# A Multi-Campus Critical Facilities Geodatabase

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## Abstract

Indian River Community College (IRCC) welcomes the use of new tools to analyze its campuses and help plan for the future. Engineering consultants suggested such a tool, a geographic information system (GIS) representing IRCC infrastructure in ESRI Geodatabase format. Items such as historical engineering and architectural drawings and underground utilities could be viewable from the system.

GPS data was collected for many visible assets, the data was imported to the geodatabase, and existing record information was added. IRCC has begun the GIS at its campuses and is planning for the incorporation of more assets. A multitude of potential uses of the GIS were conceived for before, during, and for the future of this project. This includes a building/room database and inventory of certain items in the rooms to be viewable in the GIS system, of which a sample has been completed.

## Introduction

Geographic information systems are being used by many organizations to house information in a geographic framework which can be linked to external database information. Organizations can realize advantages of GIS in areas such as planning, maintenance, asset inventory, analysis, daily operations, and emergency/disaster response.

IRCC and engineering consultants are developing the Multi-Campus Critical Facilities GIS representing IRCC infrastructure, valuable assets, and other data layers of interest in a geodatabase format. Items such as historical engineering documents, architectural drawings and above/underground utilities can be viewed using the database. Using Global Positioning Systems (GPS), visible asset data was collected and imported to a geodatabase along with existing record information.

IRCC is located in southeast Florida, covering an area known as the Treasure Coast, named for all the ships carrying treasure that sunk off the coast on shallow reefs. IRCC is headquartered in Fort, Pierce, Florida, and its campuses are located in four counties: St. Lucie, Martin, Indian River, and Okeechobee. The project consists of nine campuses as follows: Main Campus, Ft. Pierce; Chastain Campus, Stuart; Dixon Hendry Campus, Okeechobee; Mueller Campus, Vero Beach; St. Lucie West Campus, Port St. Lucie; Prima Vista Adult Education Center, Port. St. Lucie; Indian River Academy, Ft. Pierce; Indiantown Education Center; IRCC Northwest Center, Ft. Pierce.

IRCC has begun implementing the geodatabase of its nine campuses. There are many potential uses of GIS already conceived for the College. A building/room database was developed that includes an inventory of specific resources (computers, fire safety

equipment, etc…) within classrooms and offices. Course schedules and room usage are planned for the system. When finalized, the entire system will enable a user to view the campus in ways previously difficult or unattainable - from a regional scale multi-campus level, down to individual classrooms.

The GIS will be used to house information in a geographic coordinate system and will allow a link to external database information, such as course schedule, room database and asset databases. The team will populate finer detailed information in this framework, such as GIS data being collected for new projects, or going back to enter information for existing facilities.

**The Data Model**

The data model and geodatabase structures for the external and internal components of the campus buildings were designed by the project team. This was important for considering all components of the project and the relationships they have with each other at the outset of the project. As the team proceeds in this project, there is some flexibility to adjust the data model if needed.

Each geodatabase houses one of the nine IRCC campuses. Within each geodatabase the feature datasets represent each campus building. Within each feature dataset, the feature classes will represent the unique and exclusive groups of rooms. Attributes will be created to relate each feature to a campus. The data model also contains the framework for the many asset layers being collected, such as utilities and drainage.

| | **Various Polygon Features Classes** | **Room Use Codes** |
|---|---|---|
| 1 | Administration/Faculty | 310, 315 |
| 2 | Auditoriums/Lecture Halls | 610 |
| 3 | Classrooms | 640, 110 |
| 4 | Corridors (i.e.; Hallways, Elevators) | 020 |
| 5 | Laboratories | 210 |
| 6 | Maintenance/Storage | 215, 010 |
| 7 | Miscellaneous (i.e.; Vending area) | 000 |
| 8 | Restrooms | 030 |
| 9 | Student Services (i.e.; Bookstore) | 400 |

**Figure 1**. This figure shows how the rooms are grouped by similar room use codes devised by IRCC. The floors are mapped in ArcGIS using these criteria.

**Building the Foundation**

Research was conducted to determine available base layers for the project. Data was gathered from multiple local governments and other agencies. The data included aerial photography, parcel ownership boundaries, and land use. These and many other layers of useful existing information (e.g., data from state and local governmental agencies and educational institutions) will be incorporated into a digital basemap, though some of this information is not available for all areas.

