Using ArcGIS for Fire Pre-Incident Planning

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Abstract:
Until recently, the Kirkland Fire Department has been pre-planning responses to fires and other emergency incidents for years drawing buildings using relatively primitive techniques. Digital mapping, begun several years ago for the city's 20 square-mile service area, was an improvement over earlier approaches, but even these efficiencies were surpassed with the citywide implementation of ArcGIS. This platform provides vastly improved cartographic display options, such as standard National Fire Protection Association (NFPA) symbols, as well as robust spatial analysis and editing tools. A wide variety of data sets including enterprise GIS vector data, high-resolution raster products such as color ortho-photography, CAD drawings, pictures, and documents are all easily integrated into a single pre-incident plan for easy access by all. Additional functionality is provided by links between these plans and other applications.

The KFD uses ArcGIS 8.3 to create their pre-incident plans. Pre-incident plans are documents that contain diagrams of buildings and features that could be hazardous to fire fighters and civilians. Most fire departments create there pre-incident plans using a CAD package like AutoCAD or some of the industry specific packages like Fire Zone or FireCAD.

Background: Kirkland Washington is located on the east side of Lake Washington across from the City of Seattle. Kirkland is mixed urban suburban community with approximately 80,000 people living within a 20 square mile service area. The Kirkland Fire Department (KFD) is a multi service fire department providing EMS, Fire Suppression and Prevention, Hazardous Material, and Specialized Rescue Response for the City of Kirkland, King County Fire District #41 and automatic aid agreements with surrounding departments. We have 6 fire stations and talks continue about consolidation of several fire departments to form a regional fire service.

History: The use of GIS in creating pre-incident plans was born out of necessity to reduce duplicate work. KFD was already using ArcView 3.2 and eventually ArcGIS 8.3 to create the map books and wall maps for the fire stations. The pre-incident planning program languished for years with out any real progress from hand drawn site plan diagrams. Many attempts were made to use software like Visio and AutoCAD but the learning curve for on duty firefighters was steep and the production time consuming.

For all intents and purpose a pre-fire or pre-incident diagram is a map. Much of the required data that is required for a pre-incident diagram include

- Building shape
- Hydrant
- Streets
- Edge of Pavement
- Aerial Photos
- Utilities

Kirkland and the surrounding area has excellent GIS data (street edge of pavement, centerline data, and building data) and the fire department maintains accurate hydrant, and address information. This caused us to explore using GIS for most of our source data for the diagrams.

First attempts involved using these layers in conjunction with AutoCAD where we had most of the building symbols. This was convenient considering that if anything like hydrant location changed is would be reflected on the pre-fire. It was still time consuming considering that you had to maintain the drawing in AutoCAD and then add the data as a theme in ArcView. Plus it was a challenge to format the wording and turn of the "Live Link" on each individual pre-fire page layout.

After converting over to ArcGIS 8.3 there was still the desire for the multiple layout features in ArcView 3.2. Then we started using the DS map page extension from the ESRI website.

How it usually is done

Most fire departments use a graphics program like Visio, AutoCAD, or specialty programs like Fire Zone. They also usually maintain data in a database like Access, dBase, or a SQL Server type database. A graphic and database, sounds like GIS!

Procedure:

1. Base data has to be established. A polygon index layer is created similar to a map page grid with the exception that the grid needs to encompass any features that responders would find pertinent to that occupancy. This may include grids overlapping when pre-incident plans are close together. It may even include other buildings or features from other buildings

2. The Map Book samples allows for field values to be included on the layout. So in the index layer we've included several fields that relate to pre-incident planning. See Appendix A for database schema. This is basically our pre-fire database we use to maintain building information.

Currently we've been experimenting with using Access to edit the table value in a form for consistent data entry.

3. To put together the base data for the document you need to add the following layers
    a. Buildings
    b. Edge of pavement
    c. Street centerline network
    d. Hydrant
    e. Utility data
    f. Aerial photo if available
4. The building, fire protection, and hazardous features need to be represented. In most pre-fire plans a rough representation of what the building looks like is drawn and then drawing symbols showing things like sprinkler connections, standpipe discharges, Knox box locations, and fire alarm panel location are put on the data frame. We've decided to outline what symbols we would like to show and then create a separate shapefile for each feature. Most things are represented by a point file but things like fences and fire wall are represented by lines and hazardous areas are a polygon. See appendix B for a detailed list. KFD decided to use the pre-fire symbols outlined in NFPA 170.

