

Table of Contents

Introduction	6
Editorial and Associated News [by Dr. Lee D. Miller, President]	8
Software Longevity.	8
Getting the Word Out.	8
Late? Not really.	10
Testing and Retesting.	11
Getting Support.	13
Searching for Information.	14
Hardware News	16
Software News	17
Global Reference Geodata	18
Introduction.	18
Geodata Descriptions.	19
Floating TNT Licenses	25
Windows 95 and Windows 98	25
Mac OS X	25
Mac OS X 10.3 (Panther).	25
Mac OS X.	25
TNTmips Does 64-bit	25
Background.	25
Apple's Mac OS X for the G5.	27
Sun's Solaris 9.x of the SPARC.	27
AMD's Athlon and Opteron using SuSE Linux 9.x.	27
AMD's Athlon and Opteron using Microsoft's Beta 64-bit Windows XP.	28
Itanium II using Linux or Windows XP.	28
TNTlite[®] 6.9	28
TNTsdk[™]	29
TNTsim3D[™] for Windows	29
Introduction.	29
TNTsim3D Interactive Tools.	29
TNTsim3D DataTips.	32
Using SML Scripts.	32
TNTatlas 6.9 for X	34
Customizing the User Interface.	34
Miscellaneous.	35
TNTserver/clients 6.9	36
New Formats Served.	36
HTML-based TNTclient.	37
DV7.0—Supporting OpenGIS's Web Map Service (WMS).	38
TNTview[®] 6.9	39
Inherited New Features.	39

Upgrading TNTview.	40
TNTedit™ RV6.9	40
Inherited New Features.	41
Upgrading TNTedit.	41
Tutorial and Reference Booklets	42
Searching with Indexes.	42
New Booklets Available.	42
Revised Tutorials with Major Changes.	44
Revised Tutorials with Minor Changes.	46
New TNTmips Features	47
System Level Changes.	47
TIFF Support.	48
JPEG2000 Compression.	49
2D Display.	58
* 3D Display.	62
Label Frames and Leaders.	64
Shape Object.	65
Raster Import.	66
Arc Shapefile Point Symbols Import/Export.	67
Oracle Spatial Layer Import.	67
Open DataBase Connectivity (ODBC).	67
Refreshing Tabular Views of External RDBMS.	68
Map Projections and Coordinate Systems.	69
* Orthorectification of QuickBird and IKONOS Images.	69
*Georeferencing.	79
Spatial Data Editor.	83
Map Layouts.	83
Render to SVG.	84
* Color Management.	86
Printing.	92
* SML Scripting.	93
Upgrading TNTmips.	102
Internationalization and Localization	103
Maintaining Translations.	103
Available Languages.	103
Pending Languages.	103
Microlmages Authorized Resellers	103
Discontinued Resellers	104
Appendix: Abbreviations	106
Attached Color Plates	
Global Data Sets	
Making a Global Data Set from VMap0	

Global Data Set with Scale Controlled Labels	
Viewing Global Data Sets in 3D (1/2)	
Antialiasing and Hinting of Thin Lines	
Clipping Near/Far in 3D Views	
TNTmips Does 64-bits	
TNTsim3D Interactive Tools	
Edit Point Positions in TNTsim3D	
DataTips for Point Overlays in TNTsim3D (1/2)	
Symbol Rendering Quality in TNTsim3D (1/2)	
Customizing TNTsim3D with SML	2-sided
Create Flight Paths in TNTsim3D via SML	2-sided
Customize Your View Interface	
Providing a Custom Interface for TNTAtlas/X (1/2)	
Link Sensitive Cursor with Navigator Tool (1/2)	
Use Layouts to Cusomize TNTAtlas/X	
New Tutorials	
Searching with the Index in Adobe Reader	
Macro Script Setup	
Automatically Vary Transparency in Raster Color Palettes	
Zooming to a Specified Location (1/2)	
Viewing Two Position Reports (1/2)	
Modifying SML Tool Scripts for New Applications	2-sided
Label Frames and Leader Lines	
Converting Symbols to/from Shapefiles	
Refresh Tabular Views of Linked Tables	
Orthorectification Results for QuickBird	
Orthorectification Results for IKONOS	
Rational Polynomial Orthorectification of IKONOS/QuickBird Images	
Evaluating Control Points for Rational Polynomial Orthorectification	
Testing Rational Polynomial Orthorectification	
Color Management for X Server and Views	
Color Management for Printing and Proofing	
Color Management and Printer Profiles	
Tool Script Templates	
SML Debugger and Script Timer	
Validating SML Dialogs Created in XML	
Build SML Dialogs Using Visual Basic	2-sided
ActiveX Callbacks to SML	2-sided
Automate Batch Imports using SML	2-sided
Calibrate Multitemporal Landsat Scenes via SML	
New Text Localization Utility	

Introduction

Microlmages in its 18th year in business is pleased to distribute **RV6.9** of the **TNT** products. This is the 54th release of **TNTmips** and adds approximately 150 new features submitted by clients and Microlmages. What follows is a brief summary of many of the significant new capabilities in **RV6.9**.

- **Global Geodata:** A DVD providing global reference geodata is included with **RV6.9** of your **TNT** product. It provides several Project Files containing clean objects each of which is world-wide in extent. These include a high quality color image of the globe and a digital elevation model of the continents both at 1 km resolution. The vector objects include hydrography, boundary, transportation, elevation, industrial, physiography, population, utility, vegetation, and data quality features. These features were prepared from 1:1,000,000 maps.
- **64-bit Products:** 64-bit versions of the **TNT** products are now available for Mac OS X 10.3.2 for the Apple G5, for Sun Sparc 9.x, and SuSE Linux 9.x and Windows beta XP for the AMD Athlon and Opteron.
- **TNTsim3D:** The free **TNTsim3D** geosimulation program for Windows now has a new compact icon tool interface. Styled surface feature points can now be selected, moved, and saved and their attributes edited. DataTips set up in other **TNT** products can also be used in a similar manner. Actively running simulations can now use **SML** scripts for tools and features such as route design and recording and to interactively communicate with other non-**TNT** programs.
- **TNTatlas:** The free **TNTatlas** publication tool can now be easily set up to use a custom, simplified interface. Special purpose tools such as data dependent queries created using **SML** Tool Scripts or Macro Scripts can be managed and provided as part of the layout(s) defining the specific atlases geographic structure.
- **TNTserver:** Web clients can now request that rasters be returned as lossy or lossless JP2 files or lossless PNG files with transparency in addition to lossy JPEG files. Vector content including attributes can be now be requested as an SVG layout.
- **Tutorials:** Four new tutorials booklets are available on the topics of designing user interfaces in **SML**, orthorectifying satellite images, geospatial science terms, and installing **TNT** products. Twelve other tutorials have been updated and expanded in scope to cover new features and ten more have been updated.
- **TIFF Support:** Auto-linking for direct use can now be made to any supported TIFF file, not just grayscale and RGB files. For example, links can be made to TIFF files with a hierarchical structure of multiple images/rasters and convenient autonaming is assigned. TIFF export now permits multiple images/rasters of various data types to be put into one TIFF file.
- **JPEG2000 Support:** Lossy and lossless JPEG2000 support can be used in **TNT** raster objects and in other **TNT** processes. For example, raster extract allows input objects in this compression and will write out JPEG2000 compressed raster objects. The import, export creation, and internal compression of a single file and raster object using JPEG2000 compression has been tested up to 275 GB. Files can be exported in the GeoJP2 modified JP2 format.
- **2D Displays:** Thin lines are now antialiased. LegendView is more compact. **SML** scripts can be attached to display layouts and thereby automatically added to the view's tools and menus. Coordinates readouts are simultaneously presented in

