Composite Source Feature File: Simplifying the Complexities of Near Shore Hydrography

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Abstract

Surveying the steep rocky shores of Alaska and the Pacific Northwest is a complex and potentially hazardous undertaking. Accurate charting of near shore features is essential for maritime safety and protection of the marine and coastal environment. The complicated process of surveying these areas has now been simplified by supplying field units with a composite (charted) source feature file produced with spatial extract transfer and load (ETL) technologies. In the past the myriad of sources for near shore feature information–including raster and electronic charts, prior hydrographic surveys, aerial and satellite derived shoreline files and LIDAR–have complicated the process of verifying or disproving these features. Analyzing and manipulating these various sources from their diverse formats into a useable format is a complex and time consuming task often completed by shipboard personnel. This paper addresses the process used to manipulate these sources into a composite source file in IHO S-57 standard exchange format prior to delivery to the field unit. This file is then easily ingested into shipboard processing and acquisition systems. Efficiencies created in data integrity and processing time will be addressed.

Introduction

The handling of hydrographic features from survey planning to final product is a cumbersome and extremely inefficient process fraught with opportunities to lose or corrupt data. In order to minimize these risks and inefficiencies the Office of Coast Survey (OCS) has transitioned its feature data flow to International Hydrographic Organization Special Publication 57 format. This data exchange format has standardized the way navigational data is transferred worldwide. OCS is attempting to gain efficiencies by standardizing the data flow of all features into S-57 format–beginning in the planning stages and extending to the navigational product. This paper will describe how feature source data existing in various formats and schemas is converted in the planning stages of the survey to a single composite source file in S-57 format. Performing this conversion early on has greatly increased efficiency and data integrity throughout the pipeline, allowing features to be handled in a consistent format from survey acquisition to final product.

Feature Source	Vector/Raster	Format
Remote Sensing Shoreline Data	Vector	.shp
Prior Hydrographic Survey	Both	.tiff or .tab
Lidar	Vector	.000 or .xls
Nautical Chart	Both	.bsb or .000

Figure 1: Source Feature Types and Formats

Background

Under traditional project planning, source feature data was gathered by the project planner and delivered to the field unit for verification. The NOS Hydrographic Surveys Specifications and Deliverables document states that features include “wrecks, obstructions, shoreline, rocks, islets, oil platforms, nature of seabed (bottom samples) … [that] require additional information that cannot be included in the BAG [Bathymetric Attributed Grid]” (118). These features exist in different data formats including remote sensing shoreline data, prior hydrographic surveys, LIDAR surveys, and the largest scale nautical chart (see Figure 1). Before field units could verify or disprove features, they first converted them to a single format type which allowed them to be viewed in a single software package (MapInfo). Then shipboard personnel created a boat sheet from MapInfo, which became their loose equivalent to a composite source file. The features were then color coded to denote their various sources. Next the field unit performed their shoreline investigation, making notes on the paper smooth sheet and recording GPS data in a different format. These written notes were reentered and saved in a MapInfo workspace as hard coded text, not attributes correlated to the features. This workspace was the ship’s deliverable to the processing branch, who in turn compiled the features into a Microstation (.dgn) file. After the Marine Chart Division began producing Electronic Navigation Charts (ENCs) in S-57 format, the processing centers followed suite by producing their final output in S-57 format. Rather than flowing in a consistent manner from one working group to the next, features required conversion to a new format at each stage, necessitating frequent manual reattributions and resulting in dead end products (see Figure 2).

Transitioning to S-57

As OCS began the process of creating products in S-57 format, the processing branches requested data from the ship be submitted in S-57 format. By this time, commercial vendors began creating software packages that could directly manipulate data in S-57 format. West coast field units began using one of these packages, CARIS Notebook, to manage their feature data but the various source feature formats were not easily ingested into this product. Consequently, the field units requested a fully attributed composite

