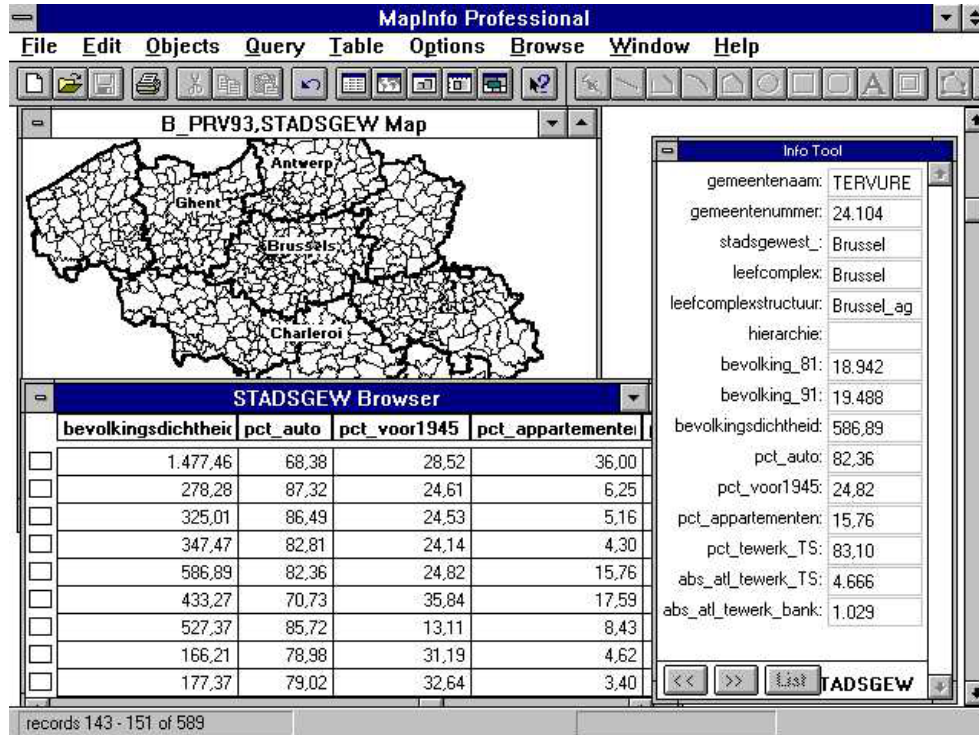
### 2.3 Illustrative educational elements: some examples from the "urban region" lessons

The full content of both lessons is beyond the aim of this article but it might be useful to highlight some elements that illustrate the way of achieving the educational goals.

The **first stage** of the lesson has to do with *some notions* about urban regions in general. It's the one and only step that has nothing to do with GIS. Therefore, the introduction is short and rather superficial because the students are supposed to get acquainted with some terms while understanding their content is based on experience with GIS in later stages.

In a **second stage**, the students can *explore the (geo-relational) database*. The structure of the database is simple, only showing one geographical layer (basic map with the boundaries of the Belgian communes) and a few limited tables on the commune level with numeric or quantitative variables (e.g. population, % of car ownership, % of old dwellings etc.) and categorical or qualitative data (e.g. identification of the urban regions, identification of the urban segments within each of the urban regions etc.). By scrolling through these data and using functionalities such as "find" and "info", the student experience the link between the map and the tables, while notions as "key", "attribute" and "object" take shape.

Figure 2.2 Screen dump of the exploration of the database "Belgian urban regions" (Vanneste, 1997)



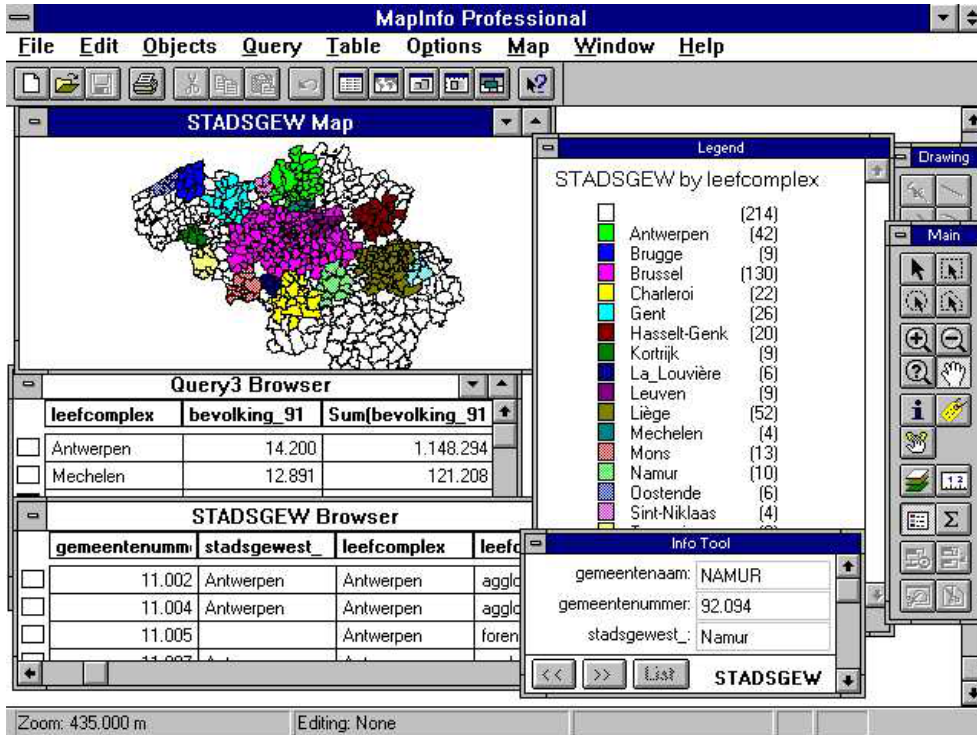
In the **third and the fourth stages**, when examining the network of the Belgian urban regions, the students are asked to generate correct information in order to answer such questions as

- report on the Belgian urban regions: number, identification, regional location,
- report on the impact of the urban regions on space and on population, both in an absolute and a relative way.

For this, a cartographic representation of the network is necessary but the ability to map thematically can be delayed until the last stages of the lesson by using a workspace in which the network is already put in place. The emphasis is put on *queries*.

Figure 2.3 Screen dump of the evaluation of the urban regions network in Belgium (Vanneste, 1997).



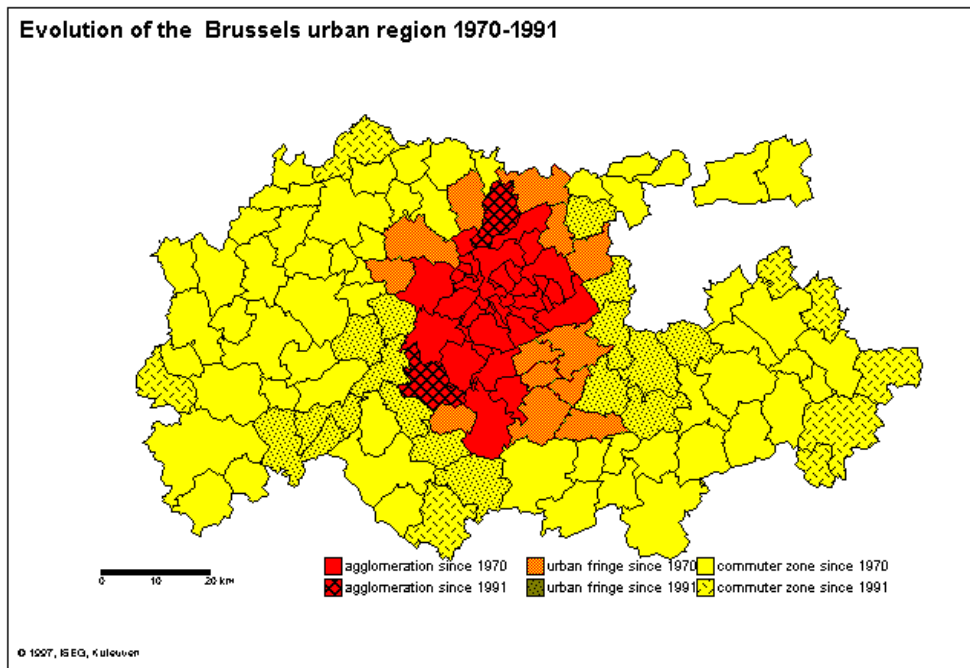


In the **fifth and the sixth stages**, the students explore the internal structure of one particular urban region.

