

## **The Way Forward**

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### **ABSTRACT**

The ambition for photogrammetric data providers has been the same for years – fewer processes, more productivity, more automation, and most importantly – more accuracy. The future is not hard to predict. We are on the threshold of one button processes – automatic aerial triangulation can be performed with little or no “professional” intervention, DTM generation from stereo is realizable, so-called “true” orthophoto capability is available automatically, unassisted change detection is used widely. Even the elusive automatic feature extraction is improving, and promising to become a contender in the fight for automation. As we improve these processes, we must keep our ears and eyes on the future. Where are we going? What are our long term goals? This paper will present Z/I Imaging’s goals, and our vision for the future. It will candidly present the near term trends, and stand back and look at the longer term, with a birds-eye view of the field, and perhaps, a sobering view of our future.

### **1. INTRODUCTION**

The goal of Z/I Imaging has always been twofold – first, to make its customers productive, and thus profitable, and second, to encourage rapid advancement in the technological capabilities, in the Photogrammetric community, that help achieve the first goal. Even the formation of Z/I Imaging, as a joint venture, was partly undertaken for these reasons. The work on the Digital Mapping Camera (DMC), undertaken at Carl Zeiss, was married with the rapidly increasing popularity of the ImageStation. Four years into the making, Z/I Imaging has crossed some wide rivers, but there are still many waters to cross, and lots of progress to make, before our customers experience a completely automated end-to-end workflow.

### **2. PRODUCTIVITY IMPROVEMENTS TODAY**

Let’s take a candid look at today’s technology, and its presence in commercial Photogrammetric systems. Automation is widespread and continuing to offer the best leaps in productivity. However, there are still gaps in our ability to truly automate processes. New algorithms and methods, such as true orthophotos and GIS databases, are still being developed for newer products. Digital cameras have arrived on the scene, and new processes and applications are being developed to support their different workflows. What are Photogrammetric system vendors doing to reduce the cost of Photogrammetric processes to a negligible amount? Most of today’s productivity enhancements can be placed into one of the following classes – more automated processes, application performance improvements, more flexibility, better programmability, and enterprise data management tools.

#### **More Automated Processes**

Automated processes give the greatest productivity increases today. There are automatic aerial triangulation (AAT) programs that can correlate on overlapping images, and perform a bundle adjustment in one step. They can integrate GPS/IMU data for a more accurate initial estimate and tighter constraints, and can incorporate elevation data for even more precise geo-locating. But what do they do with the results? Most AAT programs can give a numerical or graphical representation

of the accuracy of the adjustment, but can't accurately judge the quality of an adjustment themselves, without the eye of a Photogrammetrist.

Automatic digital terrain model generation programs use similar techniques to generate elevation data from stereo models. But can they perform the same function as a quality control operator, and inspect the output DTM for spikes or holes? Can they determine the accuracy of the product, and make the decision to continue and generate an orthophoto? A one-button orthophoto generation process that blindly performs automatic aerial triangulation, generates a DTM, and produces inaccurate orthophotos certainly doesn't INcrease productivity. An effective productivity tool estimates and reports the final product's quality before processing begins, notifies the user when the predicted outcome changes or is problematic, and allows the user to intervene, fix any data errors, and proceed with the process. Today, we still rely on some level of Photogrammetric expertise to analyze and approve of the intermediate results of our processes, and decide how and when to proceed to the next process step. Our automation improvements need to expand to include multiple steps in the workflow, and make workflow related decisions. For this, we need expert systems.

### **Application Performance Improvements**

Application performance improvements result in a moderate boost in productivity. Since these performance increases are easily measurable, they are the most visible, and sometimes, the most sought after. Such improvements include reducing the number of mouse clicks on project setup and control point measurement, increasing roaming speed, improving menu traversal, or adding shortcuts or quick keys. With the arrival of digital cameras, there is more need to move away from the model-by-model method of stereo compilation (which should have gone away with softcopy photogrammetry anyway). Most stereo applications either a) offer an easy way to move between "virtual" models, or b) have removed the concept of stereo models altogether. Another performance improvement that is common is the removal of intermediate steps in a workflow. The true orthophoto capability added to Z/I Imaging's OrthoPro removes incorrect redundant imagery automatically – something that was previously done as a post process to the orthophoto generation.

