CONCEPTUAL VISION OF AIRPORT GEOGRAPHIC INFORMATION SYSTEM (AGIS)

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Abstract

GIS can providethe airport management staff with visual pavement information and powerful analysis tool. Mean while, the spatial information managed by GIS can ensure the accumulation of valid attribute data of airport pavement. Based on the principle and general implementation process of GIS and the characteristics of airport pavement management, this paper describes the implementation process of GIS in Iraqi Airport planning and design.

To organize the spatial entities effectively, some layers are set according to the characteristics of spatial entities. The spatial database is established,and thenthe function design of the GIS software is presented including map exploring, map locating, spatial query, rendering style of map and output of map. In this paper the section on the ground was the case study, Representative the AGIS in building infrastructure layers of Baghdad international airport buildings and pavements. The results were two maps, the first include eleven layers and the other includes two layers, each layer hasinformation that describes the thickness of subsurface.

In consequence of the above, comparative study for each type of pavement was made to find the most suitable pavement structure for Baghdad International Airport (BIAP).

Keywords: Airport, AGIS, GIS, Information Technology (IT), Pavement, Planning.

Introduction

There are two major types of pavement utilized in the construction of runways, taxiways and aprons for airports handling the wide Varity of aircraft traffic of today. These types are classified generally as rigid pavement and flexible pavement, each involving a different approach of analysis, design and construction. Which one is used, depends upon local conditions, construction difficulties and economics. In consequence of the above, comparative study for each type of pavement shall be made to find the most suitable pavement structure for Baghdad International Airport (BIAP) (FOUGEROLLE and SPIE, 1978).

As the process of comparison, the following four types of pavement are studied, of which the first three types are considered as rigid pavement, and at last one being a flexible pavement:

1. Ordinary Portland cement concrete pavement with temperature reinforcement, hereafter called “NC” pavement.
2. Continuously reinforced concrete pavement, hereafter called “CRC” pavement.
3. Pre-stressed concrete pavement, hereafter called “PC” pavement.
4. Flexible pavement, hereafter called “AC” pavement.

Airports are inherently spatial. From planning to maintenance to security, airport managers need to know where events are taking place. GIS adds spatial information and 3D modeling to the airport manager's toolkit to support efficient operations. For example, the ability to use 3D and elevation measurements in the GIS environment helps you visualize the location of flight path obstructions. GIS server technology serves maps and other information, such as noise monitoring results, to the public via the Internet.

Commercial, emergency, and defense-related airfields use GIS to:

1. Manage facilities, both air side and land side.
2. Model and monitor noise.
3. Track environmental compliance.
4. Manage construction and maintenance.
5. Plan traffic and capacity.

In the strictest sense, a GIS is a computer system capable of assembling, storing, manipulating, and displaying geographically referenced information (that is data identified according to their locations). Practitioners also regard the total GIS as including operating personnel and the data that go into the system (Science for Changing World, 2007).

Airport Geographic Information System (AGIS)

Geographic Information Systems (GIS) are increasingly being implemented by airport operators. Airport operators today face unprecedented challenges to provide greater safety and security for passengers, while still efficiently managing their facilities. Modern airports are finding an integrated geographic information system (GIS) that can help in to better management both air and ground side operations. Some of the applications can be classified into two groups follows as (Airport Technology, Esri, 2012):

2.1 In the air

- **Flight Tracking**: commercial airlines and air traffic control regulators use GIS for airspace planning and routing applications, integrated flight monitoring, and real time flight tracking. These applications facilitate greater airspace efficiencies, and support a number of security and public information programs, including noise monitoring and real time flight arrival information.
- **Three Dimensional Analysis**: Recent enhancements to three-dimensional GIS allow more advanced airspace modeling applications to be combined with geographic information from the surrounding communities, such as land use, building heights and modified terrain around the airport. These applications provide a better common operational picture around modern airports, and are used for security vulnerability, obstruction analysis and land use permitting.
- **Navigation:** Numerous aviation administrations have discovered the benefits of ArcGIS: a database driven aeronautical solution used to create Enroute charts for navigation. Because all the critical information is stored in the database, updates are easily made and seamlessly incorporated into the navigational charts.

