Integrating Orienteering Maps and Data into an Enterprise Geodatabase

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ABSTRACT

The sport of orienteering requires participants to navigate over the earth using a compass and large-scale map. To support this requirement, orienteering clubs create detailed large-scale maps with photogrammetry and time intensive field surveys. At the United States Military Academy, for example, a large set of orienteering maps have been produced over the last 30 years. Recently, the features of these maps have been digitized in a proprietary orienteering vector map format. However, orienteering maps differ from many other topographic products in that position coordinates are not included with the map. As a result, integrating this data set with Installation's enterprise geodatabase, or using GPS and mobile computing to assist in field checking and map updating is problematic. This paper described efforts at West Point to integrate their historic orienteering dataset into the installation's enterprise geodatabase and continue to build on previous work related to generating orienteering maps in ArcGIS.

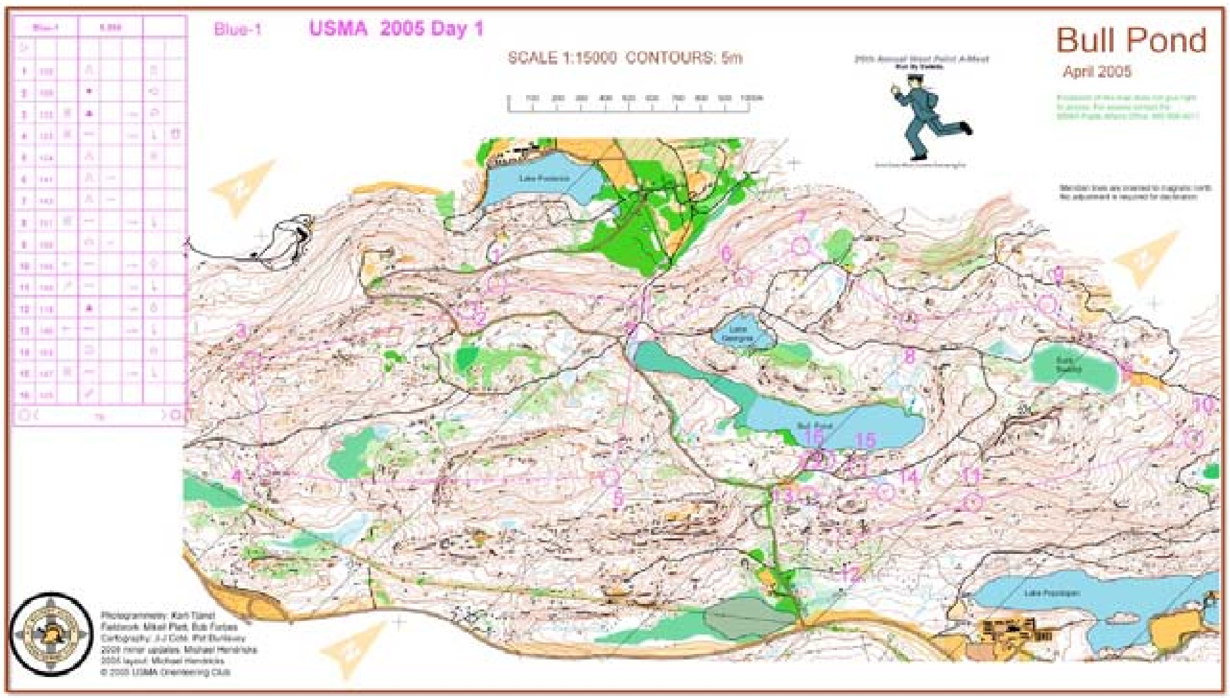
INTRODUCTION

Orienteering is a sport that demands extremely detailed topographic maps. Participants navigate with these maps to complete a pre-defined course as quickly as possible. To support this requirement, orienteering clubs place considerable effort and resources into creating and maintaining standard orienteering maps. At the United States Military Academy (USMA), for example, a set of orienteering maps have been produced over the last 30 years. Though these maps have recently been digitized in a proprietary orienteering vector map format, they are rapidly becoming outdated. This paper describes efforts at West Point to integrate historic orienteering maps and datasets into the installation's enterprise geodatabase and continue to build on previous work related to the generation of orienteering maps in ArcGIS.

ORIENTEERING

The sport of orienteering relies on detailed and accurate large scale maps. In a classic orienteering event competitors begin at a start point and receive a map annotated with locations they must visit in a specific order. The winner is the runner who navigates the course using only this map and a compass in the shortest period of time. The best orienteers blend both speed and effective route choice. Routes are chosen based on distance, runnablity, easy of navigation, and other factors. The best route, in most cases, is not the shortest route but the route that takes advantage of the terrain.

