Cartographic Production with GeoMedia®

Intergraph® Mapping and Cartographic Production Solutions Provide Expertise in Collecting, Managing and Producing Cartographic Products
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1. Introduction

Map producers around the world share a common mission – providing quality, accurate map products in a timely manner to support the requirements of the industries and customers they serve. This can include hardcopy and softcopy map products, the generation of cartographic databases, and may involve the exploitation and distribution of these products over the Internet, e.g. Web services. Providing this service is critical for military and national mapping agencies, regional transportation agencies, and commercial mapping companies. The scope and context of the maps produced may vary, which is easily illustrated in the variation between topographic maps, image maps, transportation maps, and geologic maps. However, the underlying foundation required to support high-end cartographic production is similar across each of these industries.

Cartographic production solutions from Intergraph® enable mapping agencies and companies to accomplish their mission and meet their production objectives by providing a robust, adaptable environment supporting all aspects of high-end cartographic production. This includes processes and workflows that support sophisticated data management, complex data modeling and data validation, efficient cartographic geo-processing, artistic graphic rendering, flexible map design, and lithographic output.

High-end cartographic production systems must be able to incorporate well-founded production techniques to facilitate the processes associated with the construction and maintenance of established map products. The system must also provide the flexibility to produce maps on demand to respond to unforeseen events involving public safety, emergency management, and national security. Supporting one scenario should not impose limitations on the other. Users can accomplish each by providing comprehensive, efficient workflows that simplify the overall map production task, while maintaining stringent cartographic standards and increasing productivity.
2. Key Applications

2.1. Cartographic Data Management

The tasks associated with map production span a wide array of activities, ranging from data collection to publication. One of the key challenges in producing maps is managing data in a manner that allows users to produce multiple cartographic products from a single data source. This is often complicated when the data used in map production is collected and stored in different map scales and geographic extents as the desired cartographic products. As cartographic symbology and neatlines are defined, additional manipulation of the data is often necessary for achieving the optimal cartographic presentation.

Traditionally, the need to perform these additional cartographic processes has led many map producers to either make multiple copies of their source data, or compromise the integrity of their source data to accommodate the needs of specific cartographic products. Both of these options have serious implications for data management and can impose severe restrictions on the utility of the source data and impact map revision workflows downstream.

The architecture for Intergraph’s GeoMedia® operates on the premise that the cartographic data is comprised of two distinct database schemas: a cartographic source schema often referred to as a Digital Landscape Model (DLM) and a cartographic edits schema or Digital Cartographic Model (DCM). These schemas can be defined as separate databases, or combined into a single database. This enhanced data management capability is highly configurable; providing users with the unique ability to build and maintain cartographic databases separately from the originating source data. This capability has the added benefit of maintaining the integrity of the source data as cartographic edits occur, and eliminates the need to make copies of the source data for cartographic products. This can be critical for mapping agencies or companies where cartographic products are being generated in a different department from the department responsible for managing the source data.

GeoMedia supports various configurations for managing the relationship between the cartographic source data and the cartographic edited data, allowing users to define the configuration best suiting their business needs. Since the source data and cartographic edited data are linked, it enables the portrayal of the data collectively in a single view, providing a more current and accurate representation. This improves productivity for cartographic editing, quality control/assurance, and significantly reduces the time and effort required for map revision workflows. It also provides users with the necessary framework for supporting Multiple Representation Databases (MRDB).

2.2. Data Validation and Data Modeling

The geospatial data used in cartographic production can originate from a wide variety of sources – collected internally or obtained externally. Variations in the data collection methods used and the sources they were derived from can result in differences in content, accuracy, and quality. This can occur with the geometric representation of the data, as well as the informational attributes used to describe the data. For example, data collected at different scales can influence whether a building is collected as a point feature or an area feature. Data collected from different sources can influence whether a vegetation polygon is attributed as “woods,” or “coniferous forest.” These variations may be acceptable when viewing and processing feature data independently of other features, but are generally not acceptable in a cartographic production environment where feature data are presented collectively across themes to represent the portrayal of a particular map product. In many cartographic production environments, it is necessary to combine multiple, diverse data sources to establish a common baseline for generating cartographic output. This generally involves some level of data validation and modeling to ensure the accuracy, completeness, and currency of the source data have been established and are consistent across all features.
GeoMedia provides an assortment of tools and processes uniquely designed to address these needs with the objective of reducing data resource requirements and lowering production costs.

Validation techniques ensure consistency and data integrity by using processes that assess geometry, topology, and topological relationships. Processes include:

- **Conflation** – Compare two datasets with multiple representations of the same features and then selectively combine their geometries and attributes to create a singular representation.
- **Advanced Validation** – Create specific rules for features to be validated, tests to be performed, and routines to be applied for validation.
- **Queued Edit** – Graphically present a list of items in a single environment for review and resolution.
- **Schema Remodeling** – Create, modify, and manage data schemas to support cartographic production workflows.

