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ABSTRACT

This report presents the Front Range Community College (FRCC) (Colorado) Office of Institutional Research's recent expansion of its data analysis and reporting capabilities to include a geographic information system (GIS). Utilizing ArcView GIS software, the college is better able to visualize institutional and environmental data. They have created a mapping database of their state and service area to which institutional and environmental scanning information can be added. The resulting maps geographically display select data. In addition to creating a unique visual representation, GIS allows for spatial data analysis that would not be possible otherwise. This increases the ability to distinguish trends or patterns that may go unnoticed when data are presented in traditional tables or graphs only. The report includes a presentation of how FRCC utilized GIS to answer the following questions: (1) where do FRCC students live? (2) how would moving a site affect students? (3) is the Multimedia Technology program attracting students from outside the designated service area? And (4) where is Colorado's biotechnology industry located? Ideas for future applications include marketing and program evaluation. Report includes eight GIS generated displays. (KP)

Geographic Information System (GIS) Applications at a Multi-Site Community College

JC# 010702

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GEOGRAPHIC INFORMATION SYSTEM (GIS) APPLICATIONS AT A MULTI-SITE COMMUNITY COLLEGE

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Abstract: As part of our efforts to support institutional decision-making at Front Range Community College, the Office of Institutional Research recently expanded it's data analysis and reporting capabilities to include a geographic information system (GIS). Utilizing ArcView GIS software, we are now able to better visualize institutional and environmental data. We have created a mapping database of our state and service area to which institutional and environmental scanning information can be added. The resulting maps geographically display select data. In addition to creating a unique visual representation, GIS allows for spatial data analysis that would not be possible otherwise. In this way, we are able to distinguish trends or patterns that may go unnoticed when data are presented in traditional tables or graphs only. For this reason, we will continue to utilize GIS as a compliment to traditional data analysis when appropriate. The current presentation highlights a few of the applications for which we have utilized GIS, displays the final products, and offers ideas for future applications.

Note: The current document is an adaptation of an Association for Institutional Research Annual Forum 2001 presentation. A copy of the actual presentation may be obtained by e-mail at Laura.pottle@wc.frcc.cccoes.edu

The use of geographic information system (GIS) technology is especially important to Front Range Community College (FRCC) because we are a multi-site institution with a large, multi-county service area. As a result, we have a great need to geographically understand our institution, our students, and the communities we serve. A geographic information system allows institutional (student) and environmental (community) information to be represented geospatially. In this way, trends or patterns emerge that may have gone unnoticed if the same data were presented in traditional tables or graphs only. For example, by utilizing GIS we can better visualize where our students reside in relation to each other and to each of our campus sites. To obtain the same information through zip code or census block frequency counts and cross referencing enrollment data would not be as user friendly and would not allow relational trends to show as clearly. I believe the pilot projects presented later will more clearly illustrate this important point.

There are a variety of GIS softwares on the market. The industry standard for basic to intermediate users is ArcView, an ESRI product. We currently run ArcView 3.2. If your institution has a site license through the geography or geology department, an extension is about \$200. If you purchase the software, the price increases to about \$1000. In addition, as with any new processes or products, personnel time (and time is money) must also be committed. The majority of personnel time will be spent on initial data transformation and input into the system.

GIS data are used for two highly interrelated purposes; mapping templates and geospatial analysis. Mapping templates are those base maps which we created with the intention of reusing for a variety of analyses. For example, we have mapping templates of our state, our entire service area, and each individual county within our service area. Each template is created in layers, which ArcView terms themes. The layers we included are as follows: state boundaries, county boundaries, cities, FRCC locations, streets and highways, and in the near future we hope to add public transportation lines. It is important to note that some of these data files, especially streets, are quite large. An adequate operating system is essential. Software minimum specifications are for 24 megabites RAM (32MB is highly recommended).

The second use for data in GIS is spatial analysis. In higher education institutional research, there are a variety of data sets of interest that our individual institutions or governing boards can provide, such as student data and course/program data. Environmental scanning data such as industry location, census counts and projections, and marketing information are also of interest and may be downloaded as public information or purchased through private organizations.

The first step in spatial analysis is to geospatially reference each data record. For example, each student residence must be located on the reference map template. In this way, each student will show as a data point at his/her address of record. This is completed through a process called geocoding. ArcView matches each address to the reference map template data utilizing preprogrammed settings, which provide parameters for ensuring accuracy. For example, we may set a spelling accuracy parameter of 90%. This means that only student addresses that match the map database with 90% accuracy or greater will be geocoded. The geocoding process may be done in batch or interactive mode. Batch means that the entire database can be matched at once. Then any unmatched records can be looked at interactively to check for anomalies and then matched one at a time.

