Production Line Tool Sets Desktop and Component Tools

An ESRI® White Paper • July 2001

ESRI 380 New York St., Redlands, CA 92373-8100, USA • TEL 909-793-2853 • FAX 909-793-5953 • E-MAIL info@esri.com • WEB www.esri.com

Production Line Tool Sets Desktop and Component Tools

An ESRI White Paper

Contents **Page**

Production Line Tool Sets Desktop and Component Tools

Introduction

ESRI® Production Line Tool Sets (PLTS) is a commercial off-the-shelf (COTS) software package designed to manage, build, and maintain digital databases and hardcopy products in a production environment. PLTS leverages the object-oriented ArcGIS™ Desktop technology to provide a "next generation," functionality rich software suite that streamlines the management and semantics of production. PLTS is designed using the ArcGIS Component Object Model (COM) programming standards and object relational geodatabase data structure, maintaining open-ended user accessibility to all ArcGIS components. An optional component is the ArcSDE™ multiuser system for distributed geodatabases for long transactions, alternate versions, and history logging functionalities.

These tools have been initially developed to produce National Imagery and Mapping Agency (NIMA) database products in Vector Product Format (VPF) that meet NIMA specifications. The database-driven architecture of PLTS allows for easy new product creation and plug in for both database and hardcopy production with minimized development overhead.

The PLTS software has been developed within the ESRI Database Services Department and used on actual production projects. The tools have evolved into simple, easy-to-use components that form a highly integrated system for producing digital databases and cartographic products. These tool sets operate on top of standard ESRI base desktop and workstation software for Windows NT® environments.

PLTS Desktop currently supports the following database products of NIMA.

- Production Line Tool Set for Digital Nautical Chart (DNC)® database
- Production Line Tool Set for Foundation Feature Data (FFD) database

The following PLTS component is included with each PLTS and is also offered separately.

- GIS Data ReViewer extension for database quality control

Production Line Tool Sets

Database production and maintenance, VPF finishing, and hardcopy finishing are complex tasks that require many processes to successfully complete. PLTS is designed to streamline both database production and product finishing. While each PLTS is designed to produce NIMA-compliant products, the production environment, processes, and tools are generic, with only the product-specific tools being packaged into a product processing

toolbar. PLTS takes full advantage of the ArcGIS Desktop application framework, which makes all production and finishing tasks more efficient and easier to understand. By designing PLTS within the ArcGIS application framework, the PLTS system is easy to learn while giving you the ability to quickly produce NIMA-compliant products.

The following is a general description of the main components of all applicable Production Line Tool Sets followed by product-specific details.

Project and Map Sheet Catalog

Centric to the PLTS application is the Project and Map Sheet Catalog (PMC). The PMC provides the environment for establishing project control through storing metadata and geometries of all projects, products, and source material. The PMC is composed of a geodatabase, an application for populating the PMC geodatabase with geometry and metadata, and an ArcMap™ Map Document for viewing and querying the PMC geodatabase contents.

PMC Geodatabase

The PMC geodatabase has the following structure:

1. The Project Table

This table contains all metadata pertaining to the project. The project is conceptually viewed as a contract to perform work. The metadata is defined to encompass all information necessary to collect specifics of the contract (e.g., contract number, contact, due date). This table has a one-to-many relationship to the feature classes that exist in the specification data sets.

2. The Project Feature Class

This feature class contains the outlining geometry of the project and attribute metadata specific to that geometry (e.g., scale, creation date, process).

3. The Specification Data Sets

These data sets contain both the digital data product feature classes and the hardcopy product feature classes that can be produced from the defined specification. For example, the DNC Specification Data Set contains the DNC Collection Area of Interest feature class that contains the geometry and attribute metadata of all the collection areas of interest that build a DNC library. In addition, the DNC Specification Data Set contains the DNC Map Production System (MPS) Area of Interest feature class that contains the geometry and attribute metadata for all hardcopy charts produced from the DNC data.

