Theater Geospatial Database Value-Adding in a Distributive Environment (ESRI UC Paper UC1042)

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Abstract
As the U.S. Pacific Command's Executive Agent for all Pacific Theater terrain analysis and geospatial production, U.S. Army, Pacific (USARPAC) established a Pacific Theater Geospatial Database (TGD) in 2003-2004. Since its inception, USARPAC has steadily built on the success of this program. In concert with forces across the Pacific, units such as the Theater Topographic Company (70th Engineer Company) and Theater Dive Detachment (7th Engineer Detachment) have provided TGD value-adding with feature extraction, attribution and hydrographic survey data. This paper will discuss the challenges, shortfalls, and successes of this distributive value-adding workflow among units of differing missions, locations, and visions.

Background

Last year, 2004, saw the Pacific Theater Geospatial Database (TGD) moving from concept to full operational capability. Since this transformation, the TGD has provided a rich and very capable unified data model to function within our particular geospatial practice. More so, the TGD is also a hardware and software capability allowing collaborative data producers to densify, store, retrieve and disseminate extensive Pacific Theater data holdings and products. As a result, geospatial analysts have streamlined workflow for data discovery/data creation and, ultimately, analysis, modeling and battle space visualization (Haefner 1). Yet, today's TGD is more than the sum of silicone, fiber, and software licenses: the TGD requires capable personnel, training, and doctrine to sustain its production efforts.

Building on lessons of 2004 and to further capitalize on analysis organizational capacity, I see 2005 as the "year of value-adding" to the TGD. In our language of "value-adding," or taking a baseline dataset and enriching it with additional features or attribution, there are two workflow directions: value-adding *internal* to USARPAC (those enriching the TGD within this command) and *external* value-adding (actions using the TGD to enrich national data consumers/providers such as the National Geospatial Intelligence Agency (NGA)). For the purpose of this discussion, we will only focus on the former: internal data value-adding from subordinate USARPAC data producers to the TGD.[i]

Just Do It

Observers of economic globalization know that we cannot afford to marginalize our data producing partners. In effect, many users, producers, and consumers of geospatial data are natural links in a large and complex "geospatial supply chain." With the advent of free geospatial viewers, open formats and desktop GIS, the complex tools of yesterday are now simplified and mainstream. Community failure to simplify system usability and data exchange will weaken the growing bond between data producers and data consumer; the result: users at the end of the chain will look elsewhere to satisfy their appetite for data and tools. We witnessed this first hand with our own intelligence analysts. Imagine a regional analyst who requires a

simple, country-level product. Rather than request the data or a product from a geospatial analyst, the intelligence analyst uses Microsoft Encarta or Streets & Trips software to produce his own map. In all the power of GIS, we often miss this boat of just quickly building a suitable product or giving that capability to an average user. Our data processes, schemas, and tools must thus speak to that gamut of users up and down the chain. The response might be to demand that only the certified analyst can handle the data or produce a map or product—in effect, such protectionist measure in terms of unwieldy data formats or lack of usability will only serve to subsidize mediocrity; a "free market" approach to production will elicit a "best of breed."

Secrets to Our Success

Value adding within this year has been successful on a small, but very significant, scale. Central to this success was our internal organizational control. In last year's introduction of the TGD (Haefner), we defined our USARPAC geospatial organization as an enabling control (see Figure 1). As such, the 29th Engineer Battalion (Topographic) forms the core of the TGD effort with its 5th Engineer Detachment (Planning and Control) located on the USARPAC staff (in G-2 Deputy Chief of Staff for Intelligence) functioning as the de facto TGD operators. After a year of TGD literacy, we refined our focus to data production capabilities of other units such as the 70th Engineer Company (Topographic) and 7th Engineer Detachment (Dive).