After the initial base layers are gathered, other GIS features can be added to enhance the base map. Features like soils, FEMA flood, nearby cities and schools were also added to the geodatabase to further develop and create a comprehensive database. Cumulatively, these base map layers are a massive amount of information and can answer many questions from the staff and students of the campus. Everything from recent aerial photography to roadways could be used to figure out directions and provide a good reference point to where somebody is or needs to go in and around campus.

Survey boundaries are being included where available as part of an accurate framework. Several campus survey boundaries exist and are being used in the GIS. These boundaries reside in a digital CAD format in State Plane Coordinate System, making incorporation in the GIS relatively simple. Where survey boundaries are not available, approximate boundaries are being created. In addition, the property appraiser parcel coverage in GIS format can be used for further information on property boundary location and ownership information of neighboring properties.

Another aspect of the framework is the building outlines. The team is creating building outlines from high resolution digital aerial photography. The goal is to maintain an accuracy level of several feet. Given the curvature of the Earth and the curvature of the digital camera lens, there is distortion. The distortion increases the farther one gets from the focal point of the image and the higher the building. In the case of IRCC, most buildings are 1-2 stories with several 3-4 story buildings, making the distortion from building height minimal. In one GPS phase of the project, building corners will be shot to tie the building footprints closer to sub-meter accuracy. To further enhance the accuracy and comprehensiveness, available floorplans from existing CAD files are being hyperlinked in the attribute table for the buildings.

Attribute data describing the buildings are being input based on available information. Building footprints become an essential feature and basis for the campus infrastructure. These footprints provide the user a general layout of the campus and how it is organized. They can be used to create campus maps, provide quick information regarding the building structure and use, and contain hyperlinks to important documentation concerning the building's emergency and safety features.

## Adding IRCC Assets

IRCC assets are added to the basemap including fire hydrants, sanitary sewer gravity mains, irrigation pumps, storm grates, security features, accessibility features, and many more. The team gathered various data layers on and around the IRCC campus to create a diversified and complete geographic database which can assist in solving many of the College's facility management challenges. These data layers came mainly from two sources. Some were developed internally from architectural drawings and heads up digitizing and some had to be collected in the field with GPS.

Initially, several meetings were conducted among the project team to learn various aspects of operations and see how a GIS could most benefit the staff and students. A comprehensive data model was developed to take into consideration all aspects of the College's current and possible future facility management needs. The database design had to incorporate not only geographic features, like fire hydrants and building footprints, but also tabular information such as room and course schedules. The decision was made to build a model centered on the ESRI Personal Geodatabase and to break up the data layers into external and internal categories.

The external components of the model centered around any features relating to or around the vicinity of the IRCC Mueller campus property. These layers include features such as parcels, roads, aerials, and utilities. The first step in the process of building a high quality foundation in a facility management database is to develop a good set of base layers. These base layers comprise the groundwork for the entire model and facility management system. Some of these layers were easily derived from local County FTP sites that made the GIS data readily available to the public, but some of the layers had to be created from scratch. Base map layers were necessary to develop a reference point for the entire project including the internal building GIS layers.

This is an overwhelming benefit of creating such a database, for it contains critical information at the user's fingertips. Previously, a facility manager might have to dig through piles of documents or search various buildings across campus for a specific document. The information, housed in a GIS format, is as the user's fingertips. As the base layers and footprints are completed, the next phase is to add the remaining infrastructure elements.

Utilities are an essential aspect of overall facility management. Utility information contained in record drawings is usually filed away and are seldom stored within easy access of campus personnel. Also, there is a good chance that over years of use, they could be damaged, misplaced or lost entirely. A facility GIS becomes a central depository for all these different types of data, and with its ability to store multiple formats and create relationships between them, it becomes an indispensable tool for any facility manager. For IRCC, utility information for water, waste water, gas, electric, and storm water was gathered and entered into the GIS.

**Figure 2.** Utility features captured for a facility GIS.

In addition to capturing the spatial location of these utility features, attribute information was also added to the database. Attributes like diameters, materials, invert elevations, types, etc. were added to enhance the system and make it a truly comprehensive database. Information regarding these features was captured from design drawings, surveys, record information, and by means of field GPS data collection.

When possible, the GPS data collection begins when construction of new buildings on the IRCC campus is under way. This allows the team to collect new utility features prior to them being buried. Utility piping, valves, electrical lines, and fiber optic lines are being located and GPS points collected along with attributes in some cases even before the final record information was provided to the GIS team by the surveyors. Also, existing above ground features were collected during this phase of the project. This served as quality assurance for the information which was put in using record drawings from various engineers and consultants. Additionally, GIS is being used to tighten up the accuracy of the heads-up digitizing done in the office prior to the GPS phase. In addition, attributes that might not have been available on the record or design drawings, such as, manufacturer, model numbers, material etc. are being picked up in the field and added to enhance the GIS. Of course, a majority of the assets will not be collected during

construction because they already exist. For these, the same data model and field methodology are used for above ground assets.