4. The Product Feature Classes

These feature classes contain the geometry and metadata specific to producing the defined product. Both hardcopy and digital data outputs are defined as products. There can be many digital data and hardcopy products contained within a specification data set.

5. The Source Data Set

This data set contains all source materials to produce a product. The source materials can be stored as either a feature class, if geometry as well as attribute metadata are to be stored, or as a table if only attribute metadata is pertinent. Examples of source data in which it is necessary to store geometry and metadata are imagery and other digital geographic source data. Examples of source data in which only metadata information is pertinent are scanned hardcopy sources, nongeographic databases, and textual information (e.g., Notice to Mariners).

6. The Basemap Data Set

Provided with the PMC geodatabase is basemap data to geographically reference the geometry stored in the PMC. Basemap data provided with the PMC geodatabase is world shoreline, continent polygons, and world drainage. This data set is fully extendable in that the user may add and populate feature classes commensurate with the scale of their project area of interest.

PMC Application

The PMC application allows the user to populate the PMC geodatabase with project, product, and source geometries and metadata. The forms are dynamically built based on the PMC geodatabase structure. As the PMC geodatabase is customized to incorporate new specifications and products, the PMC application recognizes these changes and exposes these added specifications and products to the user.

PMC Map Document

The PMC Map Document is an ArcMap Map Document supplied with cartographic enhancements and representation of the PMC geodatabase. The ArcMap core application can then be used to manage, query, track, and report on both the geometry and metadata of the PMC (i.e., Select by Attribute, Select by Location, etc.).

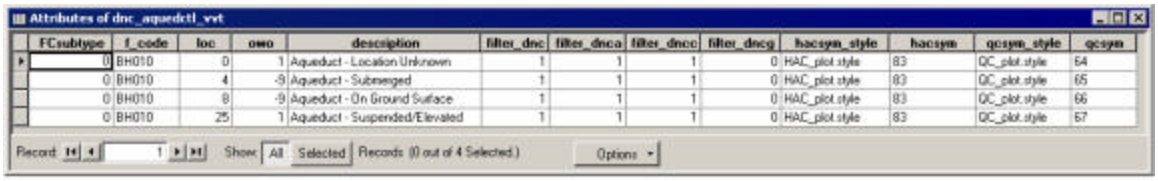
VPF Import Tool

This tool imports VPF Specification Data into an existing geodatabase for the supported products in PLTS. The application is a wizard that supports import into personal as well as distributed geodatabases. The VPF Importer validates the existing geodatabase's feature classes against the VPF data feature classes to corroborate the existing geodatabase's structure. Once validated, the user can import one or many libraries as well as one or many feature classes. The VPF Importer also contains functionality to clip imported data to a defined geometry through an existing shapefile or preformatted coordinates text file.

Valid Value Tables

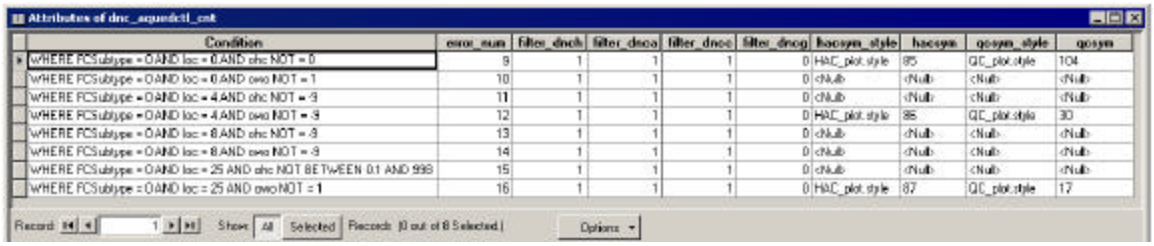
Valid Value Tables (VVTs) are tables designed to be accessed and synchronized with PLTS tools to extend the core functionality of the ArcMap application and provide extended validation, feature coding, and feature symbolization functionality to PLTS. For each feature class that exists within a given product geodatabase, a VVT exists within the same geodatabase. In structure, contained within each VVT are all the possible data permeantations for each subtype contained in the feature class, a textual description of the data permeantation, and all possible symbology renderings (e.g., hardcopy specification symbology, QC symbology, and ortho symbology). VVTs extend the validation functionality of the ArcMap application by also validating item dependencies and valid combinations. VVTs extend the feature coding functionality of the ArcMap application by exposing the VVT description field of all unique combinations of attributes within the