2.2 On the ground

Modern airports are some of the most intensively used facilities, and must remain at a high level of performance at all times of the year, sometimes under trying circumstances. To meet these challenges, airport managers are turning to GIS technology to support their efforts in planning, operation, maintenance, and security by adding spatial information and modeling capabilities. GIS provides them with unique information and analytical power not available in

other information systems. and most important of all, a comprehensive GIS can support a wide array of airport missions.

- **Planning and Design**: many engineering firms have adopted GIS as a tool for expansion studies and design reviews. Using mapping data from the local community, such as ground access, neighborhood constraints and environmental sensitivities, can significantly reduce the time spent analyzing significant land use issues, particularly for expansions of land locked facilities in large, densely populated urban areas .

  GIS software can now provide a greater level of interoperability with other key software tools such as Computer Aided Design (CAD) systems and relational database management systems, allowing airport managers to better integrate their information technology environment. Users can now bring information captured in digital aerial photographs, environmental and design data into the same environment for analysis and planning.
- **Operations**: Significant growth in traffic has left many airport properties severely constrained for space. Airport managers must carefully balance security concerns with increasing revenue requirements. GIS can be integrated with property management applications, and used to effectively manage competing needs for revenue-generating facilities and readjust facilities for the ever-changing needs of their tenants.
- **Maintenance**: Airports have discovered the value of GIS in a modern maintenance management system. From pavement and runway lighting systems, to terminal side facilities, GIS can provide a powerful graphical component to the maintenance of an airport's critical infrastructure.
- **Security**: The security needs of airports have been significantly revised in recent years. GIS provides a powerful analytic capability for understanding vulnerability in existing facilities, and a way to integrate disparate security information into a single command environment. Airports have discovered that GIS is an integral part of a well designed security infrastructure, from perimeter control to terminal side access control and monitoring.

Airport Planning Studies

Airport planning may be defined as the employment of an organized strategy for the future management of airport operations, facilities designs, airfield configurations, financial allocations and revenues, environmental impacts, and organizational structures. There are various types of airport planning studies, including:

- **Facilities planning:** Which focuses on future needs for airfield infrastructure such as runways, taxiways, aircraft parking facilities, associated lighting, communication and navigational systems, terminal buildings and facilities, parking lots, ground access infrastructure, and support facilities such as fuel farms, power plants, and no-aeronautical land uses such as office parks, hotels, restaurants, or rental car locations.
- **Financial planning:** Which is concerned with predicting future revenues and expenses, budgeting resources, and planning for financial assistance through grant programs, bond issues, or private investment?
- **Economic planning:** Which considers the future of economic activity, such as trade and commerce, and the activity of industries that exist on airport and off-airport property and are either a direct or indirect result of airport operations.
- **Environmental planning:** Which concentrates on maintaining or improving existing environmental conditions in the face of changes in future airport activity. Environmental planning includes land use planning, noise mitigation, wetland reclamation, and wildlife preservation.

- **Organizational planning:** Which entails the management of future labor requirements and organizational structures for the airport administration, staff, and associated labor force.
- **Strategic planning:** Which encompasses all other planning activities into a coordinated effort to maximize the future potential of the airport to the community. (Wells and Yung, 2004

Airport Development

An airport is established at a particular situation, not as an individual unit but as part of anetwork for the entire region or the country so as to ensure integrated long range development. Before planning an airport, every detail has to be worked out in an orderly manner for a particular set of conditions such as potential air traffic originating in the vicinity, number and type of aircrafts which are likely to use the airport, its location with respect to nearby airport, whether it is going to be used for commercial, defuse or mixed traffic, actual need of the area for present as well as future anticipated requirement.

On the basis of the proposed development of the region, an area airport plan or a master plan is usually prepared and the establishment of new airports or extensions and improvements of the old ones goes on steadily accordingly depending upon the new needs. The master plan, which is a written and a graphic documentation of complete earlier, investigation, evaluation and location etc., includes information about:

- The evaluation of existing airport facilities ,
- Anticipation of future facilities ,and
- The relative urgency of the component parts so that only appropriate type of airport is provided at any place.

Airport Geographic Information System (AGIS)

GIS is a computerized database management system that provides geographic access (capture, storage retrieval, analysis and display) to spatial data. GIS provides an excellent means for civil engineers to manipulate and examine the complex data usually required in the design and analysis processes. As a result, civil engineers deal with a voluminous amount of GIS allows civil engineers to manage and share data with easily understood reports and visualizations that can be analyzed and communicated to others. This data can be related to both project level and its broader geographic context.