5. *Labeling* is the biggest challenge. Many of the shapefiles have label attribute data and invariably you want to include information on the drawing that can be only represented by text. We approached this with creating separate point shape files for certain categories of labels. Our categories included
    a. Building labels
    b. Address labels
    c. Hazardous information
    d. Other
6. We would label according to the point type

Layout Setup

This is perhaps the most enjoyable part of the project. Before with static templates in Microsoft Visio you were stuck with one template and if you wanted

to change that template you would have to go to each individual file. With ArcGIS and the Map Book extension you can create a book based on any layout design you desire. For instruction purpose we'll go through some key steps to make this as easy as possible.

1. Add the following layers to your document
    a. Edge of Pavement
    b. Buildings
    c. Street centerline network. Make the layer invisible and auto label the street names
    d. Hydrants, use any desire symbol
    e. Water features
2. Next add the layers that have been developed
    a. Index Grid, set the display so that the outline and fill have no color
    b. Pre-fire symbol layers, you can use either your own symbols or the NFPA symbols that are included in the symbols palette.

3. Go to your layout view and position the data frame in the position you want. In this example we'll place it top and centered
4. At the bottom we'll include the page number we want to use. REMEMBER, YOU MUST HAVE AN UNIQUE ID FIELDS IN YOUR INDEX TABLE.
5. Usually pre-fire diagrams include a name, address and specific building information like occupancy type. Add some text at the bottom of the layout
6. Create the map series using the index grid to create your "pre-fire book".
7. Right click on the map series tree in the map book tab and you'll come up with this menu on the right. Highlight the text label you identified with the page number and highlight Tag as Page Number. Use Tag with Index Layer Field for adding the other field values
8. Next you can add a local grid indicator to your layout to show surrounding information like closest hydrants. Add the layers that you feel may be appropriate for this

Other tips

- Add geo-referenced raster images to map document. For example some buildings have floor plans drawn for evacuation. Just take a copy of these, scan them in and then geo-reference them onto your document.
- Add the aerial photo underneath all of the other layers. Law enforcement really finds this useful in school incidents.
- Export the "pre-fire book" and use Crystal reports to create an html index that can be used to access the pre-fires on a web browser.

The Pros and Cons

Pros	Cons
• Can be used in conjunction with departments mapping program • Allows a lot of flexibility in creating layouts • Symbols can be changed globally • Combines the functionality of a graphics program and database • Helps to conform to global standards like symbols and layout design • Can be used for limited text reporting • Increases interoperability between departments • Dynamic labeling with GIS layers • Reduced time in creating layouts • Increased speed in creating diagrams (most of the work is already complete with the GIS layers!)	• Steep learning curve • Not out of the box • Expense of ArcGIS • Must have at least a minimum of GIS data (Ortho Photos) • Point data needs to be managed at a unit or battalion level

Future Improvements

This program is definitely in the toddler's stages. Some benefits of using a graphics program like Visio is that you can drag and drop a symbol onto a location. I've explored creating and ArcObjects program that would combines some of this functionality. I'm not there yet.

Conclusions

Using ArcGIS for pre-incident planning is new and interesting way to create pre-incident plan diagrams. By creating a strong set of base information, a fire department can manage their pre-incident information on the fly and with room to grow.

