Application of GIS/GPS In Petroleum Sector (Case Study ONGC)

विद्याया शक्ति वर्धम

Project dissertation submitted in partial fulfillment

Of the requirement for

M.Tech (Petro Informatics)

By

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DECLARATION BY THE GUIDE

This is to certify that the dissertation report on "Application of GIS/GPS for Petroleum Industry, Case Study: ONGC" submitted to the University of Petroleum & Energy Studies, Dehradun, by Balendu Goel, in partial fulfillment of the requirement for the award of the degree of Master of Technology (Petro Informatics) is a bonafide work carried out by him under my supervision and guidance.

Date: 28/4/07

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ABSTRACT

Making decisions based on geography isn't new in the oil business. Where to drill a well, route a pipeline, or build a refinery are all questions that rely heavily on an understanding of geography in order to make intelligent business decisions. GIS technology today allows us to manage the spatial components of these everyday petroleum "business objects," such as leases, wells, pipelines, environmental concerns, facilities, and retail outlets, in the corporate database, and apply appropriate geographic analysis efficiently in a desktop-focused application.

GIS helps petroleum companies make important decisions such as where to drill wells, route a pipeline, or build a refinery. More than 90 percent of major oil companies use GIS as an integral part of their decision making process. GIS can help us to evaluate the potential for oil in promising locations. Exploration requires the analysis of data such as satellite imagery, digital aerial photo mosaics, seismic surveys, surface geology studies, subsurface and cross section interpretations and images, well locations, and existing infrastructure information.

This Dissertation report is all about identifying slope of terrain, Route optimization & other application of GIS/GPS in Petroleum industry.

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Chapter 1:

Introduction

1.1 What is GIS

Geographic Information System (GIS) is defined as an information system that is used to input, store, retrieve, manipulate, analyze and output geographically referenced data or geo-spatial data, in order to support decision making for planning and management of land use, natural resources, environment, transportation, urban facilities, and other administrative records.

Modern GIS technology has evolved from thematic cartography due of the combination of increased computational capabilities, refined analytical techniques, and a renewed interest in environmental and/or social responsibility. Throughout this evolution the primary goal has been to take raw data and transform it, through overlays and other analytical operations, into new information that can support the decision making process.

Figure 1: Application of GIS in Petroleum Industry

GIS is a core information technology with capabilities to effectively collect, organize, access, visualize, and analyze geographic information. In its simplest form, GIS technology supports automated mapping —the creation, update, and production of maps that provide great advantages over manual mapping methods. But a GIS can also manage and access information about map features.

GIS is much more than a mapping tool. GIS software has the ability both to store graphic representations of map features and to access diverse types of data and records that are geographically referenced. GIS allows users to access, examine, and analyze geographically referenced information.

In other words, it is related to a location or feature on the surface of the Earth.

GIS is core information technologies with capabilities to effectively collect, organize access, visualize, and analyze geographic information. In its simplest form, GIS technology supports automated mapping —the creation, update, and production of maps that provide great advantages over manual mapping methods.

But a GIS can also manage and access information about map features. Simply put, GIS technology can extend the reach and ability of user to use information about the land and its man-made facilities and natural resources to help administer programs and support decisions.

A GIS database stores map features as well as information

about those features, as Figure 2 shows. The feature information, providing descriptive or numerical information, is stored as database attribute records linked to the map feature.

GIS is a powerful tool for producing maps and for conducting more complex database queries and analysis.

GIS software can be used to easily import or directly access geographic records from other systems (e.g., permit, work order, business license, or parcel ownership information stored in databases or spreadsheets).

1.2 Tools for Analysis and Modeling

One of the most important features of a geographic information system is the manipulation and analysis of both spatial (graphic) and tabular (non-graphic) data. The procedures for data analysis typically found in most GIS programs include:

- Map overlay procedures, including arithmetic, weighted average, comparison, and correlation functions.
- Spatial connectivity procedures, including proximity functions, optimum route selection and network analysis.
- Spatial neighborhood statistics, such as slope, aspect ratio, profile and clustering.
- Measurements of line and arc lengths, of point-to-point distances, of polygon perimeters, areas and volumes.
- Statistical analysis, including histograms or frequency counts, regressions, correlations and cross-tabulation.
- Report generation, including maps, charts, graphs, tables and other user-defined information.

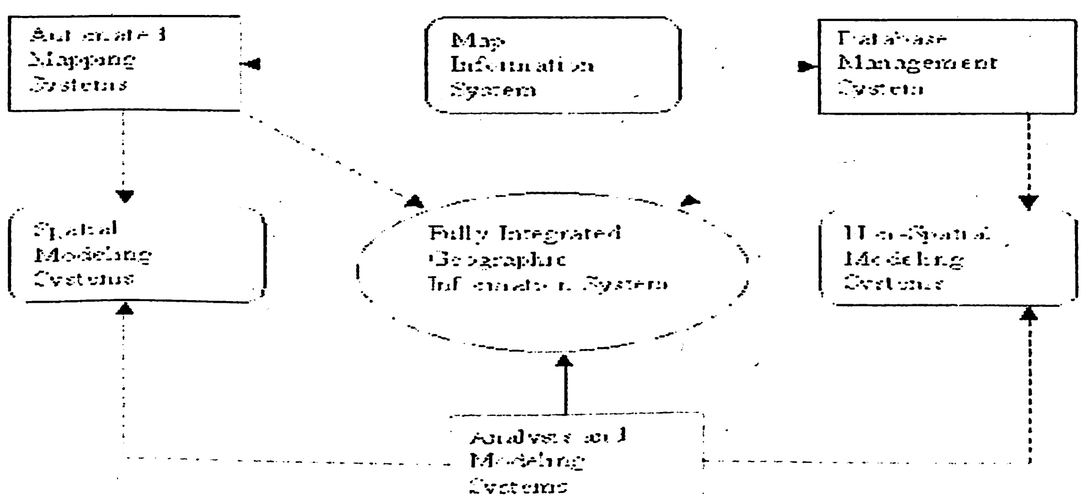


Figure 2: GIS Tools & Techniques

Most systems include some sort of built-in programming capability usually in the form of a software-specific macro language. This allows the user to develop a set of functions or analysis procedures that can be stored in a user-defined library. Most GIS programs have the ability to communicate with external analysis and modeling programs. A system can typically output data in various formats to be used in various external programs such as spreadsheets, word processing, graphics, and other user-specified executable programs. The results of an external analysis can then be used by GIS as both graphic and non-graphic data for further manipulation and analysis, or for final report and map generation.

1.3 What is GPS

The Global Positioning System (GPS) is a worldwide radio-navigation system formed from a constellation of 24 satellites and their ground stations.

GPS uses these "man-made stars" as reference points to calculate positions accurate to a matter of meters. In fact, with advanced forms of GPS we can make measurements to better than a centimeter! In a sense it's like giving every square meter on the planet a unique address.

GPS receivers have been miniaturized to just a few integrated circuits and so are becoming very economical. And that makes the technology accessible to virtually everyone. These days GPS is finding its way into cars, boats, planes, construction equipment, movie making gear, farm machinery, even laptop computers. Soon GPS will become almost as basic as the telephone

GPS works in any weather conditions, anywhere in the world, 24 hours a day. There are no subscription fees or setup charges to use GPS.

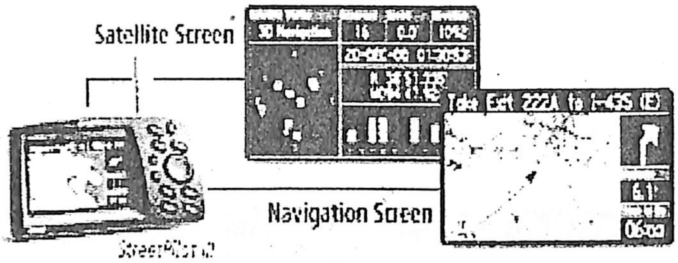


Figure 3: GPS Navigation Screen

1.4 How GPS works

GPS satellites circle the earth twice a day in a very precise orbit and transmit signal information to earth. GPS receivers take this information and use triangulation to calculate the user's exact location. Essentially, the GPS receiver compares the time a signal was transmitted by a satellite with the time it was received. The time difference tells the GPS receiver how far away the satellite is. Now, with distance measurements from a few more satellites, the receiver can determine the user's position and display it on the unit's electronic map.

A GPS receiver must be locked on to the signal of at least three satellites to calculate a 2D position (latitude and longitude) and track movement. With four or more satellites in view, the receiver can determine the user's 3D position (latitude, longitude and altitude). Once the user's position has been determined, the GPS unit can calculate other information, such as speed, bearing, track, trip distance, distance to destination, sunrise and sunset time and more.

The 24 satellites that make up the GPS space segment are orbiting the earth about 12,000 miles above us. They are constantly moving, making two complete orbits in less than 24 hours. These satellites are travelling at speeds of roughly 7,000 miles an hour.

GPS satellites are powered by solar energy. They have backup batteries onboard to keep them running in the event of a solar eclipse, when there's no solar power. Small rocket boosters on each satellite keep them flying in the correct path.

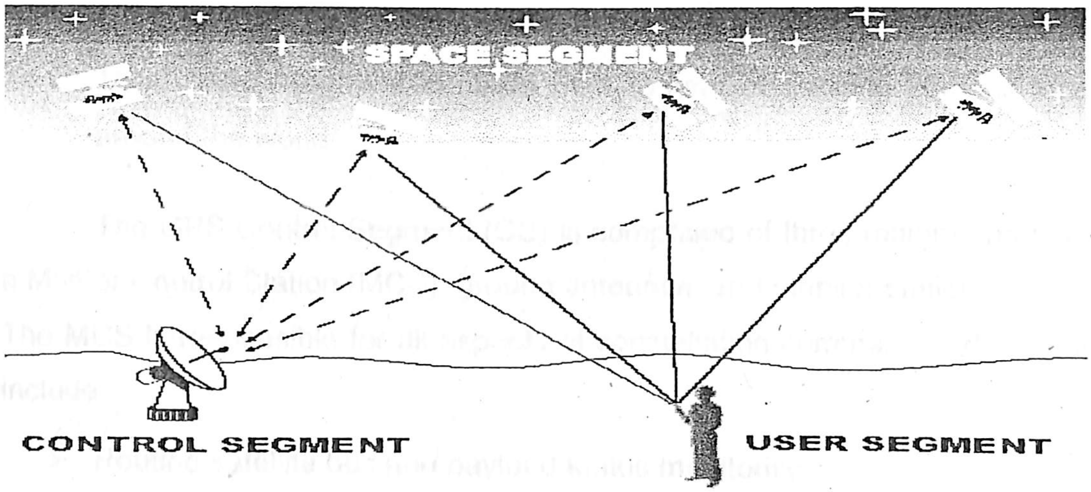


Figure 4: GPS Segments

1.5 GPS Segments

For GPS there are basically three segments.

1.5.1 Space Segment

- The Space Segment of the system consists of the GPS satellites. These space vehicles (SVs) send radio signals from space.
- The nominal GPS Operational Constellation consists of 24 satellites that orbit the earth in 12 hours. There are often more than 24 operational satellites as new ones are launched to replace older satellites. The satellite orbits repeat almost the same ground track (as the earth turns beneath them) once each day.

1.5.2 Control Segment

- The Control Segment consists of a system of tracking stations located around the world.

The GPS Control Segment (CS) is comprised of three major components: a Master Control Station (MCS), ground antennas, and monitor stations.
The MCS is responsible for all aspects of constellation command and control, to include:

- Routine satellite bus and payload status monitoring.
- Satellite maintenance and anomaly resolution.
- Monitoring and management of SPS performance in support of all performance standards.
- Navigation data upload operations as required to sustain performance in accordance with accuracy performance standards.
- Prompt detection and response to service failures.

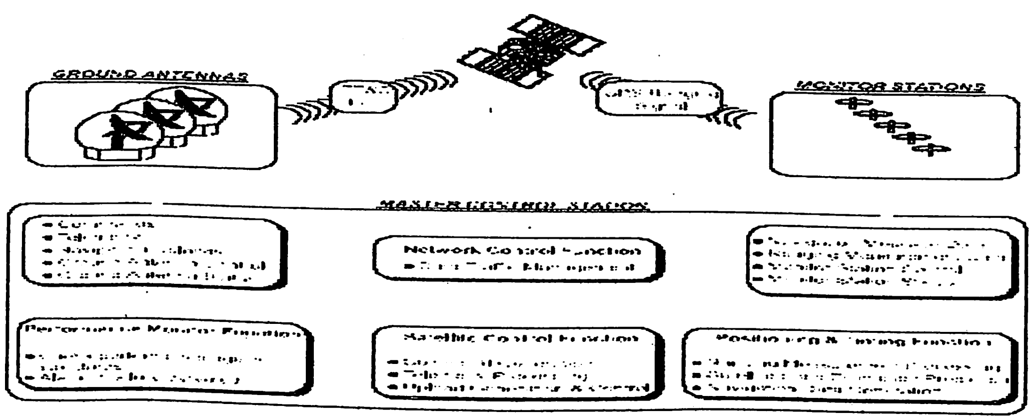


Figure 1-2. The GPS Control Segment

Figure 5: GPS Control Segments

1.5.3 User Segment

- The GPS User Segment consists of the GPS receivers and the user community. GPS receivers convert SV signals into position, velocity, and time estimates. Four satellites are required to compute the four dimensions of X, Y, Z (position) and Time. GPS receivers are used for navigation, positioning, time dissemination, and other research.

    - Navigation in three dimensions is the primary function of GPS. Navigation receivers are made for aircraft, ships, ground vehicles, and for hand carrying by individuals.
    - Precise positioning is possible using GPS receivers at reference locations providing corrections and relative positioning data for remote receivers. Surveying, geodetic control, and plate tectonic studies are examples.
    - Research projects have used GPS signals to measure atmospheric parameters.

Chapter 2:

Application of GPS

2.1 Transportation

- ***Car Navigation:*** Previously, a basic GPS-based car navigation system could drift off course by one or two blocks, leading to erroneous guidance and directions. In areas where multiple highways run in parallel, SA made it difficult to determine which one the car was on. Terminating SA will eliminate such problems, leading to greater consumer confidence in the technology and higher adoption rates. It will also simplify the design of many systems (e.g. eliminate certain map matching software), thereby lowering their retail cost.
- ***Fleet Management:*** Companies managing fleets of vehicles such as taxicabs, buses, commercial trucks, and rental cars will enjoy increases in efficiency as their ability to track and route individual vehicles improves. This will be especially important in crowded parking lots and railroad yards, where SA previously made it impossible to identify specific vehicles, tractor trailers, or boxcars using GPS alone.

- **Cargo Tracking.** With GPS onboard, cargo or hazardous materials that need extra attention can be tracked in real time. This is especially important for on-time delivery, theft recovery and homeland security applications. Space Data can help cargo companies integrate devices into their cargos and to integrate their tracking systems.