core Object Inspector for single-click selection and coding of features. VVTs extend the symbology functionality by storing the symbol ID within the VVT instead of as a physical item on the feature class.



Condition Tables

Condition Tables (CNTs) extend validation on split range domains and fields that require character input. These tables provide alternate symbology based on condition statements and return standard error messaging when conditions are not met. The conditions are stored as Standard Query Language (SQL) statements. For each feature class that requires a CNT, that CNT is divided by subtype, and when working with DNC, further divided by library scale. The CNTs are used when features are coded with the Object Inspector or the Batch QA process is run in ArcMap.



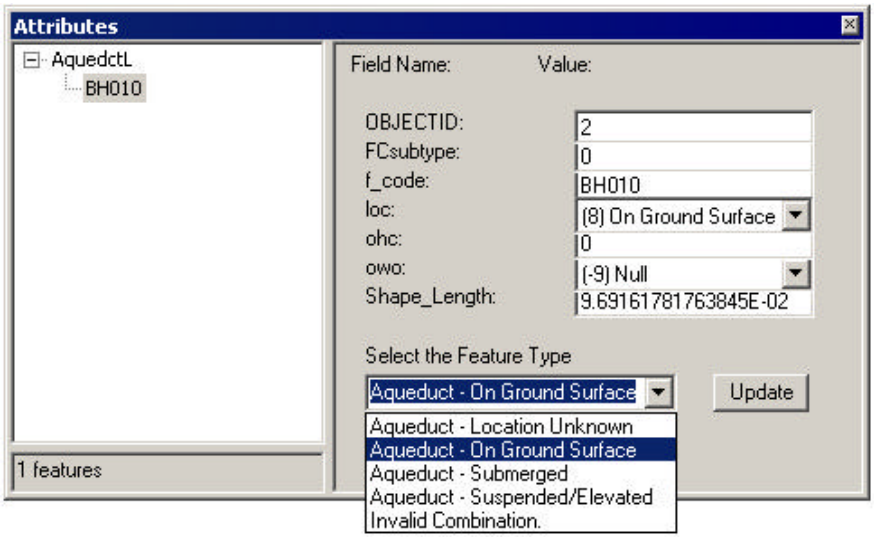
Object Inspector PLTS Custom Class Extension

Common to all products supported within PLTS are the requirements to efficiently code features and validate that the features were coded to a standard. Feature coding and validation are achieved in PLTS through an extended Object Inspector in the ArcMap application. Exposed to the user through the custom class extension is a list box containing the description field of all records in the VVT. This allows the user to select a feature attribute combination through a single-click event. To validate the attributes calculated for the feature contained within the specification, the click event of the Update command button validates the feature against the geodatabase domains and also against the VVT and condition tables. This functionality immediately reports to the user any validation errors that require fixing.

PLTS Batch QA

The PLTS Batch QA tool performs the core geodatabase validations; validation against attribute domains and enforce connectivity rules if present and also performs the PLTS extended validation functions; validation against the VVTs to enforce item dependencies and ensure that features have been coded as valid unique combinations of attributes; and validation against the Condition Tables. The report generated from the PLTS Batch QA tool is written into an ESRI Error Table that is directly accessed by the GIS Data ReViewer to easily transition into correcting the identified errors.

J-8712



PLTS Renderer

The PLTS Renderer produces views of data in a feature class based on the unique value combination of the attributes specified in the VVT. On a feature-by-feature basis, the attribute combination of the physical feature is compared to the valid value attribute combination in the VVT. Once the combination is located in the VVT, the symbols are assigned to a feature based on the stored symbol ID in the VVT. No symbol information is physically stored on the feature class; the symbology information is derived from the associated Valid Value table at run time.