two different coordinate systems. A location can be zoomed to by entering its coordinates.

- **3D Displays:** Two new faster and more accurate terrain rendering methods are available: dense ray casting and variable triangulation.
- **Labeling Styles:** The frames for labels can now have various shapes and use single line or slender triangular leaders. The boundary of the frame can be controlled in thickness and color. The frame can be filled with transparent color. Margins can be set for all four sides of the frame relative to the text.
- **Shapefiles:** Styles for shapefile points can now be imported and exported.
- **Tabular View:** Tabular views can be refreshed for tables linked to in other RDBMS using ODBC or in Oracle using OO4O. The refresh can be set to be manual, automatic, or controlled via SML from another concurrent program in Visual Basic or some other language.
- **Satellite Image Orthorectification:** Complete or partial QuickBird and IKONOS satellite images ordered in their ortho-ready kit forms that provide their rational polynomial coefficients can be easily converted to orthorectified images. A DEM and several accurate XYZ ground control points are the required inputs for this procedure.
- **Georeferencing:** The management, display, and analysis of the ground control points being entered have significantly improved. Overall statistics provide indications of the overall accuracy of the control point collection. The satellite image rational polynomial coefficient model has been added to facilitate the input and evaluation of the needed XYZ control points.
- **SVG Support:** Images can be embedded in SVG layouts in JPEG, as well as the previously supported PNG format. **TNT DataTips** can be incorporated. **TNT** layouts being converted to SVG can be clipped. External stylesheets can be created.
- **Calibrated Color:** ICM and ICC color management can now be used to cross calibrate the color view on the monitor with printers, scanners, digital cameras, and so on using the standard (sRGB) color management built into the **TNT** products long ago. The major result is the optimal reproduction of the color on the monitor on any available printer. Any out-of-range colors on your monitor can be printed choosing from relative colorimetric, perceptual, saturation, or absolute colorimetric rendering models. How much of the color range in the current view can be rendered on the color printer can be quickly examined by a soft proofing option which limits the color monitor to the calibrated characteristics of the color printer and alarms the pixels that will be out-of-range.
- **Printing:** Six, 7, and more color printers are supported in addition to the ICM and ICC color management conventions.
- **SML Documentation/Examples:** All 976 functions have interactive access to documentation and example uses. The 557 class methods for the 324 classes have interactive documentation. Two tutorial booklets are now available with about twice as much reference material on how to work with **SML** (**TNT's** geospatial scripting language).
- **SML Debugging Tools:** An open script is automatically loaded into a second view for debugging. This view provides icons to run, step through, pause, stop, show pseudo code, and show timing. This view can be used to insert breakpoints into the script and to review the time of execution of the individual steps in the script.

- **SML and ActiveX:** **SML** can now accept callbacks from other non-**TNT** programs and, in turn, communicate with some aspects of the current **TNT** process. For example, a **TNT** view can be redrawn to update its pinmap from a linked database. Another application would be the use of Visual Basic to provide the interface for the **SML** process.

Editorial and Associated News [by Dr. Lee D. Miller, President]

Software Longevity.

When you spend a lot of money for a product you want to make sure it has longevity. Companies spring up with new innovative ideas and then fade away or are digested by the monopolies. Perhaps this is why big software companies get bigger and bigger. I know that MicrolImages is not using many of the same software products we used a few years back except for big name brands and none of the computer brands except Apple. Fortunately, with your support I have had the privilege and gratification of shepherding 54 releases of the **TNT** product out the door and writing 54 of these MEMOs over the past 18 years.

However, the true test of longevity of software is how long it remains viable to you by adding new features and transcending hardware and operating systems. MicrolImages is pleased to have an active client who began using **TNTmips V1.0** and has just ordered his annual maintenance for **TNTmips RV7.0** and **RV7.1**. In this same context the first state agency to order **TNTmips V1.0** now has 20 units and most are updated through **RV7.1**. At the other end of the time scale, MicrolImages has prepaid orders for future releases out to **RV8.0** (which means, to year 2010). Thirty years is a lot of releases, loyalty, and trust from the users of any software product. We appreciate your long term support, confidence, and patience with our products.

Getting the Word Out.

Advertising our **TNT** products into the face of a monopoly is a waste. As many of you know, I am of the opinion that MicrolImages' income is better spent to advance the capabilities of the **TNT** products for you, supply the best professional support possible, and more recently to improve automated product testing. Thus I greatly appreciate the excellent assistance our dealers and clients give us in the promotion of our products. Whether you help us promote our products and approach one-on-one with a friend or in bulk as follows, I appreciate it.

Japan does 6500 TNTlites.

The Japanese language periodical covering GIS is called GIS-NEXT (see http://www.c-crews.co.jp/gnext_express). GIS-NEXT has a circulation of 6,500 (90% subscription and 10% newsstand). The target audience is in survey, construction, and design (33%); education (22%); government and related 21%; IT and system integrators (15%), and individuals and others (9%).