GIS software provides civil engineers with the framework formaintaining and deploying critical data and applications across every aspect of the infrastructure project life cycleincluding planning and design, data collection and management, spatial analysis, construction, and operations management and maintenance. The provides the tools to assemble intelligent GIS applications and improve a project process by giving engineers, construction contractors, surveyors, and analysts a single data source from which to work. Centrally hosting applications and data makes it easy to manage, organize, and integrate geographic data, including CAD data, from existing databases to visualize, analyze, and make decisions**.**

ArcGIS for Airport Application

Arc GIS is a desktop geographic information system (GIS) from Environmental Systems Research Institute, Inc. (ESRI). A GIS is a database that links information to location (it connects what to the where), allowing you to see and analyze data in new and useful ways.

The ArcView interface consists of windows that present information in different ways. Rows of menus, buttons, and tools at the top of the main application window allow you to view and perform analytical operations on the data in the database.

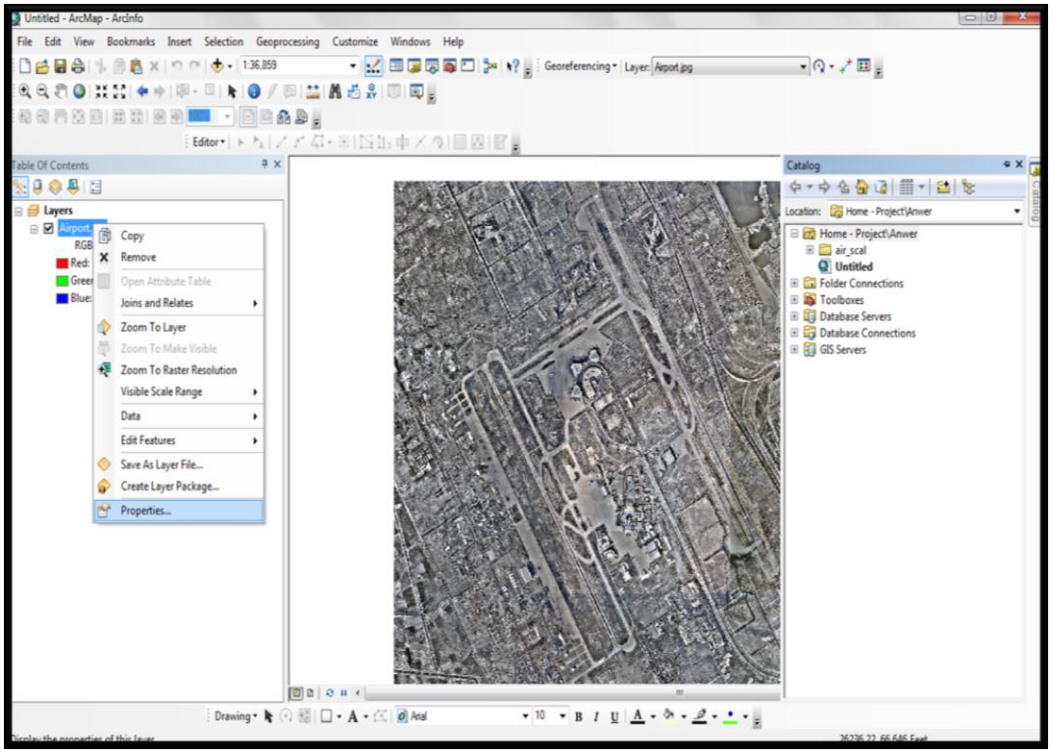
Many engineering firms have adopted GIS as a tool for expansion studies and design reviews. Using mapping data from the local community, such as current roadway or railway access to the airport grounds, airport pavements, neighborhood constraints, and environmental sensitivities, can significantly reduce the time spent in understanding the complexities involved, particularly for expansions of landlocked facilities in large. (Science for Changing World, 2013).

Arc Map

Arc Map is where you display and explore GIS datasets for any study area, where you assign symbols, and where you create map layouts for printing or publication. Arc Map is also the application you use to create and edit dataset

Arc Map represents geographic information as a collection of layers and other elements in a map figure (1) shows that. Common map elements include the data frame containing map layers for a given extent plus a scale bar, north arrow, title, descriptive text, a symbol legend, and so on.

