Houston: Past, Present and Future And its Relationship to Regional Mobility

Bill Pisciella

Narrative

When I arrived in Houston, Texas in 1973, I was surprised to find no horses on the streets and no cacti. My visions of Houston were based purely on the cowboy and Indians movies of the 1950's. I fully expected to see a western town with saloons. I didn't even realize that Houston was a major city.

My second shock came with the realization that Houston was a major city. Major cities to me had mass transit systems that allowed anyone to go anywhere easily, conveniently and cheaply. But in Houston, the automobile was THE mode of transportation.

Buses did exist but the routes to downtown and out of downtown. To travel to somewhere like the Galleria to shop required a complicated master plan. The whole mess was too much for me. I chose to keep my automobile. I have never taken a transit bus in Houston to this day.

Automobiles offered only a "lesser of two evils" choice. The major interstates I-45, I-10, and I-610 were under construction. So was US 59. That was in 1973. In 1999 they are all still under construction. It seemed to me from the very beginning that there must be an alternative to endless highway construction.

I remember watching a special on transportation. The fact that stuck in my mind was that the transit system that travels in the median on freeways in Chicago had the capacity to carry more passengers than the freeway itself.

I came to Houston to seek employment in engineering. A friend of mine suggested that I would make an excellent teacher because of my idealism. Being young, naive and idealistic, I applied to teach in the only school district I knew at the time, the Houston Independent School District. I had absolutely no teaching credentials and no experience. I was hired on the spot at 50% of my previous salary.

I started teaching at Kashmere High School in November 1973. When I arrived, I replaced a substitute who had been teaching mathematics since the beginning of September. I was assigned classes in Fundamental Mathematics. The mathematics specialist suggested that I buy dominoes and teach the students to add using them. I learned my first lesson. Students who could not add single digit numbers on paper could add in dominoes in their head and could even tell me what dominoes each of the other people has "in their hands". The lesson learned- Students learn best when they could relate what they were studying to life experiences.

Two ideas coalesced. Why not teach mathematics while designing a transportation system for Houston? I went to Gulf Oil, where they gave me a classroom set of Houston

maps. I was ready to go. I would have the students select routes, measure distances, and estimate the number of passengers at each stop. I could teach measurement scaling, estimation and addition in the midst of learning problem solving. I was about to learn my second lesson.

The first two questions that I faced were:

- "Where is Houston on this map?" (a map of Houston)
- "Where are the streets in Houston" (a street map of Houston)

The students had no idea about where they lived, where anything was in Houston, or any idea about direction and distance. The mathematics class turned into a study of Houston. We started with the Astrodome because they had a playoff game there.

We finally went on to measurement. I decided to use metric measurements of distance. I first tried to have them measure distances on the map. I had to begin with which end of the ruler to start at. Then I found that when they tried to measure tenths of a centimeter they would go right past a whole number. For example, 4.2 centimeters was measured as 3.12 centimeters.

It was at this point that I realized that the Houston Independent School District was running a dual school system with segregated schools that were "separate and unequal". In fact, when I confronted the superintendent, Billy R. Reagan in a public meeting about the fact that we had such a separate and unequal system 20 years after the Brown Decision, he replied that what I said was true. My subversive campaign to turn Houston's schools into education institutions became public.

I also realized that there is a time and place for everything. The weakest students at Kashmere High School in the early 1970's were not ready for transportation systems. My idea went on hold for the next quarter of a century. It revived with a chance meeting with a senior official fron the US Department of Transportation. That's the focus of this unit.

Introduction

This unit is designed to prepare students to design a regional mobility plan for the Houston-Galveston Metropolitan Region. The Houston-Galveston Metropolitan Region consists of eight counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller. These eight counties represent a Consolidated Metropolitan Statistical Area (CMSA). The CMSA is presently 11^{th} largest in the United States and should become the 10^{th} largest when the 2000 census data becomes available. It is the largest CMSA without a mass transit system.

The unit covers the various aspects that caused the Houston region to be come one of the largest metropolitan regions in the United States in terms of both population and land area. The reasons that there is no mass transit system will be covered as well as the

problems that this has caused. Finally the students will project their own plans to solve the regional mobility problems. The unit will require about four weeks.

Several factors were critical in the development of the region. These factors can be organized into seven categories: geography, geology, sociology, politics, economics, and technology. Each of the categories is studied and comparisons are made to regions that developed differently.

The demographics of the growth are analyzed so that predictions can be made about the future. The students will learn how to analyze data and its changes. This analysis is used to extrapolate to predict the future. Major emphasis is placed on the development of the single-occupied automobile as the major transportation system for commuters.

The unit hopefully will be incorporated into a multi-high school case study entitled "Case Study: Designing a Regional Mobility plan for the Houston-Galveston Region: A Multi-School Approach". Four schools are projected for the 1999-2000 school year: Milby, Madison, Reagan, and Washington High Schools. The schools will collaborate with the Houston Independent School District (HISD) and the National Action Committee for Minorities in Engineering, Inc. (NACME).

The educational goals of the course are listed in the document *Case Study: Designing a Regional Mobility Plan for the Houston-Galveston Region: A Multi-School Approach, (A Draft Proposal):*

> "Several major concepts were used in the creation of this case study. Students should see:
>
> - The value of material covered in all curriculum areas in the solution of major engineering projects.
> - How huge databases are "mined" to find, analyze and integrate pertinent data in the development of solutions to major problems.
> - How to use technology in the analysis, description and presentation of solutions to problems.
> - That working with others in a cooperative rather than competitive environment benefits all in developing solutions to complex problems." (*Case Study: Designing a Regional Mobility Plan for the Houston-Galveston Region: A Multi-School Approach ,(A Draft Proposal)* , 1)

As the Houston region continues to grow and expand its geographic outreach, mobility will become a major issue. Continued growth without an accompanying infrastructure could easily become the region's downfall. At some point, commuters will become increasingly frustrated and may begin to seek "greener pastures". It is the responsibility of those who care to raise the issues presented in this document