Again, the basic present-day structure, in terms of "agglomeration", "urban fringe" and "commuter zone", is put in place by opening a workspace. This pattern offers the opportunity to explain the spatial structure as a *growth model*, modelled by the *process* of suburbanisation. The students can experience the dynamics of the pattern by putting the map of the same urban region in an earlier period on top of the present-day structure. This makes the student experience the significance of *overlay*.

This means a *step by step exercise in thematic mapping*, taking into account the cartographic rules about the use of colours and symbols, according to the variable type.

Figure 2.4 Screen dump of comparing the structure of an urban region in 2 periods, by overlay of maps (Vanneste, 1997).



Not only the internal structure is put in place but also the characteristics of the different segments, as a result of the suburbanisation process. The teacher can ask (different groups of students) to judge the impact of suburbanisation

- on the housing market, by mapping the percentage of old houses (built before 1945) as an indicator,
- on mobility by mapping the percentage of car ownership as an indicator,
- on space and space-consuming behaviour, by mapping densities, e.g. population/km<sup>2</sup> or apartments/km<sup>2</sup> or gardens/km<sup>2</sup>.

In the best case, the teacher can ask the students to combine these indicators so as to illustrate that, when moving from the centre to the periphery, an urban region is characterised by a decreasing age of the housing stock, an increasing mobility and a decreasing pressure on the soil. This means that students have to experience that such a problem needs careful *reflection* about data to be used, about threshold values to be taken into account, about the syntax of the logical expression to be calculated before they can take action on their PC. Implicitly, this gives them some idea of the meaning and necessity of what is called "*cartographic modelling*" in a real GIS environment.

#### 2.4 Social and educational justification

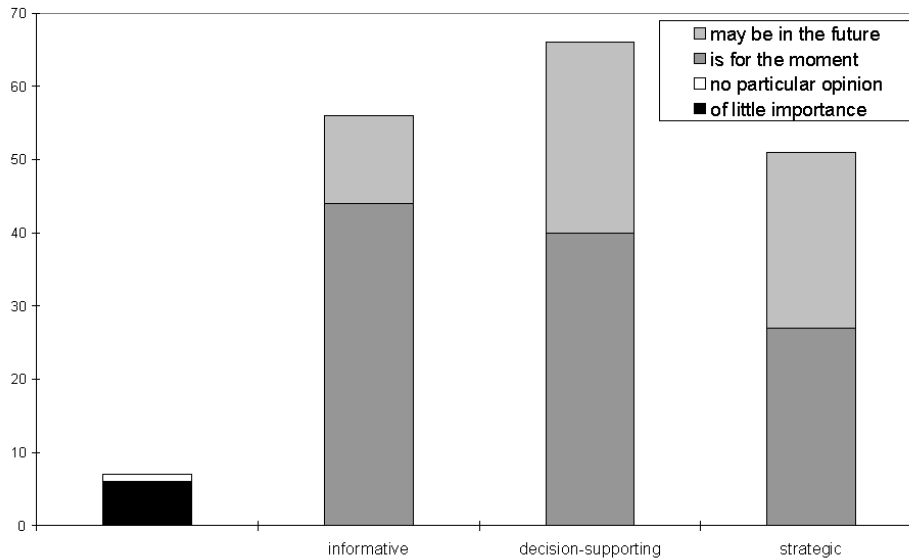
We are very much aware of the fact that (geography) teachers still need strong arguments to convince their school board of the benefits of investment in GIS for educational purposes. Therefore, the most relevant results of a survey about the use of spatial data in the (Belgian) private sector (Vanneste, 1996) are communicated to the participating teachers.

First, teachers get information about the kind of applications Belgian firms are using spatial data and analysis for. It is obvious for a GIS specialist that the survey shows that many applications are beyond the field of geography *sensu stricto*, but it may create a broader base of support by convincing boards and colleagues that GIS is also important for students with interest in environmental and urban management, geo-marketing, archaeology, information technology etc.

As seen from the enquiry, it also occurs that firms not only attribute an informative value to GIS but that

they do consider GIS as a decision-supporting tool (using it as such or expressing their conviction about such a capacity).

Figure 2.5 Importance attributed to the spatial aspect of data handling (results of an inquiry of Belgian private firms) (Vanneste & De Wilde, 1996).



Nevertheless, one discovers that many firms are attempting to reach new goals in the old way, e.g. by using CAD instead of GIS for spatial analysis or by using a GIS only for inventory, design and mapping while ignoring the more fundamental abilities of their system. This can stimulate school boards to invest in GIS for geography classes as they become convinced that the managers of tomorrow may not be able to generate full information if they do not have enough insight into appropriate information tools such as GIS.

Beyond those elements, some arguments are put forward in order to motivate the geography teacher him/herself.

1. One can not deny that cartography, as an integrated and uncontested part of the official curriculum, has to be linked with GIS because of the predominant use of GIS: thematic mapping. Moreover, many GIS users are using the tool for mapping without realising that even GIS software does not automatically produce correct maps and thus useful information. Using GIS does not prove geography and cartography to be superfluous, on the contrary.

Therefore, it is important for students to leave secondary school realising

- that spatial information, as a basis for spatial decisions, is in optimal shape when represented in a cartographic way,
  - that a good cartographic product is subject to rules and therefore needs a careful and justified lay-out,
  - that a nice map isn't equivalent to a good map when the message is not communicated in a quick and clear way.
2. One of the reasons why geography is not very popular among the (Belgian) secondary school students is its fairly strong "knowledge-orientation". GIS offers the possibility to move away from aspects to be known towards elements that can be done and therefore allows a better "ability-orientation". GIS not only stimulates students to actively participate in a lesson by exploring the educational material but it excites some enthusiasm by being new and progressive.
  3. Working with GIS in a classroom situation is often considered as too time-consuming. On the other hand, current desktop software is really user friendly and it takes very little time to get acquainted with the basics. This means that, very soon after starting with GIS, the students are able to move away from information about GIS as such and attention can be focused on whatever spatial structure or problem that presents itself within the geography program. Moreover, one has to bear in mind that

exploration and experiment may take more time than lecturing but that after all it stands for a much stronger rooting of knowledge.

### 3 *The gis workbench: a metaphor for development of gis distance education*

#### 3.1 coping with non-traditional students

As already stated in section 1 and also one of the outcomes of the research to employment needs (Vanneste, 1996), there is a need among the appearing group of potential GIS users to personalised GIS educational materials with guidance incorporated. These potential GIS students are already working or shifting their carrier in a firm where GIS is already in use, or could be used because of the business activities or collected data. To cope with this diversified student group by absence of sufficient GIS teachers, the idea of a workbench practical is linked to distance learning methods. The main objective of this educational project described in this section is to develop an introductory practical in geo information systems, to be studied independently of tutors at the students' own study-environment. The GIS workbench: the computer working environment of a GIS professional, consisting of GIS software, hardware, life-ware and connected to the outside GIS expert world by information- and communication technologies is an ideal metaphor by designing GIS education. The interactive GIS practical on CD-ROM described is developed to be studied at the students own computer learning environment with access to Internet. The practical can be studied independently of place, time and pace of study, with tutoring designed within the material, and by mutual guidance by fellow students.