Due to the size of our databases, ArcView only allows for the aggregate analysis of summary table information. For this reason, I use ArcView to select students for analysis and then I prefer to complete aggregate analyses in SPSS. For example, after geocoding our student database, I may select students that reside more than 10 miles from the campus they attend and then conduct statistical analysis on those students in SPSS. However, GIS allows for individual level analysis that SPSS does not. For example, if I see a particular student resides very far outside our service area, I may want to see who that student is. With ArcView I just point my mouse on the geocoded data point and click. The entire student record comes up on the screen. So, spatial analysis is possible at the individual as well as the aggregate level.

Once the mapping template is made and the spatial analysis is completed, it's time to create the final product. ArcView calls this product a layout. Each layout can include a variety of components. I include the map with geocoded data points, a legend, a scale, tables, charts, and any text explanation that is necessary. Completed layouts can only be viewed in ArcView so when I am finished with one, I save it as a .jpg file. In this way, most people can view it. It does lose a little of the detail in the translation, as you will see. However, if layouts are printed on a laser printer, the detail is wonderful. Either way, the layout is user friendly and provides valuable information in a very visual manner.

The response to our GIS capabilities has been overwhelming. In the first year, we received more requests than we could process. Following are the four pilot GIS projects we completed in our office to introduce our college to our new capabilities. We chose to complete four pilot projects that answer four very different questions to demonstrate the variety of issues that GIS could help address at our institution.

The pilot projects answered the following questions:

#1 Where do FRCC students live?

#2 How would moving one of our sites effect our students?

#3 Is our Multimedia Technology program attracting students from outside our designated service area?

#4 Where is Colorado's biotechnology industry located?

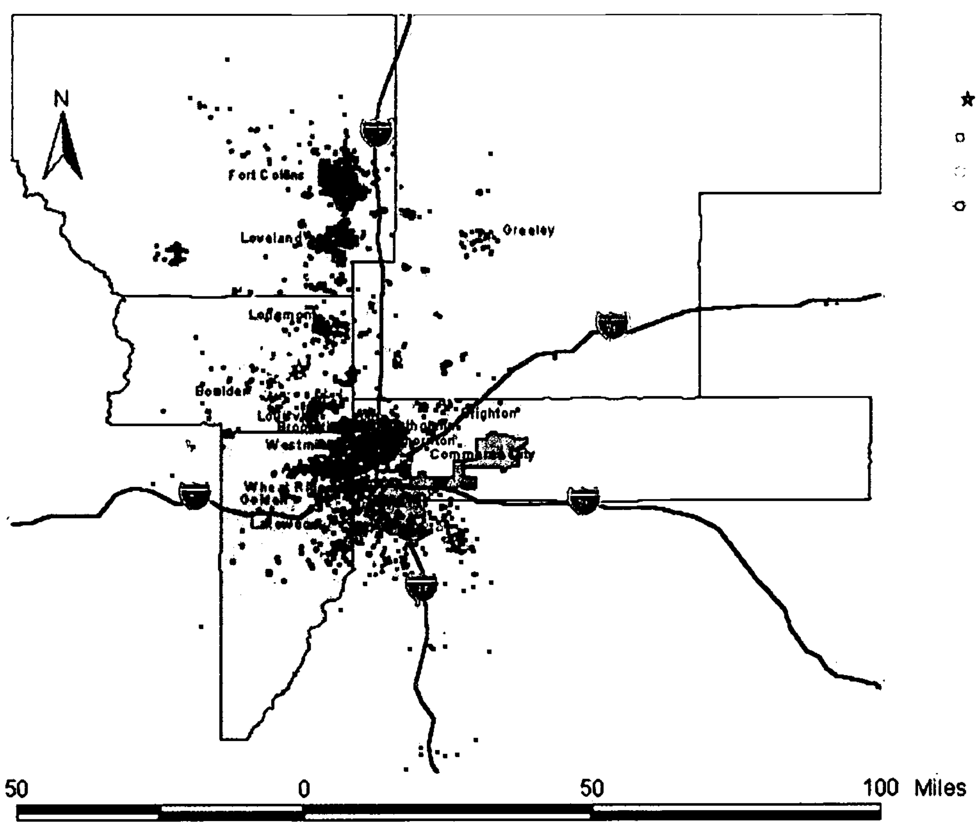
This first pilot project layout describes our Fall 2000 student population. Each student is represented by a data point at their address of record, which is color coded to identify the specific site/campus the student primarily attends.

The map is zoomed in from the state level to show our six-county service area. The interstates provide a point of reference for the user and also help define the southern boundary of our service area. Not shown in the layout, but present behind the scene, are all of the streets in our state. To show them in the layout would clutter the image and literally cover student data trends. As the legend indicates, in addition to student data, the five FRCC campus/sites are also represented here.

The combination of student and campus information helps us to visualize how far students reside from the campus they attend and also shows what areas are not utilizing our services. For more detail, I included tables that describe the student population characteristics in a more traditional format.

Without GIS, zip code frequency counts would have been our only way of trying to visual this same information. As you can see, GIS allows for a much more user-friendly view of the data.