Scope and Sequence

1. The effects of geography on the development of the Houston Region: Comparisons are made to other major urban areas. The students are asked to make inferences about the relationship of geography to growth

2. The effects of geology on the development of the Houston Region: Comparisons are made to other major urban areas. The students are asked to make inferences about the relationship of geology to growth.
3. The effect of sociological factors on the development of the Houston Region: Comparisons are made to other major urban areas. The students are asked to make inferences about the relationship of societal factors to growth.
4. The effect of economic factors on the development of the Houston Region: Comparisons are made to other major urban areas. The students are asked to make inferences about the relationship of economic factors to growth.
5. The effect of automobiles on the development of the Houston Region: A study of the history of automobiles in Houston and how it affected Houston's growth.
6. The interrelationship between factors in the areas of geography, geology, sociology, economics, and technology; and their effect on growth: Students will study this interrelationship as an interactive system.
7. The demographics of Houston in the past and present: Students will learn to select the factors relevant to their task and analyze the data and its changes.
8. The demographics of the future: Students will learn to develop techniques to extrapolate data and to make estimations of future economic data. They will also learn the limitations of such predictions.

Course Activities

The unit is designed to require approximately twenty traditional class periods. There is, however, a multitude of scheduling options. The three most prevalent scheduling techniques are:

Traditional: Class meets every day for approximately 50 to 55 minutes. A semester is eighteen weeks. The class period used in these activities is based on the traditional schedule.

Alternating Block: Class meets ninety minutes per day on alternating days. A semester is eighteen weeks. Two class periods are contained in one ninety-minute block.

Accelerated Block: Class meets ninety minutes per day. A semester is nine weeks. Two class periods are contained in one ninety-minute block.

<u>Class Periods One and Two: The effects of geography and geology on the development of the Houston Region.</u>

Background Material

Houston is located in close proximity to the Gulf of Mexico. This region is called the Gulf Coast Region. The climate in this region is typically mild from late autumn to early spring. From late spring to early autumn, the region is typically very hot and humid. Hurricanes and tornadoes are the major meteorological threat to lives and property. Snow, sleet and ice are rare occurrences in the region. Earthquakes are an almost nonexistent threat in the Gulf Coast Region.

This climate is in contrast to major metropolitan areas of the northeast and north central regions of the United States. Sleet, snow and ice are the major meteorological threats. Hurricanes are much less prevalent. Tornadoes are much less a threat. The south central and the southeast regions are threatened by tornadoes. The Atlantic Coast Region is sometimes threatened by hurricanes. Earthquakes in this entire region are rare.

The Pacific Coast and western metropolitan areas have a diversity of climates due primarily to ocean current patterns, the latitudes and mountains. The formation of these mountains is primarily due to plate tectonics. The plate tectonics also greatly increase the frequency of earthquakes in the region.

These differences in climate, geology, and meteorological weather patterns has had an effect on the development of these regions in terms of their growth patterns, their economies and their major modes of transportation. The major metropolitan centers Gulf Coast Region are among the last to show major growth. Indeed, the Gulf Coast Region has some of the fastest growing metropolitan centers in the United States.

There are, however, some vast differences in the growth patterns of two major metropolitan regions within the Gulf Coast Region: Galveston, Houston and New Orleans. The way that these cities developed in the twentieth century may provide clues as to growth in the twenty-first century and its effect on transportation infrastructures. Quoting from the *Houston Metropolitan Study*:

> "...we close with a tale of two cities in the 20th century – New Orleans and Houston. New Orleans was the South's largest city in 1900, its preeminent mercantile and manufacturing city. The Louisiana city had an excellent natural deepwater port, the nation's best inland waterway connections, well established universities, and a vigorous cultural life. Houston had less than a fifth of New Orleans' population at the turn of the century, had a lower per capita income, was 50 miles from the Gulf of Mexico, with no river connection, had no universities and few cultural attractions. .... And now as 2000 approaches, we see a very different pattern when we compare these Gulf Coast metropolitan areas. Houston has three times the population of New Orleans, far higher per capita income, a much lower crime rate, and, at least in areas like opera, ballet, and classical music, superior cultural assets." (*Houston Metropolitan Study*, 17)

There were two geographic factors that helped lead to such a dramatic turnaround in these two areas. The first of these factors was the availability of usable land. In the Houston area, land was available at low cost in virtually all directions around Houston. This contrasts to New Orleans, which is blocked from expansion to the north by Lake Ponchetrain, the south by the Gulf of Mexico. To the east and west, there are vast areas of swamp land. This land is approximately an average of forty feet above sea level.

The threat of flooding as a result of major storms and hurricanes is the second factor. New Orleans is virtually at sea level and right on the Gulf of Mexico. Houston is fifty miles inland and about forty feet above sea level. While both areas are threatened by the possibility of hurricanes coming inland from the Gulf of Mexico, New Orleans is much more vulnerable.

Large deposits of oil existed in both the Houston and New Orleans regions. Again quoting from the *Houston Metropolitan Study*:

> "Large deposits of oil and natural gas were discovered near both cities in the first decades of the century, so Houston gained little advantage in that regard." (*Houston Metropolitan Study*, 17)

However, Houston had one major geological advantage over New Orleans with regard to the oil reserves. Houston was located above a very large aquifer. This large supply of cheap water gave Houston a major advantage. Oil refining needs large quantities of fresh water.

A bayou runs through Houston to the Gulf of Mexico. This bayou, the Buffalo Bayou, gave Houston the opportunity to create a path to the Gulf. The Houston Ship Channel was created. Houston become a huge shipping port, negating New Orleans major advantage.