To effectively choose routes based on the terrain, a detailed, accurate, and legible map must be available. This map must contain features that can clearly be identified on the ground by competitors moving quickly across the terrain. Additionally, competitors should not perceive any inaccuracies in the map. Absolute positional accuracy is of little significance compared to relative accuracy and proper representation of terrain shape. Coordinates are not indicated on orienteering maps and GPS does not have a role in classic orienteering. Typically, orienteering maps are created at 1:15,000 and 1:10,000 scale.



The International Drawing Specifications for Orienteering Maps (ISOM2000) is the definitive guide for orienteering map production. The specification is a cartographic based symbol definition and drawing standard. Hundreds of symbols are specified and organized into seven categories; landforms, rock and boulders, water and marsh, vegetation, man-made features, technical symbols, and course symbols. Symbol 206, for example, is a boulder with the following definition: *A small distinct boulder (minimum height 1 m). Every boulder marked on the map should be immediately identifiable on the ground. To be able to show the distinction between boulders with significant difference in size it is permitted to enlarge this symbol by 20% (diameter 0.5mm). Color Black.*

ORIENTEERING MAPPING AT WEST POINT

The first set of six orienteering maps at the USMA were created between 1978 and 1982. To create these products, base maps were first generated photogrammetrically from stereo aerial photography. These base maps were validated and extensively densified through field surveys with features such as boulders, vegetation runnability, and many other types of information. Final map layouts were generated through a manual cartographic process involving the compilation of the base map and field survey notes. Color separates were sent to an offset printer for large production runs. For competitions, courses would be overprinted or drawn by hand in magenta on these standard maps.

Though field based revisions even to this day often remain a manual process using colored pencils and mylar, in the early 1990s computers begin to impact the cartographic work flow used for the USMA orienteering maps. Hardcopy field notes and base map drawings were sent to a cartographer (in most cases Pat Dunlavey Cartographics and later maps to J-J Cote). During this time frame, map features from base maps and field notes were digitized using a CAD program. Pat Dunlavey used MicroStation for his CAD work. The cartographic limitations of CAD at the time necessitated importing features into a vector based drawing package. Pat Dunlavey, for example, used Freehand for final cartographic editing and map layout. As in the past, color separates were produced and maps printed in large runs. The last of these updated maps were printed in 1996.

In the late 1990s Pat Dunlavey used MicroStation to stitch together the separate maps into one vector file. The required conflation and edge matching was accomplished visually without exhaustive accuracy checks. An additional accuracy concern results from the previous cartographic editing work flow between MicroStation and Freehand. Cartographic edits had been made in Freehand when producing final map layouts and these edits were not represented in the MicroStation files. A final issue that results from the production history of these maps is that the data is not georeferenced. Remember that orienteering navigation does not use coordinates and coordinates are not indicated on the map. Until the use of GIS and GPS for map updating and editing this had not been a major concern.

The full orienteering feature file of the USMA was eventually exported out of MicroStation and imported into an orienteering production software packaged named OCAD. OCAD was introduced in 1990 by Hans Stienegger and is currently the overwhelming favorite software package for orienteering map production throughout the world. OCAD has evolved over the years beyond just map production, and now offers a course setting capability that allows event organizers to plan and overprint courses. As a result many users of the software open maps in OCAD format, plan events and print maps with course overprints and never use the software for map production.

The Orienteering club at the USMA has been using OCAD for several years, primarily in the course setting mode, but also in the production of custom layouts and to a minimal extent data editing. However, as the USMA orienteering maps become older and out of date, additional emphasis has been placed on updating these maps. The Geospatial Information Science program at USMA offers the potential to leverage the advantages of geospatial technology to the next generation of map updates at the USMA. In addition, it is hoped that data can be shared between the rich set of orienteering maps and the installation's enterprise GIS.

GIS AT THE USMA

The Director of Housing and Public Works (DHPW) at the USMA has a contractor managing the installation's GIS database. The database is loaded in ArcSDE running on SQLServer and uses the Spatial Data Standard for Facilities, Infrastructure, and Environment (SDSFIE) schema developed by the military's CADD/GIS Technology Center in Vicksburg Mississippi. Initially populated from CAD drawing and other sources, the database is in a UTM projection using the NAD83 datum. Recently GPS based technologies have become an important component of the data acquisition and validation process. The USMA installation GIS contains data layers that can be used to update orienteering maps. At the same time the orienteering maps include data that can be integrated into the installation GIS.