Geographic Origin: Fall 2000



Legend

- FRCC Location
- Boulder
- Brighton
- Distance Learning
- HEAT
- Larimer
- Longmont
- Westminster

	Total
Headcount	12709
Full-time	3596
Part-time	9113
Female	7223
Male	5486
Nonresident	654
Resident	12055
Ethnicity	
Unknown	446
Black	170
Hispanic	1184
Indian	178
Asian	508
White	10223
Age	
<18	615
18-20	3469
21-24	2590
25-29	1751
30-34	1121
35-44	1941
45+	1322

Data are from Fall 2000 end-of-term. 81% of students were geocoded for graphic display.

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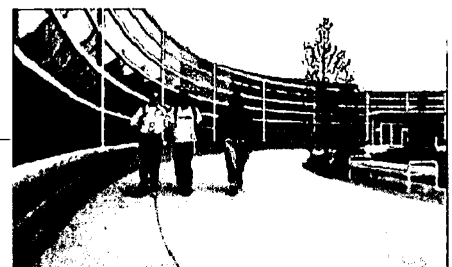
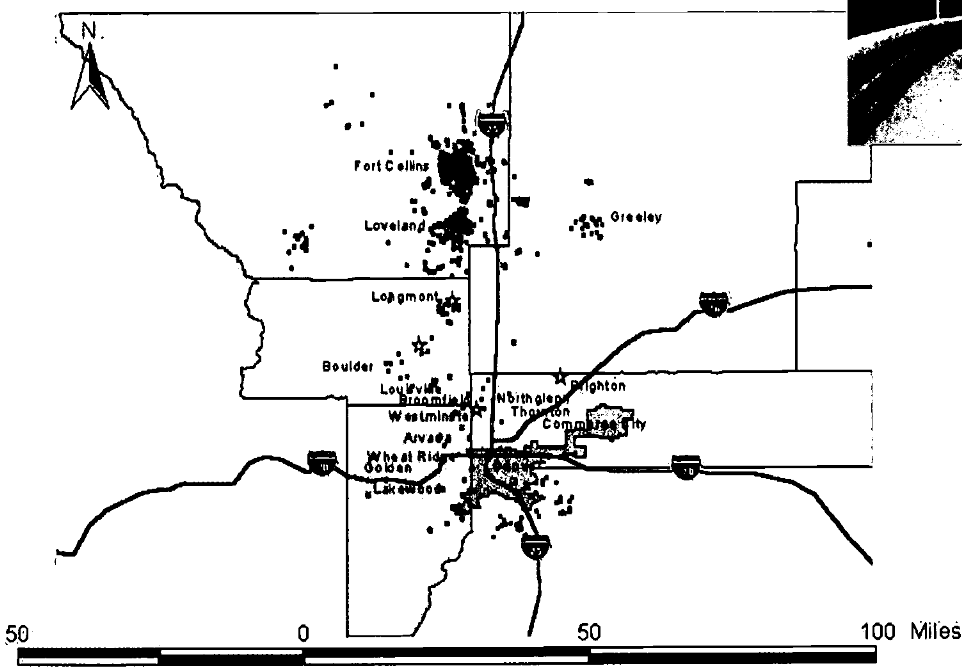
The previous layout displayed all FRCC students and color-coded the data points by which campus the student primarily attends. The current layout shows only our Larimer campus students and again is accompanied by a table to further detail the population. In addition, a photo of the campus has also been added. In a live ArcView presentation, photos can be integrated in with just the point and click of the mouse. For example, our base maps have photos of each of our locations built in so that by clicking on the geocode location, a photo of that location automatically appears.

Geographic Origin: Larimer (Fall 2000)





Larimer Fall 2000		
Headcount	[illegible]	
Full-time	[illegible]	[illegible]
Part-time	2450	50.90%
Female	[illegible]	[illegible]
Male	[illegible]	[illegible]
Nonresident	210	6.52%
Resident	[illegible]	[illegible]
Ethnicity		
Unknown	[illegible]	4.76%
Black	[illegible]	[illegible]
Hispanic	[illegible]	[illegible]
Indian	[illegible]	[illegible]
Asian	[illegible]	[illegible]
White	[illegible]	84.44%
Age		
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
21-24	[illegible]	20.32%
25-29	647	14.10%
[illegible]	259	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Legend
☆ FRCC Location
• Student Residence

Note: The current map displays a data point at the address of record for FRCC students that primarily attend at the Larimer campus. The accompanying table shows exact demographics of the fall 2000 Larimer campus student population. Due to new construction and the use of post office boxes, 66% of students were accurately geocoded for graphic display.