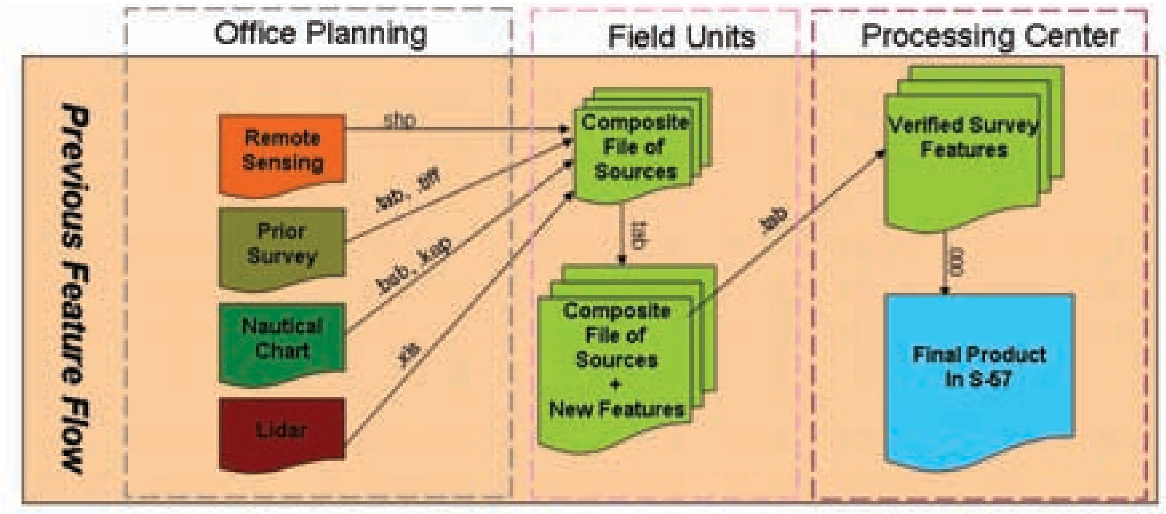

Figure 2: Simplified Feature Flow Prior to Composite Source File

source file in S-57 format from the project planner. In their own words: "Each feature within this file should have its SORIND and SORDAT attributes populated to indicate its source (RSD Photogrametry, ... LIDAR, RNC [Raster Nautical Chart], etc.), ... This single source file ... would be directly edited by the field unit, and both the original and edited versions transmitted to the Hydrographic Branch as survey deliverables for verification" (Ben Evans and Lynnette Morgan, NOAA, "Shoreline "Top 3"", page 1, 2006, pers. comm.).

Furthermore, field personnel described the consequences of maintaining status quo thus:

> Field units must produce the composite source file if it is not provided. This currently requires the following steps:
>
> 1. Gather individual source files.
> 2. Geo-reference source files (such as prior surveys) that are delivered from HSD [Hydrographic Survey Division] unregistered.
> 3. Import data [one feature class at a time] into CARIS Notebook. (Currently vector data is delivered in S-57 formatted .shp files. Within each source, each object type has a separate .shp file, resulting in tens of files that must be imported individually. Importing these files is possible with the [CARIS] Notebook Object Import Utility, but laborious and error prone.)
> 4. Check S-57 encoding of DCFF [Digital Cartographic Feature File or remote sensing shoreline data] source data and correct errors ...
> 5. Compare vector data to raster chart, and manually digitize any features on the chart but not in the source data. ... Depending on complexity of the survey area, this preparation can require as much as two to three man-days per 1:10,000 [scale] survey sheet. In addition,

> disproval of generalized raster chart features incurs additional work throughout the data acquisition, processing, verification, and compilation process aboard the field units and in the processing branches. (Ben Evans and Lynnette Morgan, NOAA, "Shoreline "Top 3"", page 1, 2006, pers. comm.

Per the ship's request, the survey planners began working towards the development of a composite source file from the beginning. This standardization would make info exchange more efficient with fewer translations. Rather than receiving multiple data sources, the field would receive one composite source file (see Figure 3). This file would be attributed to reflect feature origins and other key descriptive information. As shoreline work commenced the composite source file could be modified or updated with the results from the current survey and then passed along to the processing branches. This would create a more efficient work flow, as illustrated by Figure 4 below. Additionally, the complex task of compiling feature source data would be performed in the office rather than during expensive ship time.

