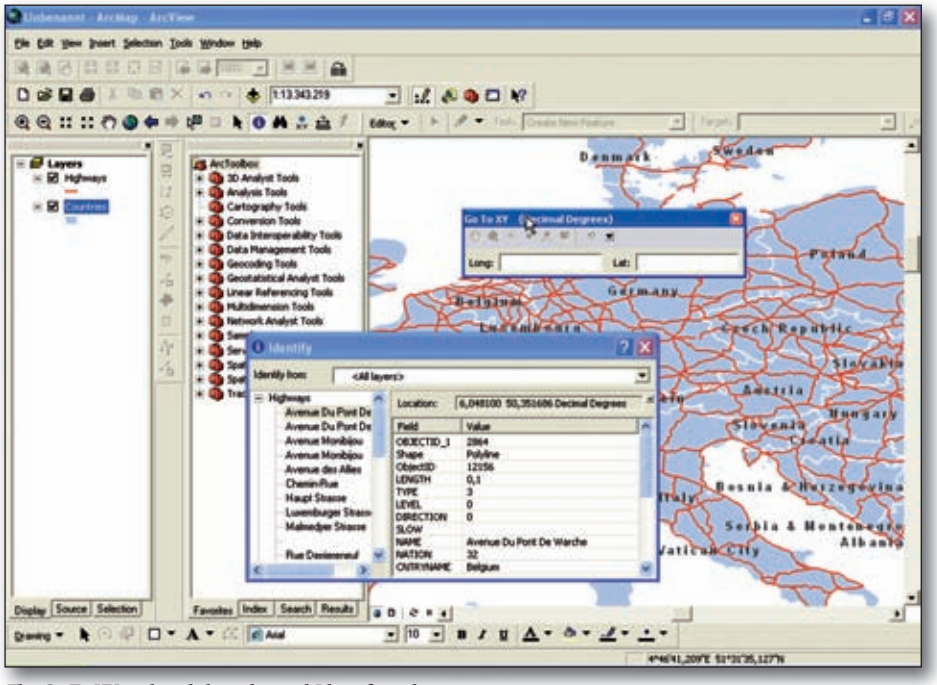
From ArcGIS 9.1 to Version 9.2 – A Small Step for ESRI but a

ESRI ArcGIS 9.2 Reviewed

I had that happy feeling of anticipating something big when I received the package from Redlands, California in the middle of January 2007. It contained the brand new ArcGIS 9.2 release which I was to review during the next few weeks. After installing it I took my first look at the desktop and, to my surprise, almost nothing seemed to have changed. But appearances were deceptive and in fact the jump from release 9.1 to 9.2 is significant. It is definitely worth looking at!

By Florian Fischer



The Go To XY tool and the enhanced Identify tool.

The new release offers extended geodatabase management, a new file geodatabase format, advanced archiving and replication options, the concept of cartographic representations, massive enhancements in the model builder concept, hundreds of detailed improvements for better usability and a new web-based processing environment from ArcServer.

Just a Small Step?

While not the first to ask this question, I still wonder why ESRI has announced just a small step in the version number while shipping a version of ArcGIS that contains not only hundreds of detailed improvements but also some major increments that fundamentally change the way ArcGIS is applied in spatial reasoning. I will briefly mention some ArcGIS 9.2 improvements and then proceed to a detailed discussion of the major innovations. Besides adding to the already extensive number (200) of shortcuts, ESRI has equipped ArcGIS 9.2 to print tables, import Microsoft Excel files and enable double marking within attribute tables to highlight lines after selecting them. An extended identify tool and measure tool, the new Go To XY command and a zoom function that uses the mouse wheel, simplify work and navigation within big geodatasets. The full extent can now be defined by the user which is a very interesting improvement for editing tasks. Coordinates are stored in a 64-bit double data type that actually leaves 53-bit for coordinates. Hence no restrictions now exist that require the definition of a spatial domain for coordinates. Nevertheless, spatial domains remain useful to avoid mistakes while entering coordinates.

ArcGIS 9.2 has a new chart engine and offers more types of charts and functions to export the charts to other software packages. Furthermore, a live connection between a chart and the map makes the work with charts more interactive than before. While bookmarks are bound to an mxd file, ArcGIS's project file, the MyPlaces function allows one to save bookmarks bound to a user account. MyPlaces can be exported to a file and it is even possible to share them via a personal ArcWebService as everyone can deploy their own ArcWebService.