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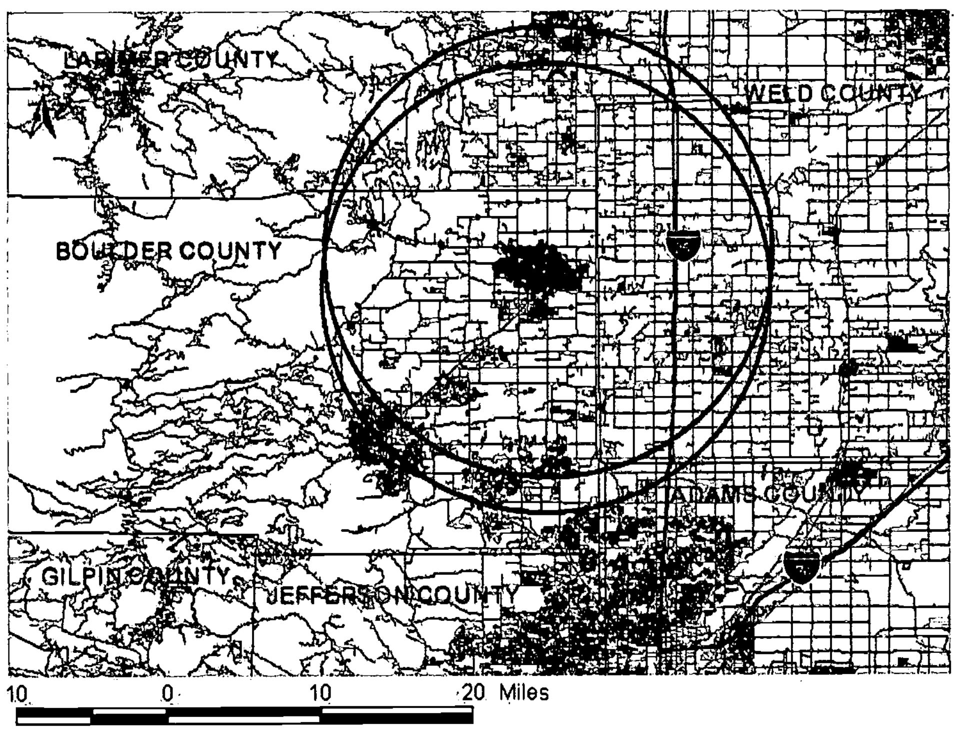
This second pilot project helped us to visualize the impact of moving one of our sites. This layout map is zoomed into the county in which the current and proposed sites are located. It is important to note that we have two current sites in Boulder County, and impact analysis was conducted for each site individually and then for our Boulder County students as a whole. Currently, 60% of students attending our Longmont site live within 15 miles from campus. With the proposed new campus, 64% would drive less than 15 miles from their home to attend. It is interesting to note here that GIS can create the radius circles for any size and location. It can then automatically count the number of data points in or out of the circle.

Geographic Origin: Longmont Campus



☆ Current FRCC locations

★ Proposed Longmont campus location

▪ Student residence

	Longmont	
	Count	Percent
Headcount	[illegible]	
Full time	169.	18.4%
Part time	721	81.6%
Male	[illegible]	[illegible]
Female	608	32.0%
Resident	806	98.2%
Nonresident	16	1.8%
Ethnicity		
American	[illegible]	[illegible]
Black	11	1.2%
Hispanic	[illegible]	[illegible]
Native	[illegible]	[illegible]
Asian	2C	2.3%
White	[illegible]	83.0%
Age		
<19	[illegible]	6.4%
19-20	[illegible]	23.8%
21-24	[illegible]	[illegible]
25-29	[illegible]	11.1%
30-34	[illegible]	[illegible]
35-44	180	20.4%
45+	131	14.9%
Not given	0	0.0%

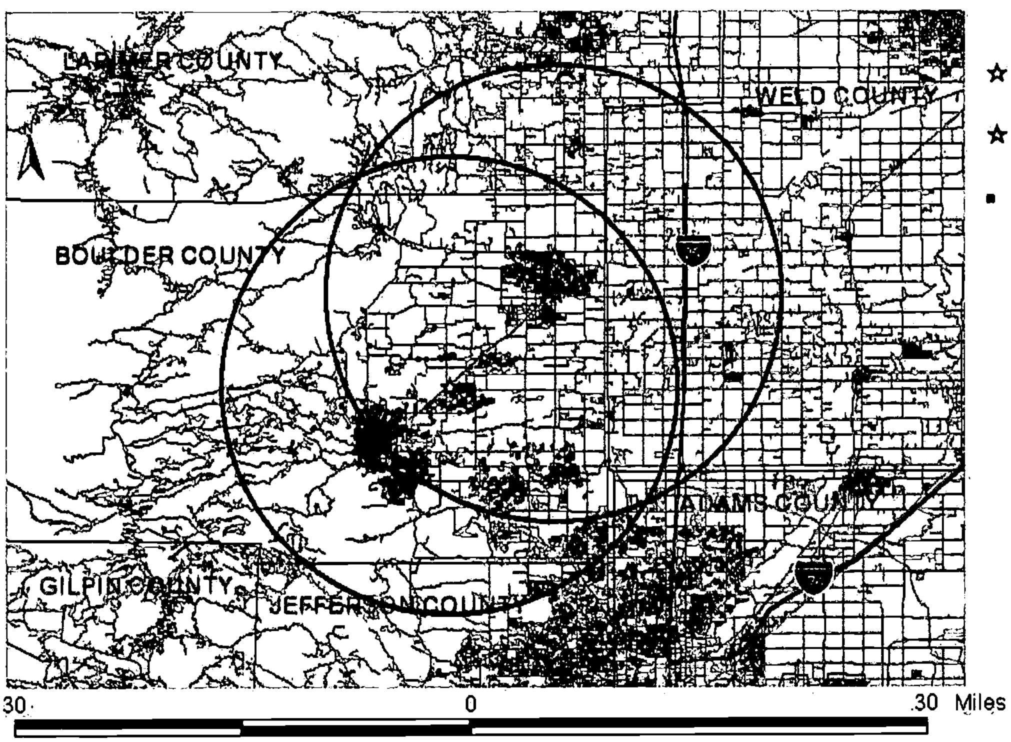
Currently, 60% of Longmont students live within 15 miles from the Longmont campus; 40% drive greater than 15 miles. With the proposed new campus, 64% of these students would drive less than 15 miles from their home to attend; 36% would drive greater than 15 miles.