This project will be developed in joint co-operation with institutions with expertise on GIS-education and -research and on distance education. The metaphor of the GIS workbench is also used in the design of the developmental process of the materials. The authors work with especially developed authoring tools and their own GIS educational materials on their own computer working environment, in close contact and interaction with co-authors and development team.

#### 3.2 Project settings and aims

The project *Geo Information Systems: an introductory practical* is part of the first programme (96/97) of the "Consortium Innovatie Hoger Onderwijs", a consortium of several Dutch and Flemish universities and colleges with the aim to innovate higher education by means of joint projects. The GIS project is initiated and developed by the Faculty of Natural sciences of the Open University of the Netherlands together with the Educational Technology Expertise Centre of the same university. The OUNL is a government institution and offers academic programmes in open distance education, with twenty-four regional study centres in the Netherlands and the Flemish part of Belgium. In a major part of the courses, written material is the preferred media, because of its freedom of place, time and pace of study of the student. In accordance to the didactic concept of open distance education (Crombag *et al.*, 1979) new media, like interactive computer programs, and innovative didactic techniques, like case studies and simulations, must be considered when learning aims can not be achieved by means of written material.

Although the first ideas on this full electronic practical and related contacts with GIS educational experts started in 1994, the first project design came into existence in 1995 (Lansu & Nadolski, 1995). With the start of the Consortium the project developed to a joint international educational co-operation with partners in Belgium (KU Leuven), The Netherlands (e.g. GEON, Groningen) and the United Kingdom (e.g. Manchester Metropolitan University).

At this moment the developmental testing of the especially developed authoring tools has been ended. As part of this stage the first module, consisting of a lesson on digital terrain models and an Idrisi case on DTMs in erosion research is developed. The next section will show the details of these educational materials developed by the KU Leuven (Roesems, 1997; Roesems and Govers, 1997). The first developmental testing of the developed materials, consisting of five modules, is planned in the spring of 1998, with students of the different institutions. After this testing among students and the fellow authors, the comments will be incorporated in the material. The final release of the materials, computer based learning programmes on CD-ROM, is expected at the end of 1998.

Aim of the practical to be developed is to give the student the opportunity to understand concepts of, and to acquire skills in processing of spatial data in an advanced technology by "hands-on" training at an established geographical information system at her/his own study environment. In addition, this computer-

based practical will train students in handling the new ways of (academic) communication and familiarise them with data availability, access of data, metadata and quality of data through electronic networks (Internet). This practical (in English) is aimed to be used at undergraduate level of higher education. Indication of the study load is three study credits in Dutch system of higher education (100 hours net study load).

The contents of this introductory practical in geo information systems consist of the two parts *Lessons in gis* and *Case studies in gis*. The lessons give students a broad overview of gis concepts, the data of the case studies on several application areas have to be processed by the students with professional gis-software.

Because the core contents are in essence digital, the educational design (figure 3.1) concentrates on the computer learning environment of the student like a GIS workbench. The design of this project on gis guarantees that the introductory practical fits into the diverse educational settings of the partner institutions involved. Each copy of the practical contains a CD-ROM with the professional gis software *Idrisi* to be used and two computer based learning (CBL) programs *CBL Lessons in gis* and *CBL Cases in gis* and access to a study guide on the world wide web and a practical related *computer conferencing*. The *www study guide* will direct the student through the practical components. In addition, two course books (a *workbook* and a *manual*) will be available to the student.

Figure 3.1 Educational design of the project Geo Information Systems: an introductory practical (Lansu, 1996).

(image to come)

The educational and technical model of this project, specifically designed to this gis practical, could be used to the development of electronic practicals on other subject areas, which are directed to visualisation of complexity. For example, areas in which comparison and processing of sources of (imagery) information is a major objective of the educational contents: the processing of bio-medical imagery or the analysis of environmental problems.

### 3.3 The GIS workbench: a learning environment

The educational design of this project consists of an introductory practical in gis and is concentrated on the computer learning environment of the students according to the GIS workbench metaphor. Problem in gis practical education without face-to-face contact between student and teacher is the way in which feedback on complex activities and visual spatial information should be given. A solution is found in the design of the practical by co-operating of students via pre-structured methods of communication (mutual guidance), with minimal tutoring only if teacher contact is really needed. Because communication concerned the exchange of the students results (digital files of gis images) electronic communication methods are a prerequisite. Access to Internet is a condition to consult gis experts and to obtain cheap and original gis data all over the world, like a real GIS working environment.

Figure 3.2 The gis workbench: a learning environment (Lansu et al., 1997).

(image to come)

The educational model followed in this educational package is a pragmatic combination of embedded learning, collaborative learning, and discovery learning. *Embedded learning* supposes learning in an authentic context with authentic tools and authentic problems. This authenticity is as much as possible realised by presenting the student with unaltered professional software (Idrisi) as well as real or realistic cases. Working in study groups is considered as an aspect of this authenticity (virtually no GIS user works alone nowadays) and as a way to invoke *collaborative learning*. The study group provides a discussion forum as well as a 'project team' of 'fellow researchers', in which students brings in their own specific background, skills, and interest. The project aspect is realised by forcing the group to study at least one case collaboratively and hand in a report. The discussion forum aspect is realised by letting one group evaluate the work of another group. *Discovery learning* is much the way in which the professional acquires more complex skills in using the gis and interpreting results, refining strategies, and making use of other information sources.

## Contents

The contents of this introductory practical in geo information systems consist of two main parts. The first part *Lessons in GIS* contains a broad overview of GIS concepts, illustrated with examples and exercises. The lessons introduce students in the uses and requirements of geo information systems, in mapping geographical data and in spatial analysis and modelling. The second part of the practical consists of hands-on *Case studies in GIS* on several application areas. The data of the case studies have to be processed by the students with professional GIS-software (the Idrisi GIS software). The contents of the lessons and case studies are based on pre-existing educational materials of the participating institutions like lecture notes, exercises, slides, maps, tutorials, demo-software and case studies in use at the educational programmes of the partner institutions. These materials will be adapted to be used in the introductory practical.

## Computer learning environment

The core contents of a hands-on training in GIS is the processing of digital spatial data by using GIS computer software. Because the core contents are in essence digital, the design concentrates on the computer learning environment of the student. An outline of the computer learning environment as a GIS workbench is given in figure 3.2. These core contents, to be studied at the students own computer configuration, consist of a number of computer applications: the study-guide on world wide web, the professional GIS software program Idrisi, the CBL program CBL Lessons in GIS and the CBL program CBL Cases in GIS with data on case studies (GIS files, documentation). The www-study guide and the CBL programs are developed within this project.

### ***www-study guide***

To direct students through all the components of the practical an electronic study guide on the world wide web will be developed. Such a more time-dynamic www-study guide is preferred to written material, because of four aspects. Firstly, there is no need to switch media in consulting the study guide or the other computer applications. Secondly, the costs of "publishing" full colour geographical maps on world wide web are extremely low compared to the costs of producing paper maps (maps are needed in introduction and feedback on the practical contents). At third, new developments in the use of GIS are part of the contents are site-specific and depending on the educational setting of the partner institution. The www-study guide can be simply linked to www-pages of a institution or educational programme. Four, information on GIS, especially sources of GIS data on the Internet, is rapidly changing. A www-page can be altered cheap and simple. The www-study guide contains of a general introduction to the practical and (site-specific) information on aims, contents, tuition and examination. The study guide consists of a www-home page, linked www-pages of each institution or educational programme and guidance by didactic techniques (introduction, learning objectives, tasks, data, sites) on each lesson and case-study.

### ***CBL Lessons in GIS***

To be able to study the lessons on GIS concepts a computer based learning program will be developed (CBL Lessons in GIS). The CBL Lessons in GIS contains self-contained lessons with documentation, questions and exercises on GIS concepts, illustrated by digital images. Also an illustrated glossary is part of the program. All digital image formats and slide shows of images can be used (scans of paper maps and text-illustrating figures, images of vector and raster GIS software, animations of GIS software use).