GIS Data ReViewer

GIS Data ReViewer is a custom ArcMap GIS Application developed to conduct visual quality review of data in support of database production. The GIS Data ReViewer environment is made up of a series of buttons and tools that support the visual review of ArcInfo™ data and VPF data. GIS Data ReViewer is used to identify where corrections, additions, and deletions must be made to spatial data and to attributes of spatial data. Features are symbolized in a consistent manner to facilitate interpretation. This software automates and applies a database process to what was formerly a paper trail of quality control error files and corrections.

GIS Data ReViewer enables you to do the following:

- Batch validation of a geodatabase.
- Locate errors in data capture/attribution with a variety of tools.
- Log error information easily and accurately.
- Eliminate the paper trail associated with error files by storing data error information in an electronic file.
- Make and log corrections to the data.
- Verify corrections made to the data.

PLTS DNC Production Toolbar

The Digital Nautical Chart Production Line Tool Set is used to produce NIMA VPF-standard DNC databases from existing hardcopy sources, perform maintenance on existing VPF libraries, and import ocean bathymetric survey data. The DNC tool set is used for high-volume production and maintenance of DNC libraries. The DNC toolbar contains all the DNC-specific processes arranged from left to right to facilitate work flow and provide a highly efficient and effective manner in which to process data.

There are two geodatabase models for the DNC product: a relational model and a DNC feature subtype model. The relational model is used to collect data from scanned hardcopy chart sources. Only three feature classes exist in this model, Edge, Face, and Points. The DNC Relational Attributer exposes the related tables to these three feature classes and allows the user to code a single piece of geometry as multiple features and maintain the attribution in the related tables. The concept is that the geometry of a feature is stored only once, but the feature can be coded as one or many of the DNC feature classes by storing the Object ID of the physical feature as a foreign key in the related table and exposing the attributes from the related table for coding. The DNC Class Converter splits the relational model into the DNC feature subtype model for final quality control checks and final VPF export.

The DNC feature subtype model has a geodatabase feature class for every feature class that exists in the DNC VPF specification and expresses subtyping. This model is also used to import existing DNC VPF data for maintenance.

In addition to the DNC Relational Attributer and the Object Inspector there are three other custom coders that work in both models to expedite the collection of soundings, bottom characteristics, and spot elevation points.

A Notice to Mariners application also exists that allows for Notice to Mariners updates. This tool allows for sector lights, line features, area features, and point features to be added, selected, relocated, and deleted from a selected feature class.

PLTS FFD Production

The Foundation Feature Data Production Line Tool Set is used to produce NIMA VPF-standard FFD databases from features and elevation data collected primarily from stereo imagery. Stereo collection can be performed on any system that supports the output of three-dimensional shapefiles. The tool set also supports the collection of cartographic source information from existing hardcopy maps and other ancillary sources.

All processing occurs within an FFD geodatabase model that has been developed based on the database design defined in the FFD specification (MIL-PRF-89049/1). VPF thematic layers (e.g., trans and pop) are modeled as individual feature data sets within the geodatabase, and each VPF feature table (e.g., roadl.lft and chanela.aft) has a corresponding feature class within the appropriate feature data set of the FFD geodatabase. Valid attribute range and value domains have been established as an inherent part of the FFD geodatabase. These domains ensure that data is compliant with the FFD specification while eliminating user error in attribution coding operations.

The FFD tool set provides the ability to import data from three-dimensional shapefiles directly into the appropriate feature class of the FFD geodatabase model. All feature coordinates (*x*, *y*, and *z*) are stored within the geodatabase eliminating the need to create

J-8712

separate triangulated irregular network structures to store the three-dimensional portion of the data and allowing for the direct manipulation of feature vertex *z*-values within the PLTS environment.