Note: The map represents student data from Fall 1999 only.

Produced by the Front Range Community College Office of Institutional Research (January 15, 2001)

To compare site locations, a second layout was created. Note that the student data are the same. To create the changes, I just moved the radius circles and adjusted the student counts. Layouts are live representations of maps, unless otherwise specified. This means that after creating the last layout, I moved the radius circles and came back to the layout to have it automatically updated. Then I just saved both versions. Currently, 66% of Boulder campus students live within 15 miles of the campus. With the proposed campus, 52% of students would drive 15 miles or less to attend at the new site. Again, for more detail about student characteristics, I included a traditional table.

Geographic Origin: Boulder Campus



☆ Current FRCC locations

★ Proposed Longmont campus location

■ Student residence

	Boulder	
	Count	Percent
Headcount	[illegible]	
Full time	[illegible]	[illegible]
Part time	[illegible]	[illegible]
Male	[illegible]	[illegible]
Female	[illegible]	[illegible]
Resident	[illegible]	[illegible]
Nonresident	[illegible]	13.7%
Ethnicity		
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
White	[illegible]	[illegible]
Age		
[illegible]	[illegible]	[illegible]
19-20	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
36-44	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Currently, 66% of Boulder students live within 15 miles from the Boulder campus; 34% drive greater than 15 miles. With the proposed new campus, 52% of these students would drive less than 15 miles from their home to attend; 48% would drive greater than 15 miles.
Note: The map represents student data from Fall 1999 only.
Produced by the Front Range Community College Office of Institutional Research (January 15, 2001)

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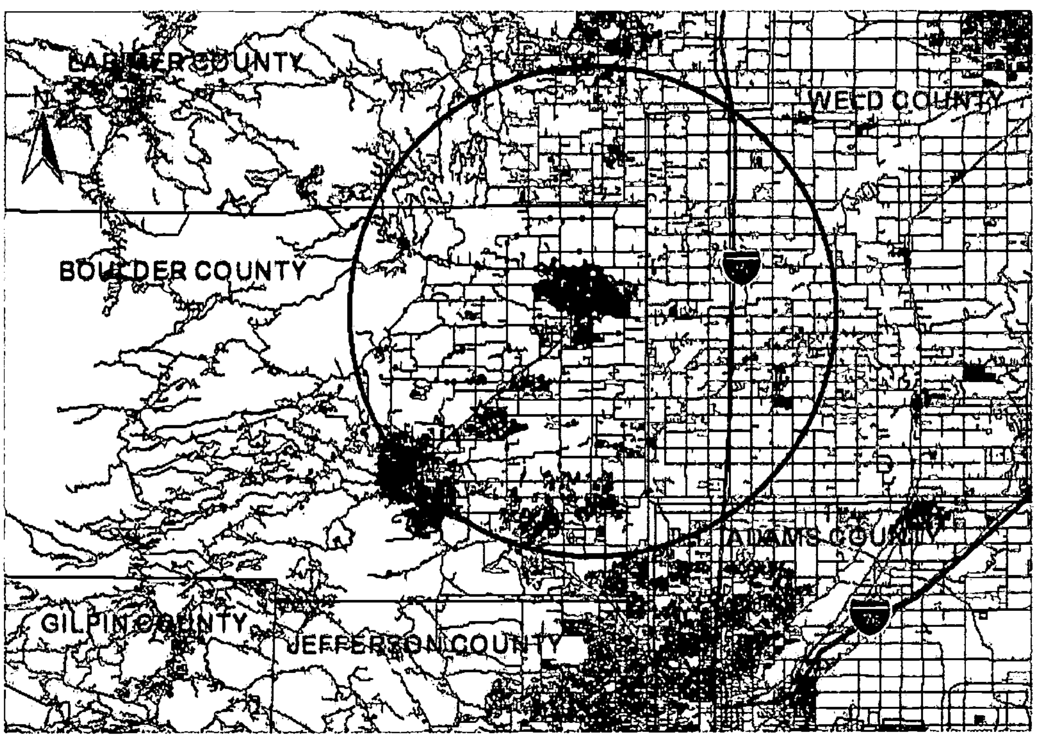
With the proposed new site location, 60% of Boulder County students as a whole (Boulder and Longmont sites combined), would drive 15 miles or less to attend. This three-step project really illustrates how useful GIS is. Without this visualization capability, zip code frequency charts would have to be cross-referenced for the current and proposed site. GIS also allows decision makers to visualize and estimate the impact of multiple new site locations before choosing the most appropriate one.