The Leica GS20 Professional Data Mapper used for the GPS data collection. This unit is wireless, easy to use, and collects with sub-meter accuracy consistently. In addition to the unit an external antenna was added to increase satellite signal strength, thus providing increased accuracy and minimizing lag time between shots.

To achieve sub-meter accuracy the unit must receive corrections by means of DGPS or WAAS (Wide Area Augmentation System). DGPS (differential GPS) receives its corrections from the Coast Guard towers located in several locations across Florida. This is a radio signal which strongly relies on proximity to the Coast Guard towers that relay the signals. As one goes farther from the towers the signal gets weaker and lag time between shots increases. Also an additional receiver must be taken in the field in order to receive this radio signal and transmit it to the hand held GPS unit. WAAS was developed by the FAA for air traffic, but is very convenient to GPS users alike. It is a system of satellites and ground stations that provide GPS signal corrections. The WAAS signal comes straight from the satellites themselves, thus minimizing lag time and equipment needed in the field. Recently, an additional WAAS satellite was launched to provide even better more accurate corrections.

**Mapping Inside**

The interior of the campus buildings were mapped based on the architectural floor plans. The architectural floor plans were scanned to create digital images and rectified. Currently, only one floor can be viewed at a time, as the campus floors were mapped in a 2-D, planar data view. The attribute table of each feature class, under the Building Floor Plan feature dataset contains a field for the floor number (i.e., 1, 2, 3 or 4). This is an important attribute because the end-user will need to incorporate the floor when building an SQL expression. In later phases of the project, multiple floors could be mapped and viewed simultaneously using the 3D Analyst Extension.

The team has determined there are several categories of buildings that should be considered, generally based on the age of the building and corresponding data available. There are varying levels of accuracy from IRCC architectural drawings and CAD drawings. The older drawings tend to be less accurate and have missing data. Older drawings tend to be less accurate and comprehensive. For example, the oldest architectural drawings may only have design layout with room numbers, excluding dimensions of rooms. The newest buildings would be designed in AutoCAD to overlay accurately on the aerials. Additionally, the newest drawings would specify dimensions of rooms, with supplementary furniture floor plans.