Before the turn of the century, Galveston was considered to be the center of the Houston-Galveston metropolitan area. The populations and economies were roughly similar. All that changed on September 8, 1900. Quoting from *Progrowth Politics-Change and Governance in Houston:*

> "Houston's greatest locational advantage over Galveston became tragically apparent on September 8, 1900. That afternoon a powerful Gulf hurricane smashed across the low, sandy island at the mouth of the Galveston Bay. Virtually every dwelling in the city was destroyed or badly damaged, and 6,000 people were killed, a sixth of Galveston's residents. No greater natural disaster has ever struck the nation. Houston, though only 50 air miles from Galveston, suffered comparatively little damage." (*Progrowth Politics-Change and Governance in Houston, 40)*

Classroom Activities

The activities below are designed to be fast paced. The tight time limits will encourage students to be active learners.

The background material above will be distributed to the students in advance of the class. The students will be asked to read the material. The teacher will summarize the material. (This will take approximately 15 minutes)

The students will be divided into groups of four or five. Their tasks will be to discuss their opinions on the discussion topics below, form consensus opinions on the topics, and develop rationales for their opinions. At the end of each topic, the groups will present their findings in a one to two minute presentation. Each topic will require approximately 20 minutes)

- Compare the climates of the various regions in the United States and develop a table of the advantages and disadvantages of each region.
- Compare Houston to New Orleans and Houston and Galveston determine a priority order for the reasons of the difference in growth patterns in the twentieth century.

- Make educated guesses as to why there was tremendous growth in the North and Central regions of the United States in the nineteenth century and tremendous growth in the Gulf Coast region in the twentieth century.

The last activity for students is to make a journal entry for this topic. It should cover:

- What they learned.
- What they can apply to other courses of study.
- What they hope to learn in the future.

Class Periods 3 and 4: The effect of sociological and economic factors on the development of the Houston Region

Background Material

The growth of the Houston-Galveston region can be divided roughly into three fifty-year periods. These were the last half of the nineteenth century, the first half of the twentieth century, and the second half of the twentieth century. By using these three time periods, the sociological and economic factors that most influenced the region's growth become more coherent.

The population of Houston region grew from about 2,400 people in 1850 to about 64,000 in 1900, almost a 2700% increase. This growth occurred despite the Civil War (1861-1865). During the Civil War, the Houston region suffered economically. From *Progrowth Politics-Change and Governance in Houston:*

> "While Houston was one of the very few towns in the confederacy that escaped fighting and wartime occupation by federal forces, its local trading economy was severely disrupted by the union blockade of Galveston. With the cotton trade virtually shut down, the railroads and ship channel deteriorated during the war years."(*Progrowth Politics-Change and Governance in Houston,* 39)

The Houston region was relatively unscathed by the Civil War due to its small size, its isolation from the rest of the south and lack of viable large ship transportation from the North. After the Civil War, Houston recovered quickly. From *Progrowth Politics-Change and Governance in Houston:*

> "Yet Houston recovered from the war relatively quickly, undoubtedly aided by the absence of local destruction and the rapid population growth in the surrounding agricultural areas." (*Progrowth Politics-Change and Governance in Houston,* 39)

One major factor that affected Houston's growth during this period was the rapid development of the Houston Ship Channel. The Buffalo Bayou Ship Channel Company raised $100,000 to restore the ship channel in 1869. During the 1870's, Congress declared Houston a port of entry, ordered a survey for a deepwater channel and approved $200,000 to improve the ship channel. (*Progrowth Politics-Change and Governance in Houston,* 40)

Houston was a very poor city during the latter half of the nineteenth century. The per capita income was very low. The economy was based on mercantile trade in cattle, cotton and timber. The period marked the beginning of the Industrial Revolution. Most investments were being made in the manufacturing. Houston was at the bottom of Value Added Manufacturing (VAM) by 1899. The Houston area's VAM was at $5 million while New York, Philadelphia and Chicago were in the hundreds of millions of dollars.

The first half of the twentieth century brought about the most important discovery in Houston's history: **OIL**! In 1901, Spindletop provided a major oil gusher in Beaumont, Texas. This event put Houston on the economic map. From *Progrowth Politics-Change and Governance in Houston:*

> "The Spindletop strike captured the nations attention, much as the discovery of gold in California had done a half-century earlier. The effects of the Texas oil boom, were, however, to be more far-reaching than those of the gold rush. The Spindeltop discovery heralded the beginning of an energy revolution – a change that has had profound regional, national, and international effects throughout the 20th century. Nowhere was the impact greater than in Houston."(*Progrowth Politics-Change and Governance in Houston,* 42)

The discovery of oil also posed a major problem for the Houston area. The Houston Ship Channel was not deep enough for large oil cargo ships. From *Progrowth Politics-Change and Governance in Houston:*

> "Aware of the problem, a group of local business leaders, headed by Jesse H. Jones, coordinated a drive for local and congressional funds to improve the shallow existing ship channel in the first decade of the 20th century. A federal appropriation of $1,250, 000 was secured in 1909 and matched with local bond monies. These funds allowed the channel to be widened and deepened so that after 1914, ocean-going ships could use the ship channel without reducing their cargoes... By the 1930's Houston had established itself as the nation's third largest port, ranking just behind New Orleans."(*Progrowth Politics-Change and Governance in Houston:* 45)

The cost of developing refineries to produce gasoline and petroleum products and running pipelines for natural gas limited the growth of the petrochemical industry. The need just did not justify the cost. World War II changed all that. The government was in dire need of rubber for tires. Natural rubber supplies had been severely depleted by Japan. The solution was synthetic rubber produced form petrochemical products. The United States chose to invest heavily in Houston's petrochemical industry. "In all some $700,000,000 was invested in local chemical companies during the war."(*Progrowth Politics-Change and Governance in Houston,* 46)

The latter half of the twentieth century began with Houston's economy very strongly tied to oil. This was due to its prominence as the oil capital of the world. The 1950's and 60's were marked by low oil prices. The economy did not see dramatic growth. All of that changed, however, in 1973 In 1973, prices rose sharply due to the Yom Kippur War and an oil embargo. The Houston economy boomed. Investment grew. By 1977, Houston had become the largest urban area in the United States in terms of investment.