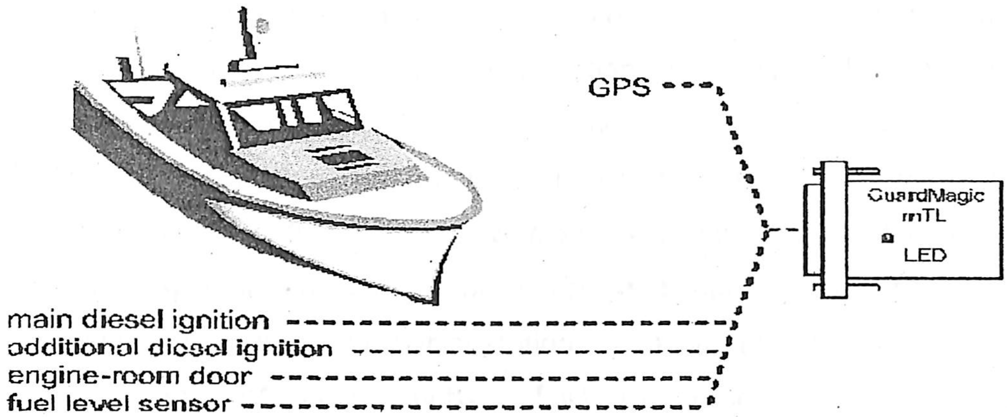
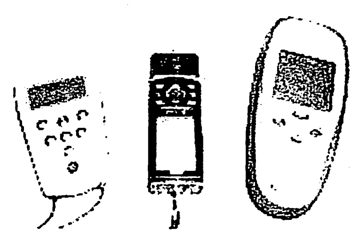


Figure 6: GPS Cargo Tracking System

- ***Delivery Services:*** Message couriers and package and cargo transportation companies will also benefit from better real-time tracking and management of assets. Automakers and other manufacturers operating under the "just-in-time" assembly philosophy will get a better handle on when component shipments will arrive and where they are within the factory grounds.
- ***Aviation:*** The removal of SA will improve the accuracy of unaugmented GPS receivers. This increased accuracy improves safety by aligning pilots more closely with the runway during instrument approaches, and improving the accuracy of terrain awareness, warning systems and moving map displays that provide situational awareness to the pilot.
- ***Highway/Waterway Maintenance:*** For the first time, many state and federal transportation authorities will be able to use basic, unaugmented GPS receivers for highway and waterway maintenance and management, lowering the cost and effort involved with these activities.
- ***Nationwide DGPS:*** The Department of Transportation is currently fielding the Nationwide Differential GPS (NDGPS) network to improve the accuracy and integrity of GPS for surface and maritime users across the United States to the 1-3 meter range. In addition, 34 countries around the world have already installed DGPS radio beacon networks, and more are

considering the adoption of this navigation standard. The improvement of the basic GPS signal through elimination of SA may allow the NDGPS radio beacons to transmit fewer error corrections and more value-added navigation messages, improving highway, railroad, and waterway safety. The range of individual NDGPS stations is also expected to increase, benefiting mariners farther off shore and opening the possibility of reducing the overall number of stations to be fielded. This flexibility allows for a more cost effective network for the government and the nation. In addition, the complexity of all DGPS systems will be reduced, lowering costs for those who will be using this technology.

- **Geocaching**



GPS receivers come in a variety of formats, from devices integrated into cars, phones, and watches, to dedicated devices such those shown here from manufacturers Trimble, Garmin and Leica (respectively, left to right).

The availability of hand-held GPS receivers for a cost of about $90 has led to recreational applications including Geocaching. Geocaching involves using a hand-held GPS unit to travel to a specific longitude and latitude to search for objects deliberately hidden there by other Geocachers. Geocaching often includes walking or hiking to natural locations, and is very popular.

2.2 Natural Resources

- ***Mineral and Resource Exploration:*** In many cases, removal of SA will eliminate the need for costly differential correction equipment and services as companies explore remote, uncharted geographic regions for minerals, oil, coal, and other natural resources.
- ***Resource Management:*** Agencies such as the Bureau of Land Management and the Forest Service will be able to apply basic GPS to the management of wetlands, forests, and other natural resources without the use of costly augmentation systems or, in some cases, tightly controlled, highly burdensome military receivers. This should reduce government costs and increase productivity. Similarly, paper and lumber companies may be able to identify and manage individual trees to using basic GPS.

- ***Wildlife Tracking:*** Scientists and other individuals seeking to observe and/or tag animals in the wild will have a more powerful positioning and tracking tool at their disposal. This includes zoologists, ecologists, marine biologists, and communities seeking to safeguard themselves from animal threats (e.g., wolves).

2.3 Space

- ***Satellite Tracking:*** NASA satellites using GPS receivers will be able to determine their orbit positions more accurately. For example, satellites using GPS Standard Positioning Service signals, orbiting at around 700 kilometer altitude, will be able to go from the present 100 meter level of accuracy for orbit position determination to about 10 meter accuracy in near real time. This will enable improvements in science observations and satellite operations.

- ***Future Space Station Operations:*** Among the many benefits that may be realized by space users of GPS in the future will be simplification of systems supporting critical rendezvous operations and navigation of "Free Fliers" near the International Space Station. The elimination of SA may enable the performance of early satellite rendezvous operations to be greatly simplified and may significantly enhance the performance of relative GPS during close in maneuvering operations.

2.4 DGPS

Differential Global Positioning System (DGPS) is an enhancement to Global Positioning System that uses a network of fixed ground based reference stations to broadcast the difference between the positions indicated by the satellite systems and the known fixed positions. These stations broadcast the difference between the measured satellite pseudoranges and actual (internally computed) pseudoranges, and receiver stations may correct their pseudoranges by the same amount. These system commonly use long wave radio frequencies between 285 kHz and 325 kHz.

Operation

A reference station calculates differential corrections for its own location and time. Users may be up to 200 nautical miles (370 km) from the station, however, and some of the compensated errors vary with space: specifically, satellite ephemeris errors and those introduced by ionospheric and tropospheric distortions. For this reason, the accuracy of DGPS decreases with distance from the reference station. The problem can be aggravated if the user and the station lack "indivisibility"—when they are unable to see the same satellites.

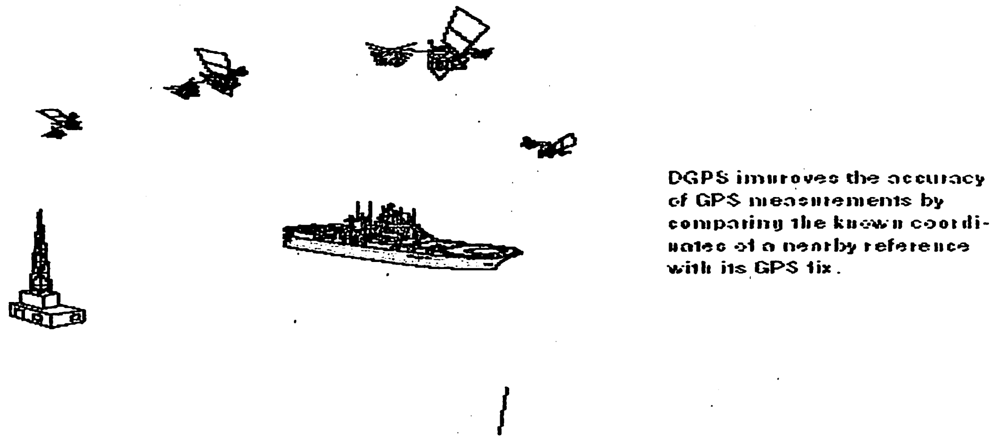


Figure 8: DGPS in Offshore region

Chapter 3:

Application of GIS/GPS in Petroleum Industry

3.1 Introduction

Geographical Information Systems (GIS) provides a framework for modeling real world at different map scales through projection systems and spatial data models (raster or vector). Processing functionalities have been deemed fundamental to such a modeling environment and are further being developed for applications on a real-time basis. Distance and area processing in GIS play an important role in the decision making process. It is therefore important to evaluate techniques by the GIS model, to obtain reliable distance and area measurements.

Traditionally, distance and area measurements from field surveying methods were entered in the feature attribute table. It is desirable to replace this time and cost consuming practice through accurate processing of spatial features in GIS. The current article discusses and compares techniques for real world area approximation within GIS.

GPS is a fundamental tool throughout institutes, particularly in our hazard forecasting and mapping sections but not quite so prominently in the petroleum sector. For petroleum, it serves two functions:

1- Cartography - presenting models and results of research in map form.

2- Data archive - we use Oracle + ESRI SDE to store vast amounts of information derived from seismic, drilling and also our modeling.

These tools are more convenient and have more grunts for the specialized requirements of petroleum than a tool like GPS (which only has two dimensions). At completion of the analysis, we then pass data to the GPS.

Petroleum Industry – Need of Integrated Business-GIS

The convergence of GIS and other technologies specially Relational Database Management Systems (RDBMS) with the support of spatial information via spatial cartridges has opened a new era which will allows us to manage the spatial components of these everyday petroleum "business objects," such as leases, wells, pipelines, environmental concerns, facilities, and retail outlets, in the corporate database, and apply appropriate geographic analysis efficiently in a desktop-focused application.

The petroleum Industry can be functionally divided into 2 categories:

- **Upstream**
- **Downstream.**

3.2 Upstream

This involves the process of exploring new locations as petroleum reserves, managing the Production of crude petroleum from earth strata, managing the pipeline network to transfer crude sources to refining plant and facility management of various resources connected to such a huge industry.

3.2.1 Petroleum Exploration

An efficient GIS can help to evaluate the potential for oil in promising locations. One of the biggest benefits of GPS is the ability of these programs to do analysis. Petroleum exploration is a very complicated field dependent on a multitude of variables, because of this the analysis capabilities of GPS will surly be able to lower the cost of petroleum exploration by analyzing the potential of petroleum being found at a potential location and also the potential yield of an oil field. GPS are also used to monitor the condition and flow of pipelines and determine the best locations for the pipelines, locations, and existing A GPS can tie these data together to the location in question and allow us to overlay, view, and manipulate tie data in the form of a map to thoroughly analyze the potential for finding new or extending play potential.

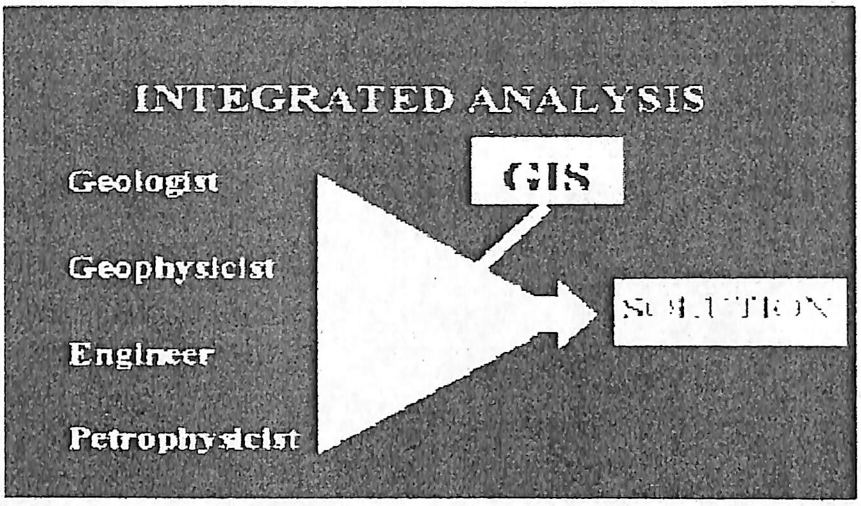


Figure 9: GIS an Integrated Approach

Following the analysis process, the individuals come together to integrate the independent evaluations into a final solution. The recent trend in the industry is to form multi-discipline teams and approach the analysis through integrated analyses.

GIS is a powerful tool for petroleum exploration, particularly with regard to exploration mapping. Such mapping is usually performed across large geographic areas, where many data sets or map layers are used in the analysis of hydrocarbon potential. Raster data, such as aerial photos or satellite imagery, can be incorporated with vector data, and surface culture, such as hydrography, elevation contours, and topographic landmarks or points of interest, can be presented. Where appropriate, coordinates from land surveys, such as section, township, and range, can be integrated with well data.

In exploration applications, one of the first steps taken is the creation of reconnaissance maps. Such maps are typically produced relative to the available well or well layers, with the sizes of the well data sets being dependent on the maturity of the area or basin of interest. Reconnaissance maps of mature exploration areas can present distinct trends, patterns, and anomalies.

Maps of the following features and characteristics should be included in the first phase of any exploration reconnaissance mapping program:

- Total depth
- Spud or completion date
- Well operator identification
- Producing formation
- Cumulative production
- Initial potential
- Well classification

A map of total depth can quickly identify where shallow and deep drilling has occurred over a basin, trend, or field, and apparent trends, patterns, and anomalies can be identified.

Spud date maps represent a chronological history.

Using this map, it can be determined when and where drilling has taken place. Such a map is useful when an interpreter has just started evaluating a new trend or basin because it represents a chronological history of the area.

To produce found reserves, the company must first understand certain geographic, infrastructure, business conditions, and environmental factors about the area in question. GIS technology is ideally suited to this kind of overlay analysis and can be integrated with other business risk or economic business planning engines to provide a focused business solution toolset.

3.2.2 WebDriller

WebDriller provides a method of filing water well completion data using a personal computer connected to the Internet. WebDriller is designed to replace the multi-part paper forms that are usually completed by hand.
In addition to a faster and easier method of reporting, WebDriller also makes all of water well databases available online. This data can be easily retrieved and either viewed online or downloaded to the computer. This historical data can prove invaluable to the management of drilling business. Among other things, it can tell us about typical well construction when we are considering work in an unfamiliar part of the state, or it can provide information regarding that old well we have been asked to service. As mentioned, WebDriller uses coordinates, such as latitude and longitude, to define the location of each well. These coordinates are determined by GPS. The coordinates replace the hand-drawn maps used on the paper form.

There are several ways to calculate these coordinates including paper maps, free software with digital maps, inexpensive street atlas programs, and GPS (Global Positioning System) receivers.

3.2.3 Well Surveys/sampling

A common well surveillance method is to conduct well surveys. The two essential activities performed when completing a well survey are locating facilities (i.e. service stations) .Each CHD provides accurate Global Positioning System (GPS) locations for the requested petroleum service station and drinking water wells located within a 1½ mile radius, and all large public wells (more than 100,000 gallons per day) within a ï¿½ mile radius. The map above shows the results of a typical well survey. Symbols for facilities (red gas pumps) and private drinking water wells (blue spigots) illustrate the locational relationship within the survey area.

3.2.4 Offshore Marine Rigs

Offshore pile driving is generally in much deeper water depths than inland marine work. The additional consideration of providing a work platform suitable for open sea operations distinguishes this type work. The bell or, "offshore lead" used in deep water marine environments, is a special, relatively short, swinging lead having a "bell" guide at the lower end to assist and hold alignment of the pile and hammer. It is a specially designed structure used to handle the much larger equipment and piles found in these unique conditions. A template is commonly utilized to maintain pile location in the unstable environment of the sea. Alignment and placement of the pile and rig is frequently determined by GPS and satellite navigation triangulation.