### ***CBL Cases in GIS***

Another computer based learning program will introduce students in real world applications of GIS by means of "hands-on" case studies. The CBL Cases in GIS describes the role and task of the student in the case study, directs the student to the needed data and documentation and the GIS software and gives feedback on the assignments. Technically the design of this program is similar to the CBL Lessons in GIS, although the contents and didactic techniques used will differ.

### ***professional GIS system***

The practical is concentrated around a professional GIS system, which is available to the student in its full complexity. The GIS software to be used is Idrisi for Windows, developed by Clark university (a raster based GIS). Because of this restrictive choice to one GIS, the case studies have to be developed with

Idrisi. Images, processed by other professional GIS software (e.g. vector-based Arc/Info) will be used as images and slide shows, e.g. to show essential differences in using vector data models or raster data models.

### ***conferencing system***

A practical related computer conferencing system plays an important role by mutual guidance by communication and information transfer between student groups. There is the added advantage of the possibility to distribute more "time-dynamic" information, like new data or new gis applications. Information on the conferencing system comes from both students and tutor and is co-ordinated (and controlled and justified) by the tutor.

### **Written materials**

Written materials are also part of the practical components, mainly because larger texts are unpleasant to be read on the computer screen. A workbook will be produced with introductory texts and background documentation, and a manual on the use of electronic communication and information.

#### *workbook*

The **workbook** contains larger textual explications as an introduction on each lesson and case-study, documentation on GIS concepts and application areas, and documentation on the gis program and the case-study assignments. The workbook, structured in chapters parallel to the lessons and case studies, will also serve as a paper study planner.

#### *manual*

The **telematics manual** will introduce the students in data transfer, electronic communication and computer conferencing and use of Internet. It is meant to be produced as a camera-ready publication which can be easily updated.

A CD-ROM will contain the professional GIS software and the CBL programs. The possibilities to add demo versions of professional GIS software to the CD-ROM will be studied. The www-study guide and the computer conferencing system will be available on < B>Internet. Both will be closely linked and even be integrated (depending on the ICT- infrastructure of the participating institutions). The **written materials** (one workbook and one manual) will be produced and published by the Open university of the Netherlands.

### 3.4 The GIS workbench: the authoring environment

The main aim of the project *Geo Information Systems: an introductory practical* is to develop a self-tuition practical on CD-ROM with a "hands-on" training in gis technology. The practical is designed by the Open University of the Netherlands in co-operating with some gis educational institutions of the Netherlands, Belgium and UK. The participants (authors) co-operate with means of specially developed authoring tools and a restricted computer conferencing newsgroup. Manuscript versions of the modules are updated by means of FTP (file transfer protocol) with access restricted to authors and editors.

Figure 3.2 The gis workbench: an authoring environment (Lansu et al., 1997).

(image to come)

As a part of the project, the Open University of the Netherlands has developed authoring tools, in cooperation with KULeuven, to be able to provide the authors in the stage of writing with data-entry software, electronic communication software and guidelines concerning didactic techniques to be used. The writing and adaptation of the educational contents is done by the authors primarily using pre-existing educational materials. Editors will be review the materials, together with the students in the stage of developmental testing. All participants are able to review and comment upon the developed materials, as soon as the concerned author has released his/her material by FTP to the other project participants. The be able to obtain quick answers on questions of authors, which could be contents-related, didactic or technological of nature, the authors, the educational technologist and engineer and the editor are participating in a computer conference. In this way a direct and effective project communication is possible.

At the final stage of the project the project participants will implement the practical to be used in the own educational setting of the partner institution.

#### *4 A multimedia introductory practical in GIS: the DTM module*

##### 4.1 The practical

As part of the developmental testing (or pilot) stage of the authoring tools of the Consortium project Geo Information systems: an introductory practical, the KU Leuven developed in co-operation with the Open University of the Netherlands, the first module of this practical. The module consists of a lesson Digital terrain modelling in the part Lessons on GIS and a case study on visibility analysis (with means of DTMs) in the part Cases on GIS.

The design of the educational materials is developed by the Open University of the Netherlands, and the authors of the project participants are developing and writing the modules the practical consists of. In order to "write" this multimedia introductory practical (in which images and student tasks are far more abundantly than plain texts), the authors use authoring tools. These authoring tools are developed by the OUNL, in co-operation with KU Leuven. The authoring tools: the GIS workbench as an authoring environment consists of two data entry programs (Lessons in GIS and Cases in GIS) with a data-entry mode to the GIS-glossary and to the meta-database (with image descriptions, lineage of maps, copyrights etc.), a computer conferencing news group with restricted access to authors and an Author's Guide (Nadolski, 1997). The Author's Guide is meant to be a reference book and guide by its table of contents, also offering full explanation about the installation of the material in order to avoid any problem about "getting started" with the authoring tools.

##### 4.2 The lesson: digital terrain modelling

In order to study the introductory practical on GIS, the student must dispose of a PC with access to Internet and a CD-ROM driver. The student receives a CD-ROM and a small workbook.

By means of Internet, students get in touch with the Open University of the Netherlands, offering a study guide (on www), with Internet related tasks, possibilities for guidance by fellow students (in restricted newsgroups), and a managed update exchange site (by FTP) (see figure 3.1).

The CD-ROM contains the computer based learning program (CBL) consisting of a tutorial on Lessons in GIS, a practical on Cases in GIS, a GIS glossary, and the IDRISI-software.

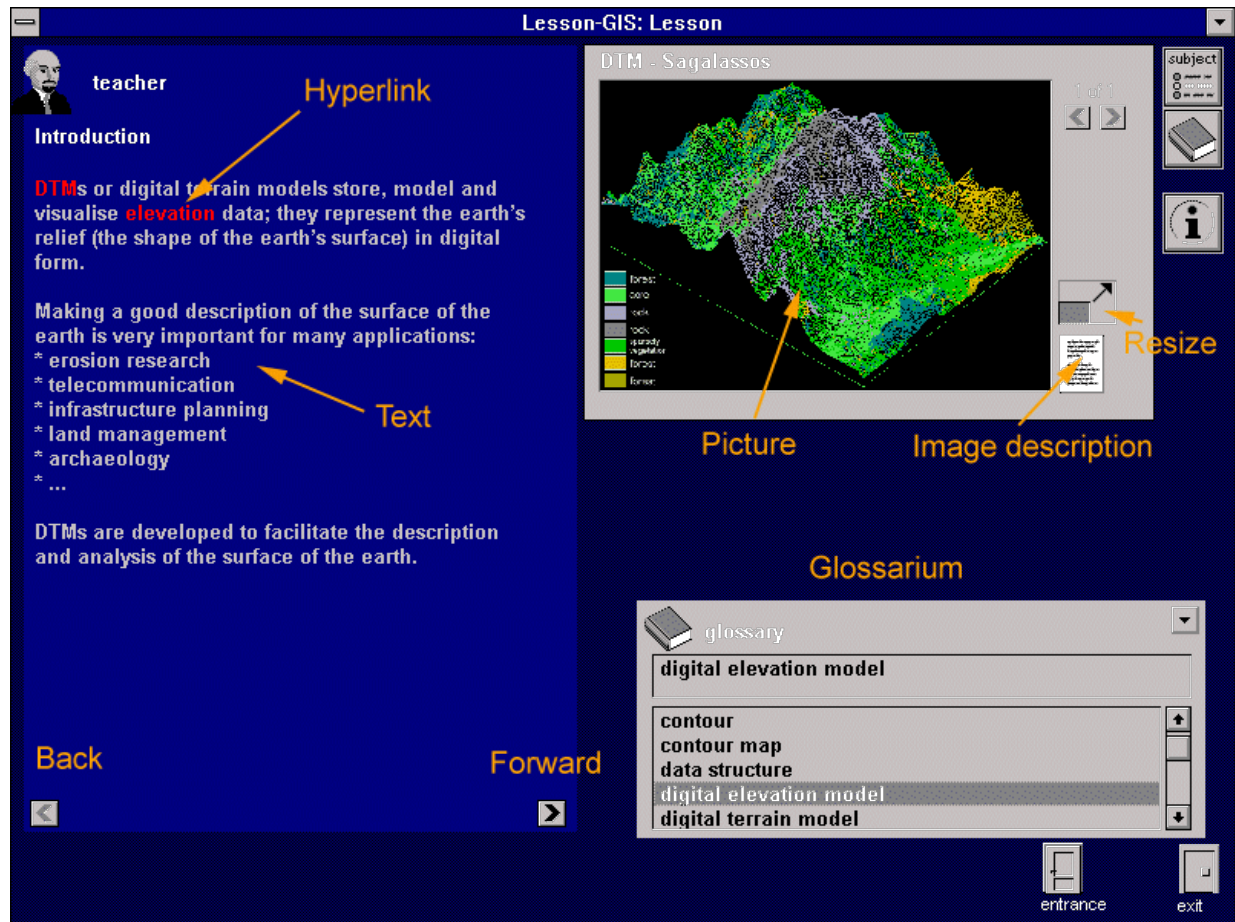
The tutorial is consists of 14 lessons focusing on different aspects of GIS:

1. General introduction to the practical
2. Geo information systems: an introduction
3. Requirements of geo information systems
4. Mapping
5. Quality of processing spatial data
6. Pre-processing data
7. Remote sensing and GIS
8. Visualisation and presentation
9. Site selection
10. Networks: routing and vector analysis
11. Digital terrain models
12. Modelling and GIS
13. Spatial analysis for socio-economic strategic decision making
14. Spatial planning: urban planning and management.

The principal component of the lesson about DTMs (Digital terrain models) is presented in the following sections. The CBL lessons consists of several elements: first a simple text, richly illustrated with images. Hyperlinks lead to a glossary which offers possibilities to go back and forth to other part(s) of the lesson.



Figure 4.1 Didactic means of the CBL Lessons in GIS: text, hyperlinks, glossary and images (Roesems & Govers, 1997, Nadolski, 1997).



When going through the tutorial text, the student is regularly questioned or is asked to carry out a little exercise with IDRISI or an Internet task. Sufficient feedback for these questions and tasks is provided.

The DTM-lesson takes about 4 hours of study and is divided into 5 chapters.

Figure 4.2 Didactic means of the CBL Lessons in GIS: tasks and feedback (Roesems & Govers, 1997, Nadolski, 1997).

**Lesson-GIS: Lesson**

teacher

**Introduction - relief**

Fig. 1 is an extract of a Belgian topographic map. Altitude is indicated by contour lines and expressed in meters. The local co-ordinate system, the Lambert co-ordinate system is also expressed in meters.

**Question**

What is the position of the red point (A) relative to the point (B) with co-ordinates:  $x=220\ 000\ \text{m}$   
 $y=159\ 000\ \text{m}$   
 $z=85\ \text{m}$

The position of A is ... than the position B.

lower, more north-east

lower, more north-west

higher, more north-west

higher, more north-east

**Feedback**

check answer

hint

false: point A has co-ordinates:

$x=219\ 310\ \text{m}$  this is the longitude (in OL)

$y=160\ 033\ \text{m}$  this is the latitude (in WL)

$z=110\ \text{m}$  this is elevation (in m above sea-level)

Point B has co-ordinates:

**Belgian co-ordinate system**

subject

www - task indicator

Idrisi - task indicator

entrance

exit

An introduction explains the notions of "DTM", relief, and illustrates graphic representations, types of information and applications using DTMs. As a result, students have to be able to define a digital terrain model and to give an overview of its use.

A second part handles data models for DTMs, i.e. the raster and the (vector)TIN model. Advantages and disadvantages of both data models are discussed, differences are explained and illustrated. There is also some focus on the concept of resolution.

DTM-construction (i.e. the collection of data, interpolation/triangulation and filtering) forms the object of the third chapter of the lesson. Students learn how to describe and comment the main sources of information for DTMs critically. Various methods for DTM-construction are presented and their (dis)advantages, relatively to each other, are discussed. The principle of parallax measurement and the construction of a DTM based on data of contour lines (maps) using standard IDRISI procedures are explained.

The fourth chapter is about the quality of DTMs. The students have to know and understand the effect of sampling schemes on DTM quality (e.g. by field survey and photogrammetry). They get acquainted to simple **Idrisi** procedures for the evaluation of DTM quality.

The last chapter handles DTM-applications. Students are trained so as to calculate geomorphometric variables from DTMs, to construct a slope map using standard procedures in IDRISI using specific filters, to construct a block diagram with overlay in **Idrisi**.

#### 4.3 The case study: Visibility analysis

When the student got through all lessons, he/she has to choose a more extensive and complex task of about 20 hours study load on topics of the different lessons.

When related to DTMs, students have to execute a simple visibility analysis, as an example of a real-life

application, which can be carried out with relatively simple algorithms (also in Idrisi). Their task is to consist of determining the visible parts of the terrain from a certain spot on the surface and to map the result in a visibility map. First, the DTM must be created from a scanned contour map. Uncertainties about the DTM must be incorporated in the analysis, in order to be aware of the quality of the DTM.

### 5 A Virtual Future

As was stated in the cases about the educational tools developed, the opportunity to enhance professional awareness of GIS is offered by both secondary education (Vanneste, 1997) and open higher education (Lansu *et al.*, 1997). The introduction to GIS can take important effect on the perception and the judgement of many (decision making) people about spatial analysis in general and GIS in particular. The awareness of the value of spatial data and their handling, creates an open mind, even when not really applying GIS.

Nevertheless, one has to take into account the difficulties of teaching GIS (e.g. by lessons in geography) on a secondary school level because of obstacles in terms of time and budget. Therefore, packages with cut-and-dried material seems the only solution (Steenberghen en Vanneste, 1996).

The notice of GIS as a decision-supporting tool and as a direct response-tool for spatial questions leads to a need for more problem-oriented education. The large and diverse group of individuals interested in GIS and spatial concepts on different levels and from different angles as (potential) GIS users, is best served with self directed learning material, like the given example of open distance education (Lansu *et al.*, 1997). The multimedia introductory practical shows that there exists suitable opportunities in combination with the new information- and communication technologies (Roesems and Lansu, 1997).

In the larger software producing firms and information departments of private as well as public sector institutions, the tasks are strongly divided between programmers and analysts. At the moment the same process appears in the GIS world. The way in which geo-oriented data are transformed into spatial information as required by the actors, is becoming of great importance. This refers to a growing need for GIS analysts who can proceed to a problem solving strategy by following a systematic approach, defining the information needed and designing the analysis procedure to meet the goals (Aronoff, 1993).

Therefore, learning materials on GIS should not be directed to knowledge-based learning and hands-on training only. As was shown by the concept of the GIS practical (Lansu *et al.*, 1997), the mutual contacts with employees, GIS experts and other actors are essential in an effective and complete GIS education, so as to prepare for a real GIS environment. A more competence-based way of co-operative learning guarantees the best possibilities, e.g. the mentioned modifications in the Dutch secondary school system (Min. van OCW, 1997).

Another realistic example of a self-directed competence-based learning environment is the virtual company initiative of the Open University of the Netherlands (Westera & Sloep, 1997). The first business unit in this 3-D cyberspace consultancy firm on planning and environment will be a unit for environmental assessment. This pilot unit will be tested among working adult students in spring 1998. Pushing forward the technology of interactive CD-rom design and of virtual environments opens new horizons for advanced GIS learning and education, dedicated to the needs of the targeted students.