In 1982, the oil boom came crashing down. Foreign oil drove prices down. By 1983, local employment had dropped about 10%. Quoting from *Progrowth Politics-Change and Governance in Houston:*

"In March, 1982 at the peak of the oil boom, local employment was estimated to be 1,642,000; by August 1983 it had dropped to 1,487,000." (."(*Progrowth Politics-Change and Governance in Houston,* 52)

Since the 1980's, the Houston economy has diversified. The Medical Center, NASA, corporate headquarters and service industries have helped shield the Houston economy from downturns in the oil industry.

Classroom Activities

The background material above will be distributed to the students in advance of the class. The students will be asked to read the material. The teacher will summarize the material. (This will take approximately 15 minutes)

The students will be divided into groups of four or five. Their tasks will be to discuss their opinions on the discussion topics below, form consensus opinions on the topics, and develop rationales for their opinions. At the end of each topic, the groups will present their findings in a one to two minute presentation. Each topic will require approximately 20 minutes)

- How did Houston's location affect its early economy?
- Make an economic time line for the Houston region from 1836 to the present. Use milestones to represent major events that influenced Houston's economy. State your reasons for the choices of milestones that you chose.
- Compare the long-term effects on Houston's economy of the oil industry, the ship channel and the original major components: cotton, cattle and timber. What were the strengths and weaknesses of each?

The last activity for students is to make a journal entry for this topic. It should cover:

- What they learned.
- What they can apply to other courses of study.
- What they hope to learn in the future.

Class 5 to 8: The effect of automobiles on the development of the Houston Region.

Background Material

Regional mobility at the turn of the century, consisted of two primary modes of transportation, the train and the horse. In 1901, Oldsmobile began "mass-producing" gas-powered automobiles.

> "Oldsmobile builds 425 Curved Dash models, making them the world's first mass-produced gas cars and the largest number of gasoline powered automobiles produced in a year"
> (*Automotive History: 1901,* www.motorcraft.com/history/index.html)

By 1910, national automobile production reached 181,000. In 1912, however, horses still dominated the national landscape, but not for long.

> "The once overwhelming notes of rebuttal began to flag, and in spite of the fact that there were 25,000,000 horses in the country in 1912, Dobbin was definitely "out" and "Betsy" was "in."
> (*Automotive, History,* www.autoshop-online.com/auto101/histtrxt.html)

In 1910, the population of the United States was approximately 76 million people. Thus in 1910, only about 1 car was being produced for every 400 people. (*Statistical Abstract of the United States 1998*, 8) Houston's population in 1910 was about 116 thousand. (*Houston Metropolitan Study*, 23) This would mean that if Houston was near the national average, only about three hundred automobiles were purchased in Houston. Since very few automobiles existed before then, this would probably be a good estimate of the number of automobiles in Houston.

The first automobile assembly line was built in 1914 by Henry Ford:

> "In 1914, Ford opened the world's first auto assembly line. Production jumped to 472,000; a car could be turned out in 93 minutes. In 1924, when half of the cars in the world were Fords, the Model T sold for $290 and profit piled up. The last "tin lizzy"(the 15,007,003rd) rolled off the assembly line. It was truly the "universal car", in every corner of the world."
> (*Automotive, History,* www.autoshop-online.com/auto101/histtrxt.html)

Auto production by 1923 had grown to 3.6 million automobiles. Thus, there was a twenty fold increase in auto production in just 11 years. The automobile was here to stay. In 1931,the 50 millionth U.S. Vehicle was built. By 1960, "eighty percent of U.S. families have cars."
(*Automotive History: 1960,* www.motorcraft.com/history/index.html)

In 1923, the population of the United States was approximately 110 million people. Thus in 1910, about 1 car was being produced for every 30 people. Thus, in thirteen years, there was a 13 fold increase in production of cars per person. (*Statistical Abstract of the United States 1998*, 8)

Houston's population in 1923 was about 240 thousand. (*Houston Metropolitan Study*, 23) This would mean that if Houston was near the national average, there was an increase of 8,000 automobiles in Houston in 1923.

By 1960, 80% of American families owned automobiles. (*Houston Metropolitan Study*, 23) The population of the Houston metropolitan region was about 1.4 million people. Assuming an average family of 4.2 people, there would be about 266,000 vehicles in the Houston metropolitan region in 1960.

In 1997, there were approximately 3.13 million people in Harris County and about 4.2 million in the metropolitan area. This would project to about 4.58 million people in the year 2000. According to the U.S. Census Bureau's 1997 American Community Survey for Harris County, there were about 1.85 million vehicles available in Harris County. This projects to 2.47 million vehicles in the metropolitan area. By 2000, this would project to 2.62 million vehicles.

The American Community Survey for 1997 also provides statistics on vehicles available per household. From this data, the regional vehicles available per household for the region in the year 2000 can be estimated as:

- No Vehicles: 106, 223 (7.85%)
- One Vehicle: 525, 080 (38.82%)
- Two Vehicles: 542, 856 (40.14%)
- Three Vehicles: 139, 658 (10.33%)
- Four Vehicles : 30,778 (2.28%)
- Five or More Vehicles: (.58%)

Therefor, more than half the households own more than one vehicle. Those vehicles are expensive. The average costs for 1997 for owning and operating a vehicle in 1997 were:

- Variable costs per mile: 10.80 cents
  - Gas and oil: 6.6 cents
  - Maintenance: 2.8 cents
  - Tires: 1.4 cents

1. Fixed Costs per vehicle:
   - Insurance: $809
   - Licenses and Registration: $220
   - Depreciation: $ 3, 268
   - Finance Charges: $793

(*Statistical Abstract of the United States: 1998*, 644)

Using both the American Community Survey from 1997 and data from the US Census Bureau's abstract data, there will be about 2.2 million commuters in the region by 2000 (*Statistical Abstract of the United States: 1998*, 42). Of these, 79% will drive alone, 9% will be in car pools, and 3% will use public transportation.

The Houston region's population grew almost 38 times since 1910. The number of automobiles has grown over 800 times. The explosive growth of both numbers

demonstrates that Houston has become a highly populated region with a very large number of automobiles.