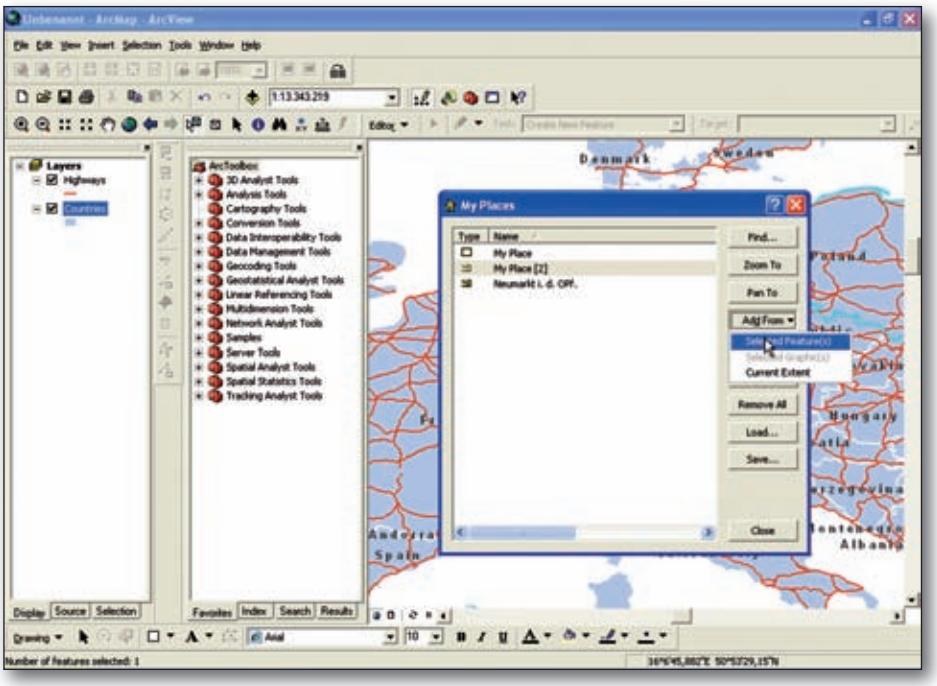
Terrain, Value Attribute Tables and netCDF

Along with better usability ArcGIS 9.2 introduces a terrain data format, a new way to store massive datasets containing elevation or other surface data in the geodatabase. Until now integrating these huge datasets into GIS and generating 3D surfaces from them has been difficult. Terrains let you store very large point-based datasets in the geodatabase and produce high quality, accurate surfaces. A terrain is a multi-resolution, TIN-based surface stored in the geodatabase and built from measurements stored as features. The 3D Analyst extension is required to create terrains. The terrain format is mainly focused on surface-based analysis as ArcGIS is not oriented towards the 3D visualization domain further on but on analysis. Raster data can hold an attribute table in ArcGIS 9.2 utilizing a Value Attribute Table that is supported by all geoprocessing tools. The toolbox itself holds eighty more tools with an ArcView license than ArcGIS 9.1 did. A very interesting new feature in ArcGIS 9.2 is the support of the network Common Data Form (netCDF) format that is widely used for multi-dimensional data in the natural science domain. ArcGIS is able to map three dimensions concurrently and offers fast changes within the visualized dimensions.

Tracking Analyst and Animations

The Tracking Analyst Extension offers more options for advanced spatio-temporal analysis, that is, the prognosis of a spatio-temporal pathway for collected data. Moreover, live input of tracking data can be done via a local port without the need of a tracking server. Unfortunately, interpolation between measured data is still not applicable. The creation of animations like virtual flights, well known from ESRI's 3D-Analyst Extension, is now possible in ArcGIS 9.2 for producing exportable movies. To conduct a movie