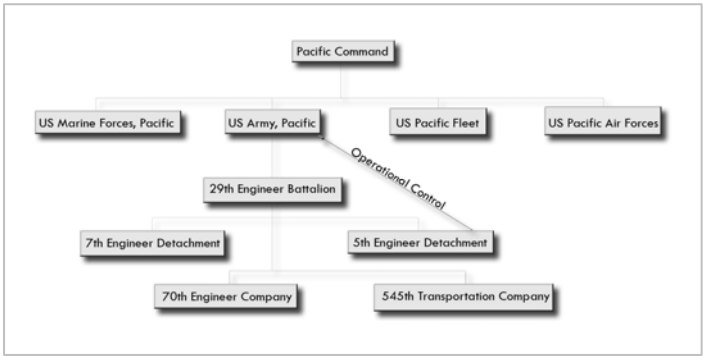

Figure 1. Simplified USARPAC Geospatial Organization Structure

The generic value-adding workflow begins as the 5th Engineer Detachment ships an initial extract from the TGD as a baseline for co-producer use. The 5th Engineer Detachment may elect to add more data before the baseline shipment in the form of feature extraction or ingesting commodity data. All TGD workflows are an adaptation of NGA co-production methods. To guarantee some degree of data surety—and to function as a trusted co-producer for NGA—extraction and production methods mirror contract specifications and extraction guides used at many NGA data production contractors. In addition to creating "new" data via photointerpretive feature extraction or multispectral imagery classification techniques, TGD operators must grapple with "commodity data[ii]" of various sources, geometry, and quality. In effect, working with and often editing/massaging commodity data can occupy a majority of the production effort.

Workflow within the 29th Engineer Battalion vis-à-vis the 70th Engineer Company and 7th Engineer Detachment (Dive) is greatly simplified by requiring all to use the TGD data model. The process begins as an initial extract of the area of interest is produced by the 5th Engineer Detachment as a baseline; the units value-add on that data, then ship the improved extract back to the 5th Engineer Detachment where it is verified, reconciled and posted back to the TGD.

Challenges

Despite our successes in 2005, we faced several challenges. Of particular concern in the past year was when and how to migrate to ArcGIS 9.x. The TGD, along with other Army geospatial

analysis systems, was built on ArcGIS 8.3. Migrating to ArcGIS 9.x was a priority, but we delayed such to sustain our ArcGIS 8.3 disconnected editing processes.[iii] However, performance considerations required the TGD to advance to ArcGIS 9.x before other Army-fielded analysis systems throughout USARPAC. Although this increased TGD performance and usability at the 5th Engineer Detachment, it severed our value-adding workflow.[iv] As a stop-gap measure, ESRI assisted us by programmatically converting ArcGIS 9.x TGD extracts so as to be read in ArcGIS 8.3; however, full-scale check-in/check-out is not possible until larger US Army system upgrade fielding is complete in 2006.

Our next challenge was overcoming Army cultural barriers to geospatial skills progression. To best understand the issue of forming an Army geospatial analyst, the reader must understand Soldier skills requirements. Above all, an Army geospatial analyst is a Soldier. As such, each Soldier must be proficient in his or her core tasks: carry a rucksack, fire his or her weapon, defend themselves against an attack, etc. It is in addition to this litany of Soldier tasks, the geospatial analyst must conduct tactical analysis (analyze terrain and terrain battle space), non-tactical analysis (analysis of other spatial data), and produce/manage geospatial data. Soldiers only perfect this first skill—tactical analysis—during initial training.

Army-baseline training does not provide adequate skills for TGD value-adding. To counter this, we assign all new 29th Engineer Battalion analysts to the 70th Engineer Company. After verifying basic skills, we move analysts from the 70th Engineer Company up to the 5th Engineer Detachment with sufficient dwell time (18 months) to learn and apply more advanced skills. From the 5th Engineer Detachment, analysts return to the 70th Engineer Company to re-seed the value-adding effort and pass the knowledge to others.[v]

Our final challenge, oddly enough, was the TGD data model. For all its richness and capability, I regard the TGD data model as often our best friend and worst enemy. Owing to the model's robustness and documentation, it has been a pleasure to provide to other data producers—it is a model that says as much about what we do as who we are: the US Army, Pacific purveyors of geospatial intelligence. Often times we endeavored to just force-load miscellaneous baseline data into the TGD in hope of quickly checking out an extract to other co-producers for immediate data production. However, we soon learned that such a desire to just cram the data in did not relieve us from the responsibility of attribute mapping, geometry, and topological validation quality control. Thus, it is the TGD production manager who must be fully aware all workflow aspects—it is a pay-me-now or pay-me-later arrangement.

From Concepts to Practice

The key to working with data production partners is mutual understanding of a "line of demarcation." This boundary defines responsibilities of each party. Hydrographic surveyors/divers only have a data collection capability and do not have standard geospatial editing toolsets. Thus, this line of demarcation only requires delivery of raw and corrected data, not a TGD geodatabase. In contrast, the 70th Engineer Company possesses much of the same toolsets resident on the TGD; thus, the expectation for data population is using the TGD geodatabase schema.