Appendix A: Sample database schema

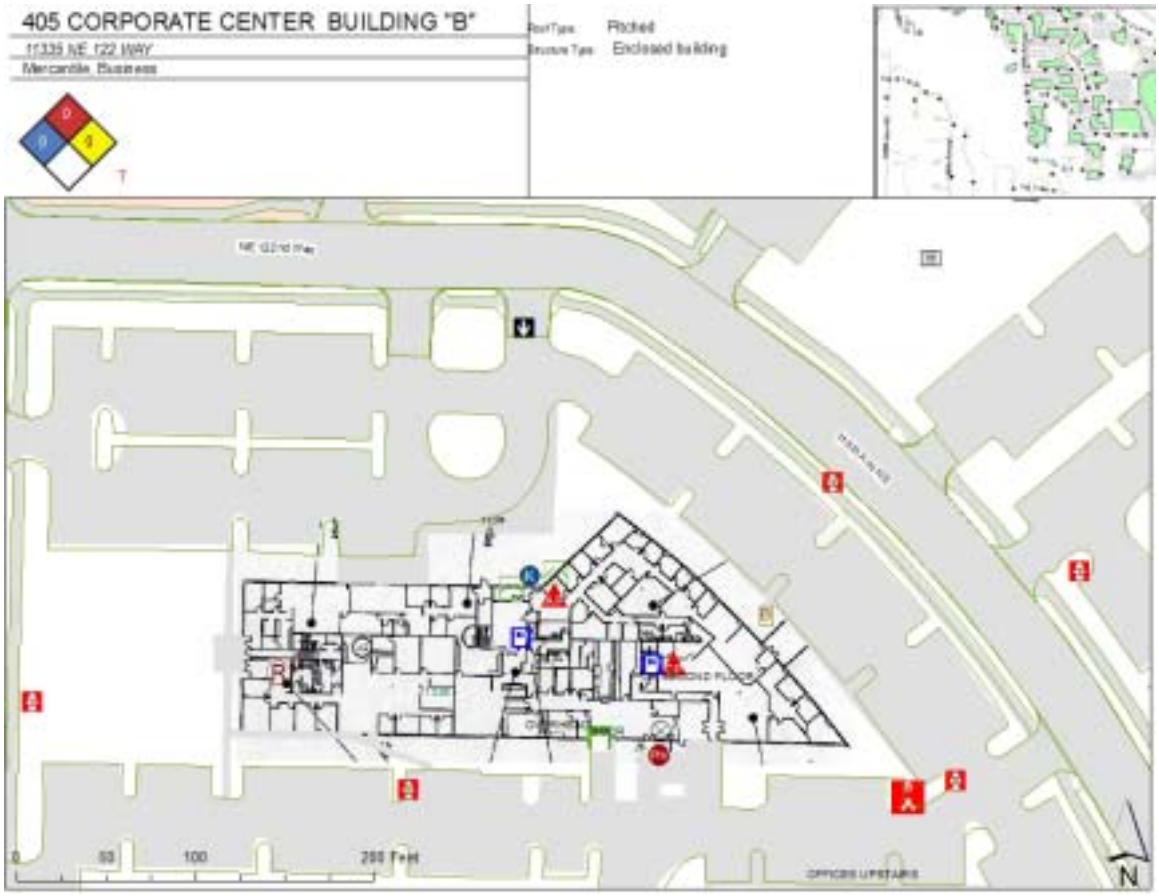
Field Name	Type	Description
NAME1	Text	Name
ADDRESS1	Text	Address
BOOK	Text	Which book the printed document belongs
COMIDNUM	Text	ID Number
STATIONARE	Text	Station Area
MAPPAGE	Text	Map Page
Knox_Box1	Text	Knox Box Location
Knox_Box2	Text	Knox Box Location
Sprinkler1	Text	sprinkler Connection
Sprinkler2	Text	Sprinkler Riser
Sprinkler3	Text	Sprinkler Riser
Sprinkler4	Text	Sprinkler Riser
Standpipe_	Text	Standpipe Connection
Standpip2	Text	Standpipe Connection 2
Stand_Dis	Text	Standpipe Discharge 1
Water_Shut	Text	Water Shutoff
Electrical	Text	Electrical Shutoff
FireAlarm	Text	Fire Alarm Panel Location
FireAnnun	Text	Fire Annunciator Panel Location
SAFETY1	Text	Safety Hazards
SAFETY2	Text	Safety Hazards
SAFETY3	Text	Safety Hazards
SAFETY4	Text	Safety Hazards
SAFETY5	Text	Safety Hazards
SAFETY6	Text	Safety Hazards
Flammabili	Text	NFPA 704 Symbol
HealthHaz	Text	NFPA 704 Symbol
Reactivity	Text	NFPA 704 Symbol
Special_Ha	Text	NFPA 704 Symbol
25percent	Text	Fire Flow
50percent	Text	Fire Flow
75percent	Text	Fire Flow
100percen	Text	Fire Flow
Picturepat	Text	File Path Information
tacticalpa	Text	File Path Information
Vent1	Text	Ventilation information
Vent2	Text	Ventilation information
Vent3	Text	Ventilation information
Vent4	Text	Ventilation information
ucPrimaryA	Text	Unified Command, Primary Access
ucOP1	Text	Unified Command, Observation Point #1
ucOP_2	Text	Unified Command, Observation Point #2
Vent5	Text	Ventilation information
UBCBldCode	Text	Building Code
Problems_A	Text	Problems Anticpated
Hazmat1	Text	Hazardous Material