Big Step for the User Community



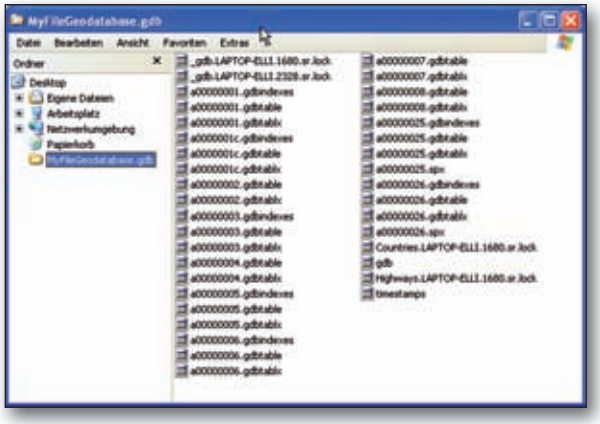
The new My Places function in ArcGIS 9.2.

one can either arrange the order of feature layers to be shown in each frame or use timestamps from the attribute table. After this partial overview of minor improvements, I will now go further and talk about the enhancements in geodata management, the concept of cartographic representation, the extended concept of the ArcGIS model builder and finally the ArcGIS Server and its web-based geoprocessing services. For deeper insight into the new release, I talked to Günter Doerffel from ESRI Germany who provided some background information.

ArcSDE Personal, Workgroup or Enterprise?

In ArcGIS 9.2 one is spoilt for choice among different types of multi-user geodatabase management environments, all based on the familiar ArcSDE technology. A customer can get the most appropriate geodatabase management for the process structures and number of users within his firm while still being in position to scale up the geodatabase requirements if necessary. ESRI thus fills the gap between having a full-blown ArcSDE and simply having none and relying on personal geodatabases.

Personal ArcSDE technology is included for free with ArcGIS Desktop at the ArcEditor and ArcInfo license levels. It uses the SQL Server 2005 Express Edition, a lightweight database management system designed specifically for simple setup and administration and provided for free by Microsoft. ArcView users can read the data in ArcSDE geodatabases but cannot create or edit this data. Personal ArcSDE supports all the advanced features found in ArcSDE. It handles up to four concurrent users, one of whom can edit the data at any time. All database administration is performed using a new set of dialogs in ArcCatalog. Consequently, in small firms anyone can set up a multi-user ArcSDE geodatabase and administer it using ArcCatalog;



File structure of ArcGIS's new file geodatabase.

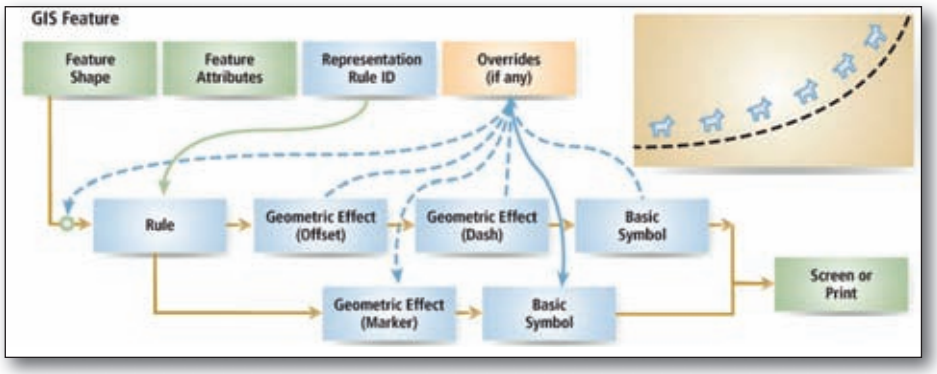
Database administration using ArcCatalog is easy to handle but also allows for sophisticated geodatabase administration by experienced users. The two sibling editions of Personal ArcSDE are called 'Workgroup' and 'Enterprise' and come with ArcGIS Server only. Workgroup ArcSDE database servers are licensed to support up to ten concurrent users, Enterprise ArcSDE technology is the traditional ArcSDE technology that can scale to databases of any size and any number of users, running on computers of any size and configuration. In most companies an IT environment already exists with a unique identifier for each user to log into the system. This can be used to authenticate an ArcSDE login, called operating system authentication (OS authentication). It is a new and comfortable way of connecting to an ArcSDE database that ESRI has finally integrated.

The New File Geodatabase Format

The most outstanding enhancement concerning geodata management in ArcGIS 9.2 is the file geodatabase format (fGDB). It is not only a new geodatabase file format, but an all-in-one device suitable for every purpose.

