Applying GIS Data to Radar Video Maps Air Traffic Control Towers

National Aeronautical Charting Group (NACG)
Silver Spring, MD
Introduction

- **Background**
  - Functions, History, Facts/Stats

- **Mapping Environment**
  - Map Request, Standards, Data/Sources, Mapping Control Systems, Ranges, Coordinate Systems, Scale, Management Control System

- **Cartographic Tools**
  - MicroStation/MGE, other tools supporting DGN files, ESRI ArcMap 9.2

- **Application and Methodologies**
  - Applications: MVA maps, EOVM, Sectional submittal plots
  - Methodologies: SDAT, ArcMap 9.2, DADS/COMPSYS

- **Case Study: Updating the Potomac TRACON EOVM**
  - Apply all of the above in this case study

- **Possible Futures of RVM**: Remain in CAD, CAD to GIS

- **Conclusion**
Organizational Hierarchy

U.S. Department of Transportation

Federal Aviation Administration

Air Traffic Organization ATO

Technical Operations Services

Aviation System Standards Office

National Aeronautical Charting Group NACG

Aeronautical Charting Team

En Route Navigation Sub-Team

Special Compilation (RVM) Section
Radar Video Maps

As of October 23, 2006
Background: Functions

- Create and revise automated maps for Air Traffic Control Tower (ATCT) and Terminal Radar Approach Control (TRACON) facilities
Background: History, Facts/Stats

- RVM section born in 1967
- Standardization of map symbology and cartographic principles were instituted to improve map accuracy and usage
- Currently maintains about 9000 maps for more than 400 facilities, including 3000 per year
Mapping Environment: Map Requests

- Map Requests
  - Requests initiated from facilities
  - Once received, requests are analyzed to examine if problems affect any or all maps of that same site
Mapping Environment: Standardization/Symbology

- **Standardization/Symbology**
  - Mandatory cartographic standards set internally: map scale, symbols (obstacle data, navaids), final approach depiction
  - Map depiction of any features customized by facility

<table>
<thead>
<tr>
<th>AERONAUTICAL OR TOPOGRAPHICAL MAP INFORMATION</th>
<th>MILITARY AIRPORTS</th>
<th>HELIPORTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airports shown by runway (rwy) patterns</td>
<td>Military airports</td>
<td>Heliports</td>
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<tr>
<td>Airports with extended rwy centerlines</td>
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<tr>
<td>Minor airports</td>
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<td>Minor airports with rwy patterns</td>
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<td>Restricted airports</td>
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<tr>
<td>General Statements: Symbol sizes, line patterns, and line lengths per Facility requests.</td>
<td>Military airports</td>
<td>Heliports</td>
</tr>
<tr>
<td>Useable rwy(s) drawn to scale. Centerlines drawn using either .5 or 1 NM increments (mile space, mile line) starting from the end of rwy. Length of hatch marks .25 NM to 1 NM.</td>
<td>Military airports</td>
<td>Heliports</td>
</tr>
<tr>
<td>Facility may use the standard RVM symbol or the symbols as shown.</td>
<td>Military airports</td>
<td>Heliports</td>
</tr>
</tbody>
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Mapping Environment: Data and Sources

- **Data and Source Materials:** 50% of all map data from published databases. Other 50% provided by facilities, non-published
  - Aeronautical data: airports, runways, navaids, final approaches, waypoints, airspace, airways, obstacles, etc.
  - Topographic/Cultural Features: roads, cities, landmarks, etc.
  - Unpublished aeronautical data: sector boundaries, final approaches, etc.
  - Visual/Enroute Charts, Instrument Approach Procedures (IAP)
  - Digital Aeronautical Database System (DADS), ESRI DVD Datasets
Mapping Environment: Mapping Control Systems

- **DBRITE**: Digital Bright Radar Indicator Tower Equipment
- **FDAD**: Fully Digital Arts Display
- **DVM [GMC0PE]**: Digital Video Mapper
- **STARS**: Standard Terminal Automation Replacement System
- **ACD**: ARTS (Automated Radar Terminal System) Color Display
Mapping Environment: Map Types

- **MVA**: Minimum Vectoring Altitude (Map). Explained later
- **EOVM**: Emergency Obstruction Video Map. Explained later
- **VFR**: Visual Flight Rules (Map)
- **IFR**: Instrument Flight Rules (Map)
- **PDM**: Position Display Map
Mapping Environment: Basic Map Structure

- Magnetic Variation Lines
- True Lines
- Map Range Circle
- ASR Position: Center of Map
- ASR Coordinates
- Map Magnetic Variation
- Map Scale
- Map Data:
  - Airspace
  - Fixes
  - Intersection
  - Navaids
  - Airports
  - Approaches
- Map Range Value
- Facility Location
- Facility Name
- Map Title
- Map / ASR IDENT
- Map Date
- Credit Note
Cartographic Tools: MicroStation / MGE