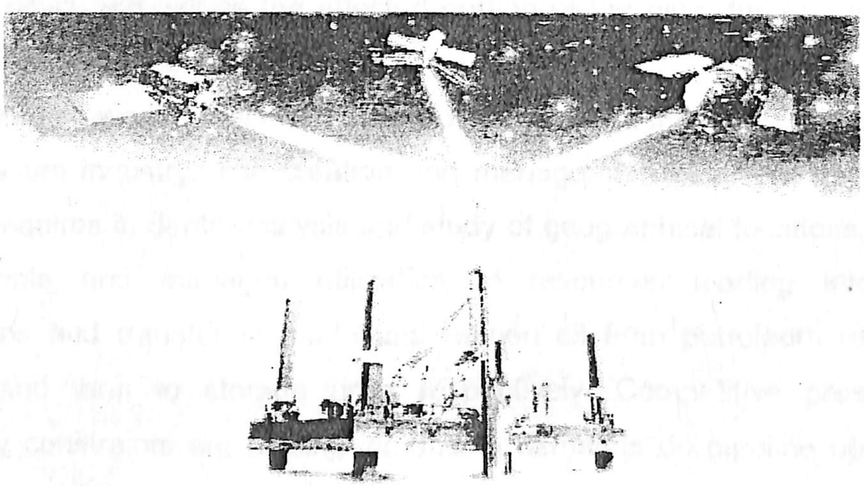


Figure 10: GPS Positioning for Offshore Location

Modern equipment can be employed by contractors to ensure safe, quick and adequate installation of driven piles. Global Positioning Systems (GPS) aid in survey and accurate layout of pile locations. New hammers are capable of energy adjustments and monitoring to provide the required hammer performance while protecting the piles from damage. Instruments can be used during testing and installation to confirm the design and pile load capabilities. Testing techniques are also available to check the performance of previously driven piles to compare them with the requirements of the specifications

3.3 Downstream

3.3.1 Pipeline Management

Pipelines are used mostly to transport refined oil from the refinery to the distribution centers. The transportation of oil occurs through a network of underground pipelines that can range from 8-45 feet in diameter. The entire pipeline system is operated from a single control center so that if a problem occurs in the pipeline due to an accident or structural failure, the control operator can shut down and isolate the affected portion of the pipe, thereby limiting the amount of petroleum product released.

The Pipeline network forms one of the most critical and intelligent components of the petroleum industry. The creation and management of a functional pipeline network requires in depth analysis and study of geographical locations, business requirements and managed utilization of resources leading into optimal productions and transfer of crude and refined oil from petroleum reserves to refinery and then to storage units respectively. Competitive pressure and regulatory constraints are placing increasing demands on pipeline operators to operate in an efficient and responsible manner.

GPS can be used in the site location process to minimize impacts to the environment during construction and from accidental release, as well as to lessen the costs of permits and liability risks associated with accidental releases. Ecological variables developed from publicly available spatial data sets can be utilized in this process.

The themes and variables used as input in this process mainly address direct construction costs and pipeline efficiency once the pipeline has been completed. Some of the variables include:

- **Shortest distance from source to market**
- **Least grading (removal of trees, etc.)**
- **Costs associated with right of way**
- **Slope of terrain**
- **Number of stream, road, and railroad crossings**
- **Substrate (rock, soils, etc., associated with burial)**
- **Existing laws and regulations (wetlands, etc.)**
- **Proximity to population centers, etc.**
- **Utilization of existing utility corridors and easements.**

The potential costs of environmental impacts during construction as well as ecological and liability costs that may result from accidental releases after construction also accounts to the cost factor of the petroleum company. Some of these costs can be substantial (potentially millions of dollars) and include:

-Environmental damage

-Litigation and settlement costs

-Environmental response and investigation

-Environmental remediation

-Damage to reputation and community relations.

An increasing number of environmental spatial data sets have become available to the general public, offering a great opportunity for companies to avoid these environmental and liability risks with relatively little effort by incorporating them into their normal GIS sitting procedures. GPS facilitates the organization and management of data with a geographic component. It also eases data acquisition and utilization. GPS provides the pipeline operator with improved capability to manage pipeline integrity, improved efficiencies in pipeline operations, and improved response to business development opportunities.

3.3.2 Routing and Delivery

Schedule deliveries and routes to petrol stations, track petrol tankers in motion, analyze delivery patterns; predict road volumes, and much more. Using delivery addresses, road networks and windows for delivery times calculate the optimum route for our deliveries.

Example of use:

New Petrol Station Sitting: Where Is the Best Place to Put a Gas Station?

Like businesses in most industries, the question of where to place a retail outlet must be answered carefully to ensure the site reaches its full sales potential. Companies use GPS to analyze demographic and transportation information to effectively choose retail sites and build outlets tailored to the anticipated customer segment. They can also use the technology to analyze customer receipts for stores to adjust the store profile and stock. GIS offers a better way to find the right site for the next petrol station. With a GPS we can identify suitable locations for the petrol stations by using a combination of density of population, where our existing petrol stations are and where are competitor's petrol stations and many more factors.

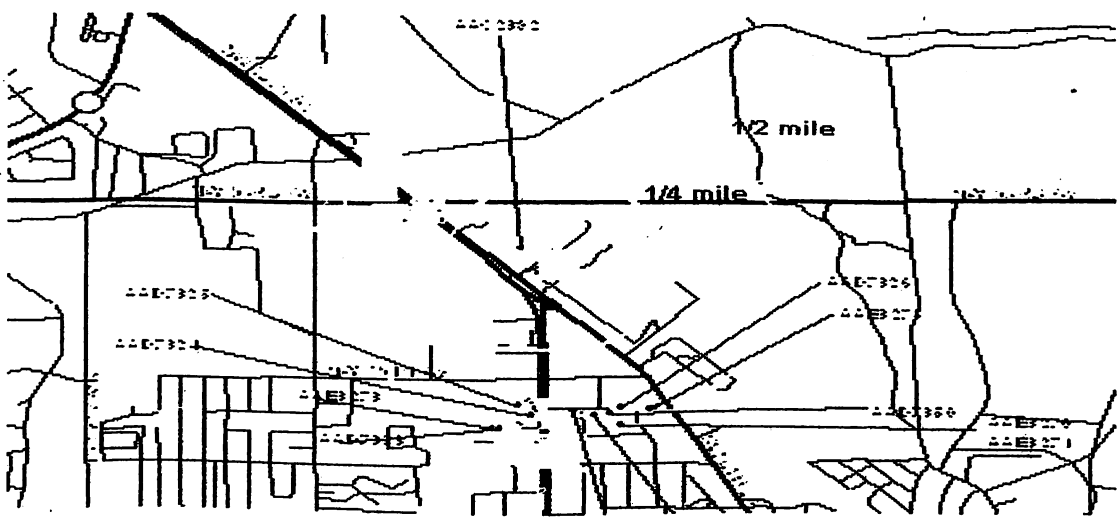


Figure 11: GPS for identifying prospective area for Gas station

3.3.3 Retail Outlet Management and Distribution

This covers the distribution of refined petroleum products from the production center to various countries and finally to the retail units like petrol pumps, gas stations and other petroleum products retail stores. This is the area where a lot of GIS developmental activities can take place. Retail companies can use the power of GIS systems to optimize their business with intelligent analytical GIS tools and planning tools and provide better customer and outlet services.

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GPS Daily Travel by Vehicle

Employee :	Jernigan, Thomas C.	Report Date	3/19/04
Tracking Date:	Wednesday March 17,2004	Report Time	11:49:39AM
Vehicle :	83G507	Time Interval:	1 Seconds
Vehicle Group:	ATTI	Speed Setting:	35 Mph
		Start Time:	12:00AM
		Stop Time:	11:59PM
		Vehicle Status:	Active Only

Begin	End	Duration	Location Name	Max Speed	Mileage
05:56PM	05:56PM		Begin: 6701 - 6798, Harwin Dr.,		
05:56PM	06:03PM	00:07	In-Transit	59	2.71
06:03PM	06:56PM	00:53	5401 - 5498, Judalon Ln.,		
06:56PM	06:57PM	00:01	In-Transit	30	0.46
06:57PM	06:59PM	00:02	3801 - 3898, Yorktown Dr.,		
06:59PM	07:05PM	00:06	In-Transit	41	2.36
07:05PM	07:06PM	00:01	5501 - 5598, Edgemoor Dr.,		
07:06PM	07:09PM	00:03	In-Transit	37	1.83
07:09PM	07:10PM	00:01	5317 - 5398, N. Braeswood Blvd.,		
07:10PM	07:13PM	00:03	In-Transit	33	1.03
07:13PM	08:26PM	01:13	10901 - 10910, Oasis Dr.,		
08:26PM	08:38PM	00:12	In-Transit	41	5.20
08:38PM	08:38PM		End: 5401 - 5498, Judalon Ln.,		

Days Accrual Statistics:

Stops		In Transit		Mileage		Speed	
Number of Stops	5	Number of Transits	6			Max. Speed	59
Total Stop Time	02:10	Total Transit Time	00:32	Total Mileage	13.59	Avg. Speed	30
Avg Stop Time	00:26	Avg. Transit Time	00:05	Avg Miles per Transit	2.27	% Over Speed	31
% Stop Time	80	% Transit Time	20	Total Accrued Time	02:42	Total Time Over Speed	00:10

Figure 12: GPS Daily Travel Sheet

Examples of such services are:

- Coverage Analysis
- Fleet management
- Thematic mapping of Petrol stations by brand, ownership, price, volume, shop size or by any geography, such as county, postcode, catchments area or sales territory
- Develop Sales territories
- Locating Optimal position of a new outlet
- Optimal routing of Petroleum tankers across the country and across the city.
- Crisis management.

- Volume distribution of petroleum products.
- Geographic analysis of distribution pattern.
- Finding a specific outlet in a city and deriving a route to go there.

3.3.4 Oil Spills and Prevention of Spills during Transportation

Oil spills can be caused by human error, equipment failure, natural disasters (e.g. hurricanes), and deliberate acts by terrorists, countries at war, vandals, or illegal dumpers.

When oil spills, the oil floats on the ocean water (because of the salt content), usually floats on fresh water (though sometimes heavy oil sinks in fresh water), spreads out on top of the water very quickly, forming a thin layer called an oil slick, and over time, continues to spread out causing a sheen on the surface of the water (think: rainbow colors on parking lots after rain). As we can see, most oil spills occur during the transportation of the oil by tanker ships.

According to the American Petroleum Institute, over the last decade, more than 99.9997% of oil shipments in the United States arrived without incident. In addition, by the year 2015, all tankers operating in U.S. waters will be double-hulled vessels, which provide extra security during transportation (if there is a collision, the outer hull will bear the brunt of the force while the interior hull will keep the cargo secure and prevent oil spills).

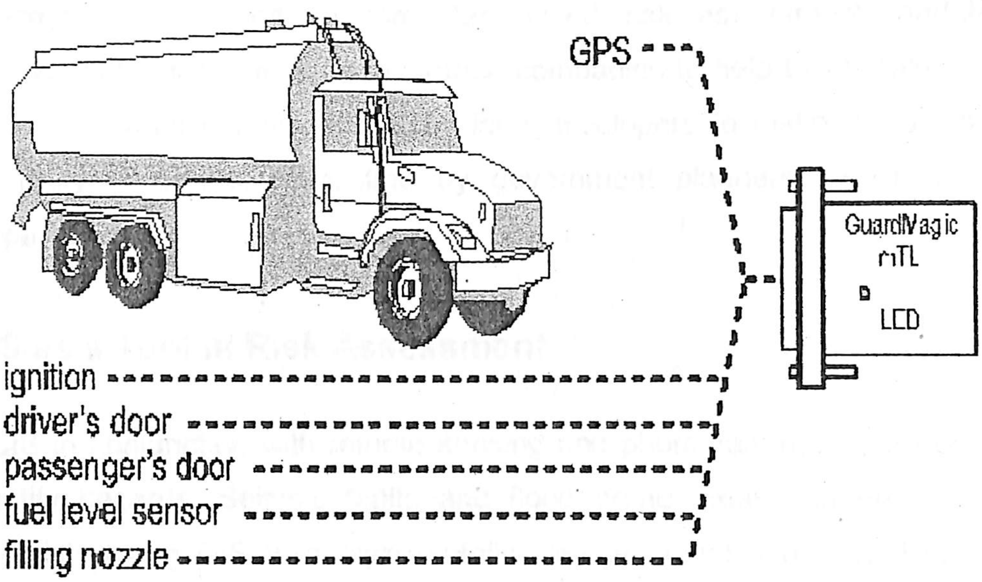


Figure.13: GPS for spills from Oil Tanker

Since many oil spills occur as the supertankers are pulling into port, the method of lightering is being used to transfer the crude oil from the supertanker to a smaller tanker, which can navigate the waterways into ports more easily than the supertanker.

In addition to the technology of the double-hull tanker, the new technologies are being used in the oil transportation industry. These technologies include **Global Positioning Systems (GPS),** back-up engines and dual-rudder systems, and Automatic Identification Systems (AIS).

3.4 Risk and Crisis Management

GIS technology is increasingly being used in spatial decision support systems. In the past few years, GIS emerged as a powerful risk assessment tool and is being put to use to assess risk to property and life stemming from natural hazards such as earthquakes, hurricanes, cyclones and floods. Manipulation, analysis, and graphic presentation of the risk and hazard data can be done within a GIS system, and because these data have associated location information which is also stored within the GIS, their spatial interrelationships can be determined and used in computer based risk assessment models. This assessment can be used by insurance companies to help them make decisions on their insurance policy rates, by land developers to make decisions on the feasibility of project sites, and by government planners for better disaster preparedness.

GIS as a Tool in Risk Assessment

GIS in conjunction with remote sensing and photogrammetry, can be used to identify hazards. Seismic faults and flood prone areas can be identified by scientists using GIS to analyze satellite image, aerial photos and field survey data.

Once the hazards have been identified, their representation can be stored conveniently in GIS databases. The information required for earthquake risk assessment includes the location and properties of seismic faults, surface geology, terrain slope, water table levels and inventories of epicenters and landslide occurrences.

In addition new hazard layers can be generated within a GIS by combining hazard layers. For example, a landslide hazard layer can be generated by overlaying elevation, surface geology, water table level landslide inventory data, and liquefaction hazard can be generated in a GIS by overlaying geology with water table level data.

The result loss patterns per regions and their associated uncertainties that are computed through this risk assessment can be mapped and again used for querying information through GIS applications. GIS technology provides a powerful tool for displaying outputs and permits users to "see" the geographic distribution of impacts from different peril scenarios and assumptions and allows the user to perform a quick graphical sensitivity analysis of the factors affecting the risk potential. A GIS based software system create the ideal framework to integrate the various components of the model

3.5 THE BENEFITS OF GIS

A geographic information system (GIS) is a powerful technological tool that can be used in the problem-solving process facing any exploration and exploitation team. A GIS can provide the team with a whole new way of analyzing, visualizing, and integrating data. GIS technology is now available across all computer platforms, including the Internet. In recent years, its cost has decreased significantly, whereas functionality has been dramatically enhanced. GIS can specifically benefit exploration and exploitation teams in the following ways:

- Integration of the contributions of various team members through cross-discipline
- Interpretation and software functionality
- Provision of new methods for visualizing data sets through the use of symbology
- Dynamic mapping of digital databases
- Presentation of data in various forms, such as maps, charts, data tables, and query results
- Sharing of, integration of, and access to centralized databases via computer networks or the Internet
- Linkage of multiple software applications
- Technology use across multiple computer platforms
- Enhanced portability of technology and data via laptop and handheld computers
- Proliferation of new tools, which are affordable and easy to use

Chapter 4:
Software required for analysis

4.1 Map Info

4.1.1 Overview

MapInfo Professional, the industry's leading business mapping solution, lets you perform sophisticated and detailed data analysis to increase revenue, lower costs, boost efficiency and improve service with location-based intelligence. Use MapInfo Professional to:

- ❖ Create highly detailed maps to enhance presentations and aid in decision making.
- ❖ Reveal patterns and trends in the data that may otherwise be impossible to see
- ❖ Perform sophisticated and extensive data analysis
- ❖ Understand customer and marketplace demographics
- ❖ Manage geographically based assets, such as stores, people and property
- ❖ Plan logistics and prepare for emergency response

The award-winning MapInfo Professional package includes a built-in geocoder, more than 579 MB of data and an extensive collection of pre-designed maps. It's simple to use, powerful and easily integrates with other mapping applications.