### Acknowledgements

We gratefully thanks prof Gerard Govers (KULeuven) and Wim Slot (Open University of the Netherlands) for their contribution to the contents and the design of the multimedia introductory practical.

### Bibliography

- Aronoff S. (1993). *Geographic Information Systems: a Management Perspective*. WDL Publications, Ottawa, Canada.
- Crombag, H.F., T.M. Chang, K.D.J.M. van der Drift and J.M. Moonen (1979). *Onderwijsmiddelen van de Open universiteit: functies en kosten* [Educational materials for the Open university: functions and costs]. Department of Education and Sciences, The Hague, NL.

Huisman, W., W. Ivens and R. van Herpen (1995). *Het doel en de middelen*. Werkvormen en eindtermen in het onderwijs van de faculteit Natuurwetenschappen. [Objectives and didactic means]. Internal report Open universiteit, Heerlen, NL.

Lansu, A. (1996), *Geo Information Systems: an introductory practical*. Project description Consortium Innovatie Hoger Onderwijs. Open universiteit, Heerlen, NL. U96/18 163 ALA.

Lansu, A. and R. Nadolski (1995). *New didactic approaches in Remote Sensing and GIS practicals*. In: Strachan, A.J. et al. Fine tuning GIS education. Workshop manual. JEC-95 conferentie, Den Haag, NL. p 45 - 53.

Lansu, A., T. Roesems and R. Nadolski (1997). *The GIS workbench: a metaphor for development of GIS distance education*. Oral presentation at GISHE 97, Chantilly, Virginia, USA (30/10 - 2/11/1997).

Min. van OCW, Rijswijk. 1997. *Tweede fase voortgezet onderwijs*. Een nieuwe tweede fase voor havo en vwo. [Second stage of secondary education, K12-K14]. Department of Education and Sciences, SDU, The Hague, NL.

Nadolski, R. (1997). *Author's Guide: CBL Lessons in GIS & CBL Cases in GIS*. Geo Information Systems: an introductory practical. Open universiteit, Heerlen, NL. Course code N.35.2.1.1.

Roesems, T. and A. Lansu (1997). *Demonstration of an multimedia introductory practical: the DTM module*. Demonstration at GISHE 97, Chantilly, Virginia, USA (30/10 - 2/11/1997).

Roesems, T. and G. Govers (1997, to be published). *Digital terrain modelling*. Computer based learning program: Geo Information Systems: an introductory practical. Lessons in GIS, Lesson 11. Open Universiteit, Heerlen, NL.

Roesems, T. and G. Govers (1997, to be published). *Visibility analysis*. Computer based learning program: Geo Information Systems: an introductory practical. Cases in GIS, Case 9. Open Universiteit, Heerlen, NL.

Steenberghen T. & Vanneste D. (1997), *Syllabus 'GIS in Onderwijs'*, Ground for GIS - K.U.Leuven, B.

Vanneste D. and De Wilde W. (1996). *Ruimtelijke gegevensverwerking en het gebruik van GIS bij privé-bedrijven in België: een enquête/ Traitement de données spatiales et utilisation des SIG par des entreprises privé; es en Belgique: une enquête*, Benelux CAD/CAM Magazine, nov. 1996: 19-26 (also in: Syllabus "GIS in business", CAD/CAM International, Kortrijk - Belgium, 1/10/1996).

Vanneste D. (1995), *GIS Education in Belgium*, Joint European Conference and Exhibition on Geographical Information (JEC), The Hague - The Netherlands, 26-31/3/1995, Proceedings Vol. 2 - Stream 6, oral presentations: 348-353 (also in: National Report on Belgian Cartography, 10th General Assembly of ICA, Barcelona, 3-9/9/1995).

Vanneste, D. and A. Lansu (1997). *Enhancing general professional awareness of GIS by improving educational GIS tools for secondary school teachers*. Oral presentation at GISHE 97, Chantilly, Virginia, USA (30/10 - 2/11/1997).

Westera, W. and P. Sloep (1997) *The virtual company: towards a self-directed, competence-based learning environment*. Open universiteit, Heerlen, NL.

## **Building Foundation for Spatial Analysis: The First Two Years**

**Shamim Naim**

University of Wisconsin-Waukesha

The need to deliver the key spatial concepts, which should form the basis for GIS education, is recognized by academic and non-academic users of GIS technology. In a comprehensive university environment the educators make sure that their students get the necessary information and training. The problem arises when a GIS curriculum is implemented on a two-year campus or a community college. These institutions are serving increasing number of undergraduates in their first two years of college education. It is difficult for them to meet the demand because of staffing problems. Often one or two member departments have to make hard choices to deliver "technique" courses at the expense of "content" courses. To address this issue, undergraduate curricula could be redesigned and vertically integrated by introducing an introductory course that will serve as a prerequisite for other courses in geographic analysis series. An outline of such a course is presented as a step towards the inclusion of geographic information sciences at the introductory level. This course, "A Survey of Geographic Skills, Techniques, and Applications", will serve as a prerequisite for additional courses in spatial analysis field. **Key words: GIS education, junior and community colleges, foundation for spatial analysis, analysis techniques, proficiencies, dissemination.**

### **Introduction**

Geography and geographic information science depend on the concept of spatial analysis. Webster's New Universal dictionary defines space as:

"Space---L. Spatium. 1. distance extending without limit in all directions; that which is thought of as boundless, continuous expanse extending in all directions, within which all material things are contained, 2. distance, interval, or area between or within things; extent, room, as leave a wide space between the rows; hence, 3. (enough) area or room for some purpose: as, we couldn't find a parking space, put your answer in these spaces, 4. reserved accommodations, as on a train or ship, 5. interval or length of time: as, too short a space between arrival and departure, 6. the universe outside the earth's atmosphere, in full outer space, 7. in mathematics a set of points or elements assumed to satisfy a given set of postulates; as, four dimensional space. . ."

Based on this definition the following aspects of spatial analysis can be delineated:

- Locations, place, and region in which a phenomenon exists.
- Direction in which space extends, defining the dimensions of space using point, line, area, and volume as defining elements.
- Interval or length of time, thus describing movement---static, dynamic, continuous, or cyclic.
- A set of elements or phenomena that interact within n-dimensional space.

Thus space, time and interactions at different scales define the nature of spatial analysis.

Maps because of their appeal to our sense of spatial relationship have emerged as the most fundamental tool for geographers, and spatial concepts of location, distance, direction, accessibility, and spatial interactions have emerged as the building blocks of every geographic analysis. Almost all of our introductory courses in geography and geology expose our students to maps, scales, projections and coordinate systems. The problem is that non-majors take only one or two courses. Therefore, these concepts are repeated in every course we offer at the expense of course content.

### **GIS Education and its Implications**

As the appeal for GIS technology grew and started to attract professionals and users from diverse fields, it became necessary to provide GIS education at the introductory college level. Students trying to get in GIS courses are not just geography majors. They are coming from a vast spectrum of the society with little or no knowledge of geo-spatial concepts, but they want GIS. This has created a need for educators to deliver proper foundation for spatial analysis. While large comprehensive universities have resources to handle this demand, it is not easy for smaller campuses, two years colleges, and community colleges with one to two member departments. If they want to provide this education, they have to make hard choices to deliver "technique" courses at the expense of "content" courses.

To bring geography majors and non-majors, technical and non-technical students at the same level of understanding of geographical concepts, undergraduate geography curricula could be redesigned and vertically integrated by introducing a new course that will build foundation for spatial analysis. This course will provide important skills and introduction to techniques enabling students to solve simple geographic problems. To achieve this objective "Introduction to Geographic Skills, Techniques, and Applications" was offered at the University of Wisconsin-Waukesha in the Spring 1997.