- MicroStation / MGE
  - All compilation and quality control in CAD setting
  - All radar maps in design file format (DGN)
  - Map data with DGN comprise line strings and cells for data processing
  - MGE critical tool for the RVM cartographer
  - MGE provides map conversion and coordinate read-out capability
  - Map conversion moves map data from one map to another with different parameters while maintaining location accuracy
  - MGE is essential tool for updating RVM maps in two projections, and differing radar centers with the same map data. The two projections are:
    - Lambert Conic
    - Stereographic
**Cartographic Tools: Map Levels**

- **Map Levels:** All RVM map data is stored as line strings and cells in the DGN file.
  - Map data added, deleted, or manipulated individually and organized by levels
  - Map elements (neatlines, titles, etc.) and map data features assigned levels for compilation for data processing purposes.

**Radar Video Maps Design File Levels:**

- Level 1: ASR Dot, Mag/True Lines, Range Marks, CENRAP Marks
- Level 2: Text
- Level 3: Airspace Boundaries, Special Use Airspace, and Holding Patterns
- Level 4: Airports, Heliports
- Level 5: Obstructions, Spot Elevations, and Tick Marks
- Level 6: Navaids
- Level 7: Visual Check Points
- Level 8: Airways, Intersections
- Level 9: Medical Facilities, Waypoints, STARS Symbols And Non-Intersection Triangle Symbols
- Level 10: Special Non Standard Symbols
- Level 11: Runway Patterns, Centerlines, Cross Marks, Outer Markers, Non-Transgression Zones
- Level 12: Approaches And Cross-Marks
- Level 13: Topo And Man-Made Features
- Level 16: Range Circles, Mag/True Text, Neatline, and Information Box
Other Tools: Critical to RVM functions

- Digital Aeronautical Database System (DADS): a Visual Basic application written by FAA to aid in the automation of compiling aeronautical data and charts.
- Establishes a link between the aeronautical database on the Oracle server and MicroStation graphics on the user’s workstation.
- User has the ability to query and place information directly from the database and perform geodetic calculations.
- DADS can be classified as an in-house Geographic Information System (GIS) without the spatial analysis component.
- For the RVM user, DADS provides accurate placement of aeronautical feature data in the design file.
Other Tools: DADS

- For the RVM user, DADS provides accurate placement of aeronautical feature data in the design file.
Cartographic Tools: Other Tools - continued

- **COMPSYS**
  - Important component of DADS
  - Powerful mathematical tool used to calculate bearing and distances
  - Serves as a robust measurement tool
Other Tools: RVM Translator

- **RVM Translator**
  - RVM processing engine that takes design files and creates the final map deliverables and associated files
Cartographic Tools: ESRI ArcMap 9.2

- Other Tools: ArcMap 9.2
  - Serves as a portal for viewing and obtaining feature data to be exported into the DGN files
  - Also used to create MVA and EOVM paper plot submittals that are sent to facilities
Applications and Methodologies

Applications

Minimum Vectoring Altitude – MVA (Map)

- Serves as the primary tool to support obstruction clearance and radar vectoring by terminal facilities
- Each facility required to have at least one MVA map, which goes through an annual FAA review and approval process
- This process can initiate the revision of existing maps or the creation of new maps
- MVA specifies the lowest mean sea level (MSL) altitude at or above the floor of controlled airspace
Applications and Methodologies

Applications

Submittal Plot

- RVM assists in the annual review process by providing the maps plotted directly over the most recent 1:500,000 scale Visual Sectional chart(s).
- Revisions can be hand marked directly on the paper plots by the facilities for FAA submission approval or proposed changes can be sent to RVM and incorporated into submittal plots.
- Latest methodology adopted by RVM to accomplish this task is the SDAT (for MVA only).
Applications and Methodologies

Methodologies

Sector Design Analysis Tools (SDAT)

- SDAT is an application tool suite that supports post-operation analysis and engineering of airspace and traffic flows.
- It performs analysis of potential conflicts, traffic density and traffic loading in air traffic control sectors, military airspace and other airspace volumes.
- For RVM, SDAT serves as a new method for creating MVA FAA approval submission paper plots as well as the creation and revision of RVM MVA maps.
- SDAT shapefiles are sent to RVM and stored on servers for compilation and quality control work.
- SDAT directly loads in the facility’s RVM map in LINE GP format.
- MVA line work must be digitized accurately to ensure that it reflects the original line work submitted to RVM via the shapefile.
- The reason for digitizing from the shapefile instead of using the shapefile is due to RVM strict processing requirements in producing the final map deliverable used at facilities.
Applications and Methodologies