Hazmat2	Text	Hazardous Material
Hazmat3	Text	Hazardous Material
TrussType	Text	Truss Type for roof
OccLoadDay	Text	Occupant Load for Day
occloadnig	Text	Occupant Load for Night
BusContact	Text	Business Contact Name
busContPho	Text	Business Contact Phone Number
MonitorAge	Text	Fire Alarm Monitor Agency
MonitorAPh	Text	Fire Alarm Monitor Agency Phone Number
PreparedBy	Text	Who Prepared Information
Shift	Text	Work Shift
Jurisdicti	Text	Jurisdiction
FirePump	Text	Fire Pump Location
SpcSuppTyp	Text	Special Suppression System Type
Gas_Meter	Text	Gas Meter Location
EmerContac	Text	Emergency Contact Name
EmerContPh	Text	Emergency Contact Phone Number
resConSpc	Text	Confined Space Problems and Location
expNorth	Text	North Exposure to Building
expSouth	Text	South Exposure to Building
expEast	Text	East Exposure to Building
expWest	Text	West exposure to building
uxCPArea	Text	Unified Command, Command Post Area
ucPriLZ	Text	Unified Command, Primary Landing Zone
ucSecLZ	Text	Unified Command, Secondary Landing Zone
ucStdStafE	Text	Unified Command, Evacuation Area
ucParentRe	Text	Unified Command, Parent Staging Area
ucMediaSta	Text	Unified Command, Media Staging Area
intArrive1	Text	Arrival Instructions, First In
intArrive2	Text	Arrival Instructions, Second In
intArrive3	Text	Arrival Instructions, Third In
intArrive4	Text	Arrival Instructions, Fourth In
intArrive5	Text	Arrival Instructions, Fifth In
Elevator1	Text	Elevator
ucRoadB2	Text	Unified Command, Road Block #2
ucRoadB3	Text	Unified Command, Road Block #3
ucRoadB4	Text	Unified Command, Road Block #4
ucTriage1	Text	Unified Command, Triage#1
ucTriage2	Text	Unified Command, Triage#2