Geographic Origin: Boulder County



30 0 30 Miles

★ Current FRCC locations

★ Proposed Longmont campus location

■ Student residence

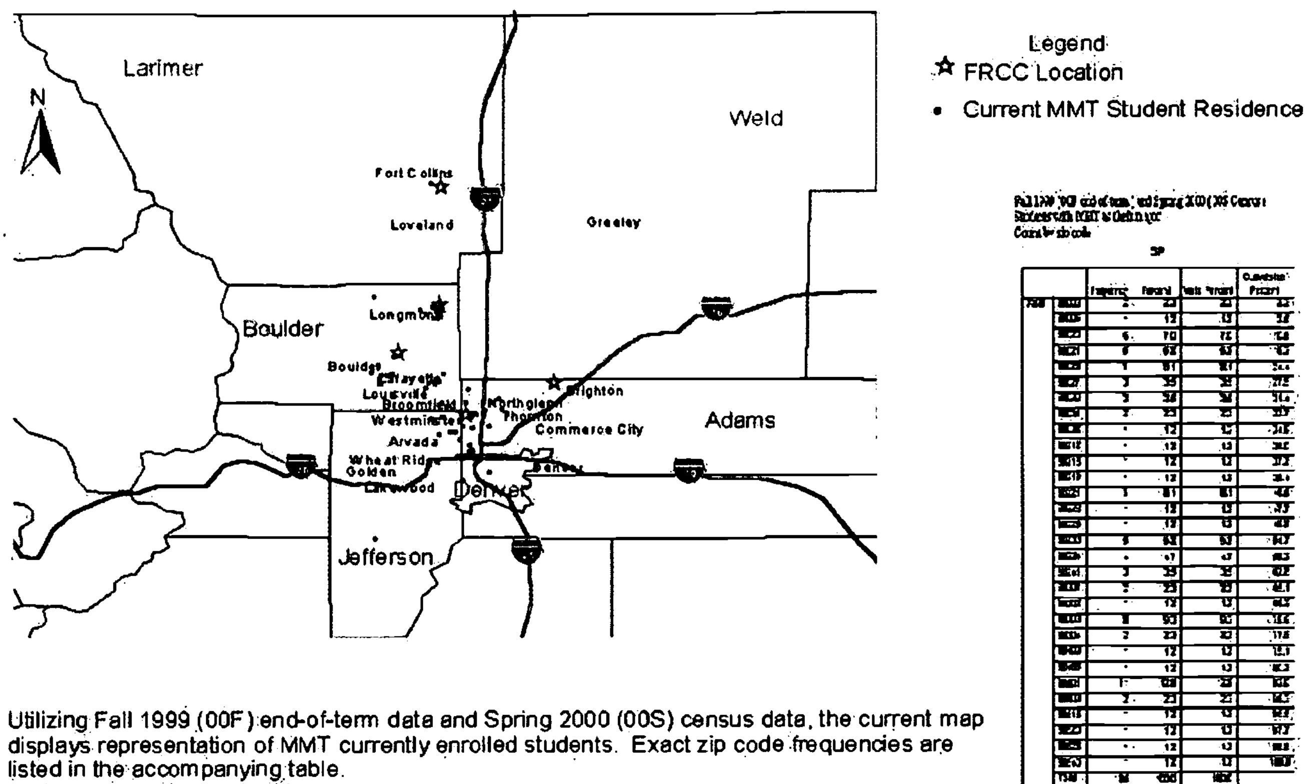
With the proposed new Longmont campus, 60% of Boulder County students would drive less than 15 miles from their home to attend; 40% would drive more than 15 mile

Note: The map represents student data from Fall 1999 only.

Produced by the FRCC Office of Institutional Research (January 15, 2001)

The third pilot project responded to concerns that one of our programs, Multimedia Technology, was attracting students from outside our designated service area. Utilizing Fall 1999 end-of-term data and Spring 2000 census data, the current layout displays currently enrolled MMT students. Exact zip code frequencies may be viewed in the accompanying frequency table. In a matter of seconds, it is clear that only one student came from outside our service area. Again, traditionally, we would have had to cross reference the student zip code frequency table against our service area zip code list. GIS provided the same information in a fast, easy to process, visual manner.