4.1.2 INTEROPERABILITY

Seamlessly connects to publicly available data over the internet through web services and enterprise-ready databases.

With MapInfo Professional we can:

- ❖ Share your MapInfo Professional workspaces with location-enabling platforms like MapXtreme 2004
- ❖ Access maps and data over the internet via the OGC WMS (Web Map

Server) standard

- ❖ Retrieve geospatial data over internet OGC WFS (Web Feature Services)
- ❖ Take advantage of real-time location data using enhanced GPS connectivity
- ❖ Supports the latest releases from Oracle, Microsoft, IBM Informix, and MapInfo SpatialWare

4.1.3 PRODUCTIVITY

Decrease the time taken to achieve common tasks by taking advantage of new automation and effort-saving shortcuts. MapInfo Professional helps us save time and get to results quicker through:

- ❖ An enhanced interface to MS Excel
- ❖ Quickly get information in and out of MapInfo Professional
- ❖ Saving snap and thin values with each table
- ❖ No reentering the same information multiple times
- ❖ Enhanced digitizing experience – auto trace mode for quickly following complex borders and lines to produce new regions
- ❖ Great new time saving tools including:

-**Distance calculator** determine the distance between multiple objects at once

-**Spider graph utility** –automatically calculate distances among customers and offices based on a join criteria

-**Synchronization utility** – simultaneously control navigation of multiple open map windows

-**Search replace feature** – automatically change a value with another value in multiple columns

4.1.4 GREATER INSIGHT

- ❖ Get more out of your investment via a finer level of manipulation for more meaningful results

Whether you are a power user employing MapInfo Professional in every day work, or an occasional user leveraging location-based analysis, offers several enhancements that extend the breath of capabilities including:

- ❖ Expanded raster file format support for MrSID® G3
- ❖ Read popular imagery data types directly and overlay it for analysis.
- ❖ New object processing capabilities that include the ability to split a line by node –quickly generate custom geographies via simple process.
- ❖ Enhanced map creation tools: snap and trim utility and enhanced COGO line utility –use the right tool for the right application all out-of-the-box.
- ❖ Simplified support for custom symbols
- ❖ Add custom symbols to MapInfo and take advantage of them right away

Solutions Provided

Distinguishing Features	**Geocoding** - MapInfo Professional's built-in geocoding capability allows for fast and accurate placement of address data onto maps. It also provides the option to recreate existing points. **Analysis** MapInfo Professional makes your analysis effortless with the ability to measure distance, length, perimeter, and area. **3D Views and Prism Mapping** **Prism Mapping** - Uncover patterns and trends based on data values with Thematic Mapping. You can shade, use bar & pie charts, graduated symbols, dot density, and grids. **3D Views** - 3D window and Prism maps continue to be a

distinctive and powerful way to visualize and analyze data and MI Pro makes this feature even more compelling.

Raster Display Option

One of the most powerful aspects of MapInfo Professional is its ability to combine data from widely different sources, even with different formats and projections, in the same map window.

--Data Access

MapInfo Professional has been enhanced to offer even more powerful enterprise data access.

-- Importing and Exporting Data

With the Universal Translator, MapInfo Professional makes importing and exporting data in different formats easier than ever before.

--SQL Selection with Geographic Extensions

Hunt for answers in the data with standard SQL queries.

--Object Processing

In addition to the simple drawing and editing tools, MapInfo Professional has powerful object processing capabilities. These include Combine, Disaggregate, Buffer, Convex Hull, Enclose, Split, Erase, and Erase Outside.

--Redistricting

MapInfo Professional has a built-in feature that gives us the ability to build and manipulate districts and territories.

--Interpolating

MapInfo Professional provides continuous thematic mapping, independent of any existing geographic layer, via interpolation.

-- Internet Connectivity

--Thematic and Cartographic Legends

Thematic legends show the colors, patterns, and styles in the map and the values associated with them

-- Creating and Modifying Graphical and Tabular Data

Create professional looking maps by creating points, lines, polylines, polygons, square/rectangles, Circle/ellipses, text, multi-point, region (multi-polyline), and collection objects

--Manipulating Table Structure

MapInfo Professional gives you the power to manipulate tables easily with intuitive tools. You can add/modify/delete/index columns and pack tables, quickly and easily.

--Projections

MapInfo Professional offers automatic, on-the-fly, and customizable, coordinate systems derived from any of 30 major projections

--Charts & Graphs

Get noticed with MapInfo Professional's interactive graphs and charts including 3D, bubble, column, histogram, surface, area, bar, line and pie scatter charts.

-- Enhanced Map, Display and Layout Options

-- Map Creation and Editing options

With the enhanced data editing functions, customers now can rotate a selection of any map objects at a specified pivot point or offset map objects using precise units for a move or a copy operation.

-- MapInfo and OGC

MapInfo is fully dedicated to providing software that enables users to easily create, provide and share geographic data with other users.

--**MapInfo and Industry Standards**
Customers can now access any Open GIS WMS Server (from any vendor) and add the data as a layer in MapInfo Professional.

--Support for numerous File Types
MI Pro now offers more options and more flexibility for working with a wide array of file types.

Pricing details	Starts at $1495.00
Operating Environment	
Operating Systems Supported	Windows XP/2000/NT Windows 95/98/ME.
Databases Supported	❖ Sybase ❖ Microsoft SQL Server ❖ Informix ❖ IBM ❖ DB2 ❖ Oracle

4.2 Surfer Overview

4.2.1 Surfer contouring and surface mapping software

Surfer is a contouring and 3D surface mapping software program that runs under Microsoft Windows. The Surfer software quickly and easily converts the data into outstanding contour, surface, wireframe, vector, image, shaded relief, and post maps. Virtually all aspects of maps can be customized to produce exactly the presentation we want using **Surfer's** software tools. Producing publication quality maps has never been quicker or easier.

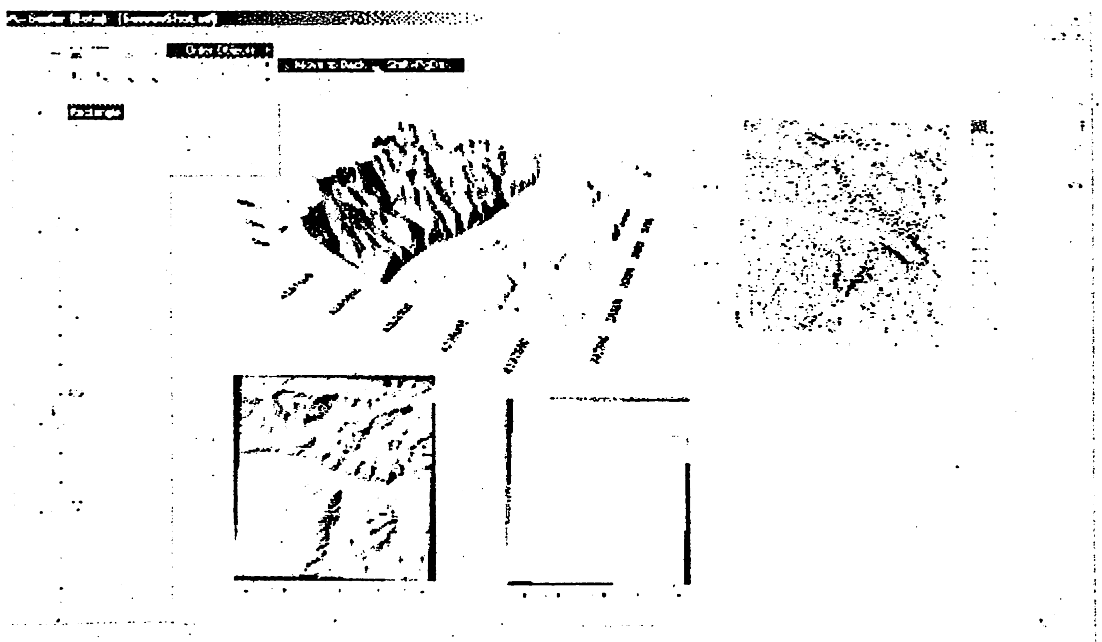


Figure 14: Surfer Main Screen

***Surfer's** software tools allow us to easily create a multitude of map types to visualize the data.*

4.2.2 Contour Maps

Surfer software's contour maps give us full control over all map parameters. We can accept the **Surfer** intelligent defaults to automatically create a contour map, or double-click a map to easily customize map features. Display contour maps over any contour range and contour interval, or specify only the contour levels we want to display on the map. And with the **Surfer** software we can add color fill between contours to produce dazzling displays of our maps, or produce gray scale fills for dramatic black and white printouts.

Contour Map Features

- Automatic or user-defined contour intervals and ranges
- Full control over contour label format, font, frequency, placement, and spacing
- Drag contour labels to place them exactly where we want them
- Automatic or user-defined color for contour lines
- Save and retrieve custom line styles and fills for contour maps
- Regulate smoothing of contour lines
- Reshape contour lines
- Blank contour lines in areas where we don't want to show any data

4.2.3 3D Surface Maps

The 3D surface map uses shading and color to emphasize on the data features. Change the lighting, display angle and tilt with a click of the mouse. Overlay several surface maps to generate informative block diagrams.

4.2.4 3D Wireframe Maps

Surfer wireframe maps provide an impressive three dimensional display of our data. Use color zones, independent X,Y,Z scaling, orthographic or perspective projections at any tilt or rotation angle, and different combinations of X, Y and Z lines to produce exactly the surface we want. Drape a color-filled contour map over a wireframe map to create the most striking color or black-and-white representations of the data. The possibilities are endless.

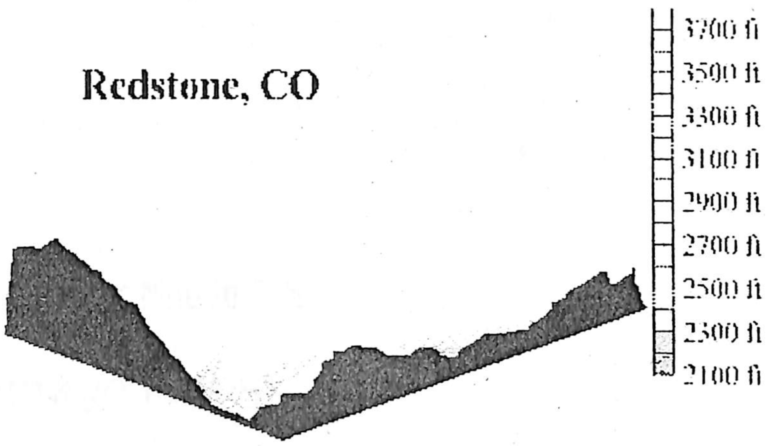


Figure 15: 3D Wireframe Map in GIS

4.2.5 Vector Maps

Instantly create vector maps in **Surfer** to show direction and magnitude of data at points on a map. We can create vector maps from information in one grid or two separate grids. The two components of the vector map, direction and magnitude, are automatically generated from a single grid by computing the gradient of the represented surface. At any given grid node, the direction of the arrow points in the direction of the steepest descent. The magnitude of the arrow changes depending on the steepness of the descent. Two-grid vector maps use two separate grid files to determine the vector direction and magnitude. The grids can contain Cartesian or polar data. With Cartesian data, one grid consists of X component data and the other grid consists of Y component data. With polar data, one grid consists of angle information and the other grid contains length information. Overlay vector maps on contour or wireframe maps to enhance the presentation!

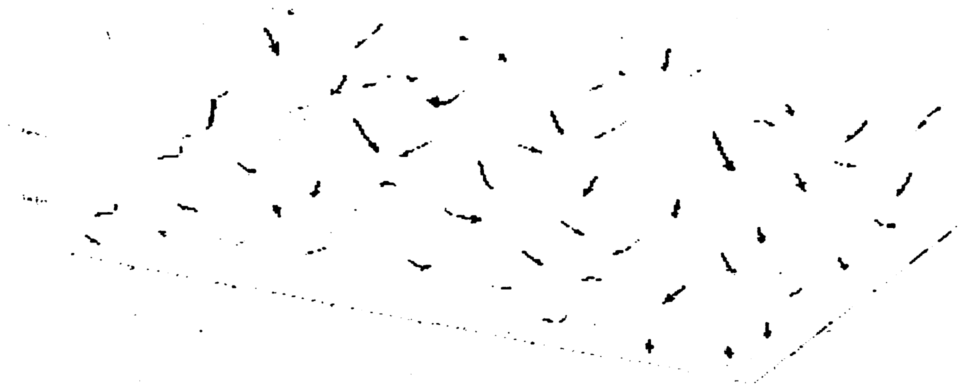


Figure 16: Vector Map in GIS

4.2.6 Image Maps

Surfer image maps use different colors to represent elevations of a grid file. Create image maps using any grid file format: GRD, DEM, SDTS DDF, and GTOP30 HDR. **Surfer** automatically blends colors between percentage values so we end up with a smooth color gradation over the map. We can add color anchors at any percentage point between 0 and 100. Each anchor point can be assigned a unique color, and the colors are automatically blended between adjacent anchor points. This allows us to create color maps using any combination of colors.

4.2.7 Base Maps

Surfer can import maps in many different formats to display geographic information. We can combine base maps with other maps in map overlays, or can create stand-alone base maps independent of other maps on the page. We can load any number of base maps on a page. Base maps can be imported from DXF, GSI, BLN, SHP, LGO, BNA, GSB, DLG, LGS, MIF, E00, USGS SDTS DLG DDF, EMF, WMF, TIF, PCX, BMP, PLT, CLP, TGA, PCX, JPG, PNG, DCX, WPG, PCT, and other formats. It is easy to overlay a base map on a contour or surface wireframe map, allowing us to display geographic information in combination with the three dimensional data.

Base Map Features

- Create any number of base maps on a single page
- Create independent base maps or overlay base maps on other map types
- Edit line, fill, text, and symbol properties for vector base map formats
- Specify real-world coordinates for TIF, JPG, GIF, and other raster files
- Independent scaling in the X and Y dimensions
- Rotate and tilt base maps to any angle

4.2.8 Map Overlays

Map overlays give us a way to combine any number of contour, wireframe, vector, base, and post maps. Draping a filled contour map over a wireframe map produces the most striking display of 3D data possible. And because we can overlay any number of maps, we can show any amount of data on a single map.

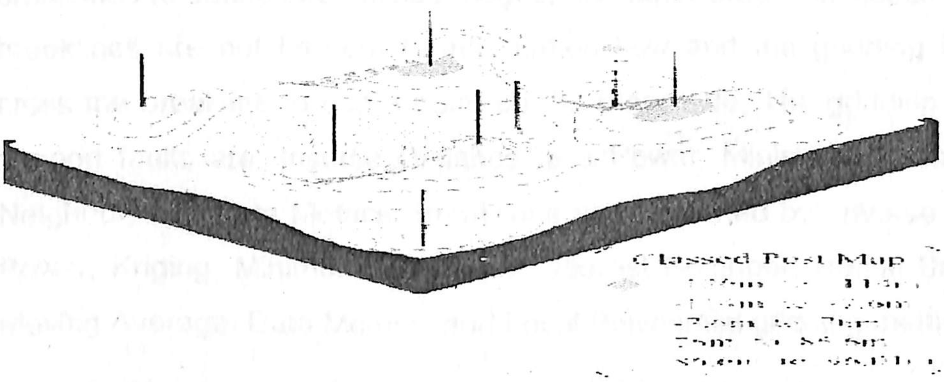


Figure 17: Map Overlay in Surfer

4.2.9 Gridding

The gridding methods in **Surfer** allow us to produce accurate contour, surface, wireframe, vector, image, and shaded relief maps from the XYZ data. The data can be randomly dispersed over the map area, and **Surfer's** gridding will interpolate the data onto a grid. We have a multitude of gridding methods to choose from, so we can produce exactly the map we want. With each gridding method we have complete control over the gridding parameters. If the data are already collected in a regular rectangular array, we can create a map directly from the data. Computer generated contour maps have never been more accurate.