Methodologies

Addition of Topographic Features using ArcMap 9.2

- Any map feature can be applied to a video map
- Topographical (physical or cultural) features most commonly requested for depiction on RVM maps are road network, water bodies, shoreline, county and state boundaries, etc.
- RVM cartographers look to ESRI DVD datasets for the above features
- Since all RVM maps are stored in DGN format while the desired topographical data is stored in ESRI file format, internal procedures were developed to achieve the task of exporting data from the ESRI format into the DGN files
- The procedures involve creating ArcMap .mxd files to select the desired topographical data and exporting the selected data into a separate shapefile
- Using ArcCatalog, the newly created shapefile is converted to DXF format
- The converted DXF file is imported into a special DGN seed file set in geographic projection
- The newly imported data has to be simplified to line string for RVM processing before map conversion into the actual RVM map
Applications and Methodologies

Methodologies

Other Methodologies: DADS

- The Digital Aeronautical Database System (DADS) has a dual purpose:
  - It serves as a source of map data
  - It serves as a cartographic tool to assist the cartographer in the accurate placement of aeronautical feature map data with the help of COMPSYS

- DADS is used to place an aeronautical feature symbol at a location specified by coordinates, name or identifier

- Vital DADS command settings are:
  - Query Point: locates and gives relevant information
  - Query Lookup: used when users know the identifier of the map feature but not its location
  - Add Cell: add control points to place specific map symbols into DGN files
  - Place Line/Cell: directly places runways. This is used to verify previous placement of runways on existing DGN
Applications and Methodologies

Methodologies

Other Methodologies: COMPSYS

- Provides true north bearing and distance from the ASR for purposes of placing range circles, true and magnetic north, south, east, west quadrant tics, and range marks
- Places line work at designated bearings and distances such as building final approach courses and new MVA boundaries
- Here are important calculations:
  - Forward
  - Inverse
  - Segment Distance
  - Circle Bearing
  - Segment Bearing
Case Study: Updating the Potomac TRACON EOVM

Task: The Potomac TRACON has submitted a request to add major highways and spot elevations to its EOVM map

- Analyze the Request: Update major highways, spot elevations
- Mapping Control System: ACD
- ASR Position (center of map): DCA ASR-9
- Symbology: use line string for highways and a dot cell for spot elevations
- Map Type: Emergency Obstruction Video Map (EOVM)
- Data Sources: ESRI DVD datasets, DADS database
- Method of Data Application: ArcMap for highways, DADS for spot elevations
Case Study: Updating the Potomac TRACON EOVM

Method of Data Application

- The desired feature data files (shapefiles) are added to an ArcMap .mxd file
- Navigate to the geographic area indicated by the map request sent by the facility
- Select the required data using the Select features icon. For RVM, the best data selection method is the “interactive” mode
Case Study: Updating the Potomac TRACON EOVM

continued

Method of Data Application

- After feature selection, the selected data is exported to a shapefile
Case Study: Updating the Potomac TRACON EOVM

continued

- In ArcCatalog, the shapefile is exported to a .DXF file
Case Study: Updating the Potomac TRACON EOVM

Within MicroStation, the DXF file is imported into a special “seed” design file set in geographic projection.

The newly imported data has to be simplified or changed to line strings for RVM processing before map conversion into the actual radar video map.
Possible Futures of RVM

- Remain in the CAD mapping environment?
  - RVM faces expiring MicroStation software contract and support
  - All graphic data must continue in the DGN format
  - Adopt DGN Version 8 file format
  - Must adopt a software replacement that possesses identical functionality to MGE because current MGE does not support DGN V8
Possible Futures of RVM

- Complete migration to the ESRI Platform?
  - Need for both CAD and GIS systems to support RVM operations
  - Here are the unique challenges to fully migrating to a GIS:

**CAD to GIS Conversion: Challenges**

- **Map Updates are by request only. No routine map maintenance**
- **High level of customization**
- **Unpublished and not yet published aeronautical data frequently requested on maps**
- **The practice of manual application or building of map data (building final approach courses, keying in coordinate data)**
- **Data within design file consist of individual line strings and cells for manipulation, deletion, and addition to the map composition for data processing**
- **Data organization by levels for compilation and data processing**
- **The necessity of map convert to transfer data to maps of differing projections and scales**
- **DADS and Compsys serve as critical tools for RVM compilation and quality control**
- **RVMTrans is the processing engine to convert a design file into the final map deliverable or another file for further processing**
- **There are thousands of individual radar video maps.**
- **The final map deliverable cannot change. It has to adhere to the facility’s radar systems.**
Contact Information

- End of presentation

For more information, please contact

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