### **Flexibility and Programmability**

One way to make our customers more productive is to give them the tools to do their own customization. To do this, our software has to be flexible and programmable. Z/I Imaging offers several different layers of programmability, ranging from macro capabilities to VB controls. Using Microsoft Component Object Model components, customers can build their own VB or VC++ applications, or customize their own workflows. Z/I Imaging components allow our customers to probe for elevation values, perform mathematical operations, perform image correlation, read or write many image formats, compress or decompress image data, utilize advanced user interface functionality, and much more.

### **Enterprise Data Management - TerraShare**

Probably one of the greatest productivity boosts does not come from enhancements to existing applications, but from new tools that take the complexity out of the entire production workflow. One such area is in data management. Today some data management products exist that control massive amounts of data, allow query and search capability, and take the guesswork out of finding information. TerraShare is Z/I Imaging's data management offering.

TerraShare stores, manages and tracks the customer's data, throughout the enterprise. Users never have to be concerned with the location of data, whether or not it is online, near-online or offline,

what file server or RAID contains the data, or how to access their data. Users access data through logical files and folders or through their geospatial location, not through arbitrary or confusing file names. TerraShare's intuitive user interface, Microsoft Windows Explorer, makes using the product almost second nature. Common windows capabilities, like cut, copy, paste, move, search, and many more are supported for the logical, geospatial, and metadata view of the data. Advanced functions, like the SQL Query capability, make searches, based on user defined metadata, as easy as finding a file in Explorer. Since logical files are made up of one or more physical files, multi-file data is represented as single entities, operating together as one. Operations on TerraShare files can be defined by the user, such that "Send To" or right mouse buttons launch Z/I Imaging or 3<sup>rd</sup> party applications.

TerraShare, as it exists today, has given customers much greater leaps in productivity than any application of the above productivity enhancement classes. Some customers have recognized a 25%-35% increase in productivity by utilizing the core TerraShare functionality to manage their large number of images and DTM data. TerraShare's query and search capability makes finding data a snap. TerraShare's customization capabilities make incorporating 3<sup>rd</sup> party applications into customers' workflows simple and fast.

### **3. WORKFLOW MANAGEMENT TOMORROW**

The next great leaps in productivity don't come from any of the above classes, but from a new direction in workflow enhancement – workflow management. Workflow management encompasses several concepts – process management and monitoring, user defined data visualization, distributed and queued processing, and programmable services. The next major enhancements to TerraShare will contain all of these concepts, and will allow the customer to manage their workflows as well as their geo-data. These concepts improve the users workflow and production management capabilities by increasing automation of inter-process functions, improving process flow monitoring capabilities, increasing CPU utilization, and improving and standardizing graphical data and process status views.

#### **A Production Scenario**

For purposes of this discussion, we will consider an imaginary company that creates thematic maps in a production capacity. The workflow for the generation of these thematic maps includes steps for creating blank GeoMedia workspaces, automatically making database connections to data, choosing from a large number of available databases, generating feature classes, creating the thematic views, adding text and marginalia, time stamping and copying the maps, and plotting to a device. The current status of a particular map can be viewed instantly by setting the parameters in the Footprint Theme form. Each process step can be represented by such attributes as color, line style, line weight, or fill pattern (Figure 1). Several views of the data can be presented – non georeferenced (Figure 2), georeferenced (Figure 3), and a logical file view (Figure 4)

**Edit Footprint Theme**

Name: TerraShare File Online Status

Description: Color indicates BIO type and line style indicates online status.

☒ TerraShare Folder Theme  
☐ ISPM Project Theme

**Footprint Attribute Defaults**

Footprint Color:   
Point Color:   
Line Weight: 1  
Line Style: Dash-Dot-Dot  
Fill Pattern: Transparent

**Attribute Mappings**

Set the Footprint Color to Light Yellow

When TerraShare Metadata is BIO Type Images

Attribute Name	Attribute Value	Source Name	Source Values
Set Line Style	to Solid	when Online Status	is Online
Set Line Style	to Dash	when Online Status	is Offline
Set Line Style	to Dot	when Online Status	is Virtual
Set Footprint Color	to Light Green	when BIO Type	is Images
Set Footprint Color	to Red	when BIO Type	is ElevationModels
Set Footprint Color	to Light Blue	when BIO Type	is LocatorMaps
Set Footprint Color	to Light Magenta	when BIO Type	is ISPMProjects
Set Footprint Color	to Light Cyan	when BIO Type	is Generics
Set Footprint Color	to Light Red	when BIO Type	is Vectors