The April 2004 issue will contain an article to introduce **TNTlite** prepared by OpenGIS, MicrolImages' Reseller in Japan (see www.opengis.co.jp). The target audience will be beginners in GIS. This same issue will bundle a CD containing **TNTlite V6.8** for Windows and Macintosh completely translated into Japanese: from installation, interface, help, comments, strings in database and so on through to publishing results as layouts, **TNTatlases**, and **TNTsim3D**. Additional tutorial exercise will be included using sample data prepared on Japanese topics and locations as well as an expanded collection of

SML scripts tailored to special Japanese interests and requirements, such as importing from the special formats of a variety of Japanese-only geodata sources. After this initial distribution, subsequent issues over the next couple of years will contain a series of articles by OpenGIS highlighting various applications of **TNTlite**.

Turkey does 9000 TNTlites.

Two illustrated and bound books have been written around the use of **TNTlite** in Turkish and 3000 copies have been previously distributed by HAT, Geographical Information Systems and Trade, Inc., MicroImages Reseller in Turkey (see www.hatgis.com.tr). One book is entitled COGRAFi BiLGi SiSTEMLERi translating as Geographic Information Systems (260 pages) and more information and some sample pages can be viewed at www.microimages.com/i18n/_tr_turkish%20COGRAFI.htm. The companion book is UZAKTAN ALGILAMA translating as Remote Sensing (176 pages) and more information and some sample pages can be viewed at www.microimages.com/i18n/_tr_turkish%20UZAKTAN.htm.

As a result of this initial effort, these HAT materials have become an important educational resource throughout Turkey where most students can not use the English language technology available in this area of study. Due to the success and interest in these materials, HAT is just completing the revision and update of these books and has scheduled a second printing of 6000 copies of each to be distributed along with **TNTlite**.

England Finalizing 5000 TNTatlases.

The Petroleum Exploration Society of Great Britain (PESGB), a non-profit organization in Britain, has recently ordered 5,000 DVD copies of the **TNTatlas** version of the Millennium Atlas of the Petroleum Geology of the North Sea. This is being prepared for them in Britain by a consultant and will be distributed free to members in April. For a synopsis of the original 400 page paper atlas published in 2002 please see www.npd.no/English/Emner/Ressursforvaltning/the_millennium_atlas.htm and other Internet sources. Recently the extensive maps in this atlas have been reduced to vector form and can be acquired in various formats for a fee. Now they will also be viewable only as an autorun **TNTatlas** using the locked Project File option. This locked option means that this geodata can be used in the atlas (viewed, manipulated, queried, ...) but the digital geodata can not be accessed by any other **TNT** product for export, modification, or further analysis except by the single, specific **TNTmips** software authorization key that created the atlas. Some additional details on this project can be found at www.exprodat.com/products/mill_atlas.htm. More information will be provided here about this **TNTatlas** after its official release.

Australia Farming Practices Book to Include TNTlite.

A book on spatial information management for farmers is being considered by CSIRO Landlinks Press (www.landlinks.com). It would include **TNTlite** on a CD and be targeted toward technical training organizations especially those conducting distributed education courses, national farm information groups, rural merchandise stores, and related agricultural groups. The CD would provide sample data sets for practice use in **TNTlite** covering local applications of GIS, GPS, and remote sensing to Australian farms. These sample datasets are already prepared and if the book is approved for publication, it could appear as early as August.

Maylasia GIS Workbook using TNTlite.

A workbook entitled GIS: Satu Pendekatan Praktikal, translating roughly as Practical Exercises in GIS, has been written in Malaysian by Dr. Mui-How Phua of the faculty of the University of Malaysia at Sabah (Ph.D. in forestry, University of Tokyo). This workbook is currently in press. Dr. Phua can be contacted at pmh@ums.edu.my.

Late? Not really.

The official release of **RV6.9** of the **TNT** products was made via microimages.com on 31 December 2003. At that time any **TNT** professional client who had ordered a license to use **RV6.9** could download, install, and immediately begin to use it. If you had not ordered **RV6.9** before that release date or subsequently ordered it you needed an activation code from MicroImages to permit you to use it with your software authorization key.

Since that date MicroImages has duplicated the CDs containing the official **RV6.9**, prepared this MEMO and other supporting materials, and is now supplying herewith your complete release kit. These activities could not be completed until **RV6.9** was completed for official release and made available for downloading, duplication, and these subsequent operations.

Responding to error reports from those who have downloaded **V6.9**, a complete patched version of **PV6.9** has been substituted weekly for any new downloads of **V6.9**. It would be meaningless to have you download the 31 December **RV6.9** and then have to immediately apply the latest patch to it. As a result, anyone who has downloaded any full or minimal **V6.9** should not install the 31 December 2003 official release **RV6.9** on this CD. Also please remember that the latest patch available from microimages.com this week for your **RV6.9** or **PV6.9 TNT** product is comprehensive, inclusive, and can be applied to any earlier **V6.9**.

NOTE: If you have downloaded and installed a V6.9 or a patch since 31 December 2003, do not replace it with the older **RV6.9** on the enclosed CD.

The time between the official release via microimages.com and shipment of this hard-copy material has been somewhat longer than for previous releases. However, many software manufacturers are gradually shifting to first releasing their product electronically. Weeks or months later it can be ordered or bought in the store on a CD with its useless online help and without any printed materials. Finally, at a much later date, you can select and buy a hardcover reference book updated for that version. For example, the most frustrating retrogressive computer experience I have had recently in this cycle was to need some information on Microsoft Word for Windows and having to go out and buy an expensive reference book for an earlier version since a book for the current version was not available.

Unfortunately you will need to get used to the idea of downloading new versions of most software and also to applying periodic patches. This poses a problem for those who do not have any access or only modem access to the Internet. However, all the industry is moving forward and these changes are the practical reality of working with the latest software products. Those who have an older computer, use Windows 95 or W98, lack a \$35 DVD reader, have access to the Internet via modem, or are working under similar handicaps must reconcile themselves to getting things accomplished at a slower pace

on a computer where time must be interchanged with money. How much of your time you wish to exchange for money by working with less than optimal equipment and Internet access is something for you to decide.

About 1 January 2004 Microlimages' software engineers began working on the new features in the Development Version of 7.0 (called **DV7.0** until its official release date). As a result there are now several interesting new features already completed.

- DataTips. Add text styling and frame fill colors to substantially improve their appearance.
- GraphTips. Create graphical DataTips which will draw in (which means, pop in) graphical information .
- Manifolds. Display 2D surfaces called manifolds in 3D views (for example, curved geologic profiles).
- F3D Views. Faster variable triangulation of terrain surfaces is being added to 3D views.
- JPEG2000. The latest JPEG2000 library is being integrated.
- OpenGIS Coordinates. ISO Standard 19111:2003 Reference Coordinate Specifications supported by the OpenGIS Consortium are being supported.
- OpenGIS WMS. **TNTserver** is being expanded to an OpenGIS Consortium Cascading Web Map Server.
- SVG layouts. Rendering to SVG adds interactive measurement tools and multi-line styled DataTips.