Classroom Activities

This activity will involve give the students to apply mathematics concepts that they have learned in classes. The background material above will be distributed to the students in advance of the class. The students will be asked to read the material. The teacher will summarize the material. (This will take approximately 30 minutes)

The class will then discuss the concepts of graphing and estimation. Examples of both should be covered. (30 minutes). The students will then be asked to do these exercises in small groups, one at a time. After each exercise, the teacher will monitor the results and re-teach if necessary.

- Using the data on the number of automobiles produced in the United States in the 20th century, graph the data. Predict the number of automobiles produced in the year 2000 from this graph. (20 minutes)
- Find the cost per year and per mile that drives 10,000 miles. Repeat for 15, 000 miles, 20, 000 miles and 25,000 miles. Graph both cost per mile and cost per year vs. miles driven. (10 minutes)
- Using data for vehicles owned, find the cost per year for each household that owns 1,2,3, or 4 vehicles. Assume that the vehicles are driven 15, 000 miles. (20 minutes)
- Assume that public transportation costs $ 6.00 per day and that the average person works 250 days. Also assume that parking costs $105 per month. How much would an average household save, if there were one less car and the driver commuted to work? (20 minutes)
- If each household sent one more person to work by public transportation, what would the figures then look like for commuters driving alone and taking public transportation? (There are approximately 2 million households in the region.) (10 minutes)
- **Class discussion**. If public transportation costs so much less, why do you think so many people commute to work alone by automobile, pick up truck of van?(30 minutes)

The last activity for students is to make a journal entry for this topic. It should cover:

- What they learned.
- What they can apply to other courses of study.
- What they hope to learn in the future.

Class 11 and 12: The interrelationship between factors in the areas of geography, geology, sociology, economics, and technology; and their effect on growth.

Background Material

The ability to predict events with some degree of accuracy is a difficult task. In real world problems, there are many factors that interact. Some of these factors are relatively static and do not change much over time. Others are dynamic and are changed by a multitude of other factors around them. Therefor, prediction becomes an approximation. Those who approximate best are the most valuable.
The simplest view is to view factors as independent systems. This works fairly well for simple static systems. An example is provided below:

Example of a simple system: *A gas pedal and engine in an automobile*.

> The gas pedal is the **INPUT.** The speed of the engine is the **OUTPUT**. The output changes speed as the input is changed. The way that these change follows some **RULE.** The rule is called a **FUNCTION.** The output is then thought of as a function of the input. This is often viewed as a diagram: (See Figure 1)

A simple **FEEDBACK SYSTEM** is the next system to look at. In a feedback system, the goal is to have the output maintained at a desired level called the **DESIRED OUTPUT.** To do this, the input is the desired output is compared to the **ACTUAL OUTPUT.** The difference is called an **ERROR.** A rule is used to create a change in the input. This rule is called a **CONTROL FUNCTION.** The control function changes the input. In a feed back system the desired output is the starting point. The feedback system is also often viewed as a diagram: (See Figure 2)

Example of a feedback control system: *A Cruise Control on a car.* (See Figure 2)

> To desired output is the speed set in the control. The actual output is the actual speed of the car. The difference between the two creates an error. The control function is used to change the setting of the gas pedal to change speeds safely and effectively.

The two examples above are simple static systems. In the real world, however even these systems have problems. They do not take into account such factors as: slope of the road, condition of the road or whether or not there is enough fuel.

Designing a system to predict behavior in the Houston region is not only beyond the level of this unit, it is beyond the level of anyone at this point. What is possible is to make approximations and test them over time. The following is an attempt to simplify the problem to make an approximation possible.

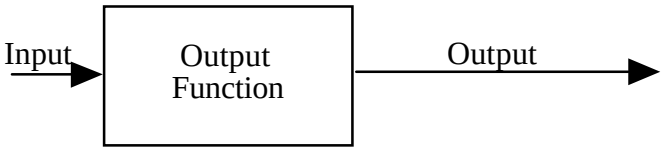

Figure 1

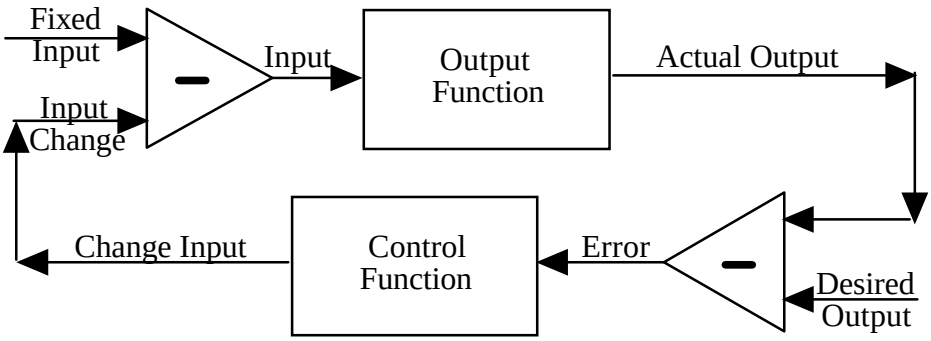

Figure 2

The first step is to decide which factors to put in the system. For this unit, the topic type with outputs are given:

1. Geology : Height above Sea Level
2. Geology: Underground Aquifer
3. Geology: Petroleum Deposits
4. Geography: Usable Land
5. Geography: Bayous
6. Technology: Automobiles
7. Technology: Computers
8. Demographics: Number of People
9. Demographics: Education Level
10. Economy: Petroleum
11. Economy: Medical Center
12. Economy: Service Industries
13. Economy: Houston Ship Channel
14. Economy: Airports
15. Society: Government

The next step is to determine which outputs are inputs to another factor. For each input, the weight of the input should be determined as **NO, WEAK, MEDIUM,** and **STRONG**. These categories are educated guesses.

The strongest influence should have the highest weight. The sum of these weights should be one. Therefor, we could label NO as 0, WEAK as .1, MEDIUM as .35, and STRONG as .55. Again these are educated guesses.