Up to now, apart from unwieldy shapefiles and full-blown geodatabases, geodata could be stored in personal geodatabases. ESRI relied on the Microsoft Database format which has a couple of restrictions. First of all, it is a Windows-only format and therefore cannot be used by application developers using ArcObjects on a Linux platform. Secondly, its maximum file size of two gigabytes is problematic for handling raster data. Technically, raster data is stored outside of the Microsoft Database using a reference in the database that points to the external data. Moreover, data compression and encryption, crucial requirements for users, cannot be fulfilled when using personal geodatabases. The SDC format (Smart Data Compression) from ESRI has in fact fully supported data compression since ArcGIS 9.0, but compression can be applied to vector data only and encryption is not available.

ESRI therefore developed the new file-based geodatabase to overcome all the obstacles mentioned above. Individual datasets can be as large as one terabyte and there is no overall database size limit. File geodatabases are also fully supported across platforms, and compression and encryption can be applied to any type of geodata ArcGIS is able to handle.



Cartographic representation pipeline.

Compression rates of 10:1 and more are possible, still with very short access times. Even extended database constructs like the ArcGIS network dataset can be handled with high performance using the file geodatabase. When you look at the file system you have a bit of a flashback to what you see when examining the more familiar shapefile structure. There are many files indicating spatial indexes, geometric data and tables, but for all that, the assignment to particular datasets is slightly blurry.

Nevertheless ESRI claims high performance of the file geodatabase in distributed file systems as well as multi-user access due to the numerous small-sized files. While this also means low performance in low-performing file systems, the aspect seems to be important for mapping applications (e.g. ArcGIS Server) not utilizing a standard database. ESRI will provide an API to the file geodatabase for developers to give them full advantage of the new format. A small downer is the read-only restriction for compressed geodata and the slight differences when executing SQL queries. In a nutshell, the new file geodatabase fulfills many of the numerous user requirements concerning geodata management using file structures. It will definitely replace the Microsoft Database format, and might supersede the shapefile format that has got a bit long-in-the-tooth, to become the new de facto standard of file-based geodata management.

Versioning, Archiving and Geodatabase Replication

In ArcGIS 9.2, multi-user editing is possible without versioning. Previously, a geodatabase could only be edited by multiple users if it had been versioned. While this presented few problems for GIS-only databases, it did create difficulties for organizations that used the same database for GIS and non-GIS applications. Nevertheless, non-versioned editing should be handled with care as one has to ensure that the latest database transaction is ultimately enforced.

Versioning allows historical records to be kept by preserving some earlier versions of the geodatabase. This causes a large amount of data to be stored. ArcGIS 9.2 offers another method of maintaining an historical record of ArcSDE geodatabase data called geodatabase archiving. Features for archiving can be selected individually. During archiving, all changes within the default version of a geodatabase are stored in an archiving class by a timestamp. The archiving class overlocks the feature class and its relations. It must be pointed out that archiving is only applicable on the default class and only creates a database history, while sometimes the real history of geometric objects is of importance.

".. ArcGIS can even have a look into the BLOB.."

ArcGIS 9.2 also provides a new utility called geodatabase replication. It extends the check-out/check-in model with various other scenarios for replication by supporting one-way and two-way replication. One-way replication means checking out one part of the database. This part can always be updated but only in one direction. Unlike check-in/check-out, both datasets have unlimited endurance and only altered features are updated. With regard to an update, in the worst case all altered features are lost in the part that has been checked out. Two-way replication enables an update in both directions. Updates can be done online, by email, by a data-storage medium or by a mobile device. All features have a global and unique ID to be identified by ArcGIS. The synchronization of features is regulated by different exchange-management schemata. The particular advantage of the geodatabase replication utility is the consideration of spatial aspects during an update. "An ordinary database uses updating mechanisms that compare for example BLOBs [binary large objects] against each other. But ArcGIS can even have a look into the BLOB and understand changes in its content. Geodatabase replication goes far beyond what normal database replication utilities do", says Günter Doerffel from ESRI Germany.