If you wish to experiment with and use these in your advanced projects you can download **DV7.0** now. Since these are prototype features, you may end up helping Microlimages debug them, but you also have the opportunity to contribute suggestions for possible improvements in them while they are receiving active attention and become part of the official release of **RV7.0**. It is often easier for a software engineer to respond to your suggestions when they are actively working on a project rather than when he/she has been given a priority on a new project for a new release.

As all these and other new other new features are added to **DV7.0** new color plates will be posted on microimages.com. Until such plates appear, it is unlikely that any other additional written information on them will be available other than the introductory notes in this memo. Of course, as always, our software engineers are willing to help you if you have a specific question.

Testing and Retesting.

It is only human nature to criticize software faults and question why its manufacturer did not test it more thoroughly. On the other hand, it is naive to conclude that commercial software manufacturers from Microsoft on down ignore this aspect of software development. Those of us who pay for the development of commercial software products learn pretty fast that solving an error after a product is delivered costs 100 times more than finding and solving it on the originating programmer's desk.

It is logical to wonder at this point why Microlimages software development engineers, most of whom each have at least 15 years experience writing the **TNT** code, simply can not do so without errors. That, of course, is not a realistic expectation as this is not a project of a single careful individual. Complex software is developed by many engineers on a day by day basis and evolves into place. It evolves as a very large, interrelated entity. Even perfect daily contributions from each team member can negatively impact on

today's work of someone else in the adjacent office or on code written years ago—all without any immediate manifestations.

Let's put the overall situation in context. Many of you who communicated with Microlimages last year requested 1 new feature or improvement to be added to the **TNT** products. Microlimages encourages you to do this as these are treated as serious inputs to focus upon in the development of our products. In many cases the requested feature is of high priority to you and your project. A few of you then separately indicated that you wish Microlimages would not worry so much about adding new features and concentrate on making the products error proof. So what we have here is a conundrum. We receive hundreds of requests for new, useful, and interesting features, many of which are individually highly important to a specific client. Paralleling this is the separate recommendation that Microlimages stop adding new features and extensively test each product by following out its thousands of procedural threads. Obviously, all these requirements can not be met. Extensive time spent testing a complex, large software product can make it more reliable, but as soon as it is altered just to correct an error or add a feature to meet your individual requests, which are often excellent, all of those testing results are suspect and should be repeated.

So what to do? You can not halt forward progress and stay in business! Humans can not and will not do the repetitious testing required over and over! Software implementation causes errors many of which ripple out into unexpected areas! To address these, the strategy gradually instituted at Microlimages has been to implement as many daily automatic testing procedures as possible. Why do it daily? Because all the Microlimages products must be rebuilt overnight on every supported platform so that each day's changes by all contributors are integrated together. This is then the basis for providing you with weekly integrated and comprehensive patches for the current version should you need them.

These are examples of the groups of nightly tests being performed with direct error reports sent to the responsible software engineer's desk.

- A large collection of complex map layouts are built and compared with the correct, stored output raster. A single complex layout can use many different object types and procedures. Layouts using non-English features are now being collected and added to this test set to help to track non-English text errors.
- The library of all SML scripts is tested to see if they parse.
- The SML scripts which can be automatically run without human input are run and checked nightly.
- A collection of complex vector objects are validated.

Some **TNT** processes, such as the Spatial Data Editor, are highly interactive with their operator. Furthermore, they provide many different interactive tools, which can be applied in a myriad of different orders. Since the Editor is difficult to automatically test, the first step was to provide it with good backup procedures in **V6.7** and **V6.8**. Now automated tests of various vector operations are being devised to monitor these activities embedded in the Editor and in related **TNT** processes. Fortunately, other "batch" oriented testing such as map layouts and vector validation also check these important operations in these products.

At the moment the nightly testing is being expanded to handle 3 versions at once: the previous release (latest **PV6.8**), the current release (latest **PV6.9**), and **DV7.0**. These have to be tested on various platforms (Windows, Mac ... 32-bit, 64-bit and so on). Re-

cently most staff computers have been equipped with Purify, an expensive IBM product that must be purchased individually for each machine to build debugging versions of all these **TNT** processes. This enables processes with built in debugging to be used the next day by the development and support engineers to help track down our problems. Unfortunately, processes built with Purify take 10 to 20 times longer to build and then equally long to run so all processes have to be built with and without Purify.

All of this, together with the nightly builds of all these products, requires extensive overnight computer processing resources. As a result, considerable recent effort has been invested in writing a network management system to use many of the MicrolImages computers for an overnight distributed processing system for these builds and tests. Now all our staff desktops and many other computers are left on at night for this purpose. This central management service sends out the next test to each available machine that reports in as ready and suitable for a task. The individual machine then finds the appropriate test software, **TNT** process(es), and test data somewhere on the network, runs the task, and reports back the results to the proper destination such as the software engineer responsible for that program. This in turn puts a lot of demand for bandwidth on the intranet, which has to be upgraded to handle these requirements.

These activities are reviewed here to assure you that errors, preventing them, and getting you timely patches are important to MicrolImages. What is necessary is to develop a scheme that can monitor software health and quality while new features are being added. Please also understand that this is accomplished at considerable expense in terms of human capital, delays, and fewer new features. Please also understand that priorities assigned to the new feature you request are directly under my control. As a result I make daily decisions with regard to which new features will do the most for the most existing users and enable our products to remain competitive while also allocating the same human capital to error management and approaches to reduce errors.

Getting Support.

At this time *all* of MicrolImages' software support engineers hold formal university degrees in **computer science**. Thus you are communicating directly, free-of-charge with a computer professional who knows about software, programming, networks, systems, and the operation **TNT** products, but is not a geospatial analyst or professional in some application area.

Gradually, over the years, the technical range and complexity of geospatial analysis and, thus, the **TNT** professional products has increased. As a result, your questions have been requiring more and more technical expertise to answer. A good example is the continuing increasing proportion of your questions related to your use of **SML**, **TNTserver** setup, **TNTsdk**, interfaces to Visual Basic and so on. These are questions best addressed by computer science professionals and you are being provided with that kind of support. Correspondingly, more geospatial technicians are being graduated or self taught and employed as this professional activity expands to mainstream. This also increases the complexity of operational oriented **TNT** questions and correspondingly decreases the number of your application questions.