Hydrographic Dive Survey

Working with the 7th Engineer Detachment (Dive) is an example of the intrinsic value of our data suppliers, both as a raw data source for analysis, and, ultimately, data population into the TGD. US Army dive teams are equipped with hydrographic survey equipment. This survey set is utilized for mapping bathymetric environments, and incorporates a differential Global Positioning System (GPS), sonar, and advanced contour software to provide a detailed 3D viewing and mapping capability to a depth of 50 meters. The system is commercial off-the-shelf software and hardware; portable and durable, it is capable of being operated on watercraft and on the shoreline.

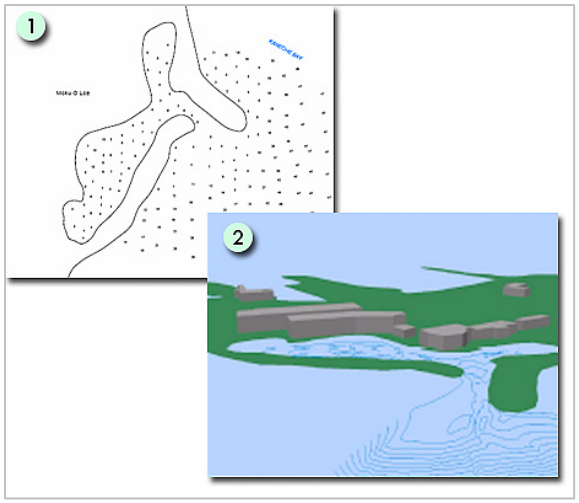

Figure 2. Hydrographic Survey: 1) shows product produced by divers; 2) indicates product produced by geospatial analysts.

Yet, although US Army divers are not geospatial or topographic analysts by any stretch of the imagination, they are, however, uniquely positioned to collect such bathymetric data and have a strong desire to make that relationship work. Very early in our collaboration, we drew the line of demarcation: divers collect, tidal correct (post-process) the data, and produce a rudimentary chart using TerraModel survey software; 70th Engineer Company geospatial analysts then use this point data and produce interpretive bathymetric surfaces for visualization or further analysis; finally, the 5th Engineer Detachment ingests the raw data into the TGD. This practice has served all these organizations well in terms of production, analysis and interoperability.[vi]

During this process, we were confronted with a challenge that revealed a very essential element to every value-adding process: trust. Fortunately, we overcame this obstacle fairly easily with simple dialog. However, as the Army transforms from achieving success via purely vertical command relationships to that of horizontal integration, developing and maintaining a trust relationship is imperative (Friedman 213).

Lastly, we faced a decision as to which and how much bathymetric data to consume into the TGD. Although feature classes have been reserved for such data (sounding points and depth lines), ingesting this data required deliberate human intervention. For instance, given an average 10,000 depth points of a small harbor (about two square kilometers), we only incorporated those points where slope change was locally significant.

Theater Terrain Analysts

As the theater geospatial production management cell, the 5th Engineer Detachment issues production directives in conjunction with required specialized or baseline datasets distributed as a personal geodatabase extract. When extracted for production by the 70th Engineer Company, that extract includes all domains found in the appropriate TGD data model.

The primary challenge with this cross-organization workflow is training and therefore familiarity with the workflow process at the data producer level, in this case, the 70th Engineer Company. After nearly six months of trial and error (producing sample extracts, value-adding to that extract, ingesting into the TGD, and redistributing as a new baseline), the basic flow became more and more familiar to all parties involved. Still, it takes strong and effective production control leadership to ensure strict application of workflow and production principles. In all cases, the 5th Engineer Detachment performs the final quality checks on the data and makes the decisions to populate the TGD.

Nonexistent network connectivity between these two organizations created another significant challenge. All data at every security level must be "air-gapped" between the 5th Engineer Detachment and its co-producers. Largely due to infrastructure and security constraints, this introduces a requirement for additional attentiveness as hard drives, CD-ROMs, and DVDs flow to/from all the organizations. This is not insurmountable, but leaders must carefully monitor this process.

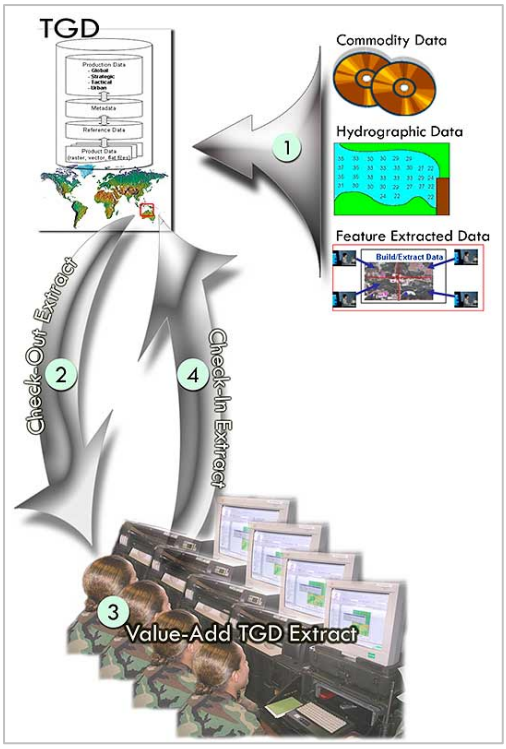

Figure 3. TGD Workflow: 1) extracted and commodity data; 2) checking-out a portion of the TGD for 3) value-adding and 4) reintegration into the TGD.