Example: Economy: Medical Center

The following will, for all practical purposes have **NO** factor:

16. Geology : Height above Sea Level
17. Geology: Underground Aquifer
18. Geology: Petroleum Deposits
19. Geography: Usable Land
20. Geography: Bayous

The following will be **WEAK** factors because they are primarily secondary factors. (They affect a component that affects the Medical Center):

21. Economy: Petroleum
22. Society: Government
23. Economy: Houston Ship Channel
24. Economy: Service Industries

The following will be **MEDIUM** factors:

25. Technology: Automobiles
26. Economy: Airports
27. Technology: Computers

The following will be **STRONG** factors:

28. Demographics: Number of People
29. Demographics: Education Level

Each CIRCLE has an output of 1 if the component changes and 0 if it remains the same. There is a THRESHOLD value for each circle. Below that threshold the value stays the same. In building real modeling systems, all the values are found by testing until the model responds to reality in the correct manner. This is used in an advanced modeling technique called NEURAL NETWORKS. (See Figure 3)

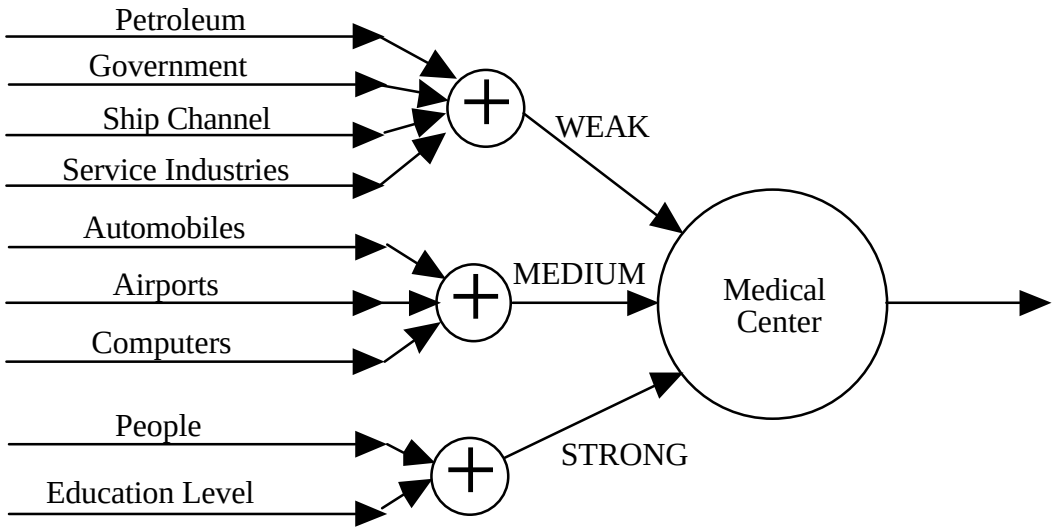
Petroleum
Government
Ship Channel
Service Industries
Automobiles
Airports
Computers
People
Education Level
WEAK
MEDIUM
STRONG
Medical
Center

Figure 3

Classroom Activities

This activity is at a very high level. Students will be able to grasp the concepts, but have difficulty applying them. The goal of this set of activities is to introduce systems and to understand both the value and limitations of this important area. The activities are structured so that students can grasp basic concepts.

The students should have read the introductory material before entering the class. A 40-minute review should allow them to complete these activities. The activities should be done in small groups. Each activity should be monitored and there should be re-teaching after every activity as necessary.

1. Students try to list as many examples of simple systems and feedback systems in small groups. The groups write their ideas on the board in diagram form. (10 minutes)
2. Student groups attempt to fill out the table below. The answers are compared. A group consensus is the goal of the comparison. (20 minutes)
3. The last activity for students is to make a journal entry for this topic. It should cover:
    - What they learned.
    - What they can apply to other courses of study.
    - What they hope to learn in the future.

COMPONENT	Inputs: Label weight as: NO, WEAK , MEDIUM or STRONG	Output: Label Change as: VERY SLOW to VERY FAST **DRAW DIAGRAM**
GEOLOGY: HEIGHT ABOVE SEA LEVEL		
GEOLOGY: UNDERGROUND AQUIFER		
GEOLOGY: PETROLEUM DEPOSITS		
GEOGRAPHY: USABLE LAND		

COMPONENT	Inputs: Label weight as: NO, WEAK , MEDIUM or STRONG	Output: Label Change as: VERY SLOW to VERY FAST **DRAW DIAGRAM**
GEOGRAPHY: BAYOUS		
TECHNOLOGY: COMPUTERS		
DEMOGRAPHICS: NUMBER OF PEOPLE		
DEMOGRAPHICS: EDUCATION LEVEL		
DEMOGRAPHICS: EDUCATION LEVEL		
ECONOMY: PETROLEUM		

COMPONENT	Inputs: Label weight as: NO, WEAK , MEDIUM or STRONG	Output: Label Change as: VERY SLOW to VERY FAST **DRAW DIAGRAM**
ECONOMY: MEDICAL CENTER		
ECONOMY: SERVICE INDUSTRIES		
ECONOMY: HOUSTON SHIP CHANNEL		
ECONOMY: AIRPORTS		
SOCIETY: GOVERNMENT		

<u>Class 13 and 14: Houston TODAY.</u>

Background Material

Houston-Galveston Metropolitan Region is the tenth largest region in the United States. It consists of eight counties. These counties are Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery and Waller. The following is an estimate of the population for the year 2000 by county. Also listed is the area and density of population.