Cartographic Representations – Embracing the Entire Cartographic Workflow

Within the cartographic workflow, ArcGIS usually has to be left at a certain point due to a conflict of interests. For a GIS the geometry is considered sacred while for cartographic products the intelligible representation of a geometry is of significance. In certain cases, particular variations of the representation including geometric insensitivities are necessary to create an articulative cartographic product. Before, a user of ArcGIS had to choose between producing rather plain maps or switching to a cartographic software like Macromedia Freehand. The changeover had several disadvantages as it meant a break within the cartographic workflow, the termination of the geodatabase connection for one dataset and the maintenance of two lingering datasets. In ArcGIS 9.2 the concept of Cartographic Representation solves this conflict in compliance with geometric integrity and enables an unbroken workflow to build sophisticated cartographic products. ArcGIS 9.2 offers rules and overrides to define the cartographic representation of a geometry and its exceptions to certain features. For each representation, the feature classes are extended by two fields to store the rules and the overrides, the latter organized as a BLOB to hold all the different variances. Geometric effects enable the user to diverge from strict geometric illustration, e.g. by using smooth curves. All effects can be added on an additive basis either for a single layer or as a global effect for all layers. The effects from different geometry types can be combined, e.g. line effect on a polygon. Furthermore, the option of free representation enables the user to dissolve totally the relationship between geometry and representation. That is, all rules for the cartographic representation are dissolved and the representation exists as a graphical element only. Conversely, the geometry can be tied to the representations, i.e. the geometry changes by changing the cartographic representation. In addition to manually adjusting symbol properties like the width of a line, symbol properties can also be given as a value of a field in the attribute table of a feature collection. This alternative is a key function for automated cartographic representations and is utilized by the cartographic toolbox to dramatically extend the potentials of cartographic representations. These tools enable the user to manipulate symbol properties by calculating individual geometric properties, e.g. to align symbols by the orientation of polygon surfaces. Considering the potential of combining all rules, overrides, effects and calculating values for an appropriate cartographic representation of individual features, ArcGIS 9.2 seems to provide infinite possibilities of illustration. To

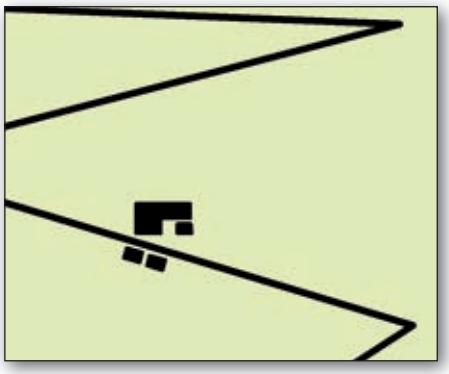
ensure effective workflow, a style manager is provided to organize the cartographic representations and make them available once again for reuse. Moreover, the toolbox enables cartographic generalization by simplifying and aggregating geometries. Generalization creates new feature classes with a relationship class to the original geometry.

All representations can be created and edited with an ArcEditor or ArcInfo license and displayed using any license level. Günter Doerffel from ESRI Germany remarks: 'The concept has much of the concept of annotations that is well known from former versions of ArcGIS as rule-based text symbol placement. But it is an enormous advance. The whole domain of cartographic representation in ArcGIS 9.2 is incredibly powerful!' Although it is a very powerful extension in ArcGIS 9.2 one can question how many users consider it important enough to integrate into their workflow. It will take a long time to become familiar with the technology and to take full advantage of it. It is attractive only for customers who produce cartographic products and use one set of geodata for several different map editions. But for once-only map productions, e.g. in the project-based branches of business, it will likely be of little interest. Swiss Topo is already adapting the methods of cartographic representation for their topographic maps. ESRI tries to intensively involve its customers while creating new effects and cartographic tools to improve performance in the cartographic domain for the future.

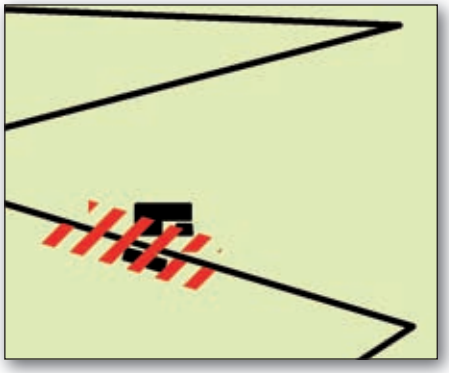
Dynamic Simulation Tool

'One of the key goals for geoprocessing at ArcGIS 9.2 was to extend the existing framework beyond the bounds of static, cartographic-style descriptive modelling into the world of dynamic, stochastic, process modelling,' notes David Maguire, director of products at ESRI, in his weblog. Along with the branching function that already exists in ArcGIS, the 9.2 release has several new capabilities to perform dynamic modelling. Iterations enable the model builder to loop models by an iteration counter, by conditional logic and by values from an input list. The creation of feedbacks is supported, which is essential for system dynamic simulations, in association with the ability to generate random functions and values. ArcGIS 9.1 only supports one data layer as input to a tool. ArcGIS 9.2 additionally supports both lists and series of data values as input. Lists force all downstream processes to execute once for each value in the list, whereas series force an entire model execution once for each input value.