Figure (1): Arc Map desktop



Arc Catalog

The Arc Catalog application provides a catalog window that is used to organize and manage various types of geographic information for ArcGIS Desktop. The kinds of information that can be organized and managed in ArcCatalog include, as shown in figure(2):

- Geodatabases.
- Raster files.
- Map documents, globe documents, 3D scene documents, and layer files.
- Geoprocessing toolboxes, models, and Python scripts.
- GIS services published using ArcGIS Server.

- Standards-based metadata for these GIS information items
- And much more

Arc Catalog organizes these contents into a tree view that you can work with to organize your GIS datasets and ArcGIS documents, search and find information items, and to manage them.Arc Catalog presents this information in a tree view and allows you to select a GIS item, view its properties, and to access tools to operate on the selected item(s). Arc Catalog is used to:

- Organize your GIS contents
- Manage geodatabase schemas
- Search for and add content to ArcGIS applications
- Document your contents
- Manage GIS servers
- Manage standards-based metadata.

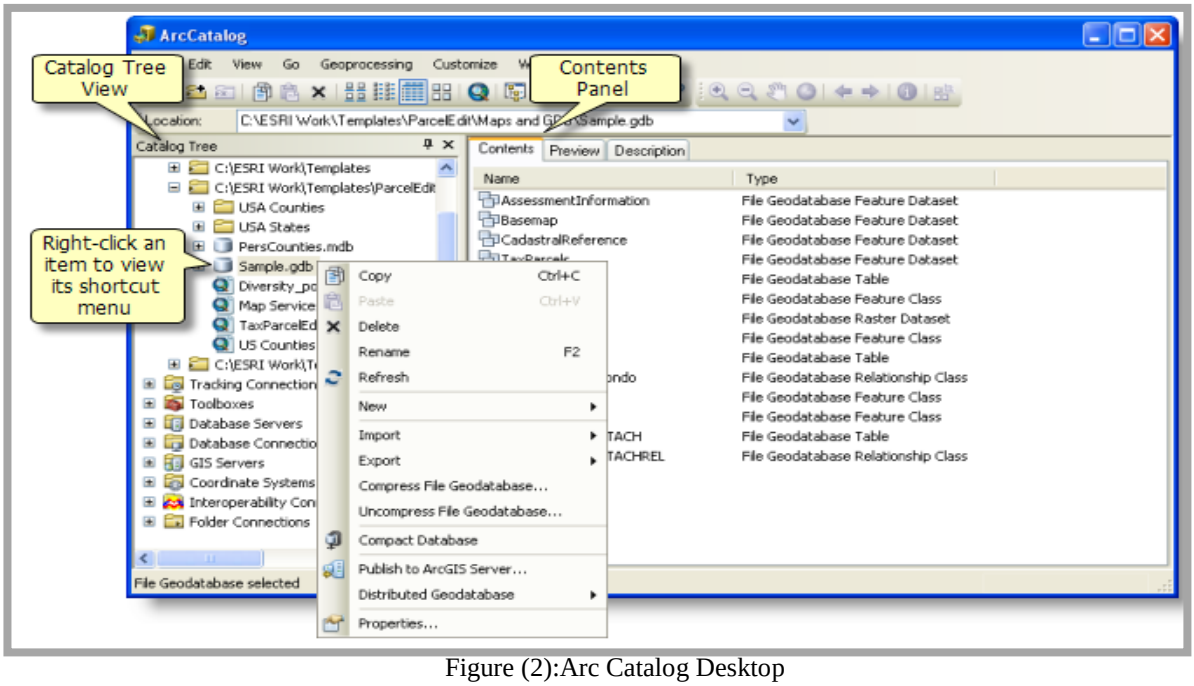


Figure (2):Arc Catalog Desktop

Case Study

Baghdad International Airport, (IATA: **BGW**, ICAO: **ORBI**), is Iraq's largest airport, located in a suburb about 20 km west of downtown Baghdad in the Baghdad Governorate. It is the home base for Iraq's national airline, Iraqi Airways. It is often abbreviated as **BIAP**, although **BIAP** is not an official airport code.