County	2000 Population (Estimated)	Area Square Miles	Density Per Sq. Mile
Brazoria	239,806	1597.5	150.1
Chambers	25,027	868.6	28.8
Fort Bend	362,175	886.1	408.7
Galveston	253,943	876.5	289.7
Harris	3,303,807	1777.9	1858.3
Liberty	68,757	1,176.3	58.3
Montgomery	290,667	1076.9	269.9
Waller	28,250	518.5	54.5
Totals	4,572,432	8,778.3	520.9

From the above, it can be seen that Harris, Fort Bend, Galveston and Montgomery Counties have a significantly larger population density than the other counties. This would seem to indicate that the most likely locations for mass transit are in these counties. The population is most dense close to the Houston city central area and is significant along major corridors.
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The first consideration in looking at travel within a region is to consider why people travel. Transportation experts call these purposes “home based” whenever they begin or end at home. If the trip is between to points other than home, the trip is considered to be non-home based.``In a study by the Texas Transportation Institute, seven purposes were used. Six were home based, the seventh, none home based (did not start or end at home). These were:

> “...home based work (HBW), home based work related (HBWR), home based school, home based social recreation (HBSR), home based shopping (HBSHP), home based other (HBO), and non-home based (NHB)” (*Urban Travel in the Houston-Galveston Area,* 3)`

The overwhelming mode of travel is a driver in an automobile travelling alone. Only 23.1% of travel is done as an auto passenger. Only about 10% is done by other means than auto. A driver driving alone does all of the rest, 65.9%, of travel by people in households.

In terms of purpose, home based work accounts for about 20% of trips. About 50% of trips are made to and from home to places other than work. The other 30% is between places other than home. There were 88 million miles of travel attributable to households

within the region each day in 1995. This travel amounted to 1.5 hours of travel per household for a distance of 57 miles. Work trips averaged 13 miles and 20 minutes. (*Urban Travel in the Houston-Galveston Area,* 8)`

In terms of locations, the largest for travel in the Houston metropolitan region is downtown. The following facts illustrate its shear size:

- The theater district attracts 2 million people a year to over 800 performances a year (second to New York's Broadway).
- The downtown workforce is 137,000.
- Over 20,000 students attend classes.
- There are 3,500 businesses.

(www.houston.org/tophoustonfacts)

The next largest area in terms of employment is the Texas Medical Center. There are 50,000 employees. There are over 100,000 patients and visitors every day. Over 90,000 people attend classes each year with 20,000 of them being fulltime students. (*Map & Information*, Texas Medical Center)

The George Bush Intercontinental Airport had over 117,000 people enter or leave the airport each day in 1995. Automobiles account for nearly 80% of this travel. Total employment was over 13,000.There are also over 5,00 trips per day by commercial vehicles. . (*Urban Travel in the Houston-Galveston Area,* 10)`

Hobby Airport, while smaller than Bush, is still the 35th busiest airport in the United States. Over 8 million passengers per year(about 22,000 per day).
(http://www.houston.org/inernationalbusiness/hobbyairport.html)

The Port of Houston is the eighth largest port in the world (160 million tons in 1997) and the largest in the United States in terms of foreign cargo (100.8 million ton in 1997). The 1997 number of ships was 6,435 (about 18 ships a day) According to the Port of Houston Authority:

> "The Houston Ship Channel has been a catalyst for growth in Harris County since the first journey of a steamship up Buffalo Bayou in 1837. Port activity generates 53,000 direct jobs and 143,000 indirect jobs. More than 80 percent of jobs generated at these terminals are held by residents of Harris County. Five and one-half billion dollars in revenue is generated by businesses providing services at the marine terminals on the Channel, excluding the value of cargo shipped through the public and private marine terminals. It is projected that the Port of Houston will continue to be an important factor as north-south trade expands. "(www.portofhouston.com)

In any regional mobility plan, these areas must be considered as key elements.

## Classroom Activities

The background material is very statistical in nature. Students have little exposure to statistics. Therefor, for this reason, the exercises should be done as a class effort with discussion.

The first question to discuss is: Why do so many people drive automobiles? The key statistics to look at are the density of population and the percentage of the trips that people make that are not to and from work. By looking at both of these, the following points should be discussed:

- The typical day of people in terms of using their automobile. Brainstorming should be done to develop profiles of different types of people in terms of their travel choices during a day.
- Develop the characteristics an alternative system to meet the needs of the profiles of the people in the first point.
- Download maps from the Internet. Have students locate the major features in the background material. Students should then identify other major centers. Discuss what the routes of a mass transit system would have to be to get people to these worksites from various regions of the area.

The last activity for students is to make a journal entry for this topic. It should cover:

- What they learned.
- What they can apply to other courses of study.
- What they hope to learn in the future.

## Class 11 and 12: The demographics of the future.

### Background Material

What will the future of the Houston metropolitan region look like? The future is impossible to predict with total accuracy. The best that can be done is to make an estimate based on the best information available. In statistics, this is called extrapolation. This class will demonstrate several techniques.

The first example is the prediction of data from previous trends in the same data. In this example, two techniques will be used. Straight line approximation and approximation by percentage. To do either, some data is needed. The data in this example is from the census bureau:

Houston Consolidated Metropolitan Statistical Area (CMSA) Population:
1980: 3,118,480
1990: 3,731, 029
(*1997 State and Metropolitan Data Book*, 128)

Straight Line Approximation:
Growth Per Year
(3,731,029 – 3,118,480)/10 = 61254.9

1997 Estimate: 3,731,029 + 61254.9x7 = 4,159,813
2000 Estimate: 3,731,029 + 61254.9x10 = 4,343,578

Percentage Approximation:

Percentage Growth Per Year (P is Decimal value for %)

$3{,}731{,}029 = 3{,}118{,}480 \cdot (1+P)^{10}$

$1.19643 = (1 + P)^{10}$

$1.19634^{.1} = 1 + P$

$1.0181 = 1 + P$

$.0181 = P$

1997 Estimate: $3{,}731{,}029(1.0181)^{7} = 4{,}229{,}868$

2000 Estimate: $3{,}731{,}029(1.0181)^{10} = 4{,}464{,}091$

The straight line approximation is lower than the percentage approximation. Therefor, for estimating growth, the straight line method is more conservative, while the percentage method is more optimistic.

The year 1997 was used because data existed for that year. The population was 4,320, 041. This time the estimate was low even for the percentage method.