It is possible to produce orienteering maps directly in ArcGIS, see *Hendricks, M. Rapid Orienteering Map Creation with ArcPad and ArcGIS*, ESRI International User Conference, San Diego, CA, July 2003. To ensure the ISOM2000 standards are maintained, a style sheet must be employed using the ISOM2000 specifications. Creating this style in ArcGIS is challenging because of the standards focus on offset print technology. The disadvantages of creating orienteering maps in a GIS are the limited accessibility of the software to other orienteers and the lack of course setting tools.

SHARING BETWEEN ORIENTEERING MAP DATA AND THE INSTALLATION GIS

There is a tremendous opportunity to share data between the USMA orienteering maps and the installation's GIS data layers. For example, orienteering maps indicate boulders, boulder clusters, rocky ground, bare rock, cliffs, and other rock and boulder features. This data is not available in the installation database but could prove to be useful for the Natural Resource managers and others at USMA. Numerous man-made features, such as new buildings and roads are included in the installation GIS. Many of those features have changed since the orienteering maps were last printed and can be used to update these maps. The integration of orienteering maps and data into the USMA enterprise GIS is planned in three phases: (1) Georeference the OCAD data, (2) Initial data transfer between OCAD and the installation GIS, and (3) Data maintenance.

Before orienteering maps and data can be shared with the USMA installation GIS, the orienteering maps and data must be georeferenced. One task is to georeference the current and historic map images to be used as background visual reference. The maps will be scanned and georeferenced in ArcGIS based on imagery and GIS data layers. The second and more important task is to georeference the vector orienteering data in the OCAD format. Currently OCAD version 8 provides limited georeferencing capability. However, the next release of the software will provide a more robust georeferencing capability. If the OCAD Georeferencing capability proves to be incapable of producing adequate results, the data will be imported into ArcGIS for georeferencing and then transferred back to OCAD.

Once the orienteering data is georeferenced, an initial swap of data between the orienteering data and installation GIS will occur. Before the actual transfer, the two schemas will be compared to determine appropriate layer transfer possibilities. The two schemas serve different purposes and only limited sharing is expected. An example of the disparity between the two representations can be found when comparing how wetlands are characterized in the two schemas. In the ISOM2000 specifications, wetlands are symbolized as either a linear feature, Narrow Marsh (308), or one of three polygonal features; Uncrossable Marsh (309), Marsh (310), and Indistinct Marsh (311). In the SDSFIE schema, wetlands are grouped in a Wetlands_Area layer with an attribute indicating either: Palustrine Emergent, Palustrine Forested, or Palustrine Scrub/Shrub. Two methods are being considered for integrating the installation's orienteering and GIS data: (1) Simple file data transfer, and (2) Intermediate orienteering geodatabase.

The simple file data transfer method takes advantage of the file import/export capability of OCAD. OCAD can import/export .dxf files and .shp shape files. This method can be effective for initial transfers of data, but managing edits over time can be cumbersome. In this method, orienteering updates are made in OCAD. A number of methods of data editing in OCAD are possible; (1) manual field checking with paper maps and possibly mylar overlays then using these field notes to make changes in OCAD back in the office, (2) supplement this process with a GPS receiver and import GPS tracks into OCAD, and (3) Use a laptop, tabletPC, or wearable computer with OCAD and GPS in the field, and use the GPS location as a reference while drawing map features directly in OCAD. Updates that should be included in the installation GIS are exported from OCAD into a shape file and then imported into the GIS. Specific features can be exported, however, exporting only changes and not every feature of the specified type is not a simple process and is a serious limitation of this method.

An improved process from simple file sharing is to employ a geodatabase designed to hold orienteering data. With this method all edits are made in ArcGIS using a Geodatabase with a schema based on ISOM2000 and designed to transfer data both to OCAD and the installation SDSFIE SDE database. In addition, data can be checked out and used in ArcPAD for field checking and editing. The complete dataset may then be exported to three shape files (point, line, and polygon) with appropriate attributes for inclusion into OCAD. Map layout and course design would still be accomplished within OCAD. However, orienteering styles can be employed and orienteering like maps produced in ArcGIS. In addition, orienteering Geodatabase to SDSFIE data transfer protocols or scripts can be developed. The advantage of this method is the ability to take advantage of the rich set of GIS editing tools, and more importantly, leveraging the data attribution and metadata generation capability inherent in GIS. Currently in OCAD attributing features and generating metadata is difficult.

CONCLUSION

An excellent opportunity presents itself to share data between the rich set of orienteering map data and USMA installation GIS. The historical processing legacy of the USMA orienteering maps presents challenges in integrating this cartographic data source into the GIS data schema. However, as the USMA orienteering maps become older the requirement only increases to leverage the installation GIS data to assist in updating these maps and then integrate this map data back into the installation GIS.