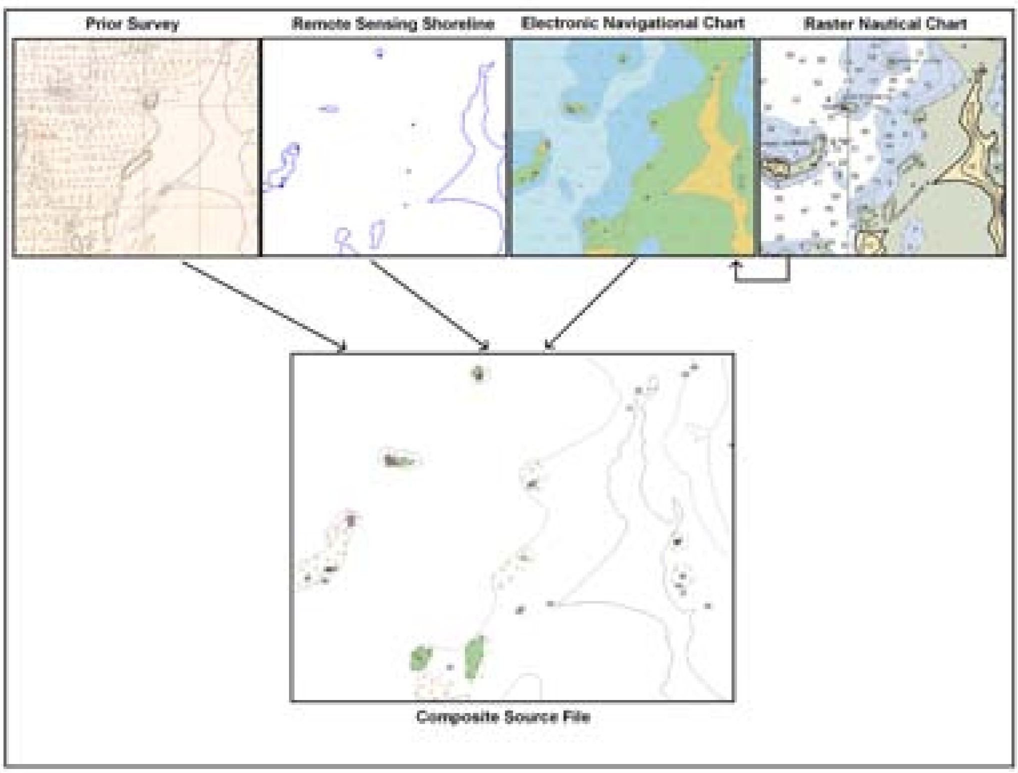

Figure 3: Composite Source File Inputs

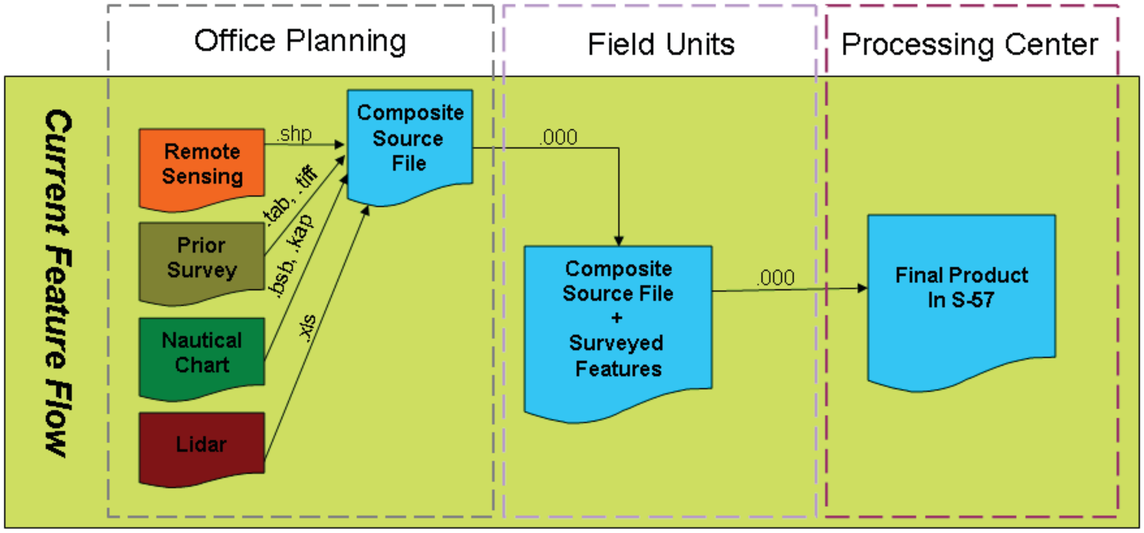

Figure 4: Simplified Feature Flow Prior to Composite Source File

Spatial Data Extract Transfer and Load (Spatial ETL) with FME

In order to compile a composite source file in the planning stages it was necessary to obtain software that could easily convert multiple date sets into S-57 format. The majority of S-57 editors have limited file reading capabilities. Most only specialize in manipulating data that is already in one of their few readable formats. Getting data into one of these formats is laborious and time consuming and data attribution can easily be lost. Safe Software, the makers of Feature Manipulation Engine (FME), specialize in vector data extract transfer and load technology. FME offers "access to data stored in any of over 200 formats, as well as sophisticated data transformation capability controlled via a graphical user interface" (Case Study: SevenCs 2007). FME can be configured to read each of the prior source formats and alter their attributes as needed to comply with S-57 formatting by using customizable transformers. It then writes these files out to a single desired format, in this case S-57. The base version of FME does not have the ability to write in S-57 format, however a plug-in exists that seamlessly enables this (SevenCs S-57 Writer Plug-in for FME).

FME was chosen for this project because of its ability to tailor data transformations to retain necessary attribution and its ability to create templates that streamline the composite source file conversion process. Each source data set has its own reader in FME. Then customizable transformers modify that data to get it into the right S-57 object class with the necessary feature attributes. When necessary, spreadsheets or databases can be utilized to map complex attributes. As the features are passed through the final transformer checks are performed and a visualizer pops up to show any erroneous results.

An example of this process using prior hydrographic surveys is illustrated in the figure below (see Figure 5). These surveys are historically attributed using the carto code system.

Via user-created look up tables FME maps these carto codes to corresponding S-57 object classes during the translation process. By creating a template for mapping prior hydrographic surveys, the prior survey data for individual projects can be run through this same transformation process in FME. Separate conversion templates were created for the other source data types as well and utilized within a single FME workspace (see Figure 6). After all applicable source data has been added to the workspace the program can be run and all the sources are simultaneously written to a single S-57 file.