Appendix B: Shape Files for Pre-incident Planning

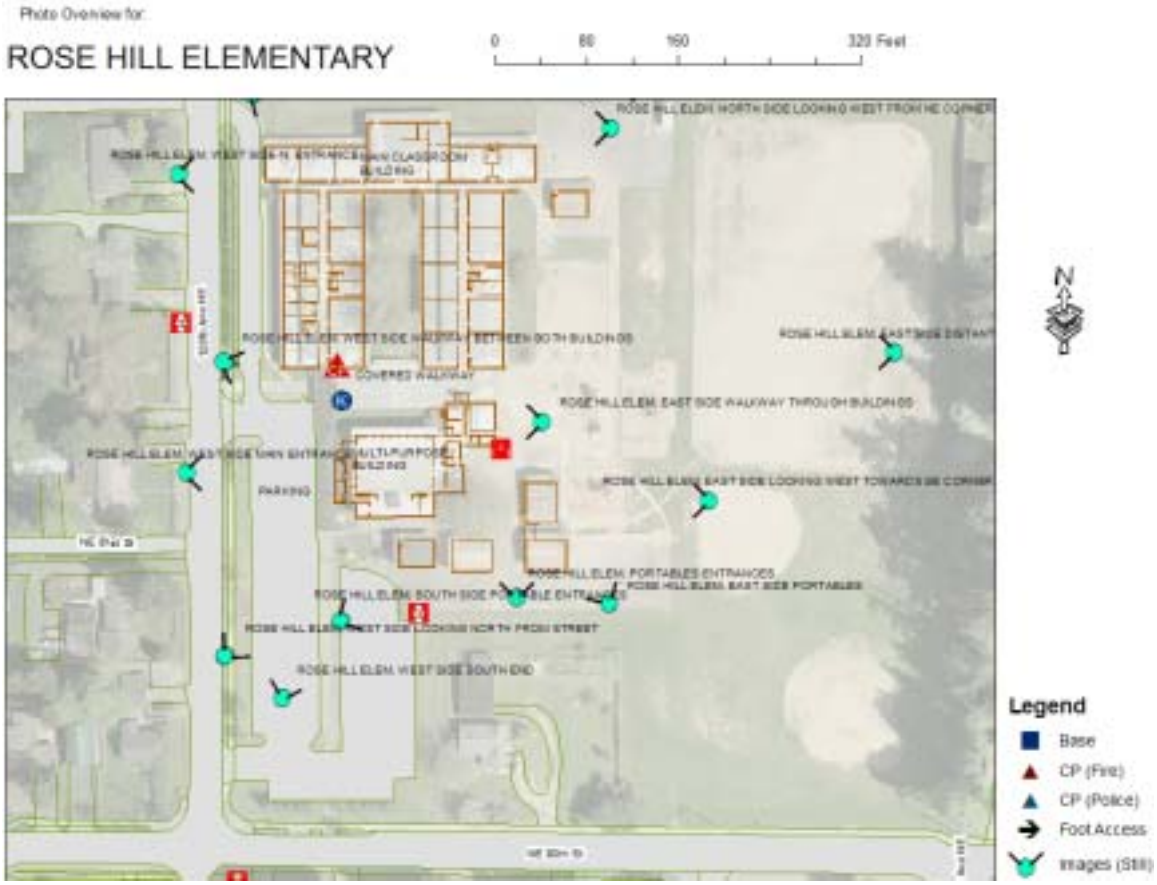
Type	Shape
Access Points	Point
Attic Access	Point
Boiler	Point
Bridges	Point
Buildings	Polygon
Child Care Center	Point
Chimney	Point
Corridors and Hallways	Polygon
Door (Double)	Point
Door (Fire Related)	Point
Doors (Garage)	Point
Doors (Roll Up)	Point
Doors (Single)	Point
Drafting Sites	Point
Electrical Shutoff	Point
Elevators	Point
Emergency Exits	Point
Emergency Generator	Point
Evacuation Areas	Point
Fences	Line
Fire Alarm Panel	Point
Fire Annunciator Panel	Point
Fire Escape	Point
Fire Pumps	Point
Guard Stations	Point
Halon Shutoff	Point
Hazardous Areas	Polygon
HVAC Systems	Point
Knox Box (Lock Boxes)	Point
Medical Offices	Point
Natural Gas Shutoff	Point
NFPA Symbols	Point
No Apparatus Access	Point
OS&Y Valaves	Point
Pressure Tanks	Point
Overhead wires	Line
Parapets	Point
PIV	Point
Hydrants	Point
Propane Tanks	Point
Roof Access	Point
Side A	Point
Skylights	Point
Smoke Vents	Point
Sprinkler Connections	Point
Sprinkler Risers	Point
Sprinkler Standpipe Connections	Point
Levels of Sprinkler Systems (Full, Partial, Not)	Point
Stairs	Point
Standpipe Connections	Point
Standpipe Discharges	Point
Walls (Fire Related)	Line
Water Shutoff	Point

Appendix C Sample 1

Appendix D Sample 2, With Geo-referenced raster image



Appendix E Sample
Tactical Overview



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Biography: Chris Rogers is a firefighter with the Kirkland Fire Department for the past 7 years. Chris has a Bachelor of Science degree in Cartography with a minor in computer science.

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References

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