4.2.10 Faults and Breaklines

Define faults and breaklines when gridding the data. The data on one side of the fault will not be directly used to calculate grid node values on the other side of the fault. When the gridding algorithm sees a breakline, any data points that lie directly on the breakline take precedence over an interpolated value. Use breaklines to define streamlines, ridges, and other breaks in slopes. Unlike faults, breaklines are not barriers to information flow and the gridding algorithm can cross the breakline to use a point on the other side. The gridding methods that support faults are: Inverse Distance to a Power, Minimum Curvature, Nearest Neighbor, and Data Metrics. Breaklines are supported by: Inverse Distance to a Power, Kriging, Minimum Curvature, Nearest Neighbor, Radial Basis Function, Moving Average, Data Metrics, and Local Polynomial gridding methods.

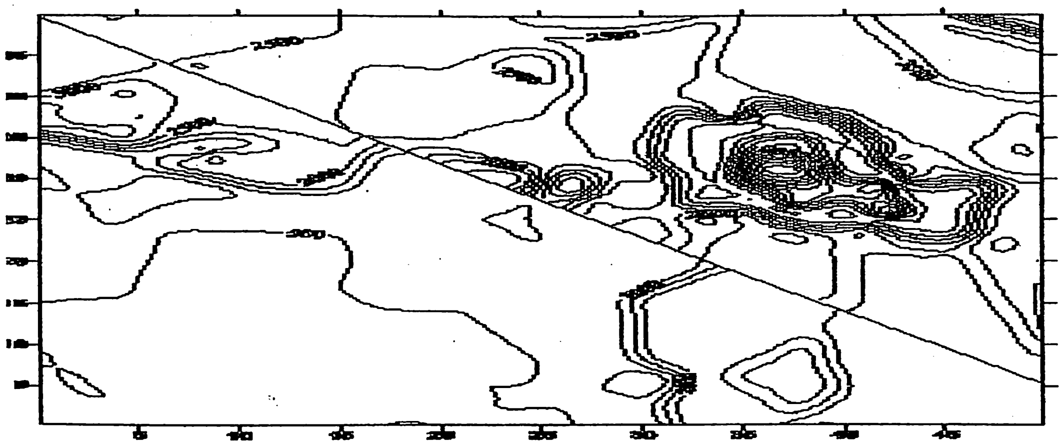


Figure 18: Fault representation in Surfer

A contour map that features a fault is displayed here. Faults and breaklines are specified when gridding the data.

4.2.11 USGS Digital Elevation Model (DEM) Files

- Use DEM files with any Surfer command that uses GRD files
- Directly use the SDTS DEM file format in native form
- Display information about the DEM
- Create contour, vector, shaded relief, image, and wireframe maps from DEM files

4.2.12 Digitize Boundaries

- Find XY coordinates
- Automatically write coordinates to ASCII data files
- Automatically save digitized coordinates as BLN files
- Create boundary files for use with other maps
- Display different properties for base map features

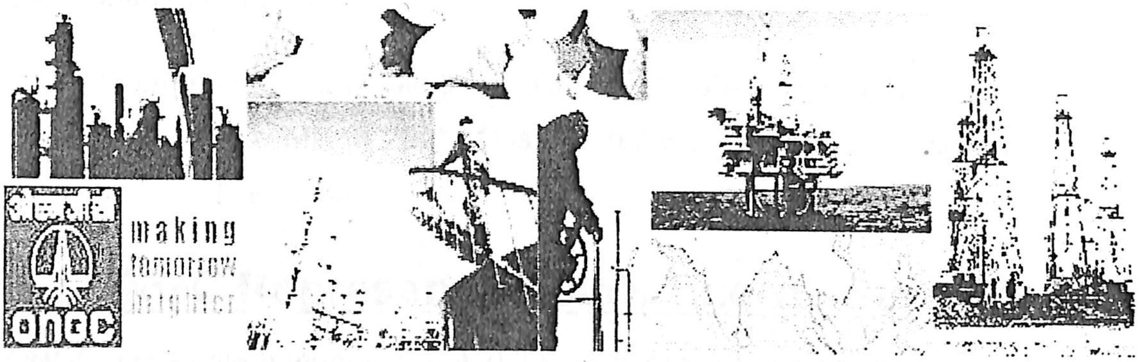
4.2.13 Worksheet

Surfer includes a full-featured worksheet for creating, opening, editing, and saving data files. Data files can be up to 1 billion rows, subject to available memory. We can use the Windows Clipboard functions to Cut, Copy, and Paste data within the **Surfer** worksheet, or between applications

4.2.14 System Requirements

- PC running Windows 98, Me, 2000, XP, or higher
- 100 MB of free hard disk space
- 64 MB RAM minimum, 128 MB or higher recommended
- 800 x 600 minimum monitor resolution

Chapter 5:
Overview of Targeted Company-ONGC



5.1 Global Ranking

- Is Asia's best Oil & Gas Company, as per a recent survey conducted by US-based magazine 'Global Finance'.
- Ranks as the 2nd biggest E&P company (and 1st in terms of profits), as per the Platts Energy Business Technology (EBT) Survey 2004
- Is placed at the top of all Indian Corporates listed in Forbes 400 Global Corporates (rank 133rd) and Financial Times Global 500 (rank 326th), by Market Capitalization.
- Is targeting to have all its installations (offshore and onshore) accredited (certified) by March 2005. This will make ONGC the only company in the world in this regard.

5.2 ONGC Represents India's Energy Security

ONGC has single-handedly scripted India's hydrocarbon saga by

- Establishing 6 billion tonnes of In-place hydrocarbon reserves with more than 300 discoveries of oil and gas; in fact, 5 out of the 6 producing basins have been discovered by ONGC: out of these In-place hydrocarbons in domestic acreage, Ultimate Reserves are 2.1 Billion Metric Tonnes (BMT) of Oil Plus Oil Equivalent Gas (O+OEG).
- Cumulatively producing 685 Million Metric Tonnes (MMT) of crude and 375 Billion Cubic Meters (BCM) of Natural Gas, from 115 fields.

5.3 Competitive Strength

- All crudes are sweet and most (76%) are light, with sulphur percentage ranging from 0.02-0.10, API gravity ranging from 26°-46° and hence attracts a premium in the market.

- ONGC owns and operates more than 11000 kilometers of pipelines in India, including nearly 3200 kilometers of sub-sea pipelines. No other company in India, operates even 50 per cent of this route length.

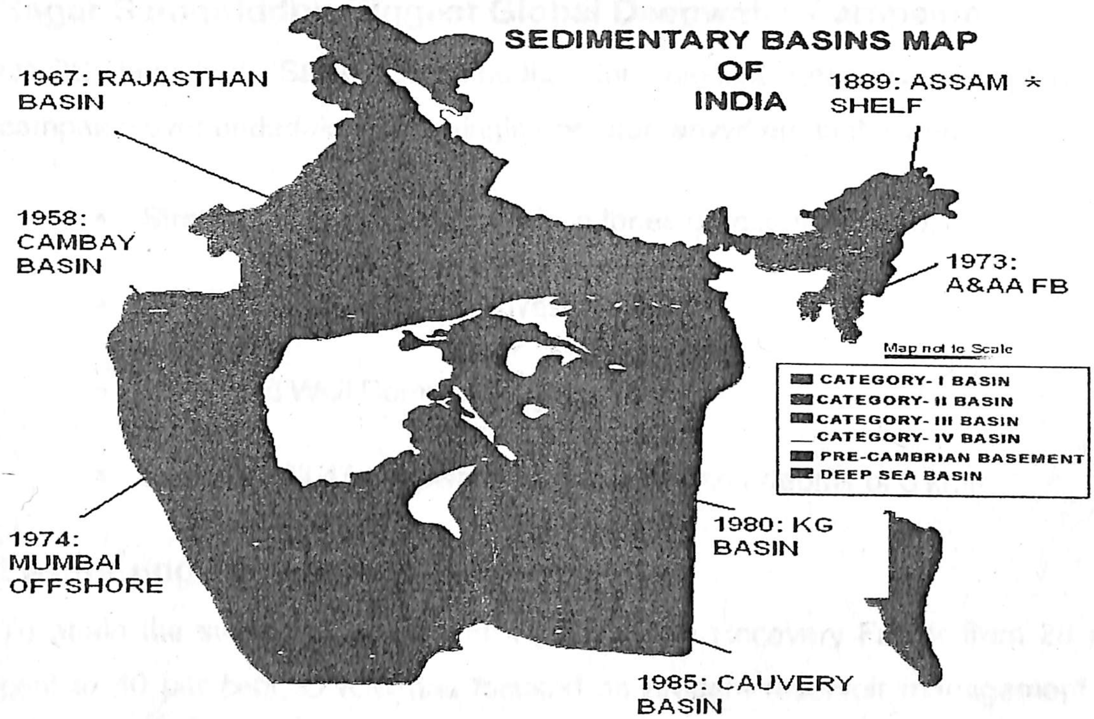


Figure 19: Sedimentary Basin Map for ONGC

5.4 Strategic Vision: 2001-2020

Focusing on core business of E&P, ONGC has set strategic objectives of:

- Doubling reserves (i.e. accreting 6 billion tonnes of O+OEG) by 2020; out of this 4 billion tonnes are targeted from the Deep-waters.

- Improving average recovery from 28 per cent to 40 per cent.
- Tie-up 20 MMTPA of equity Hydrocarbon from abroad.
- The focus of management will be to monetise the assets as well as to assetise the money.

The focus of management will be to monetize the assets as well as to assetise the money.

Sagar Sammriddhi: Biggest Global Deepwater Campaign

ONGC launched 'Sagar Sammriddhi', the biggest deep-water exploration campaign ever undertaken by a single operator, anywhere in the world.

- Strategic plan to accrete 4 billion tones of reserves by 2020.
- US $0.75 million per day investment.
- Integrated Well Completion approach.
- Plans to drill 47 deepwater wells up to water depths of 3 kms.

Leveraging Technology

To attain the strategic objective of improving the Recovery Factor from 28 per cent to 40 per cent, ONGC has focused on prudent reservoir management as well as effective implementation of technologies for incremental recovery to maximize production over the entire life cycle of existing fields

Improved Oil Recovery (IOR) and Enhanced Oil Recovery (EOR) schemes are being implemented:

- In 15 fields including Mumbai offshore
- At a total investment exceeding US $2.5 billion.
- Yielding incremental 120 MMT of O+OEG over 20 years

5.5 Onshore

- Production Installation - 225
- Pipeline Network (km) - 7900
- Major Offshore Terminals (including CFU, LPG, Gas, Sweetening plants, Storage Tanks) - 2
- Drilling Rigs - 75
- Work Over rigs - 66
- Seismic Units - 33
- Logging Units – 35

5.6 Offshore

- Well Platforms - 131
- Well-cum-Process Platforms - 5
- Process Platforms - 28
- Drilling/ Jack-up-Rigs - 18
- Pipeline Networks (km) - 3200
- Offshore Supply Vessels - 32
- Special Application Vessels - 4

❖ Special Application Vessels - 4

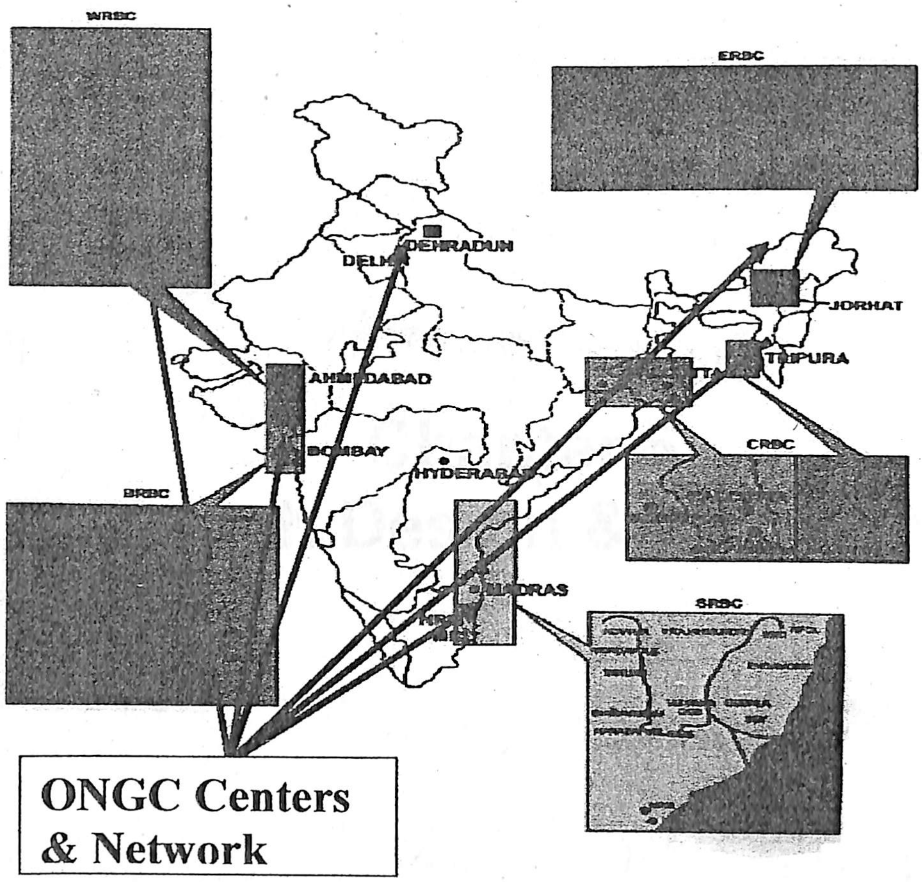


Figure 20: ONGC Main centers & Network

5.7 The Road Ahead

ONGC is entering **LNG** (regasification), **Petrochemicals, Power Generation**, as well as **Crude & Gas shipping**, to have presence along the **entire hydrocarbon value-chain**. While remaining focused on its core business of oil & gas E&P, it is also looking at the future and promoting an applied **R&D in alternate fuels** (which can be commercially brought to market). This effort in integration is basically to exploit the core competency of the organization – knowledge of hydrocarbons, gained over the five decades.

Chapter 6:
Research Design & Methodology

6.1: Upstream

Converting 3D image to 2D contour Map & Identifying the slope of terrain

Step 1:

Select the Geological-Utilities/Utils/Images/Digitize from Bitmap option.

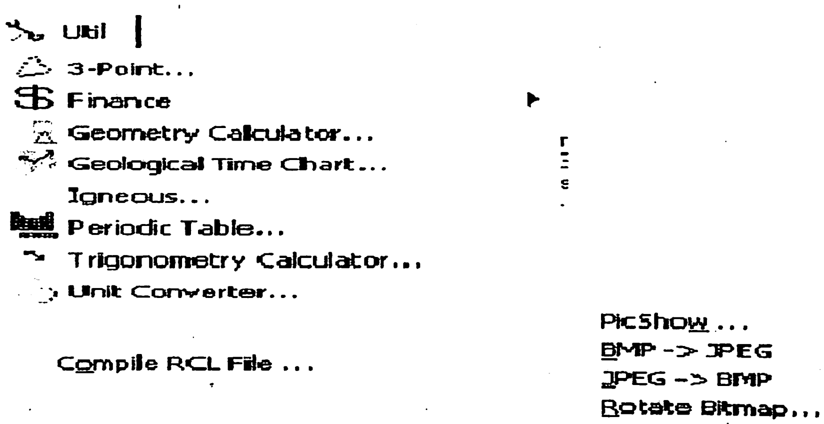


Figure 21: Utilities option in Surfer

Step 2:

Select the File/Import option from within the "On-Screen Digitizer".