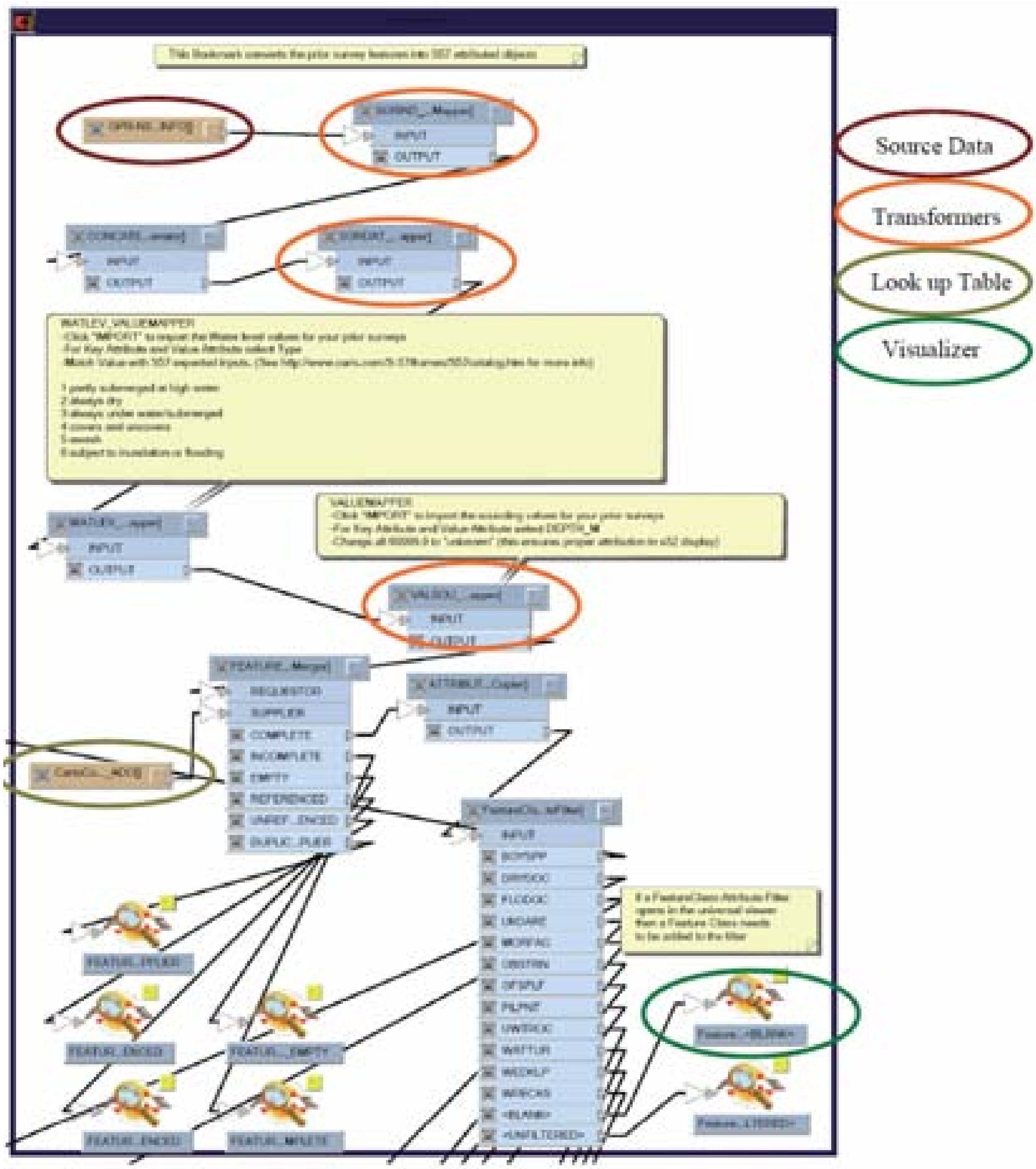

Figure 5: FME conversion from prior survey to S-57

An additional benefit of using FME is the ability to remove object classes from the ENC. For example, while the hydrographer is conducting feature investigation he/she would not