### **Course Evolution**

"Introduction to Geographic Skills, Techniques, and Applications" was offered as a three credit course to satisfy Natural Science requirements for Associate of Arts and Sciences degree. Most universities offer a course like this split in two courses offered as a sequence, or one being the pre-requisite for the other. Typically the first course in the series deals with map reading and analysis, quantification, and statistical concepts. The second course develops the understanding of computer cartography, remote sensing and geographic information systems. This second course usually serves as a pre-requisite for more in depth study of spatial analysis techniques. However "Introduction to Geographical Skills, Techniques, and Applications" is a combination of these two courses. To my knowledge no one in the United States has offered a course like this. When I was developing this course in 1996, I had no ambiguities in my mind as to what I wanted this course to be. My first major stumbling block was the absence of a text book. Several books are available, but they all deal with more specific spatial analysis techniques. This meant that it was my burden to write what I wanted to teach. Since the course was being offered for three credits only (a university policy that does not allow us to offer experimental courses for more than three credits), separating the course in lecture and lab component will not work either. So the course structure evolved into something that I have never done before, and my students were not used to it. What is unfamiliar breeds skepticism. Experimental courses with no text books and questionable transferability do not enroll well. But I did not want a full class to offer it the first time. A smaller class size is much better as it provides room for experimentation. As we stumbled, we also found

solutions to the problems. In the end a much clearer picture emerged. What could be accomplished was retained, what was problematic was simplified. The prospects for the second iteration in the spring semester of 1998 appear to be much less intimidating than they were in the spring of 1997.

## **Course Content/Discussion Topics**

### **I. Introduction:**

- A. Geography as a Discipline
  - 1. The nature of geography
  - 2. Geography as a science
- B. Geographic Method of Inquiry
  - 1. Observation
  - 2. Visualization
  - 3. Analysis
  - 4. Interpretation and communication

### **II. Geographic Data**

- A. The Nature of Geographic Data
  - 1. The concept of database
  - 2. The spatial database
- B. The Vital Statistics
  - 1. The shape of the earth
  - 2. The size of the earth
  - 3. The spherical grid
- C. Dealing with the Size and Shape
  - 1. Map scale
  - 2. Map projections
- D. Locating Places on the Maps
  - 1. Relative and absolute locations
  - 2. Geographical grid
  - 3. Plane or rectangular coordinates
  - 4. Relationship between plane coordinates and projections

### **III. Geographic Data Sources and Attributes**

- A. Primary Data Collection
  - 1. Direct environmental perception
  - 2. Technology based data collection
- B. Secondary Data Sources
  - 1. Existing maps, photos, images
  - 2. Digitized and scanned data
  - 3. Tabular data--census
  - 4. Internet as a data source
- C. Data Attributes
  - 1. Tangibility
  - 2. Temporality
  - 3. Continuity
  - 4. Dimensionality

## 5. Logical scaling

### IV. Statistical Analysis of Spatial Data

1. Descriptive Statistics
  1. Displaying numerical information
  2. Quantitative measurements
  3. Time series analysis
2. Inferential Statistics
  1. The probability theory
  2. Sampling methods and design
  3. Population parameters and sample statistics
  4. The bell curve and Central Limit Theorem
  5. Sampling distribution and standard error
  6. Making inferences

### V. Maps and Cartography

- A. The Language of Maps
- B. The Nature of Mapping
- C. Cartographic process
  1. Map making
  2. Map reading
  3. Map appreciation
- D. Types of Maps
  1. Reference maps
  2. Thematic maps

### VI. Computer Cartography

- A. The Evolution of Computer Cartography
- B. Putting Maps into Computers
- C. All about bits and bytes
- D. ASCII (text) format
- E. Data Format
  1. Raster format-scanning
  2. Vector format-digitizing

### VII. Remote Sensing

- A. Image Forming Process
- B. Electromagnetic radiation
- C. Energy interactions with the atmosphere
- D. Atmospheric windows and sensor placement
- E. Spectral signatures

### VIII. Detection and Recording

- A. Photographic systems
- B. Imaging systems
- C. Processing and Interpretation
  1. Aerial photos - manual interpretation
  2. Satellite images - digital image processing



## IX. Geographic Information Systems

### A. The origin of GIS Technology

### B. The Concept of a GIS

1. Maps and attribute data
2. The difference between MIS and GIS
3. Computer mapping and GIS
4. Multi-dimensionality and power of query

### C. GIS and Spatial Analysis

1. Transformation of projections and coordinate systems, edge matching
2. Spatial retrieval, windowing, selection
3. Classification/reclassification
4. Distance, proximity, networking, buffering
5. Overlays and merging
6. Modeling, scenario building
7. Generating maps and reports

## Proficiencies and Educational Values

This course is designed to develop generic and transferable skills that can be applied across the curriculum. The educational values and learning experiences are exceptionally good. It will develop students intellectually as they are exposed to many different skills. They will:

- analyze, synthesize, and interpret information;
- interpret graphs, tables, diagrams, maps, photos, and use statistical information appropriately;
- be exposed to a large and varied vocabulary and several methods of written communication forms including literacy, graphicacy, and numeracy;
- learn how to get information from printed and electronic sources and observation, and use computers for problem solving;
- learn how to apply appropriate methodology to a particular application.

## Dissemination of Results and Future Directions

In April of 1997, I conducted a workshop in which fifteen faculty members from various UW Colleges Geography-Geology Department, and one biologist participated. The grant for conducting the workshop was provided by the Undergraduate Teaching Improvement Council. The workshop was held in the Remote Sensing/GIS lab established by a grant from National Science Foundation and ESRI. The participants were given some of the exercises used in this course. Most of these faculty members have been teaching for a long time and had to be convinced that technology can actually help. The response from the same faculty that was so opposed to the idea of introducing this course at introductory level just two years ago, was overwhelmingly in favor. Colleagues who are thinking of retiring in near future, are excited enough to be part of the process of curricular transformation. We are hopeful that as we are able to furnish computers and software, we will be able to provide this important opportunity to our respective communities, and built additional courses on this foundation.

## ***Keynote Address*** ***Peter J. Denning, "How We Will Learn"***

Dr Peter J Denning  
Vice Provost Continuing Professional Education  
George Mason University  
Fairfax, VA 22030

Dr. Denning's address entitled, "How we will learn", will be drawn from his essay of the same title in the book, BEYOND CALCULATION: THE NEXT 50 YEARS OF COMPUTING, Copernicus Books, 1997.

PETER J. DENNING is vice provost for continuing professional education at George Mason University. He served previously as associate dean for computing and chair of the Computer Science Department in the School of Information Technology and Engineering. He is also director of the Center for the New Engineer, which he founded at GMU in August 1993. He was formerly the founding director of the Research Institute for Advanced Computer Science at the NASA Ames Research Center, was co-founder of CSNET, and was head of the computer science department at Purdue. He received a PhD from MIT and BEE from Manhattan College. He was president of the Association for Computing Machinery 1980-82 and is now chair of the ACM publications board. He has published four books and 260 articles on computers, networks, and their operating systems, and is working on two more books. He holds two honorary degrees, three professional society fellowships, two best-paper awards, two distinguished service awards, and the prestigious ACM Karl Karlstrom Outstanding Educator Award.

# GISHE97

## *Saturday Working Group Reports*

On Saturday afternoon, conference participants separated into informal groups to identify important issues and themes which had arisen during paper sessions.

---

### ***K-12 group***

Conferences:

1. Show model projects
  - Student presentations
  - Also on the web
2. Regional Workshops for Teachers
3. Instructional Materials Developers should come as well

Curriculum:

1. What standards can be addressed by GIS?
  1. Include GIS in universal technical skills.
  1. Integrate technology with curricula.