Before 1980

The first two terminal areas was a departure terminal with three gates and busses out to the aircraft and an arrival terminal. It was a green painted building with an observation deck.

After 1980

Baghdad international airport was constructed with the assistance of French firms, Designed to accommodate both civil and military operations, Baghdad International can handle up to 7.5 million passengers per year in aircraft of all sizes. The passenger terminal consists of three gate areas. These were originally named after the cities of the ancient

empires that once existed in present-day Iraq: Babylon, Samarra, and Nineveh. They are now simply called B, C and D.

The airport also had its own VIP terminal, which had a luxuriously furnished and decorated lounge, conference room and bedroom. This terminal is a VIP terminal, to welcome foreign leaders and other significantly persons. Baghdad International Airport was once served by several international airlines.

First Step: Building The Layers of Map

- **Runways:**In Baghdad airport there are two runways, first one has a length of 4000m and a width of 60 m, the second has a length of 3000m and a width of 45m, figure (4) shows the layers of runway.
- **Runways Shoulder:** For the different runway, the width of shoulders are 3.5 m for long runway and 7m for the other runway, these shoulders are using for the airfield lighting, band holes and cabling. Figure (5) shows the layers.
- **Taxiways:** Types of taxiways are parallel and connecting taxiway and its path of airplanes to the runway.
- **Taxiways Shoulder:** Area of flexible pavement in both side of taxiways used for airfield lighting and cabling.
- **Blast Pads:** Areas where it situated at the beginning and at the end of the runway.
- **Aprons:**The portion of airport, in front of the terminal buildings or adjacent to hangers, meant for parking, loading and unloading of the aircraft.
- **Apron Service Roads:**Roads for serving the apron.
- **Public and Service Access Roads:** Network of roads, using from the passenger to assess the terminal buildings inside the airport and also for other services.
- **Roads Shoulder:** Parts on the side of public roads.
- **VVIP Access And Airfield Service Roads:** These types of roads are use only for a VIP passenger and maintenance staff of airport.
- **Car parks:**Place where the passengers and staff parks their cars.

Developing the Final Map

Two final maps were developed, the first image as shown in figure (3)includes (BIAP Roads which represented in eleven layers, scale bar and compass direction), the second image as sown in figure(4) includes (BIAP pavement which represented in two layers, scale bar and compass direction).

Figure (3): BIAP Roads

Figure (4): BIAP Pavemen

These two maps were produced according to the rules of drawing and production of maps and utilized from the Engineering Unit in Baghdad International Airport

Second Step: Building The Database of Map

At the beginning we must have a personal geodatabases containing the work; figure (5) shows the buildings of that.

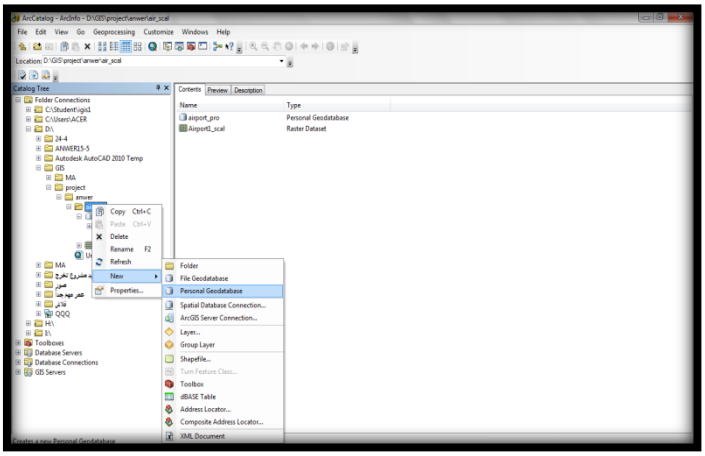


Figure (5): Personal Geodatabase

Then inside the geodatabase must create a new feature dataset as shown in figure (6), in order to collect the data of feature classes.