Buttons: Add, Delete, OK, Cancel, Help

Figure 1 – Footprint Theme Form

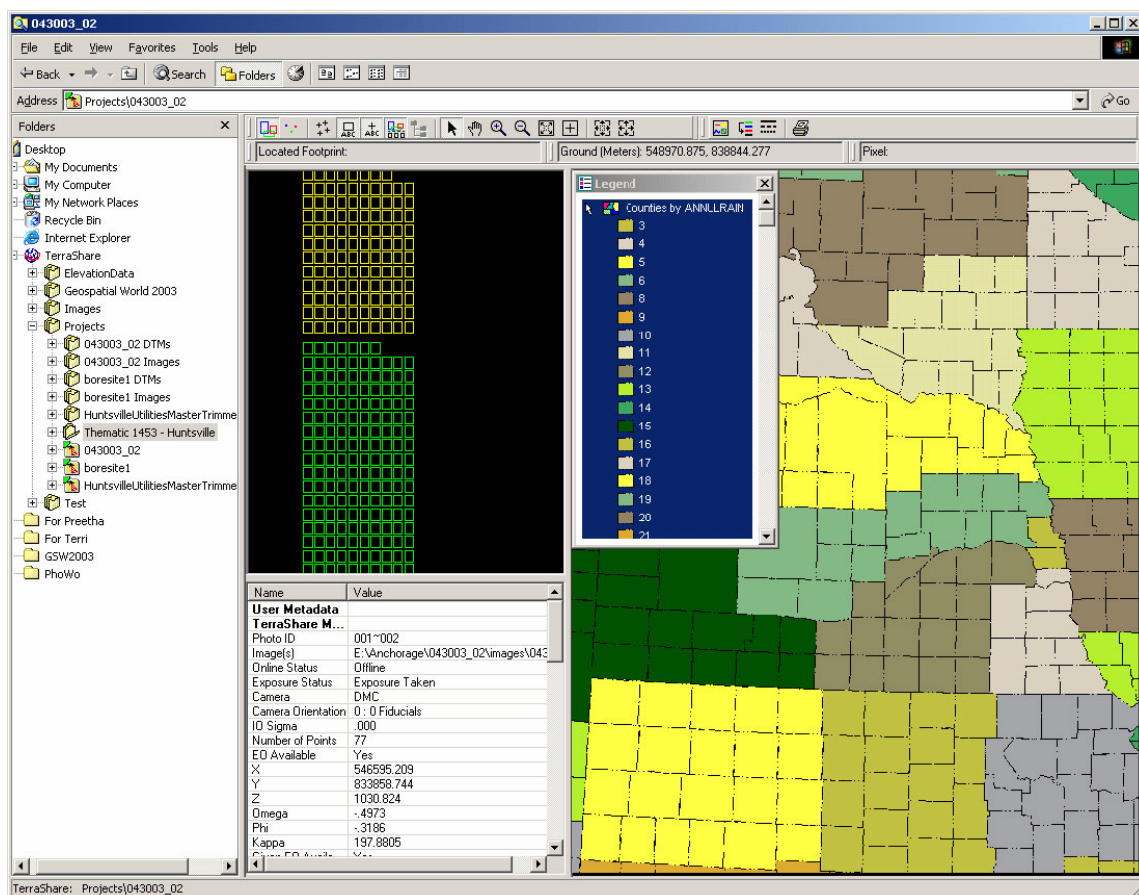


Figure 2 – Non Georeferenced View

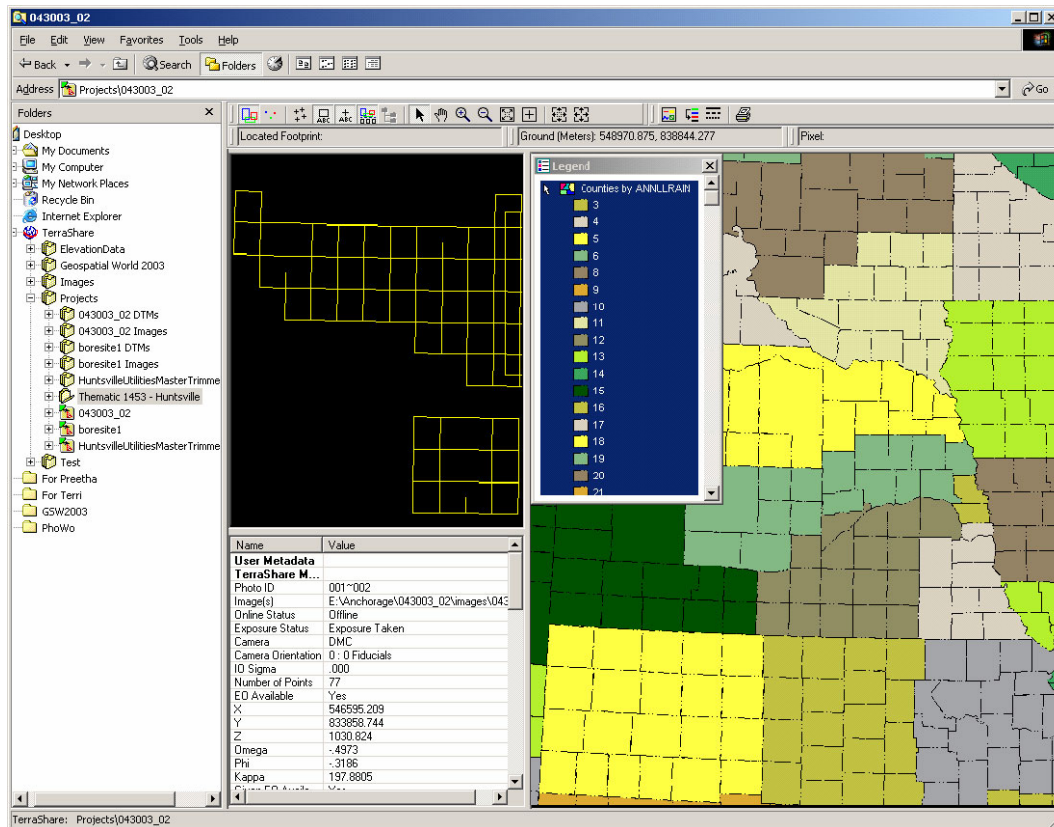


Figure 3 – Georeferenced View

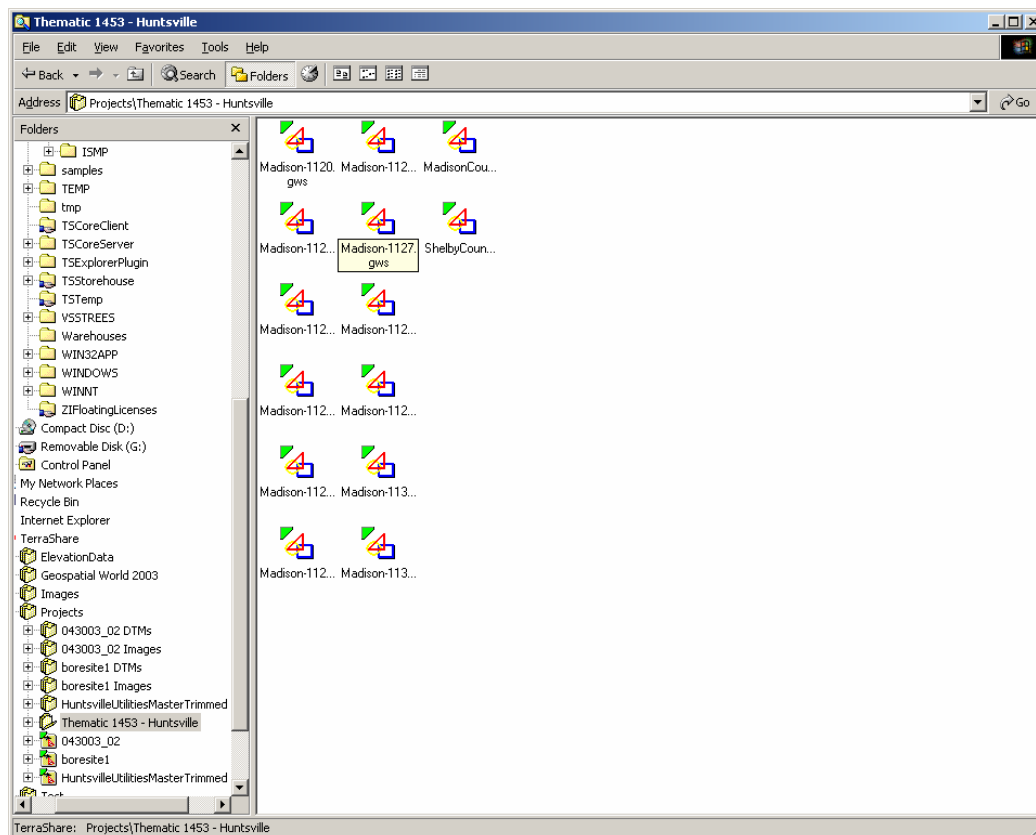


Figure 4 – Logical File

## Process Management and Data Visualization

Using pre-defined database features and user-defined database capabilities, users can define process boundaries, status conditions, and the graphical views that represent those statuses. For example, a geoworkspace with a coordinate system defined can be displayed with a green, dashed boundary. To operate on a workspace, the user simply uses the right mouse button on a footprint or file icon, chooses a menu item, or selects a defined process chain. Operations can be executed immediately or queued up for later processing. Processes can be distributed across multiple machines, thus reducing processing time by an order of magnitude.

## Queued and Distributed Processing

A process chain, which is a combination of queued TerraShare services or user defined applications, can be submitted to the Command Processing Queue (CPQ). The CPQ will initiate process steps, pushing the work out to multiple machines if distributed processing is desired. Distributed Processing offers obvious boosts to productivity, cutting processing time by dividing the work out to