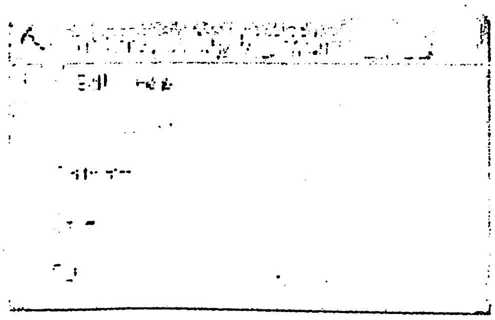
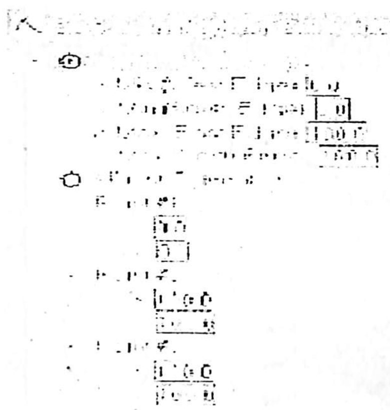


Figure 22: Onscreen Digitizer screen in surfer

Step 3:

The next menu provides methods for calibrating the map; if we know the coordinates at the edges of the map, select the option labeled "Min/Max Calibration" and enter the coordinates represented by the edges of the map



Step 4: Locate the surface area of prospective Oil field & Digitize it.

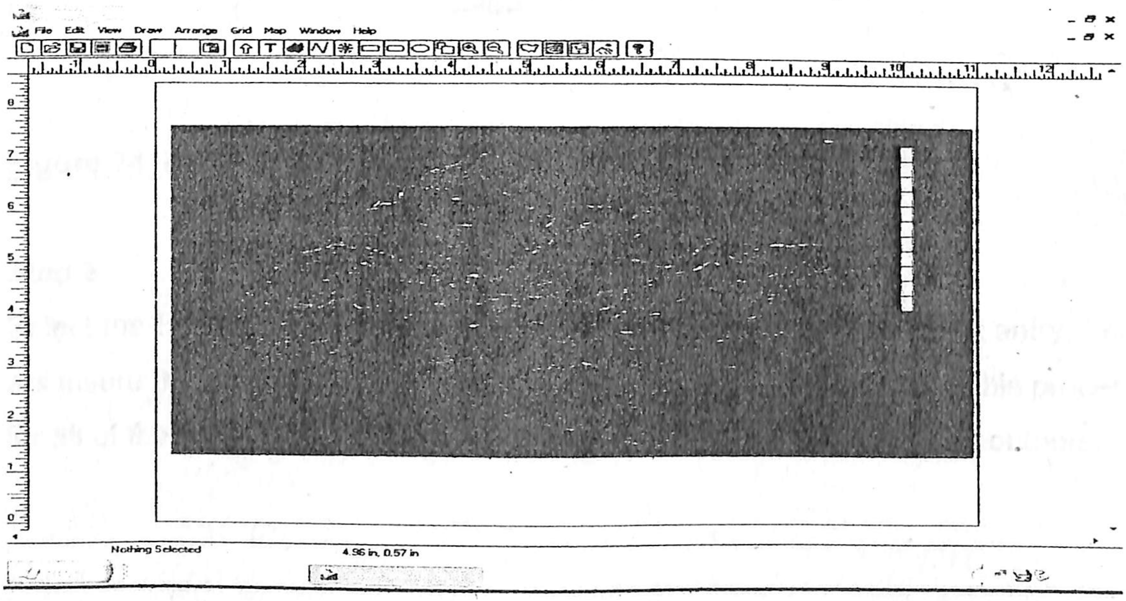


Figure 23: Digitized map of Propective Oil Field

Step 5:

Notice the Elevation option location at the top-right corner of the screen. As we digitize contours, we must remember to change this to the appropriate contour level each time we change lines. Set this to a given contour interval.

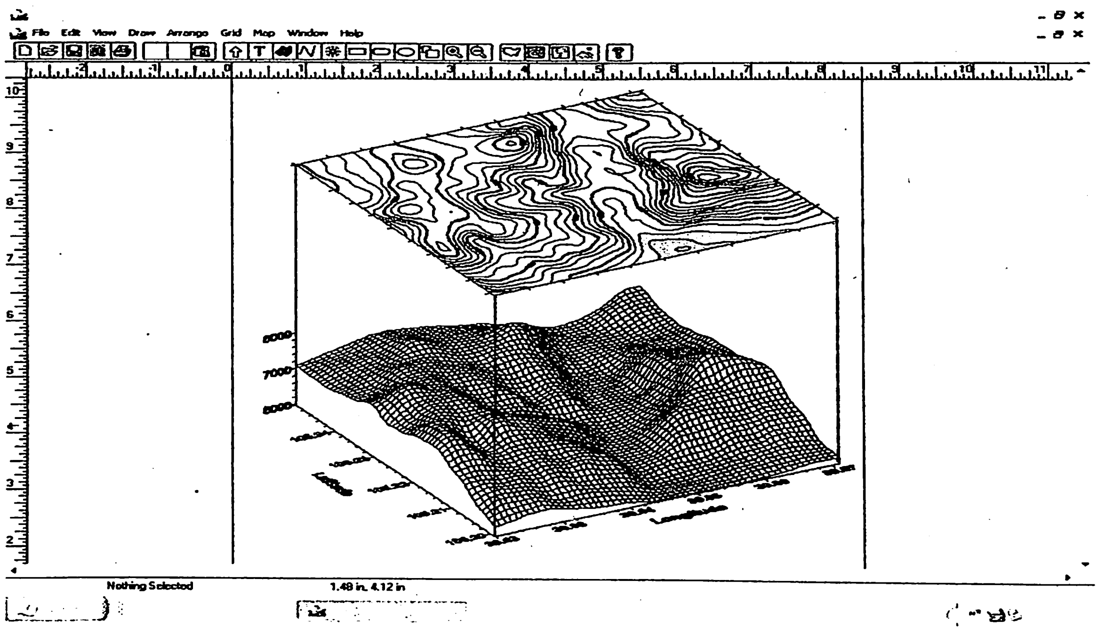


Figure 24: contour map of surface

Step 6:

Select the Edit/Options menu item and set the Point "prefix" to a blank entry. This will insure that the saved data contains only xyz coordinates. Repeat this process for all of the contours. Change the elevation setting when we change contours.

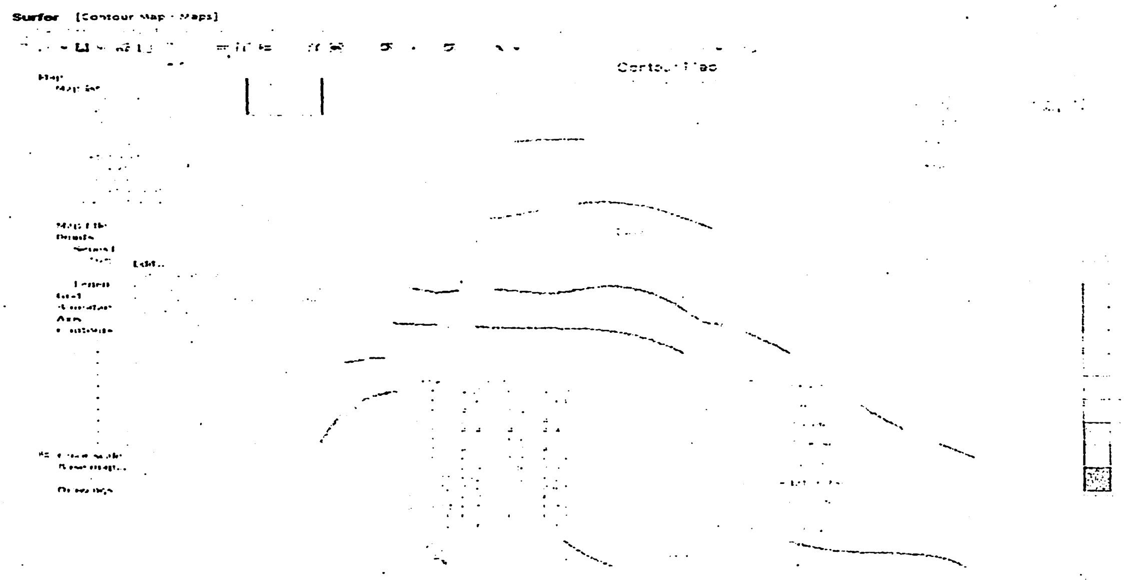


Figure 25: Identifying the depth of surface

Step 7:

Select the Map/Grid-Based-Map option and create a grid model based on the digitized points & suggest the slope of terrain & Topographical structure of plane

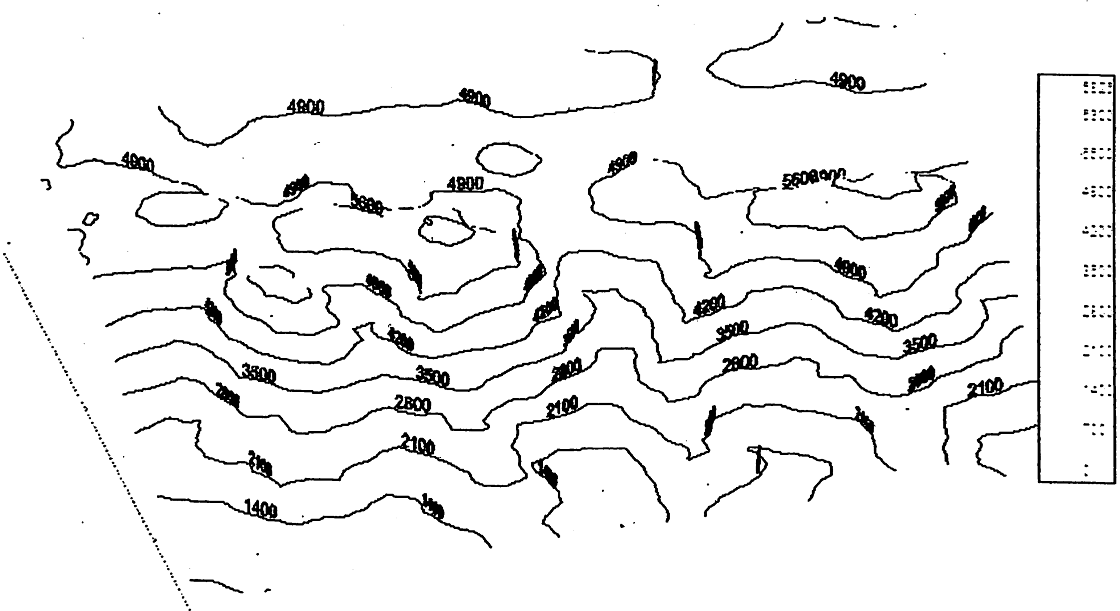


Figure 26: Digitized view of Map with depth

6.2: Downstream

Locate Different ONGC Wells & Distribution channel across all regions of India

Open the Map of India in JPEG format opened in MAP Info GIS software. To open this Map go to file and select Raster format option.

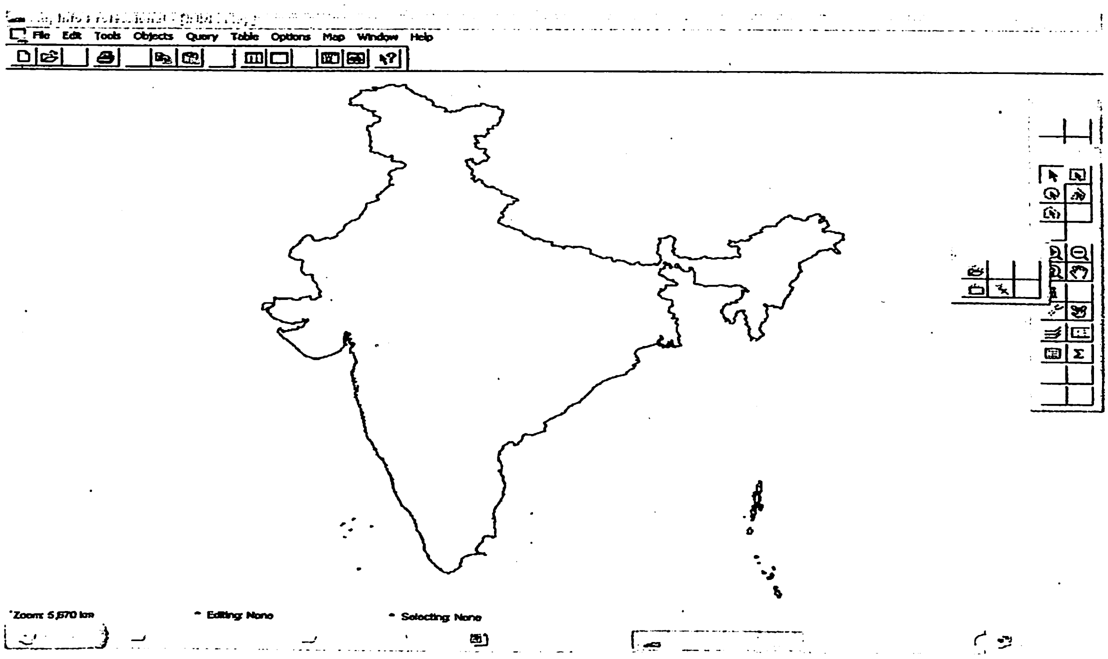


Figure 27: JPEG Image in MAP Info

- Select Raster Format from File Menu
- Click on Open in Raster Format will open JPEG image.

Locate Latitude and Longitude on MAP

- Select Register Coordinate from Menu.
- Point out latitude and longitude on different MAP location

Now assign the Latitude & Longitude to the map of India. For assigning latitude and longitude we have to select three points on this map and assign latitude and longitude.