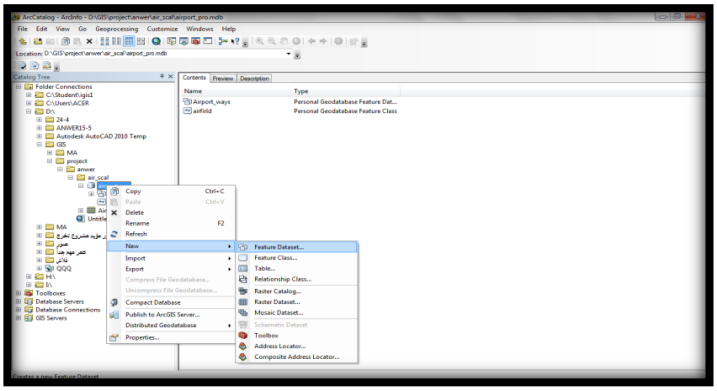


Figure (6): New Feature Dataset

Feature dataset must have a spatial reference as shown in figure (7), this spatial reference is obtained from the satellite photo (import the reference) to insure that layers of feature dataset (feature classes) are matched with the satellite photo.

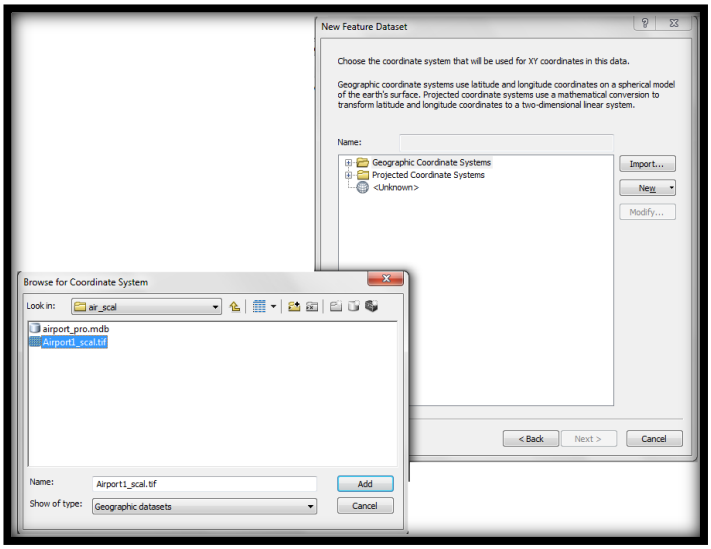


Figure (7):Import Spatial Reference

Another feature class inside feature dataset are developed as illustrate in figure (18) (it takes the same reference of feature dataset, which will help us in defining the spatial reference only once in the feature dataset).