Please also remember that, by policy, MicrolImages does not do applications in competition with you, we do the software you use. Thus, MicrolImages is generally staffed by computer specialists who are not trained as you are in the application of geospatial analysis. They are more than happy to receive your application questions on how to go

about applying a **TNT** product to a given task or series of tasks from a technical viewpoint. However, they can not readily answer your questions about project design in your or your client's professional area of expertise (for example, city and transportation planning, archaeology, mineral exploration, meteorology, coastal studies, and so on).

We occasionally get inquires from clients along the line of "how do I apply my **TNT** product to this proposed river management project," or to "a watershed management project," or "to compete for this city infrastructure management GIS system," and so on. MicroImages support engineers can not help you at all in these areas and refer them to others here. Obviously those of us who are experienced in geospatial project design are going to need quite a bit of information and adequate time to discuss and to answer these kinds of questions.

Another kind request is to "provide information on who else is using a **TNT** product" in a specific application area. A good example of this was the request today of a potential client in the U. S. Navy asking who he could talk to about using **TNTmips** for extracting a DEM from underwater stereo photographs. Fortunately, we did know of a U.S. client in Florida who has been experimenting with this for years. While these requests are reasonable the principal problem in answering them is that MicroImages does not know what 90% of our clients are specifically doing with our products. As a result, this kind of question usually can not be satisfactorily answered. Our clients are scattered around the world in a hundred nations. They are uncomfortable or cannot communicate with us in English and only work directly with our Resellers. About all we know is the general area of their organization's activity (for example, agriculture, forestry, map making, and so on) from their registration form.

When you contact MicroImages' software support engineers for help, you will always get answers even though initially they may not be what you want as they may not be able to understand your inquiry, reproduce your problem, or make decisions about what you want added to the **TNT** products. Many problems require a back and forth dialog before they can be understood and the proper solution proposed.

Fortunately, MicroImages does have some very experienced Resellers, Geospatial Consultants, and professional clients who understand geospatial applications in various professional fields and how to use the **TNT** products in them. They can help you with project design and training in our own language and local setting. However, please expect to pay them as appropriate for their efforts.

Searching for Information.

One simple MicroImages resource that I feel could help many of you is the use of Google to perform searches restricted to microimages.com for a topic of current interest, to research various **TNT** features, or to simply figure out how to do something. All you have to do is "let your fingers do the talking and the walking" by pushing the SEARCH button at www.microimages.com/search/. This brings you up the familiar Google Advanced Search form, which is preset to restrict your search to only the material they have cataloged for microimages.com.

MicroImages has carefully insured that the text content of every one of the 76 Tutorials and Reference Booklets, the text in every one of the approximately 500+ color plates, the reference manual, and the content of every one of these 54 MEMOS is on microimages.com in a form that is completely indexed by Google. Linked to, or embedded in the PDFs of these text materials are all the associated color illustrations. This same

procedure is also followed for every new color plate added during the next development of the next version (for example, **DV7.0**) and any new or updated tutorials are also immediately posted, sometimes even in incomplete form.

All these materials provide you with at least 10,000 pages of text and many thousands of associated illustrations at your finger tips. The only caution is that some of these materials are older, but even then are useful to clarify a point as long as the assumption is not made that the **TNT** products still implement the concept or application, especially the user interface, in exactly that form.

Typically Google crawls and reindexes well over 1 gigabyte of text material on microimages.com at least once a month. Therefore, on the average your searches are up-to-date to within 2 weeks of the latest written materials released via microimages.com. For example, it is likely that the contents of this MEMO will already be indexed by Google for searching by the time you read this—so try a search on some unique phrase herein.

I use this Google site search daily as I think of this collection of materials as my large filing system of all the permanent **TNT** product formal reference materials. During the writing of this MEMO, I consulted it very frequently to check a color plate or tutorial to review, and sometimes understand what had been accomplished in **RV6.9**. Often 2 well chosen words, when restricted to microimages.com in this site search, provide me a reasonably short list of references on the topic of interest. I can then locate the specific item and use the Google link to review it.

I often have a good idea of just which 2 or 3 words to try since I am quite familiar with the reasonably standardized terminology used in these written materials. This should not discourage you, as it only means I get to what I want sooner. With a little practice and thought, you will also get familiar with how things are expressed and can be located. All these documents are written as technical reference materials. They usually employ carefully selected terminology and repeat the same term over and over to avoid possible confusion in your understanding of what is meant. And, of course, you can always ask the software support engineers for the appropriate search terms, which will often lead you to more information on your topic than they could directly provide you, especially the illustrated materials.

A good source of the terminology used in these written materials is the new reference booklet released with **RV6.9** entitled Glossary for Geospatial Science. It will be of special assistance to help non-native speakers of English select search terms and phrases. Over the next couple of months MicroImages will investigate how we can assist you further in choosing what you enter into this Google site search to retrieve the references on your topic of interest.

For example, perhaps this glossary with additions can be added to this search area on microimages.com to assist you in a more direct fashion in entering your search terms. Often you can also remember something about how a feature or concept was previously presented in our written material, such as in a color plate. It may be possible to further restrict your site search to specific groups of materials, such as only color plates, only tutorials, only these release MEMOs, and so on. It may not be possible to confine your search to a date range since periodically these materials are rearranged or revised and, thus, Google assigns a new and current date to them. Watch this search area of microimages.com for these developments and come back with any ideas you have, keeping in mind that we can not readily change or humanly cross-reference over 10,000 pages.

Hardware News

nVidia Fights Back. by Dave Salvator. PC Magazine. June 30, 2003. page 38.

This review compares the performance of the most recent nVidia display board (GeForce FX 5900 Ultra) with the most recent ATI board (Radeon 9800 Pro).

Fresh Ideas in Databases. by Bill Machrone. PC Magazine. February 12, 2002. page 57.

While this editorial is a bit dated, it provides some useful insight into how and why database software is evolving.

Tough Choices: Ruggedized Notebooks. by Jim Engelhardt. Geospatial Solutions. May 2003. pages 42-43.

"It's a rough world out there. To protect your hardware and data investments, durable notebook computers are essential for withstanding the harsh environments encountered during mobile mapping and GIS data collection."

Low Cost GPS.