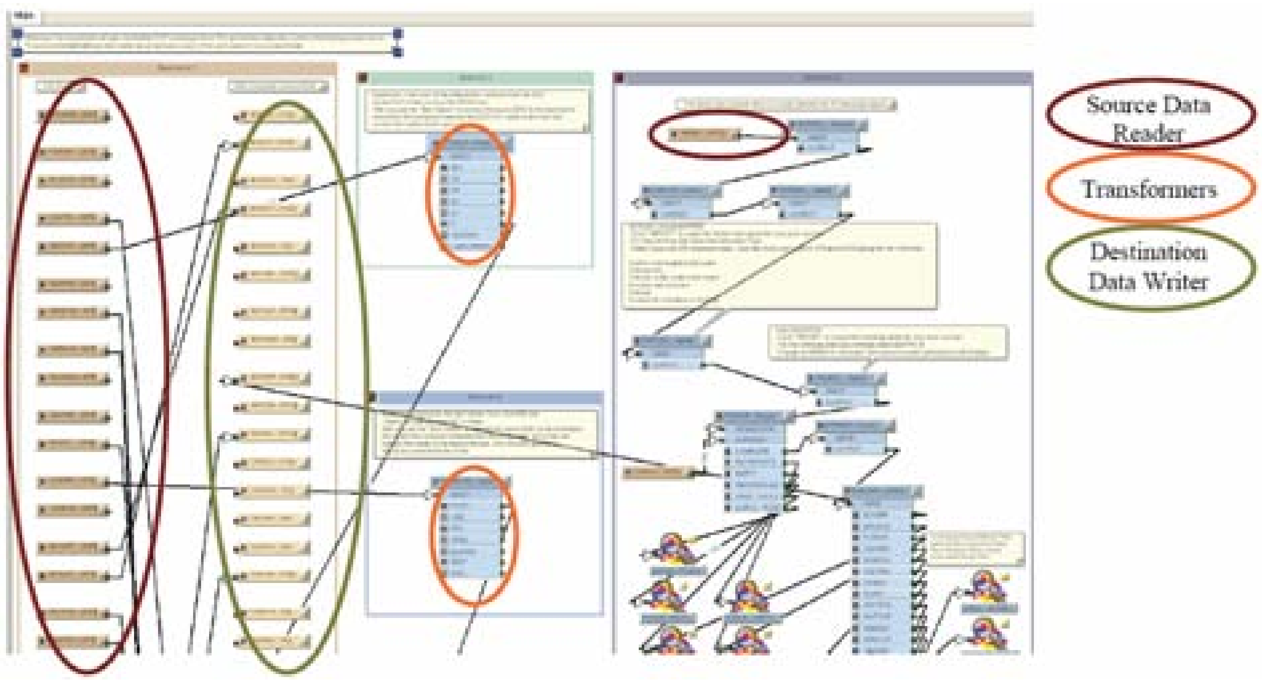

Figure 6: FME workspace template for the composite Source File

be concerned with editing the traffic separation scheme. This object class can be removed by deleting the traffic separation object class (TSLNE) from the FME workspace. Thus the composite source file can be decluttered and becomes much easier to work with.

Though the initial FME template takes time to set up, after the workspace is created it is a simple task to run the sources through this conversion process. On average it takes only 30 minutes to create a composite source file for a project area. This is a drastic reduction from the estimated 16 to 24 hours it took shipboard personnel to create their preliminary reference file before beginning the survey. With over 20 projects planned per year, each consisting of multiple surveys, the field units are saved months of processing time by not needing to complete these routine transformations.

Field Testing and Acquisition

Field testing of the composite source file began in spring 2007. Initial difficulties were experienced because the utilized S-57 editing software (CARIS) could not adequately handle the GPS input. For this reason data was acquired with software that could not write in S-57 format, necessitating that the field unit continue to make conversions to bring newly acquired data into their S-57 editing software. During the 2008 field season NOAA hydrographers expect to field test new S-57 editing software (CARIS Notebook) that can directly handle GPS input.

New procedures have been established in the Operations Branch for planning the surveys. During initial testing the project manager/author completed all the transformations for the

2007 field season. This was done for two reasons–the project planners were not familiar with FME and standard operating procedures had not been finalized. As suggestions from the field units were incorporated into the composite source file template a standardized template was created. During the winter of 2007 project planners received FME training. This field season (2008) project planners will complete their own translations using the established procedures.

OCS has seen unexpected benefits from implementing FME. Often other federal and state organizations provide hydrographic data that can be used to update our charts. This data arrives unexpectedly and in various formats. When necessary, FME is now being used to convert this data into S-57 format.

Conclusions

The creation of a composite source file in the planning stages of the survey has resulted in multiple efficiencies and data integrity improvements. Features are now standardized in S-57 format throughout the pipeline. Project planners now complete the clerical task of converting features into a single format, enabling field personnel to focus on data acquisition and quality. Because features maintain their attribution, new features only need to be attributed when they are initially surveyed. These accomplishments could not have been realized without FME's automated data conversion capabilities, allowing the planning office to create a composite source file in a fraction of the time it otherwise took. This project has aided the Office of Coast Survey's effort to streamline data flow and make information exchange more efficient.

References

Case Study: SevenCs: developing an FME writer to convert various data formats to S-57 by Safe Software 2007, viewed 31 March 2008, <http://www.safe.com/technology/documents/casestudies/CaseStudy_SevenCs.pdf>

NOAA Field Procedures Manual 2008 (Draft), Office of Coast Survey, National Oceanic and Atmospheric Administration, 2008 [http://nauticalcharts.noaa.gov/hsd/FPM/FPM.htm]

NOS Hydrographic Surveys Specifications and Deliverables, Office of Coast Survey, National Oceanic and Atmospheric Administration, viewed 31 March 2008, [http://nauticalcharts.noaa.gov/hsd/specs/Specs2007.pdf], April 2007

SevenCs S-57 Writer Plug-in for FME: SevenCs, viewed 31 March 2008, <http://www.sevencs.com/index.php?page=188&lang=>

Author Biographies

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