### 2.3. Cartographic Geo-processing

As cartographers begin assembling the data required for a specific map product, they are often faced with the dilemma that the source data is unsuitable for cartographic representation in its current form, requiring some level of cartographic geo-processing. This can range from simple coordinate transformations to complex map generalization operations. In many cases, new cartographic features must be derived from the source data. The amount and type of cartographic geo-processing required is generally dictated by variations between the way source data has been collected and stored, and how it must be portrayed in the finished map product. These processes play a critical role in map production, providing cartographic consistency between map products. This is especially evident with series mapping where multiple map products must be produced from a seamless source database. It is critical that all maps produced in the series share the same traits and characteristics for final cartographic presentation.

GeoMedia provides a variety of geo-processing tools designed to address cartographic productivity, accuracy, and consistency, while maintaining the “attention to detail” cartographers expect, including:

- **Coordinate Transformation** – Define projection algorithms for the finished map product independent of the projection or geographic space used for the source data.
- **Geometric Transformation** – Define new linear networks and reduce area boundary overprints to ensure proper cartographic phasing of dashed lines and linear patterns.
- **Map Generalization** – Perform generalization operations to account for changes in map scale, which include feature elimination, thinning, smoothing, displacement, and orientation.
- **Conflict Detection and Resolution** – Automatically perform rules-based conflict detection based on geometry (coincidence, containment) or on cartographic style (coalescence) across multiple features. Resolutions can be applied automatically or sent to a queue for interactive processing.
- **Elevation Artifacts** – Automatically generate cartographic contours, spot heights, elevation tint bands, and hill shading from a variety of elevation data sources.
- **Reference Systems** – Automatically generate grids and graticules that reference multiple coordinate systems independent of the current map projection.

### 2.4. Rendering Cartographic Features

Cartography is generally considered to be one of those unique disciplines combining art and science to achieve its final objective – the production of a map. In addition to the mathematical algorithms developed for cartographic data modeling, the ability to portray the data model eventually presented on the map is just as important. Mapping agencies, companies, and academics around the world have labored for decades to develop appropriate data presentation schemes that satisfy the map’s communication needs.
objective, while providing the map reader with the ability to easily visualize the complex spatial relationships typically presented on maps. This ranges from data classification schemes (quantitative versus qualitative), to color schemes (sequential, diverging, qualitative), to the appropriate symbols to use for point, line, and area representations. These presentation schemes can be driven by cultural, political, or economic influences; each having their own impact on the final “style” of the finished map product. In many cases, the cartographic “style” employed on a map uniquely identifies the map producer; serving as a visual trademark many cartographers identify as a badge of honor. Most mapping agencies and companies adhere to strict cartographic rendering standards for their published maps, many of which have been developed in-house.

Intergraph is keenly aware of this requirement, and through GeoMedia, provides a robust graphic rendering environment that provides unlimited flexibility in the definition and portrayal of map objects (Figures 1-4), including:

- **Data Classification** – Features can be presented as standard objects representing a consistent graphic portrayal across the feature class, or be classified as quantitative or qualitative thematic objects, representing the appropriate data classification for the intended cartographic portrayal.

- **Style Definition Flexibility** – Each geometry type provides multiple style rendering options. Point features support symbol, font, and picture styles. Linear features support simple and patterned styles. Area features support simple and patterned styles for the area boundary, and simple, hatch, and pattern styles for the area fill.

- **Attribute-Based Symbology (ABS)** – Feature rendering can be based on existing attributes in the feature data, such as specifying which point symbol to use based on a given attribute value, or defining a symbol rotation based on an orientation attribute. In addition, complex expressions can be defined which can derive any number of style related parameters. This includes all style parameters for all geometry types supported in GeoMedia.

- **Instance-Based Feature Editing** – Feature instances can be edited individually within a feature class to apply the required geometric or style rendering modifications necessary to obtain the optimal cartographic representation. This can all be accomplished without sacrificing the integrity of the source data, enabling operators to freely invoke their own “cartographic license” to achieve the desired cartographic result.

- **Enhanced Cartographic Labeling** – Sophisticated rules-based labeling reduces the need for manual intervention; increasing productivity while providing aesthetic labeling that adheres to quality mapping specifications.
Figure 1: Using GeoMedia, you can adjust the dash-gap sizes and offsets to create acceptable cartographic intersections.

Figure 2: You can also manipulate individual linear pattern elements to avoid style overprints, improving cartographic legibility.

Figure 3: GeoMedia allows you to suppress feature segments and override feature class styles to properly portray features in relation to surrounding features.