MicrolImages periodically receives questions about which GPS system to use. **RV6.9** provides a simple procedure for orthoimage production from IKONOS and QuickBird images supplied with Rational Polynomial Coefficients (RPCs). As a result you may become interested in determining which GPS device and approach to use for collecting Ground Control Points (GCPs) of suitable accuracy for this satellite image rectification. MicrolImages as a software company has little field experience with these devices and the correct solution and the accuracy that can be achieved in your area varies widely around the world. These questions are best answered by those who have experience in collecting field data in your area of interest.

If you are interested in low-cost GPS units that are convenient to use with **TNTatlas** on Tablet PCs or similar applications please review the following sites and devices. Whether or not they produce adequate accuracy for your application is a matter for you to determine. If good supporting material is available (which means, high resolution airphotos for marking GPS point locations in the field) and a large number of GCPs are collected with access to the Wide Area Augmentation System (WAAS) correction signals, these or similar GPS devices could be used to collect the control points for this **TNT** rectification procedure. On the other hand, fewer GCPs are required if survey accuracy GCPs are collected and can be very accurately located in the satellite image (for example, use high resolution airphotos for locating points in the field).

DeLorme.

The Earthmate GPS Receiver from DeLorme at www.delorme.com is a \$130 unit the size of a matchbox and has a USB cable interface or can be adapted for wireless using Bluetooth. With either interface, it can be mounted on a vehicle roof or atop a staff to get it above your body and nearby obstructions thus "seeing" more satellites. It can also provide improved accuracy by acquiring the WAAS satellite's GPS position correction signals for the United States including Alaska, most of Mexico, and southern Canada (www.nstb.tc.faa.gov/vpl.html). The European equivalent of WAAS, called European Geostationary Navigation Overlay Service (EGNOS), is scheduled to become available this year.

PHAROS Science and Applications, Inc.

The PHAROS USB Connected GPS Receiver and the GPS Receiver with Bluetooth Wireless Technology at www.pharosgps.com are quite similar devices in size and functionality to the DeLorme products outlined above.

Software NewsMrSID – LizardTech.

LizardTech, Inc. To be Acquired by Celartem Technology USA, Inc. Directions Magazine. Press Release. 20 June 2003. For details see www.directionsmag.com/press.releases/index.php?duty=Show&id=7328.

Some highlights:

“LizardTech, Inc. employs 29 people and is being acquired for US\$11.25 million in cash. [at its peak LizardTech employed 150 staff and various sources indicate that LizardTech has had US\$45 to \$50 million in outside capital over the past 11 years.” [for example see seattlepi.nwsource.com/business/liza20.shtml]

“Celartem Technology USA, Inc. is wholly owned by Japan’s Celartem Technology, Inc. which provides digital image and secure content distribution solutions. The addition of LizardTech’s core technology and applications further Celartem’s vision to consolidate and develop technology to simplify and enhance the creation, management, control and distribution of digital content.”

BREAKING NEWS: Mapping Science, Inc. no longer exists.

GeoJP2 - Mapping Science.

Effective 12 February the URL link to www.mappingscience.com points to a web page being maintained by LizardTech as follows.

“By now you’ve probably heard that LizardTech has obtained the assets of Mapping Science, Inc. This action is a result of a settlement in LizardTech’s ongoing lawsuit for claims against Mapping Science for misappropriation of trade secrets. Mapping Science has ceased operations and LizardTech will support Mapping Science customers going forward.”

The page continues on with additional information related to this topic.

Additional rumors on this topic can be found at www.lbszone.com/features/lizardtech_msi/ a portion of which are as follows.

“The ‘skinny’ on the suit. LizardTech entered into litigation as a result of six former LizardTech employees who founded Mapping Science. The findings of the settlement established that there existed a misappropriation of trade secrets and breach of NDA’s the employees had with LizardTech. Mapping Science will cease to exist as a company and all of its assets will be turned over to LizardTech. During the transition it is expected that some MS employees will be retained as consultants by LizardTech in order to facilitate a “smooth” transition and to continue supporting customers that may be affected. Documentation (such as the GeoJP2™ file specification) and other material that may have been previously available for download/access via Mapping Science’s website may not be available in the short-term, however, information can be obtained by contacting

tacting GeoJP2fileformat@lizardtech.com. Developers and software vendors will be pleased to know that LizardTech is currently working on a software development kit that will enable support for MrSID® and JPEG 2000, within a single SDK... stay tuned!"

LizardTech's official statement on this topic can be read at www.lizardtech.com/solutions/ms/msfaq.php.

Global Reference Geodata

Introduction.

Your **RV6.9** kit contains a DVD providing Global Reference Data in RVC format and illustrated in synoptic form on the attached color plate entitled Global Data Sets. These data sets were derived from the Visible Earth, VMap0, and GTOPO30 data, each of which is described in more detail below. This new geodata set is provided as a bonus feature for those who have purchased **RV6.9** or later of their **TNT** product. As a result the Project Files provided on this DVD will not work in any earlier version of a **TNT** product.

The global geodata provided on this DVD originated in the public domain as reviewed below. Since these digital geodata sets were originally created and distributed in the public domain, MicrolImages hereby declares that they remain in the public domain including this DVD and products derived from the geodata it contains. You are free to export and use the geodata on this DVD in any way you desire without restrictions.

Disclaimer: Since MicrolImages did not create this data, it has no responsibility for the accuracy of any of the geodata on this DVD.

Each of the three data sets included on the DVD (World 1 km Color Image, World 1:1,000,000 Map Features, and World 1 km Elevation) have been converted to single global layers georeferenced to latitude/longitude, centered on the Greenwich meridian. During this conversion, each original data set was subjected to extensive **TNT** processing into the appropriate **TNT** object types.

Image and Elevation. The image and elevation data were assembled and mosaicked to a common cell size, pyramided, and JPEG2000 compressed into 2 matching raster objects.

Map Features. The VMAP0 feature data started out as a ridiculous 129,588 files organized into 23,696 folders. It was reorganized into 10 **TNT** Project Files each containing several global vector objects of a common theme (for example, various hydrographic layers all in 1 Project File, boundaries in another Project File, transportation, elevation, industry, physiography, population, utilities, vegetation, and data quality in others). During this conversion extensive improvement and reorganization of these originally unmanageable data structures were performed using various **TNT** processes. These included:

- filtering out extraneous elements (for example, removing grid lines from feature layers),
- complete reorganization of the attributes,
- improved styling,
- merging all spatial coverage tiles of the globe by theme, and

- optimizing each vector object for faster access.