Multimedia Technology
(Currently Registered)



Utilizing Fall 1999 (00F) end-of-term data and Spring 2000 (00S) census data, the current map displays representation of MMT currently enrolled students. Exact zip code frequencies are listed in the accompanying table.
Note: Census data are preliminary and subject to change.
79% of students, n=68, were accurately mapped by residential address.

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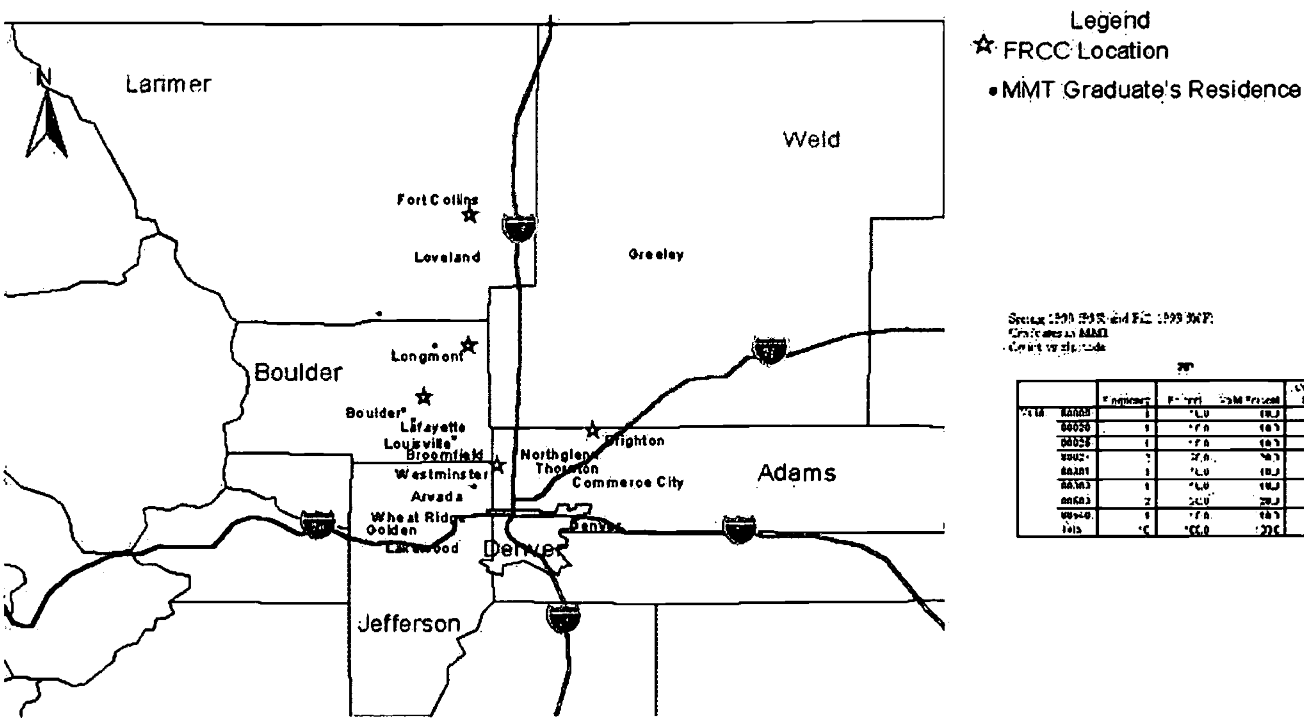
To finish this pilot project, the exact same procedures were completed utilizing MMT graduate data. Again, the accompanying frequency chart shows exact zip code counts. It is clear from this layout that not even one MMT graduate came from outside our service area. Our GIS capabilities quickly and accurately showed concerns about our MMT program "stealing students" were unfounded.

Multimedia Technology
(Graduates)



[illegible]

		[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]
	[illegible]	1	[illegible]	[illegible]	[illegible]
	[illegible]	1	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	1	[illegible]	[illegible]	[illegible]
	[illegible]	1	[illegible]	[illegible]	[illegible]
	[illegible]	2	[illegible]	[illegible]	[illegible]
	[illegible]	1	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	

Utilizing 1999 Spring and Fall (99S, 00F) end-of-term data, the current map displays representation of MMT graduates. Exact zip code frequencies are listed in the accompanying table. 60% of students, n=6, were accurately mapped by residential address.