Figure 4: You can easily displace linear feature segments where style overprints exist.
2.5. Map Composition and Product Output

One of the primary tasks associated with cartographic production is the final map composition, which involves a completely different set of processes and procedures than those used during the initial map compilation. The initial map compilation may be based on an intended output map scale, but its focus deals more with the data modeling, content, classification, and symbolization of the features portrayed on the finished map product. Most of the data processing is performed in projected or geographic space, and independently of a specific geographic map extent. Conversely, the final map composition is focused on presenting the data in paper space, providing a scaled representation of the data within a specific geographic extent or neatline. Additional information is typically provided to describe the content and characteristics of the map data to assist the map reader. All of this supporting marginalia information is composed within the constructs of a page layout or layout sheet.

GeoMedia provides two separate views of the data for cartographic production – the map window provides the environment necessary to support the tasks associated with map compilation, while the layout window provides the environment necessary to support the tasks associated with map composition. The layout window supports all of the processes typically associated with the final map design, such as page setup (size, orientation), page content (map, legend, scale bar, etc.), and position of the objects (map and marginalia) within the page. This multi-window approach provides a focused environment for cartographic production increasing productivity and usability.

Once the map composition is complete, the final task is to produce output files for lithographic printing. GeoMedia workflows support multiple output options such as CMYK PDF or high-resolution TIFF separations (continuous tone or fully screened halftone).
3. Increased Productivity

Sound production techniques, efficient processes, and workflows result in increased productivity. Intergraph embodies these simple principles with each of the applications employed in high-end cartographic production. This can involve:

- Reducing the number of mouse clicks required during interactive editing
- Providing powerful automated processes that minimize duplication and reduce or eliminate the need for manual intervention
- Operating in a graphic environment that enables the cartographer or quality assurance analyst to fully visualize the results of processes performed on the data in real time
- Providing pre-defined templates to minimize the need to produce map components from the ground up, including standardized database schemas, style definitions associated with standard map products, and layout templates

Measuring productivity gains is very subjective and can be influenced by a variety of factors, including differences in the source data and its final cartographic portrayal, as well as processing repeatability. For example, if map scale changes or data re-modeling are necessary for the finished map product, additional processes must be performed that ultimately increases the amount of time required to produce the finished map product. Whereas, if workflows and rules can be established for a single map product and then replicated across multiple map sheets, it eliminates duplication of effort and reduces the amount of time required to produce the finished map product. Regardless of these variations, cartographers should be able to realize substantial productivity gains within GeoMedia's cartographic production environment while maintaining the quality, accuracy, and aesthetics associated and expected within the cartographic community.
4. Why Mapping Agencies Choose Intergraph

**History in Cartography** – Intergraph has provided solutions for cartographic production for decades, establishing a long, trusting relationship within the cartographic community. From the early days of the “digital cartography” revolution that focused on the initial analog to digital conversion, to the current revolution that addresses the creation of cartographic data and its exploitation and distribution over the Internet. Mapping agencies and companies have relied on Intergraph throughout the years to successfully provide them with productive solutions that are relevant and address the current demands of the customers they serve.

**Customer Satisfaction** – Intergraph continues to rank high in the industry for customer satisfaction, providing excellent product functionality, services, and cartographic expertise to address the needs of our mapping customers. Intergraph is committed to supporting the requirements of the cartographic community by providing quality products and solutions that address business needs.

**Open Architecture** – As a founding and principal member of the Open Geospatial Consortium (OGC®) (formerly known as Open GIS Consortium), Intergraph is a visible force in ongoing OGC initiatives for industry standards, and spearheads interoperability in the GIS and IT marketplace. Intergraph is committed to open systems solutions and data interoperability.
5. Appendix

The following sections illustrate examples of assorted map products produced using GeoMedia solutions.

5.1. National Map Series 1:50,000 – Inset

*Data courtesy National Survey & Cadastre Denmark (KMS)*
5.2. National Map Series 1:100,000 – Inset

Data courtesy National Survey & Cadastre Denmark (KMS)
5.3. National Map Series 1:200,000 – Inset

Data courtesy National Survey & Cadastre Denmark (KMS)
5.4. Cartoimage Map Series 1:200,000 – Overview

Data courtesy National Geographic Institute Spain (IGN)
5.5. Cartoimage Map Series 1:200,000 – Inset

Data courtesy National Geographic Institute Spain (IGN)
5.6. New Map of Spain 1:500,000 – Overview

Data courtesy National Geographic Institute Spain (IGN)
5.7. Polish Hydrogeological Map Series 1:50,000 – Overview

Data courtesy Polish Geological Institute (PGI)
5.8. Polish Geoenvironmental Map Series 1:50,000 – Inset

Data courtesy Polish Geological Institute (PGI)
5.9. Polish Geoenvironmental Map Series 1:50,000 – Overview

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