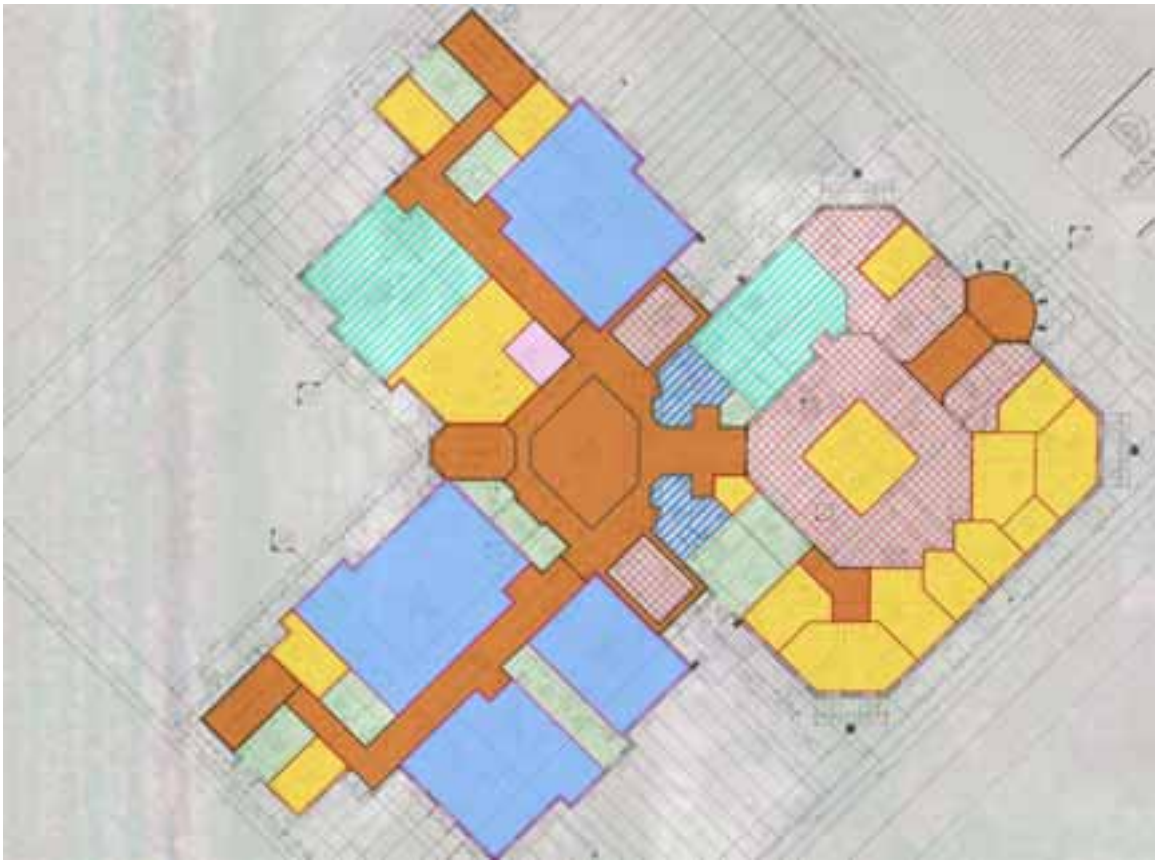

**Figure 3.** This example shows the 1rst floor of the Schumann Center (pre-construction phase) in ArcGIS 9.2 format. The rooms are grouped and mapped by room use code. The transparent layer is a georeferenced architectural floor plan drawing.

**A Multitude of Uses**

The Critical Facilities GIS can manage a large number of assets comprehensively. Information that previously took a great deal of time to research now can be easily accessible in the GIS. "Where are the assets", "what do they connect with", and "what is nearby" are just a few of the general questions that can be answered. For years, some of these questions have been asked by municipalities or utility departments who need to know the inventory and information about these assets. Now the College can do the same.

More unique to the College though, are what kinds of inventory and analysis can be conducted within the walls of the buildings. For instance, "what rooms have available audio/video equipment for the guest lecturer for the College of Science?" The purpose of building a Facilities GIS that drills down to the room inventory level is for quick answers to many questions. For instance, a user can identify which classrooms and laboratories contain projectors with recessed screens, televisions, smart boards, number of computer workstations per classroom, printers or plotters, and many more.

The Critical Facilities GIS can quickly answer questions by the university staff, such as, "Which classrooms are available between 1:00 p.m. - 4:00 p.m.? Of those available rooms, which have 40 or more seats, a projector with a recessed screen and smart board?" The selected records can be spatially mapped one floor at a time, campus-wide. Generally speaking, the system can help the College ensure it is using its space efficiently. For instance, in the summer when fewer classes are in session, the College can analyze fitting classes in underutilized buildings to more utilized buildings, reducing high energy costs. It can also help the College maximize its existing space so that it can make more informed decisions about constructing new buildings.

The GIS will link to an inventory that serves as a tracking system for many valuable assets that are considered semi-permanent or "built-in". Available detailed floor and furniture plans are hyperlinked in the GIS. The following assets are data fields in the feature classes: computers (with model # & type), TVs (with model # & type), projectors w/ recessed screens, smart boards, printers, plotters, copiers, fax machines, data jacks, and built-in furniture.

The "built-in" furniture hyperlink is helpful to show the IRCC faculty and staff the general layout of rooms that they may have never seen. For instance, many times college staff discusses a room at a remote site and cannot envision the room. The GIS will allow them to click on the room to see the floorplan, assets available, and picture of the room.

The GIS team reviewed two databases and determined the best method to link to the external databases. These databases are the room use database and the course schedule database. The team uses a unique identifier will link relate the databases while at the same time naturally grouping the feature classes and is tied into the current way IRCC operates. In this manner, the team avoids "reinventing the wheel" and there will be no duplication of efforts.

**Conclusion**

The team developing the Multi-Campus Critical Facilities GIS representing IRCC infrastructure, valuable assets, and other data layers of interest in a geodatabase format. Items such as historical engineering documents, architectural drawings and above/underground utilities can be viewed using the database. GPS was used to collect visible asset data on campus grounds and was then imported to a geodatabase. Existing record information was hyperlinked to features. This added to the comprehensiveness of the database. Facility managers can use the GIS to access information more efficiently and college planners and decision makers can make better decisions about growth and space utilization. The information is being provided in a user-friendly interface for current and future generations of staff to know the location of assets and conduct geographic analysis previously not possible.