The effects of some of these merging and cleaning operations are illustrated in the attached color plate entitled Making a Global Data Set from VMap0. As a result of these operations, the vector objects provided in this set have the same spatial detail as their original sources, and they are vastly improved in ease of use over their original form.

Data Sets. This global geodata will provide you with an excellent starting point for any continent, nation, or province scale project. It provides a single MODIS color image of the entire earth, which can be viewed at any scale from a full view to a 1:1 view in 1 or 2 seconds. The GTOPO30 elevation data for the globe's land area has been provided as a single raster object. The 1:1,000,000 map features and attributes provided originally as the Digital Chart of the World and later as a VMAP0 product have now been reduced to 10 Project Files each with a few simple consistent theme layers each as a single global vector object. If you are zoomed in somewhat these optimized vector layers can be overlaid on the MODIS image in a few seconds (even the most spatially complex theme layers such as hydrology and water bodies). This is vastly more convenient than dealing with the approximately 24,000 folders and 130,000 files used for the original form of this data.

Each of the raster and vector objects on this DVD can be viewed individually using **TNTatlas** or any **TNT** professional product. They can also be viewed in combination, extracted from, and further edited and analyzed using the appropriate **TNT** product. As noted above, with its pyramided structure, the World 1 km Color Image displays in seconds at full view. However, some of the World 1:1,000,000 Map Features vector objects (for example, global hydrology) have *hundreds of thousands of elements* and may require 1 to 2 minutes for display at full view. This, however, is an incorrect use of any of these layers as it will fill the continents with a multitude of points, lines, and/or polygons, which produce a meaningless display because no individual elements can be distinguished. For faster display times and individually discernable elements, it is recommended that you first display the World Color Image, zoom up on your area of interest, and then add to the view the World Map Features layers of interest to you. Under these circumstances **TNT's** optimized vector structure will provide fast overlay of any of the vector layers in just seconds. When you use the global layout provided on the DVD (WorldAtlas in the WorldAtlas folder), these map feature layers are automatically added at appropriate scales. Scale control has also been included for the labels in these map feature layers and is illustrated in the attached color plate entitled Global Data Set with Scale Controlled Labels.

Microworlds hopes you will find a use for this geodata and use it to build and demonstrate projects that benefit from these superior features of the geodata management in the **TNT** products.

Geodata Descriptions.

World Image (Blue Marble: Land Surface, Shallow Water, and Shaded Topography).

Source.

The global image was originally prepared from MODIS images at the NASA Goddard Space Flight Center by Reto Stöckli (land surface, shallow water, clouds). Enhancements by Robert Simmon (ocean color, compositing, 3D globes, animation). Data and technical support: MODIS Land Group; MODIS Science Data Support Team; MODIS Atmosphere Group; MODIS Ocean Group. Additional data: USGS EROS Data Center

(topography); USGS Terrestrial Remote Sensing Flagstaff Field Center (Antarctica); Defense Meteorological Satellite Program (city lights). See the metadata included with the Visible Earth image in RVC format for additional credits and web addresses.

Preparation.

These NASA MODIS color images of the globe were the starting point for preparation of the World 1 km Color Image, which has been converted from its original TIFF format by import to **TNTmips**, mosaicked, georeferenced, and lossless compressed via JPEG2000 into a single raster object in a Project File. The resulting raster object has 21,600 lines and 43,200 columns with a ground cell size of approximately one kilometer. The uncompressed RVC file is 2.78 GB, and the RVC file using embedded JPEG2000 compression is 484 MB.

World Map Features (VMap0: 1:1,000,000 Maps).

Source.

Vector Map Level 0 (VMap0) is an updated and improved version of the Digital Chart of the World (DCW[®]) prepared and released by the National Geospatial-Intelligence Agency (NGA, formerly National Image and Map Agency or NIMA). The VMap Level 0 database provides worldwide coverage of vector-based geospatial data. It consists of geographic, attribute, and textual data. The primary source for the database is the 1:1,000,000 scale Operational Navigation Chart (ONC) series co-produced by the military mapping authorities of Australia, Canada, the United Kingdom, and the United States. The original VMap0 data is organized into four libraries of many, many files covering 10 themes. These libraries are Europe and Northern Asia (EurNAs), North America (NoAmer), South America and Africa (SAmAfr), and Southern Asia and Australia (SAsAus).

Preparation.

The four VMap0 continental libraries and theme structure is inconvenient for use in the **TNT** products. MicroImages has merged each of the themes into a single, global vector object that includes all available data for the world at the time the data was obtained. Note that the VMap0 data available to MicroImages did not contain all themes or layers for all areas (which means, all libraries). For example, the Vegetation theme covers North America only and the Miscellaneous Hydrography Lines layer was not present for North America. If coverage of part of the world is missing from the VMap0 source data, it is noted in the list of themes and objects below.

After merging, the vector objects were further modified as indicated in the list below. The step referred to as "database simplified" includes the removal of ID fields in the imported table and deletion of duplicate records, which have no use in **TNT** products. "Filtered" indicates removal of excess nodes; dissolving adjacent, identically attributed polygons into one; or both. The effects of these and other cleanup operations are illustrated in the attached color plate entitled Making a Global Data Set from VMap0. As a result of these modifications and to avoid confusion with the original VMap0 data, the vector objects provided are referred to as World 1:1,000,000 Map Features.

The accuracy of the standard attribute tables provided for all planar and polygonal topology objects is limited by the Latitude/Longitude georeference. Because all layers for each theme were imported together, polygonal topology was initially assigned to all. Many of the layers, however, had line attributes only, and these were then converted to planar topology, which saves about 15% in object size and displays significantly faster.

Objects containing points only have no corresponding benefits from changing topology type, so their polygonal topology was not changed. (For information on the properties of, and differences between, the various topology types, such as **polygonal** and **planar**, see the color plates included on the DVD entitled VTopoTypes and TopoBehavior.) VMap0 in its original VPF format is 1,805,094,587 bytes with 129,588 files in 23,696 folders. VMap0 in MicrolImages' RVC Project File format is 1,862,676,480 bytes with 10 files and does not use any folders.