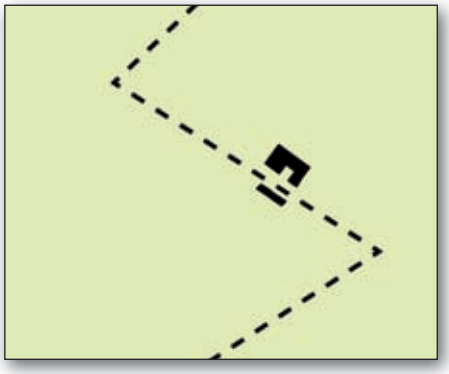
Feature classes and tables can be written to an in-memory workspace to improve the performance of models, especially when writing intermediate data. Günter Doerffel points out that "these structural extensions in particular address users who are either not able to code or simply don't want to code. The work of these users is considerably eased by the new potential of the model builder. Programmers already had the scripting option to build dynamic models." An advantage of the new concept is the ease of producing descriptive documentation of workflows to be directly incorporated into reports or illustrations.



In the original streets and buildings are accurately positioned



ArcGIS is able to detect a conflict in the cartographic representation



Generalization: The illustration shows how buildings are aggregated and aligned on the street course. Concurrently the street course has been simplified by ArcGIS 9.2

ArcGIS Server

Adding a few lines about ArcGIS Server is definitely a must in a review about the ArcGIS 9.2 release. Web-based GIS functionality is expanded greatly and allows users to run models and workflows on the server. Everything that can be done with ArcGIS Desktop can now be done server-based as well with ArcGIS Server. There are many reasons to work server-based. First of all, when using server-based processing, a desktop client is not occupied while processing. Therefore a shift in workload from ArcGIS clients to ArcGIS Server is possible. For enterprises with many clients, this means a high investment in clients can be replaced by a low investment in a server upgrade. Moreover, even an ArcView licensed desktop can use server-based functions delivered by ArcGIS Server. ArcGIS Server 9.2 introduces an out-of-the box web-based editing functionality to serve Map Services, OGC WMS, KML, Mobile ADF and many more. As well, web-service standards like SOAP and UDDI are supported to enable every developer to connect to ArcGIS Server. "Web services are the future, and this future already started with ArcGIS" says Günter Doerffel. He notes that the service infrastructure market will experience enormous development. Not only viewing will be significant, but server-based geoprocessing will also be in demand in the future. It will be important to provide appropriate services to serve this demand. And it does not matter whether it concerns a web-gis application or any web application calling a spatial query. ArcGIS Server covers different application scenarios through three different releases called Basic, Standard and Advanced. The Standard release is somewhat equivalent to the former ArcIMS release. Every release is available in two stages of extension, one for Workgroup SDE and one for Enterprise SDE.

Conclusion

In the ArcGIS 9.2 release, enhancements due to user-driven demand play an important role. ESRI offers many opportunities for users to give input and feedback on their software. To make a long story short, you do not have to go to Redlands personally and tell Jack Dangermond what you would like to have in a new release of ArcGIS. The present release offers many new features that will help a large number of users improve the management of their spatial data. All in all, ArcGIS 9.2 offers so many and such comprehensive improvements that this article could feature only some highlights. It will probably take quite a while to become ArcGIS 9.2 literate, but my recommendation is that meeting this challenge is worth the time.

Florian Fischer (ffischer@geoinformatics.com) is a contributing editor of GIS-Magazine. *For further information on this subject: ESRI – What's New in ArcGIS 9.2: www.esri.com/software/arcgis/about/whats-new.html; David Maguire's weblog 'GIS Matters': http://gismatters.blogspot.com/. Also look at the movie section of www.geoinformatics.com.*