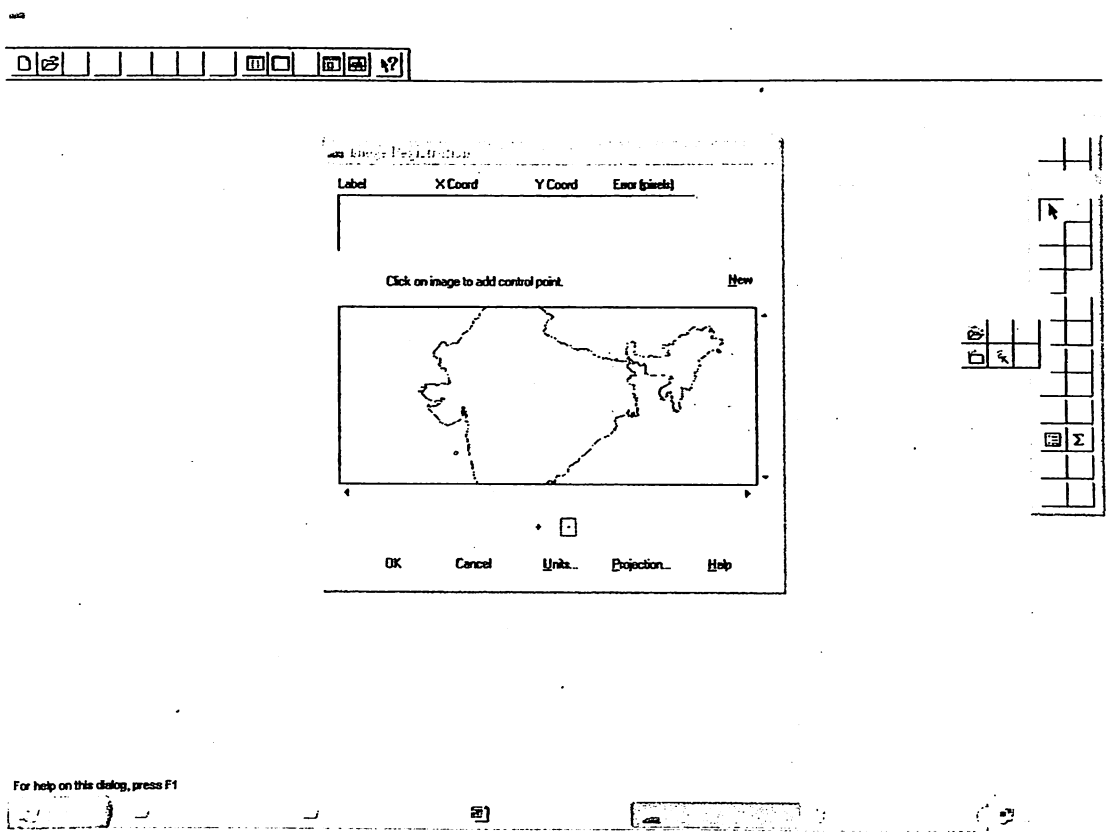
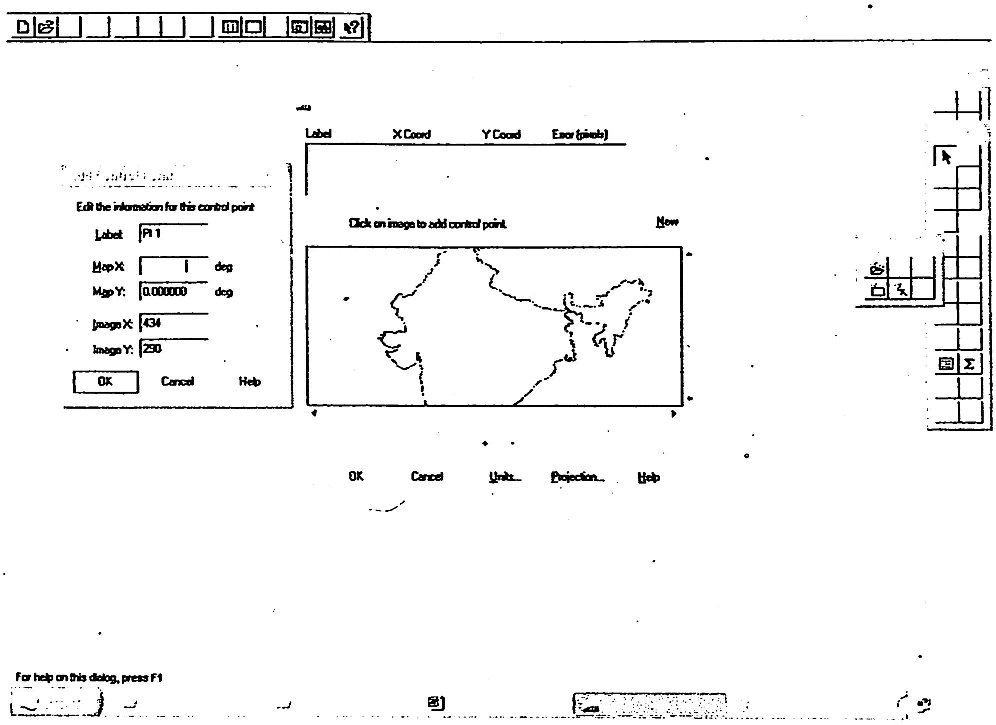
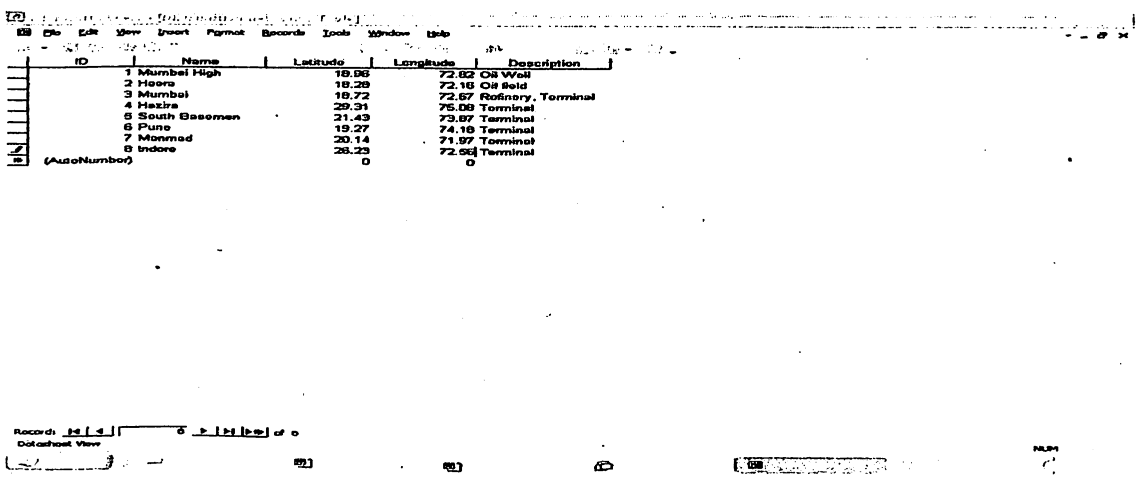


Figure 28: Latitude and Longitude Assignment



I have separated all data in three regions based on that we can give complete network of India.

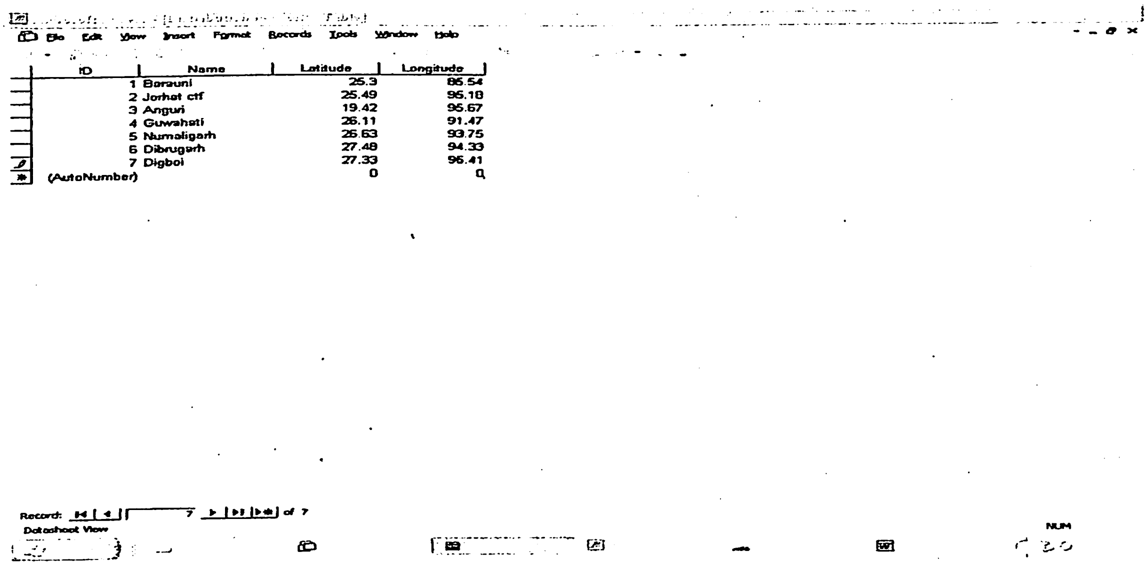
Mumbai Region



ID	Name	Latitude	Longitude	Description
1	Mumbai High	18.96	72.82	Oil Well
2	Heera	18.28	72.16	Oil field
3	Mumbai	18.72	72.67	Refinery, Terminal
4	Hazira	29.31	76.08	Terminal
5	South Bassemen	21.43	73.87	Terminal
6	Pune	19.27	74.18	Terminal
7	Manmad	20.14	71.97	Terminal
8	Indore	28.23	72.56	Terminal
(AutoNumber)		0	0	

Figure 29: All Data in MS Access for Mumbai Region

Eastern Region

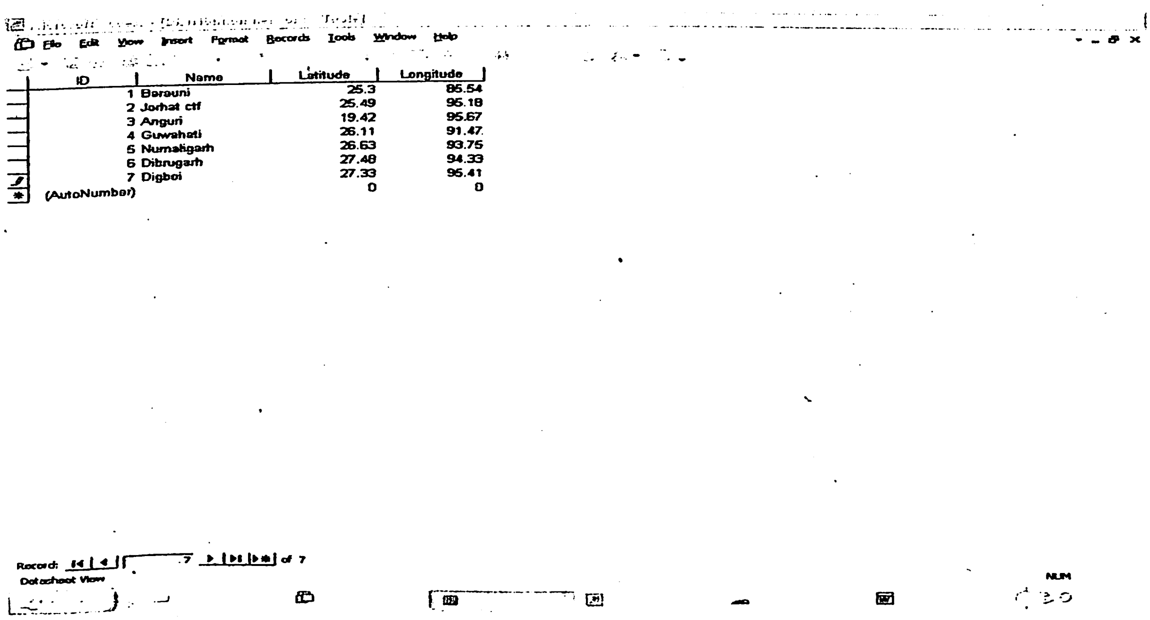


ID	Name	Latitude	Longitude
1	Barauni	25.3	85.54
2	Jorhat ctf	25.49	95.18
3	Anguri	19.42	95.67
4	Guwahati	26.11	91.47
5	Numaligarh	26.63	93.75
6	Dibrugarh	27.48	94.33
7	Digboi	27.33	95.41
(AutoNumber)		0	0

Record: 7 of 7
Datasheet View

Figure 30: All Data in MS Access for Eastern Region

Western Region



ID	Name	Latitude	Longitude
1	Barauni	25.3	85.54
2	Jorhat ctf	25.49	95.18
3	Anguri	19.42	95.67
4	Guwahati	26.11	91.47
5	Numaligarh	26.63	93.75
6	Dibrugarh	27.48	94.33
7	Digboi	27.33	95.41
(AutoNumber)		0	0

Record: 7 of 7
Datasheet View

Figure 31: All Data in MS Access for Western Region

Create MAP

As shown in figure all data is in MS Access file that is connected Now we can visualize this data through GIS software or simply open data base table from server.

Create point based upon Latitude and longitude of that particular location as shown in figure.