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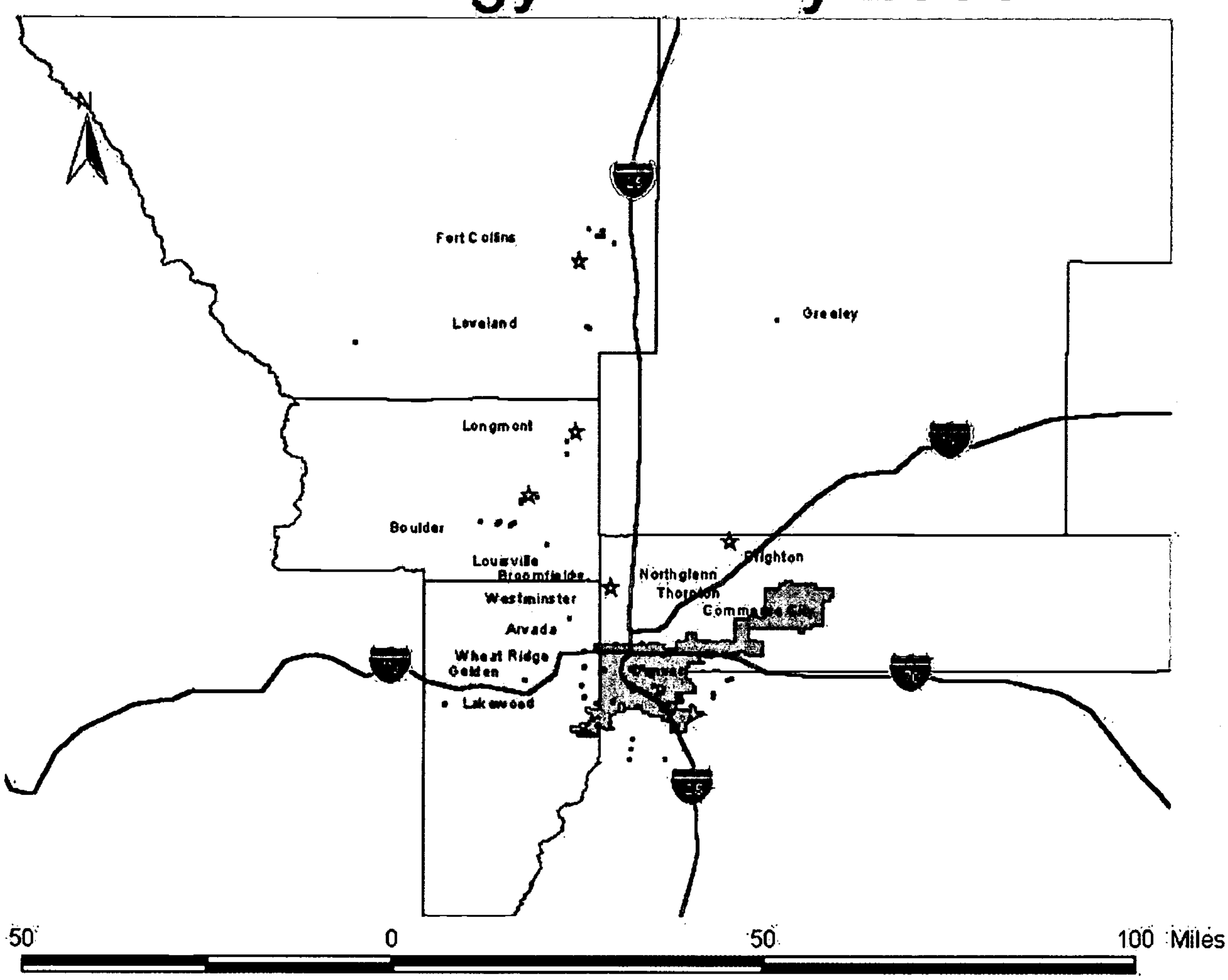
To this point, I have shown projects that utilize student and program data. Environmental scanning data are also of interest. Our fourth pilot project attempts to show where Colorado's biotechnology industry is located. The information is public record and available through the state free of charge. I chose businesses with specific standard industry codes (SIC), which I determined to be "biotechnology". This is, of course, subjective but to this point the most accurate method we could think of to classify businesses. The data are downloaded and then geocoded. Each blue data point represents a biotechnology company. This can be helpful in determining the need for new or already existing programs in our service area and may be particularly useful in industry trend analysis.

Biotechnology Industry 2000



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The pilot projects I have shown today address a variety of issues at our college. As we become more adept with GIS, we plan to expand our capabilities and begin to produce work products utilizing census data including market demographics and penetration analyses. In addition, future industry trend analysis will show us where industries are located as well as where the fastest growth is occurring. Student data reports for fall and spring semesters will also have scheduled release dates. Now that we have our mapping templates created, performing ad hoc GIS data requests is possible. These requests have usually been related to marketing or program evaluation. For example, our marketing staff wanted to know what areas had the highest numbers of non-responders to a mailing so that a second wave of mailers could be sent without having to spend the money to mail to our entire service area.

In conclusion, as I have shown, GIS can address a variety of issues in higher education (especially for multi-site institutions). It serves as an excellent primary analysis tool or as a complement to more traditional analyses. As technology improves, the cost of GIS becomes more and more reasonable and the software becomes more and more user friendly. For these reasons and its almost unlimited utility, I believe institutions and governing boards should more seriously consider an investment in GIS.

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