Prospects

We look at 2006 to be both an extremely challenging and rewarding year for the Theater Geospatial Database. The level of interest in this program is at it's absolute zenith. As we dialog with other Army commands (and outside of the Army, for that matter), all inquire about building a TGD of their own. We submit the true desire is for a TGD-like capability, and insist the TGD is more than a few additional servers and software packages. Despite our success, we face a 100% cut in program funding. Currently funded only through the end of this fiscal year, this command will have to provide most of the TGD capability out-of-pocket.

As TGD interest continues to grow, we are faced with enacting methods of data model configuration control. We are constantly faced with user requirements to add spatial and nonspatial data entities; this requires us to balance aspects of size, richness, and usability[vii]. Extending the TGD data model is a difficult prospect; however, not collaboratively doing so is fraught with even greater risks.

We at US Army, Pacific are extremely proud of these developments in value-adding. Many of the lessons of the past year greatly benefit today's unprecedented production returns. Made only possible by the TGD and the hard work and dedication of many, we continue on our data production, analysis, and dissemination mission in earnest.

Acknowledgements
The author would like to thank those who have assisted our Theater Geospatial Database (TGD) developments: CW3 Loren Small, Dr. Eugene Bingue, MAJ Nathan Rainey, Mr. Bryce Wyble, Mr. John Grammer, CW2 John Rusinko, CPT Matt Chaney, and 1LT Charles Denike.

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[i] In 2004, we were eminently successful in external data value adding to NGA's data stores. Workflows consist of effective feature and attribute mappings between our TGD data models and NGA's GIFD using ESRI Production Line Tool Set (PLTS). Thus, requests for NGA Geospatial Intelligence Feature Data (GIFD) data over the Pacific will often see credit given to US Army, Pacific (5th Engineer Detachment) in the metadata.

[ii] Commodity data is defined by us as any non-NGA validated or internally produced data that may readily yield useful information. Commodity data producers might be US Census TIGER line data, USGS DLG, or commercial purchased data.

[iii] Army geospatial analysis systems are based on the CTIS (Combat Terrain Information System). Fielded CTIS systems include the DTSS-Light (DTSS-L), a tactically mobile system mounted in an environmentally protected, standard Army shelter and carried on a HMMWV, the DTSS-Deployable (DTSS-D), a portable system comprising the same mission equipment as the DTSS-L, but mounted in portable transit cases for employment in tents, buildings or other environments as needed to support the mission, and the DTSS-Base (DTSS-B), a system employed in garrison with more robust data production capabilities and the ability to handle materials of higher security classification. CTIS upgrades consist of hardware and/or software upgrade blocks that are tested and configured as a unit Army-wide. Thus, development times from testing to subsequent fielding consist of lags well over 18 months.

[iv] ArcGIS 9.x should ship to most US Army analysis by spring, 2006.

[v] Despite the differing skill requirements between both units, the 5th Engineer Detachment is often mistaken as the "gold" training ground since analysts in that organization have the toughest training obstacles which they successfully overcome. However, reality dictates that all our geospatial units form significant and important core competencies and every geospatial leader must be very closely involved with the intricate training requirements of value-adding in both macro and micro terms. Given that we cannot provide each analyst all required training up-front, we require not only "just-in-time" training, but leadership that can understand how and when to apply training across the entire "geospatial supply chain."

[vi] We cannot stress enough the importance of exercising the lines of demarcation in data co-production. This boundary might be impervious to many, but it requires a consistent practice of meeting this line and working the issues in order to exercise Service co-production relationship. We will mention that, although we have been successful in externally value-adding from the TGD to NGA's GIFD, this success is only fully realized between those NGA offices directly supporting the Pacific. Few other Service partners in other geographic regions enjoy this relationship. Again, we feel this is due in no short order to meeting and exercising this line of demarcation between NGA and USARPAC.

[vii] Along with our US Army, Europe and US Army Topographic Engineer Center partners, we will conduct yearly data model configuration management boards to steer progress.