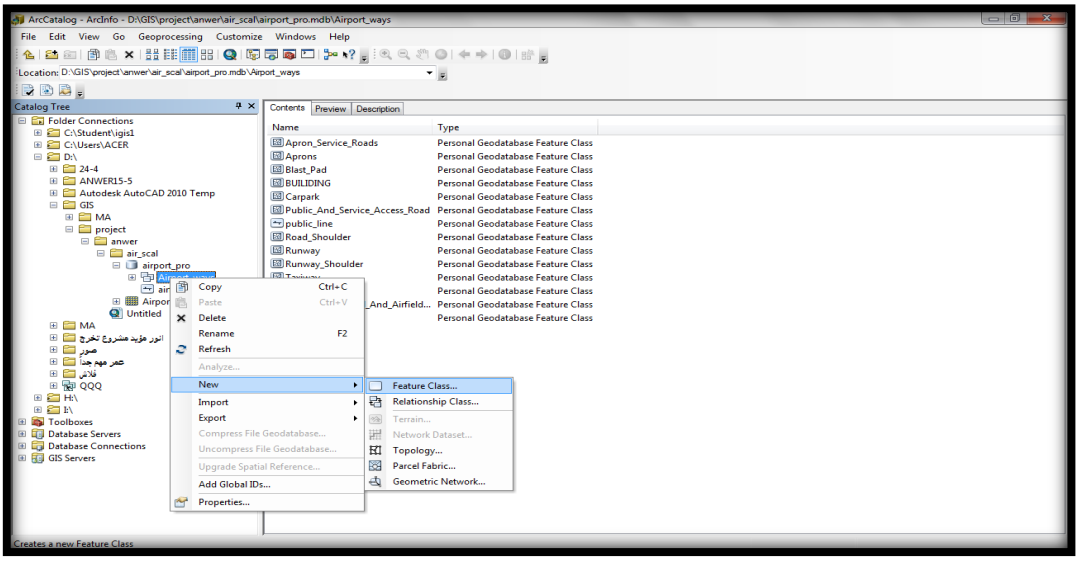
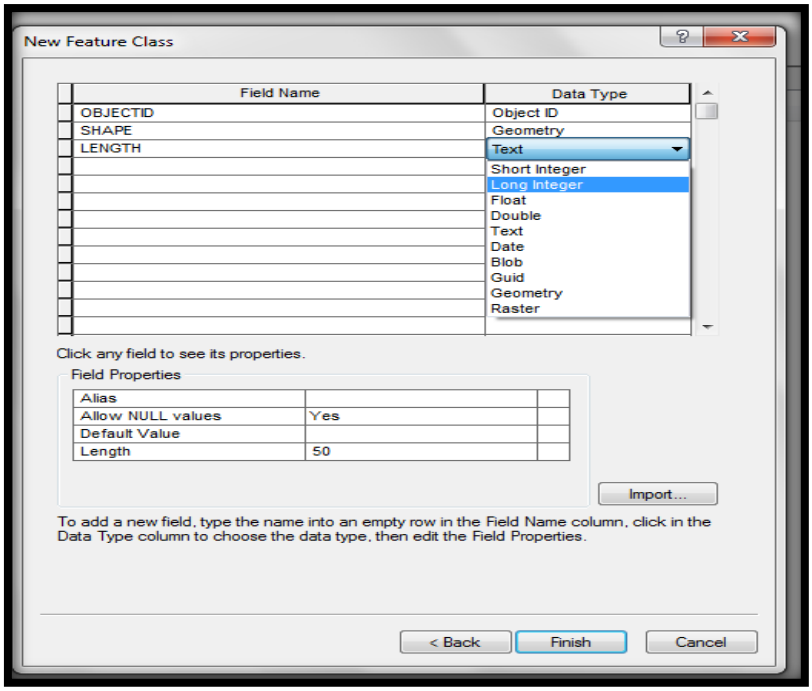


Figure (8): Create a New Feature Class.

Each feature class represent a layer and must be defined their shape as a polygon, line, point ……..etc. In these layers more fields can be added for each data type of that field as shown in figure (9).



Figure(9):DefiningField Data.

Conclusion

The conclusions drawn from this work can be summarized as follows:

1. Airports represent some of the most highly used facilities on our planet. Given the sensitive nature of flights, especially takeoffs and landings, these facilities must remain at a high level of performance at all times of the year, sometimes under trying circumstances.

2. Airport managers must turned to geographic information system (GIS) technology to support their efforts in planning, operations, maintenance, and security by adding spatial information and modeling. GIS provides unique information and analytical capabilities not available in other information systems.

3. Geographic Information System (GIS) surveys are being conducted to provide detailed geospatial data about airports. The data will be used for new Localizer Performance with Vertical Guidance approaches, including obstruction analyses, as well as electronic Notices to Airmen and flight deck airport moving maps.

4. The central database for airport GIS data enhances sharing of both safety-critical data (such as runway end points or the location of navigational aids) and non-safety-critical data (such as the location of a building on the airfield). In addition to providing users with current airport data, it will improve airport planning efforts with more efficient reviews of airport layout updates.

5. The result of this study is a high quality representation of the subsurface utility infrastructure (Roads). This allows integrating the data of Autodesk Map with Spatial GIS environment, and providing data to the project planning team to make solid planning judgments as they established the requirements and parameters for the new terminals, facilities, and transportation infrastructure.

6. To organize the spatial entities effectively, some layers are set according to the characteristics of spatial entities. Based on the above, the spatial database is established. Then, the function design of the GIS software is presented including map exploring, map locating, spatial query, rendering style of map and output of map.

7. Representative the AGIS in building infrastructure layers of Baghdad International Airport Buildings and pavements.The results were two maps, the first include eleven layers

and the other includes two layers, each layer has information that describes the thickness of subsurface

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List of Abbreviations

BIAP	Baghdad International Airport
GIS	Geographic information system
AGIS	Airport Geographic Information System
CBR	California Bering Ratio
K	Modulus of Subgrade Reaction
NC	Ordinary Portland cement concrete
CRC	Continuously reinforced concrete
PC	Pre-stressed concrete
AC	Asphalt concrete