multiple CPUs. With this capability, processes that normally take a day can be reduced to hours or minutes! Process chains eliminate the need for the user to be present to start one process after another completes.

## Programmable Services

Not only can applications and batch jobs be initiated in TerraShare, but user defined services can be programmed, as Microsoft COM components, that utilize the TerraShare framework as well as the CPQ. These services are added to the menu through a well defined and simple process, and are available for the TerraShare File Types that they operate on.

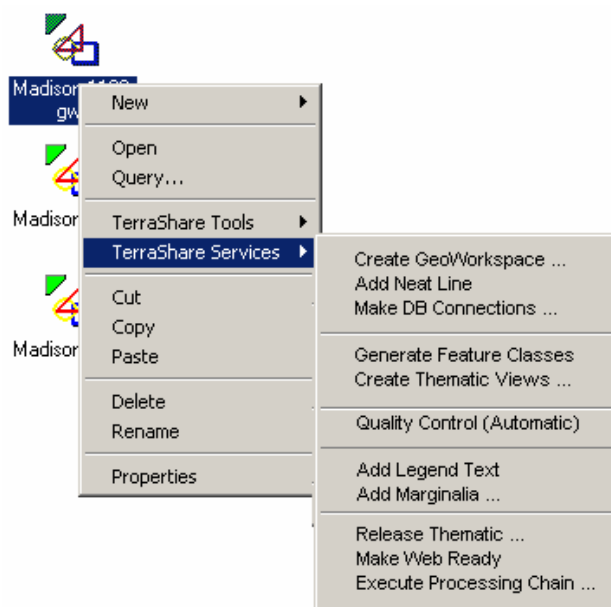


Figure 5 – Services Menu

Using a combination of the CPQ and TerraShare Services, customers can convert existing applications and tools into enterprise services that operate in a distributed environment, thus increasing productivity by major leaps. This also helps to build a tightly integrated processing environment.

What about error analysis and detection? These services, or more intermediate services, that detect error conditions or accuracy issues could be developed. Expert systems could be utilized to predict when problem conditions will occur, select what parameters to choose, and/or offer assistance to the operator. They could halt the processing chain, awaiting interaction from the user, or just suspend certain process steps. The definition of the process is in the customers' hands, and is fully programmable.

#### 4. CONCLUSION

Productivity gains can be realized in several ways, but the greatest gains are not obtained from enhancements to individual applications. Large leaps in productivity increases can be realized through extending current workstation based production into the enterprise. Extending to the enterprise means taking advantage of enterprise data management, process management and process monitoring, data visualization, distributed processing, and enterprise programmability. Clearly, the largest gains obtained from these attributes of enterprise workflow management, can be seen in distributed processing and enterprise-wide access to data, including process collaboration. Z/I Imaging has already broken the ground on enterprise data management with TerraShare, which is deployed in many customer sites throughout the world. Now we are moving our customers into enterprise production with the addition of workflow management into the TerraShare realm. Our goal, as always, is to make our customers as productive as possible.

Type of Enhancement	Percentage Gain in Productivity	Level of Productivity Increase
Application Improvements	5% - 12%	Low
Flexibility / Programmability	10% - 18%	Low
Automated Processes	15% - 27%	Medium
Enterprise Data Management	25% - 35%	Medium - High
Workflow Management	30% - Unlimited	High