Social Change:

1. It should be GISxE - for all educators
  1. Represent all stakeholders who are potential users.
  1. Find out what employers need.
    - School-to-work partnership.
  1. Intern teachers in business.
  1. Have workshops.
- 

### ***Community College group A***

- Develop a strategy/curriculum for "portable" training program [train future trainers]
  - What major topics to cover? [needs to be interdisciplinary]
- Need a survey of the need for GIS employees and technicians.
  - To be used to argue for administrative support and funding
  - Must address both national and local needs
  - How to reach the right industries and agencies?

Create a survey template so it can be conducted locally

- Need to increase general awareness and commitment within administrations to ensure academic and financial support
  - Collect model exercises and project work ideas
  - Work with in-service K-12 teachers.
    - target group [middle schooler?]
    - what materials do they need?
  - Develop national skill standards (including for CCs and schools)
    - this would be very good for obtaining administrative and financial support for programs
- 

### ***Community College group B***

- Train the trainers/teachers
  - Develop a manual on how to set up a program
    - needs to include everything, all issues
    - how to set up one course vs certificate vs AA/AS
    - provide comprehensive checklist
    - include information about:
      - technology/Equipment
      - faculty and staff
      - tech support
      - administrative support
      - list of consultants who could help
      - Funding sources
  - Set up regional support groups
  - Need regular updates on software and technology
  - How to teach new pedagogy
  - How to integrate GIS/GPS/Remote Sensing
- 

### ***Higher education group A***

- guidelines on implementing core curriculum across different disciplines/departments.
    - specify key curriculum concepts and material required.
    - customized interfaces for applications/disciplines.
  - development of a tool kit for educational implementation.
    - "needs assessment" decision matrix
  - development of a profile of skills and knowledge of the "GIS expert"
    - formalization of job title
-

## **Higher education group B**

- Foster the "Spatial Analysis in GIS" agenda at the next conference
  - invite experts
  - hold workshops/sessions
  - identify what should be taught.
- Dissemination of teaching/education/training issues.
  - *The GIS Educator* would be an excellent way to talk amongst ourselves.
  - We also need to publish elsewhere to talk with others (eg. JGHE)
  - Established journals should publish teaching related articles
- Clearinghouse for "Innovations in GIS" across all levels
  - format?
  - needs peer review/comments
- Do market research to determine the different education levels needed (defines Marble's pyramid's needs)
  - encourage more
  - share results (between academia and with industry)
  - make it a higher publication priority
- Debate the pros and cons of "Teaching GIS" vs. "Teaching with GIS"
- Relationship between academic and vendors needs to be improved
  - more collaboration
  - capitalize on mutual entrepreneurship
  - coordination of efforts and "equal playing field"
- Spreading GIS to programs where Geography or other Mapping Sciences traditionally no taught.

---

## **Mixed group**

- Develop a GIS Educators Directory.
- Create a learninghouse for sharing information on case studies, lab excercises, etc.
- Invite community leaders to the next conference.
- Consider how to deal with students with diverse backgrounds.
- Develop courses on GIS for the non-GIS specialist.
- Form interest groups based on different parts of the pyramid (refers to the education pyramid described by Prof. Duane Marble in his Luncheon Address).
- Create a web page outlining what people are doing in different parts of the pyramid.
- Merge Foote Virtual Department model with model curriculum.
- Need to do outreach to other disciplines.
- Vendors should provide info about job requirements at different levels of the pyramid.

---

## ***International issues group***

- How to keep each other informed on an international scale - of "teaching experience" and good "case studies"
    - needs to use appropriate "local" distribution methods
  - Suggestion for communication:
    - PHASE 1
      - Create a website - "The International Yellow Pages for GIS education"
        - needs a coding system for language and theme
        - needs a quality stamp or means of assessment
    - PHASE 2
      - CD Version
      - *action item*: can an annual CD of education materials be produced and distributed??
    - PHASE 3
      - Produce local newsletters addressing local and regional issues
      - Have a GIS education "Road Show" which can demonstrate good practice and encourage local institutional support
-

# GISHE97

## *Sunday Focus Group Reports*

On Sunday morning, following a summary statement by Duane Marble, five focus group themes were identified. These groups met to discuss issues in these areas and to lay out plans for action. The following are brief summaries of their conclusions.

### **Themes**

1. [Support for Curriculum, Classrooms, Labs](#)
2. [Industry, Vendors, and Jobs.](#)
3. [Future conferences and GISHE-like meetings](#)
4. [GIS, Technology, and Geographical Concepts in Education \(K-12, college\).](#)
5. [International Contacts and Issues](#)

### ***Support for Curriculum, Classrooms, and Labs***

- Requested that a letter be sent by conference organizers to institution heads of participants to encourage continued support GIS educators' special concerns
- Outline a basic curricula for spatial studies (for both teachers and for students).
- Create a forum for a) resources and b) feedback
- Create a "decision tree" or matrix which can be used by institutions planning programs. The matrix would allow institutions to match their program structures (eg. short course, training workshops, academic course) and course levels to suggested contents.
- Develop a list of available internships and opportunities for community involvement.

### ***Industry, Vendors, and Jobs***

- Identify a representative who will go to the Open GIS Consortium
  - outline interoperability needs for education and academic communities (e.g. common data formats for educational materials so they can be used in different programs)
  - discuss vendor roles in support of education activities
  - get support for this lobbying from UCGIS, AAG, APA, ACSP, ASPRS, letter from European DGs (13)
- Create a Directory or Resources Guide on-line of education materials available from vendors
- Suggestions for the next GIS Education symposium
  - Bring in "non-educators" to the next 1998 symposium
  - Incorporate the work of the Association of Research Libraries and Special Libraries Association into 1998 Symposium.

- Bring in employers to 1998 Symposium, including government agencies. Use contacts in associations such as AM/FM, URISA to find representatives.
- Bring in recent grads (in job for 1+ yrs); provide sponsorship for their attendance.
- Use a rotating venue for the GIS Education Symposium to coordinate w/ GIS/LIS and/or AAG, etc.

## ***Future Conferences and GISHE-like meetings***

- next GISxE?
  - drop "Higher" education focus
  - possibly hold in Michigan, October 1998, in association with existing ATE project (see presentation by [Raymond, Brown and Xie](#))
  - possibly hold with NCGE 1998
- Elements to add or replace to the conference:
  - Include session and discussion on "Teaching with GIS"
  - Offer main conference every other year, use GISE to plan and stimulate regional conferences in the off year.
  - Have a strategic planning element.
  - Have a strong K-12 track.
  - Include session(s) on community-based GIS education.
  - Invite librarians
- European version of GISHE will be held in The Netherlands in September 1998.
- GIS Educators should attend K-12 meetings to spread the word [NSTA,NANT,NCGE]

## ***GIS Training and Concepts in Multidisciplinary Education, K-12+ programs***

- Customize various different course pathways, including:
  - Industry driven
  - Professional retraining
  - K-12, community college, 4 year
    - basic skills
    - spatial awareness
    - visual content
- Teaching GIS vs. Using GIS
  - Use visualization to teach GIS spatially
  - Consider whether cartographic and spatial concepts should be included or prerequisite to courses
- Consider the Multidisciplinary Approach
  - What are the basic requirements for learning GIS?
  - What should be taught to non-majors?
  - for example, course contents may be:
    - K-12
      - Basic Awareness
      - Spatial Concepts



- Intro to Geodesy
  - Community College
    - technical skills
    - building and reinforcing basic concepts
  - University
    - professional themes
    - narrowing topics to disciplines
- 

## ***International Contacts and Issues***

- Create channels for communication
  - eg. Listserver, Index-Database of Educators
  - *action taken* - ITC offered to develop and maintain the international database, email addresses collected from international participants
- Ensure international issues are included in *The GIS Educator*
  - eg. Columns on international issues should be submitted
- Ensure that *The GIS Educator* includes links to web sites
- Develop a registry of local/regional contacts so that new educators can get linked into the international network
- In distance education programs, consideration needs to be made of languages other than English
- Create an index of international opportunities for continuing education