A more difficult task is predicting change when only partial data is available. For example, extensive data exists for 1990 from the last census. The American Community Survey that is available from the US Census is available for Harris County for 1997, has a very large amount of data. The problem is to make an estimate of growth based on Harris County for the CMSA.

For example, estimate the number of people that commute to work from the CMSA. The data available is:

| County | 1990 Pop | 1997 Pop. | 1990 Commuters Drive Alone | 1997 Commuters Drive Alone |
|---|---|---|---|---|
| Brazoria | 191,707 | 225,406 | 69,674 | |
| Chambers | 20,088 | 23,545 | 6,839 | |
| Fort Bend | 225,421 | 321,149 | 86,648 | |
| Galveston | 217, 399 | 242,979 | 75,490 | |
| Harris | 2,818,199 | 3,158,095 | 1,021,841 | 1,167,662 |
| Liberty | 52,726 | 63,948 | 14,655 | |
| Montgomery | 182,201 | 258,127 | 63,551 | |
| Waller | 23,390 | 26,792 | 6,518 | |
| Totals | 3,076,516 | 4,320,041 | 1,345,216 | |

Example: Estimate the number of commuters that drive alone in Brazoria County in 1997 based on Harris County Growth.

- Find % Growth of Population in Harris County:

% Growth = (3,158,095/2,818,199)*100 = 112.06%

- Find % of Commuters Driving Alone in Harris County

  % = (1,167,662/1,021,841)*100 = 114.27%

- Find % Growth of Population to Commuters in Harris County

  % = (114.27/112.06)*100 = 101.98%
  (This value can be used to estimate commuters driving alone for all other counties)

- Find % Growth for Brazoria County
  % Growth = (225,406/191,707)*100 = 117.58%

- Find number of commuters driving alone in Brazoria County in 1997.

  1.17.58*101.98*69,674 = 83,545

**Classroom Exercises**

Using the data for 1980 and 1990 Houston CMSA populations, Estimate the population for 2010 and 2020 using both the straight line method and the percentage method.

Complete the chart for 1997 by estimating the number of commuters who drive alone for all of the counties.

Using the straight line and percentage methods estimate the total number of commuters who will drive alone in 2000, 2010 and 2020.

The last activity for students is to make a journal entry for this topic. It should cover:

- What they learned.
- What they can apply to other courses of study.
- What they hope to learn in the future.

## Sources: Books

Robert D. Thomas and Richard W. Murray. Prowgrowth Politics Changes and Governance in Houston. Berkeley, California: IGS Press (Institute of Government Studies, Berkeley).

*Although this book is somewhat dated, it gives an historical perspective to developments in Houston. Particularly important is its coverage of many aspects rather than a concentration on a single factor for change.*

Richard Murray, Robert M. Stein, George R Weiher, et al. The Houston Metroplitan Study: An Entrepreneurial Community Looks Ahead. Houston, Texas: 1998

*This is probably the most important look at Houston's future that exists today. the leaders of the research team, Murray, Stein and Weiher worked with a broad coalition of regional leaders in developing a perspective on where Houston is today and a comprehensive plan for its future. Particularly important for this unit is its coverage on Infrastructure and Technology.*

## Sources: Internet

*The sources below represent a good start in seeking materials for this unit. All of the sources are authoritative rather than opinionated. Students should be educated as to the power and pitfalls in using Internet sources. Two important skills are to "Bookmark" the sites and to learn to download and open Adobe Acrobat™ files.*

**Government and Public Entity Sites**

*These sites provide the most objective material. They are also a "gold mine " for research because they provide access to even more information.*

The United Sates Census Bureau: http://www.census.gov

*The U.S. census bureau provides data that is invaluable for studies in demographics. There are several sites that can be reached from the main site above or directly at sites . the sites below were used in this unit.*

http://tiger.census.gov

*This site provides demographic maps that can be studied or downloaded. These maps feature zooming properties and the ability to modify the maps to meet specific needs (for example, population densities)*

http://www.census.gov/statab/www/smadb.html

*This site is useful for either downloading or purchasing tow important documents, the Sate and Metropolitan Data Book and the Statistical Abstract of the United States. Both are extremely large (hundreds of pages) databases for almost any demographic information that students would need for research.*

http://www.census.gov/acs/www/index_main.htm

*This site contains detailed surveys on selected metropolitan areas. Fortunately, the Houston Metropolitan Area is one of the selected sites. The information is tabulated for most of the census data that is available every 10 years. With the survey, however, the data is more recent (1997)*

The Houston-Galveston Area Council: http://www.hgac.cog.tx.us/transportation

*The Houston-Galveston Area Council (HGAC) is an organization of the counties in the Houston region. The HGAC has developed many documents on transportation needs in the region. Most of these documents can be downloaded free of charge.*

**Local Specialty Sites**

*The following sites provide information as a public service. These are more localized in nature:*

http://www.portofhouston.com
http://www.houston.org/tophoustonfacts
http://www.houston.org/inernationalbusiness/hobbyairport.html

**Automobile Information**

*These sites provide a national perspective on the development of the automobile as a major mode of transportation. Since automobile history and Houston history have practically the same time span, interesting parallels can be drawn.*

http://www.motorcraft.com/history/index.html

*This site provides a chronological outline of automobile development from the early 1830's to 1996. The facts are very valuable and interesting. There are also many photos of automobiles dating back to the beginning of the century.*

http://www.autoshop-online.com/auto101/histtrxt.html

*This site is part of a curriculum on the history of automobiles. It iprovides very humorous, but factual information.*

**Other Sources:**

Map & Information, Texas Medical Center

*This is a free map of Houston's Texas Medical Center. Inserts provide interesting data on the Texas Medical Center, one of the region's largest employers.*

Case Study: Designing a Regional Mobility Plan for the Houston-Galveston Region: A Multi-School Approach, (A Draft Proposal): Bill Pisciella, March 1999. Available at: http://intraspect.rice.edu /gm/anon in a NACME folder.