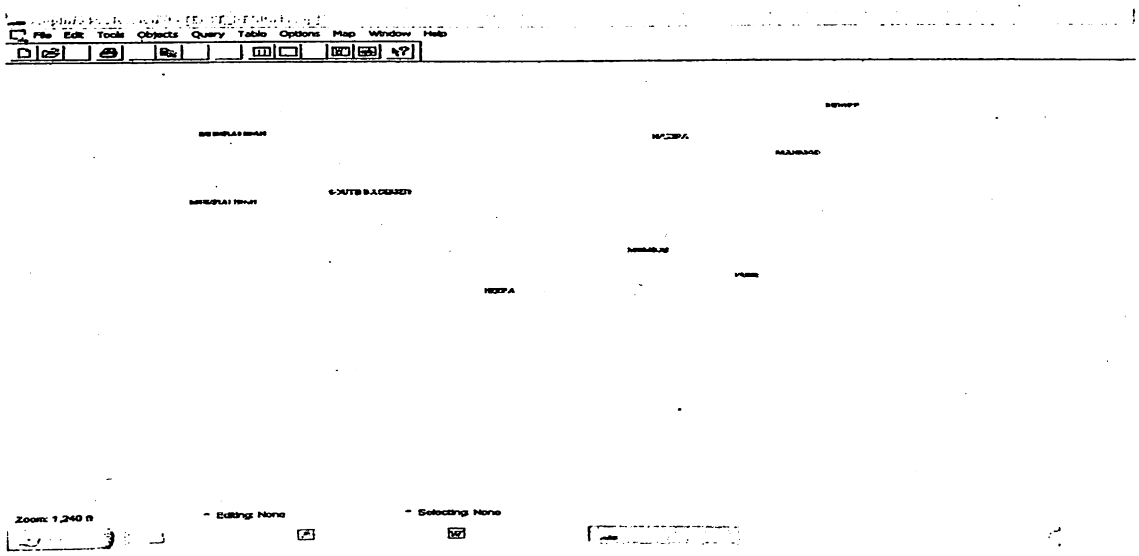


Figure 32: Location of ONGC main terminals in Mumbai Region

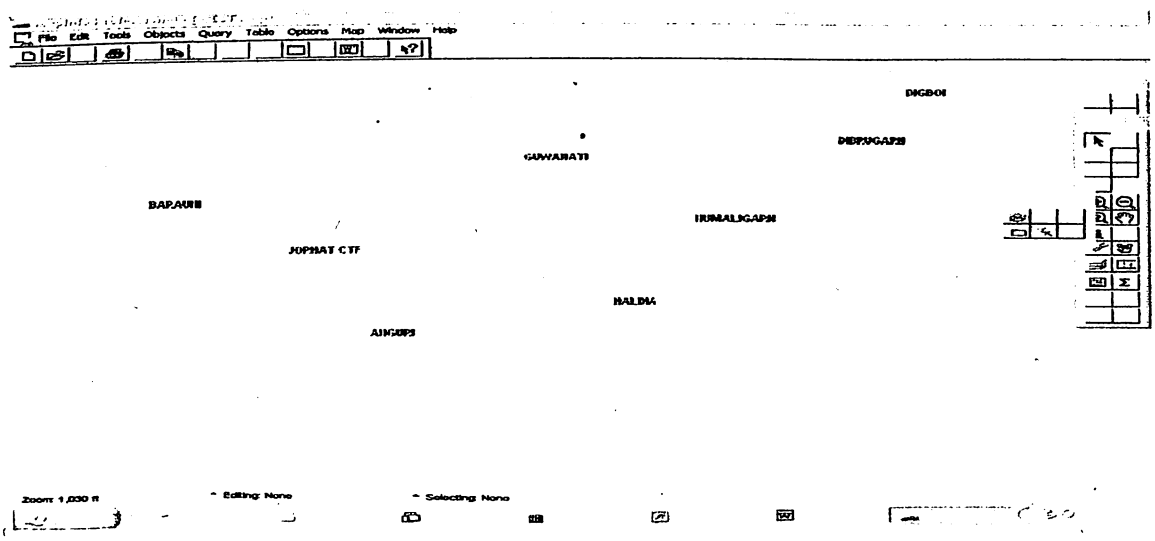


Figure 33: Location of ONGC main terminals in Eastern Region

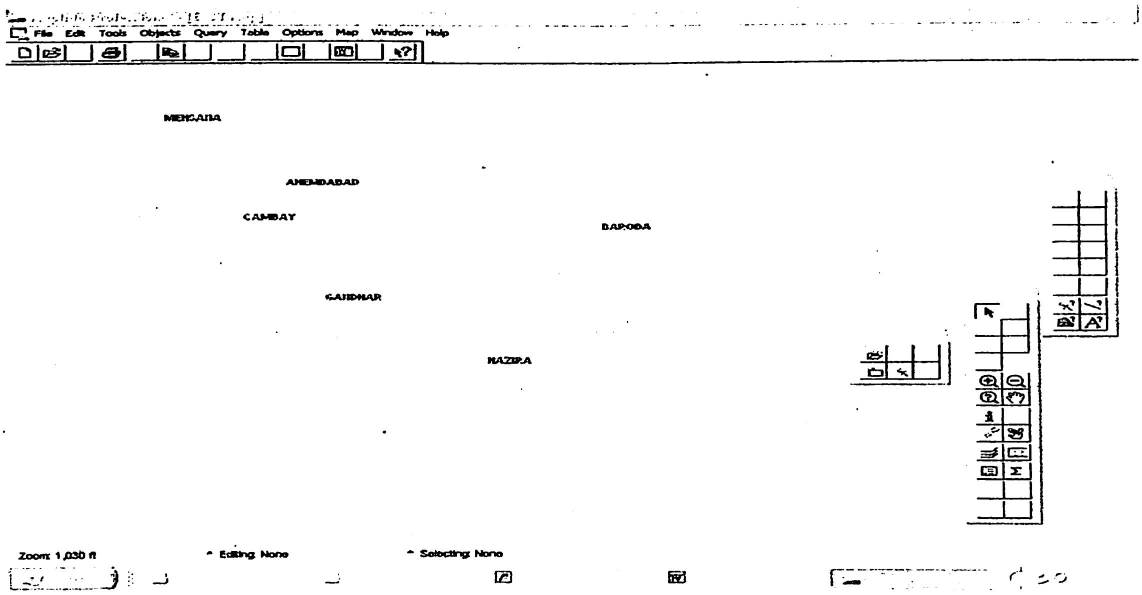


Figure 34: Location of ONGC main terminals in Western Region

Import another Layer

Next task is to import another layer on this MAP that is India MAP, Combining both these layer would give exact location on one Layer.

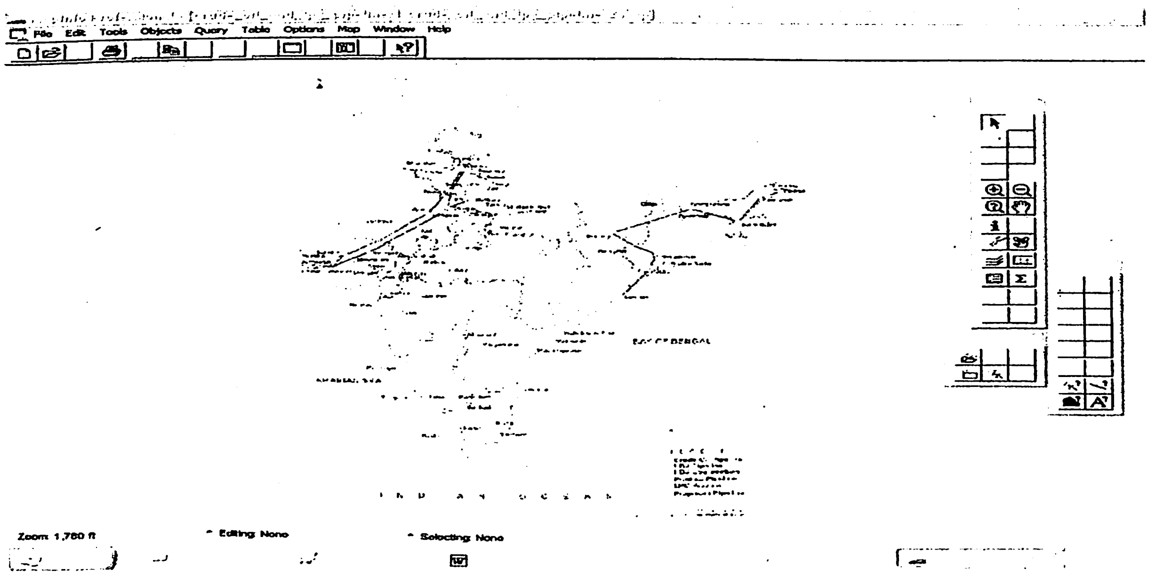


Figure 35: Map Overlaying

This Figure shows how maps are overlaid over each other. After assigning latitude and longitude for India map it was a single layer then we open MS Access Database contain information location wise that location coordinate is to be put on different layer. This is layer two and at last combine these two layers showing a complete map containing BPCL location.

Chapter 7:
Future Expectation

Although GIS technology brings lots of benefits to the oil industry already, it can still be made better. Where our requested improvements can be stated and implemented in a generic way, they can benefit all users of GIS. Some things on our "oil industry wish list" include:

Improved integration with our relational databases. Fortunately, the newly-announced Spatial Database Engine (SDE) makes a major leap in the right direction. However, we still have a way to go to link hardcopy and CAD data (though a large part of this problem results from poor record keeping and data management, which can't be fixed by the GIS...)

Improved "conflation" tools. "Conflation" is the process of merging two or more GIS datasets, so that the output has the highest-accuracy data from all the inputs. As surveying tools and GIS data from satellite and orthophoto images continues to improve, existing maps and GIS datasets must be "high-graded", i.e. adjusted to remain consistent with the newer data. Managing this process may well be our biggest challenge.

3-dimensional GIS. Right now, our use of GIS stops at the Earth's surface. To visualize subsurface reservoirs, we must change to completely different systems, which rarely present a "seamless" interface to the GIS.

7.1 Geological Evaluation Process

During the reservoir evaluation, a significant amount of geological research and analysis was performed prior to using the GIS. Conventional core measurements were evaluated to determine reservoir rock types. These rock types were combined with well log data to create a rock-to-log correlation. Well log cross-sections were then constructed and analyzed, which resulted in the definition of 16 individual reservoir units. Tops of the reservoir units in measured depth were entered into the GIS for mapping. The tops were also imported into the log analysis application to allow petrophysical calculations to be performed on each individual reservoir unit. Reservoir unit calculations were subsequently imported back into the GIS for mapping of multiple attributes on all 16 reservoir units. The result of the mapping exercise was the determination of original gas in place and remaining gas reserves for each individual reservoir unit.

Geophysical Evaluation Process

Using the geophysical workstation, synthetic seismograms were incorporated into the evaluation. Tops were imported from the GIS and merged into the synthetic seismograms. Fieldwide correlatable, continuous time reflectors were defined and mapped. Faults and stratigraphic features were also identified and mapped. Time structure and isochronal maps were generated on the definable time horizons. The time structure and isochronal maps were converted into depth and thickness. The structure and isopach maps were then exported to the GIS.

Petrophysical Evaluation Process

Rock types identified by the geologist were input into the petrophysical evaluation software. As noted, these data were combined with the well logs to determine a rock-to-log correlation index. The correlation index consisted of a probability tool that enabled the petrophysicist to predict rock types over intervals where conventional core was not available. Knowing rock types for each 1 ft interval in the well enabled the petrophysicist to apply different log parameters to each rock type for calculation. The result was a more accurate determination of the presence of hydrocarbons. Petrophysical values, such as average water saturation, net effective sand, and net pay were exported into the GIS for each of the reservoir units. For purposes of sensitivity analysis, a different set of values was calculated for each of the three different porosity values.

7.2 Reservoir Analysis

Each well was evaluated to determine original and current water levels in the reservoirs. These values were input into the GIS for spatial analysis. Production analysis was performed to predict future hydrocarbon recoveries. Cumulative production was first assessed and assigned to each perforated interval and was then allocated to each reservoir unit. Following the mapping process in the GIS, net pay contour areas were exported into a spreadsheet. Reservoir volumes were then calculated from the net pay contour areas. These calculated volumes were compared with cumulative production volumes and originally calculated ultimate reserve recoveries. Numerous iterations were then performed on the map layers in the GIS to obtain reasonable net pay contour areas.

7.3 Land / Lease Management

Mapping in the oil and gas industry is a critical tool for the management of our properties. Maps are used to display what we own and its location, to lay out an acquisition or development strategy, to display the relationships between one company's acreage position and a pipeline, or a seismic line, or a well or another company's acreage position. They are used to analyze the mineral ownership and surface topography and relate it to the subsurface stratigraphy or to a region's economics thus enabling a company to select the most optimal location to drill a well. A map is used to display what we want to sell or what we want to buy. They are used as exhibits to contracts and as evidence in judicial and regulatory hearings.In summary, maps are an integral part in the day to day work of all of our operational disciplines.

Historically our industry has managed these assets through mainframe based textual information systems while the spatial data was captured separately as hand drawn or CAD maps. The maps were not derived from the text. At best they only represented the text at a certain point in time. Due to the time involved in their creation, they became living documents maintained by hand. Therefore, the text and maps were always out of sync. Additionally, maps of the same geographical area were created multiple times by different end users reflecting each user's own query or analysis and subsequently were stored in their individual files where other users had either no access or knowledge of their existence. Decision making was a painstaking labor intensive process based on out-of-date and unreliable data with opportunities lost through the paralysis of data gathering, display and analysis. Business processes were developed just to ensure that quality decisions could be made regardless of the time, costs or people involved.

7.4 Drilling Activity Analysis

Analysis of the well header data has provided enough information to examine the growth of the field since its beginning. Mapping by the wells' First Production Date has allowed for visualization of the field growth over time. One can see that as the field expands it is encroaching on the DFW area and municipalities. Also, a query on companies involved in the field produced a map showing the major operators in the field. By mapping the spatial data an understanding of the evolution of the field has been presented in this study. An appreciation of the cultural and/or land use limitations on further expansion of the field has also been presented. It is evident from the mapping that further growth is being complicated by the urban centers. Producers will have to deal with land use issues, right of way issues, mineral rights issues, and local ordinances. Expansion of the field appears to be limited to the south and southeast by the population centers.

7.5 Gas Supply Network Management using GIS

The functionalities are specific to city gas distribution where there in an extensive underground steel pipe network and polyethylene pipe network serving gas for cooking purpose etc to a large number of residential buildings, hotels/restaurants and for industrial purposes to factories.

The linkage serves the following purposes:

- Used to logically link the customers to the gas supply points in GIS.
- For carrying out customer GeoCoding in GIS
- For carrying out actual load analysis. The customer database provides the actual loads at the gas supply points
- For identifying the points in the network with excess potential and where new customers can be added

GIS has a two-way interface with gas network analysis software

The pipe network graphic layout and the attribute information like actual loads, design loads, pipe diameters, pipe lengths (picked automatically from the graphics) etc are exported from GIS to the network analysis software. The software analysis the information and provides pressure drops at regular intervals in the pipe network. These pressure values are imported back into GIS as the result of the analysis. These pressure values are used for functionalities such as locating the upstream valves, valve closure analysis, line pack analysis etc

Decision support tool for emergency situations like fire, leakage, gas stoppage etc and prompt handling of the same.

Functionalities serving this purpose:

- To locate the upstream valve/valves, which are supplying gas to the point of leakage – In the case of gas leakage or fire due to rupture in the underground pipe it identifies and displays the closest upstream valve(s) which are to be closed to stop the supply of gas at the point of rupture of the pipe.
- **Valve Closure Analysis** – To get the number and locations of effected customers during valve closure and to find out the customer details like customer name, customer reference number, address etc. It will also highlight the portion of the gas pipe network downstream of the valve, which has been closed.

Line Pack analysis –

- To find the total amount of gas (volume of gas at atmospheric pressure) escaping during a leakage from the ruptured hole and the time it will take to do so.
- In the case of valve closure it calculates the time the gas which is entrapped in the pipe will be able to serve the customers. This will be useful is ensuring continuous supply of gas to the customers even in the case of gas leakage.
- To highlight the gas supply path for a particular customer from the main gas supply point – It will identify the pipes (and the single line path they make) through which the gas is coming to the customer and display the details of all the meters, valves, junctions and regulators in this path.
- **GeoCoding of a customer building location in case of emergency** – It will identify the building from which the emergency complaint came on the basis of the customer reference number or the customer's telephone number and will display the building location on the map. This will assist the emergency crew to reach the building quickly.
- Identify and geocode of a prominent building nearest to the customer premises – To assist the emergency crew to reach the building quickly.
- Identify and highlight of the shortest path from the crew location to the emergency location – To assist the emergency crew to reach the building quickly.

7.6 Improved Integration with our Relational Databases

Although GIS technology brings lots of benefits to the oil industry already, it can still be made better. Where our requested improvements can be stated and implemented in a generic way, they can benefit all users of GIS. Some things on our "oil industry wish list" include:

Improved integration with relational databases- Fortunately, the newly-announced Spatial Database Engine (SDE) makes a major leap in the right direction. However, we still have a way to go to link hardcopy and CAD data (though a large part of this problem results from poor record keeping and data management, which can't be fixed by the GIS...)

A truly global paradigm, where locations on the earth include "metadata" like geodetic datum, Cartesian projection/spheroid parameters, etc. I am pleased to state that the next releases of ArcView and SDE appear to be comprehensively addressing this issue.

Chapter 8: Conclusion

The convergence of GIS/GPS and other technologies specially Relational Database Management Systems (RDBMS) with the support of spatial information via spatial cartridges has opened a new era which will allows us to manage the spatial components of these everyday petroleum "business objects," such as leases, wells, pipelines, environmental concerns, facilities, and retail outlets, in the corporate database, and apply appropriate geographic analysis efficiently in a desktop-focused application.

This involves the process of exploring new locations as petroleum reserves, managing the Production of crude petroleum from earth strata, managing the pipeline network to transfer crude sources to refining plant and facility management of various resources connected to such a huge industry.

Chapter 8:
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- Geoinformatica
- Geo World (formerly GIS World)
- GIS informatics magazine
- GPS World
- International Journal of GIS
- Journal of Historical Geography
- Oil &Gas journal

- Photogrammetric Engineering and Remote Sensing
- Physical Geography
- Research & Exploration
- Transactions [Institute of British Geographers]
- Urban Geography
- URISA Journal
- Wisconsin Mapping Bulletin

9.4 Acronyms & Abbreviations

AGI	Association for Geographic Information
DGPS	Differential Global Positioning System
DEM	Digital Elevation Model
ESRI	Environmental System Research Institute
E&P	Exploration & Production
GPS	Global Positioning System
GITA	Geospatial Information & Technology Association
LNG	Liquefied Natural Gas
MI	MapInfo
SA	Selective Availability