Detailed Inventory

Following is a list of themes and layers in the World 1:1,000,000 Map Features provided at a total of 2.36 GB (larger than listed above because an additional layer that merges World_inwatera and World_watercrsl layers from the Hydrography theme has been added):

bnd: boundaries (116 MB)

- World_coastl: Coastlines, **planar**, database simplified (36,351→11 records), DataTip is exdesc (Definite, Indefin)
- World_depthl: Depth Contours, **planar**, DataTip is crv (numeric values), database simplified (48997→7 records), filtered
- World_polbnda: Administrative Areas, **polygonal**, DataTip shows state/country name, filtered, database simplified
- World_polbndl: Political Boundary Lines, **planar**, DataTip shows UseDesc (International, Primary/1st Order), may want F_CodeDesc (Administrative Boundary, Claim Line, Armistice Line), filtered and edited, database simplified
- World_oceansea: Oceans/Seas, **polygonal**, DataTip shows ocean/sea name, filtered and edited, database simplified
- World_polbndp: Political Boundary Point Features, **polygonal**, DataTip shows country code, database not simplified
- World_barrierl: Barrier line features, EurNAs, SAsAus only, **planar**, rest left as is (157 lines and records, would be just 1 record if simplified), DataTip is line length (all lines are walls)
- World_bndtxt: Boundary Coverage Text, **polygonal**, DataTip is nam

dq: Data Quality (5.85 MB)

- World_dqarea: Data Quality Areas, **polygonal**, DataTip is comp_date, database simplified (4850→314 records)
- World_dqline: Data Quality Lines, **planar**, DataTip is length
- World_dqtxt: Data Quality Text, **polygonal**, DataTip is textstring but many won't make sense because the complete DataTip is split over multiple records

elev: Elevation (695 MB)

- countourl: Contour Lines, **planar**, filtered, database simplified (1,099,573→419 records), DataTip shows ZV2
- elevp: Spot Elevations, **polygonal**, DataTip shows ZV2

hydro: Hydrography (573 MB)

- World_watcrsl: Water Courses, **planar**, filtered, database simplified (959,816→4 records), DataTip is perennial/intermittent, lines appear highly broken because polygonal water features are not part of this layer but are found in inwatera
- World_inwatera: Inland Water Areas, **polygonal**, database simplified (339965→5 records [1 is blank]), DataTip is perennial/intermittent

World_aquecanl: Aqueducts/Canals/Flumes/Penstocks, **planar**, database simplified, (3059→7), DataTip shows above/below ground surface

World_dangerp: Danger Points, **polygonal**, DataTip is rock or wreck

World_hydrotxt: Hydrography Coverage Text, **polygonal**, DataTip is textstring

World_miscl: EurNAs, SAmAfr, SAsAus only, **planar**, database simplified (190→3 records), filtered, DataTip is F_codedesc (seawall, dam/weir, breakwater/groyne)

World_miscp: Miscellaneous Hydrography Points, **polygonal**, DataTip is f_codedesc (island, waterfall, dam/weir...), labels on at 1:400,000

World_hydrology: Water Courses and Inland Water Areas, **polygonal**, merged World_watercrl and World_inwatera, then further modified to transfer polygon attributes to lines so that lines only could be selected for display to increase speed, DataTip is perennial/intermittent, perennial/permanent on at 7,000,000, non-perennial/intermittent on at 2,500,000. Because all elements have map scale controlled display, it will likely show no elements at full view even when added to a group by itself. **You must be zoomed in farther than 1:7,000,000 for any elements to show.** Other themes have their map scale control designated in the layout so it does not apply when viewed separately.

ind: Industry (3.16 MB)

World_storagep: Storage Point Features, **polygonal**, DataTip is Tank/Depot/Water Tower

World_misindp: Miscellaneous Industry Point Features, **polygonal**, DataTip is f_codedesc [Oil/Gas Facility, Processing/Treatment Plant, Tower (Non-communication)]

World_indtxt: Industry Coverage Text, **polygonal**, DataTip is textstring

World_fishinda: Fish Hatcheries/Farms, EurNAs, SAsAus only, **polygonal**, DataTip is f_codedesc

World_extractp: Extraction Point Features, **polygonal**, DataTip is Mine/Quarry, Well, Salt Evaporator, Oil/Gas Field

World_extracta: Extraction Areas, **polygonal**, database simplified (1171→4 records) filtered

phys: Physiography (62.1 MB)

World_grounda: Ground Surface Areas, **polygonal**, DataTip is smcdesc (Sand, Distorted Surface, Lava)

Landforml: SAsAus only, **planar**, DataTip is f_codedesc (Ice Cliff, Bluff/Cliff/Escarpment)

World_landicea: Land Ice Area, **polygonal**, DataTip is f_codedesc (Snow Field/Ice Field), edited (grid lines removed)

World_phystxt: Physiography Coverage Text, **polygonal**, DataTip is textstring

World_seaicea: Sea Ice Areas, grid lines removed, **polygonal**, DataTip is f_codedesc (Polar Ice, Pack Ice)

pop: Population (41.3 MB)

World_poptxt: Population Coverage Text, **polygonal**, DataTip is textstring (small villages, numerous graves, numerous buildings...), labels on at 5,000,000

World_mispopp: Miscellaneous Population Points, **polygonal**, database simplified (201,520→ 64,765 records), DataTip is txt (names or descriptions of buildings and settlements)

World_mispopa: Miscellaneous Population Areas, **polygonal**, DataTip is f_codedesc (Native Settlement or Military Base), labels on at 3,000,000

World_builtupp: Built-Up Area Points, **polygonal**, DataTip shows name (unk for many), use transfer attributes for NoAmer (from builtupa) and merge again, database union, database simplified (148→126 records), labels on at 5,000,000

World_builtupa: Built-Up Areas, **polygonal**, DataTip shows name field

trans: Transportation (203 MB)

World_aerofacp: Airfield Facilities Points, **polygonal**, DataTip shows facility name

World_dqline: Line Data Quality, **planar**, DataTip is f_codedesc (bridge, power, telephone, railroad...)

World_mistranl: Miscellaneous Transportation Lines, **planar**, DataTip is f_codedesc (Aerial Cableway Line/Ski Lift Line, Pier/Wharf/Quay)

World_railrdl: Railroads, **planar**, filtered, (database simplified (159980 records→13), DataTip shows single/multiple tracks

World_roadl: Roads, **planar**, filtered, database simplified (571334 records→42), DataTip shows primary/secondary route (names not present)

World_rryardp: Railroad Yard Points, **polygonal**, DataTip is f_desccode (Railroad Yard/Marshalling Yard), labels on at 3,000,000.

World_traill: Trails and Tracks, **planar**, filtered, DataTip shows length, database simplified (53339→4)

World_transtrc: Transportation Structure Points, **polygonal**, DataTip is f_codedesc (Bridge/Overpass/Viaduct, Causeway, Ferry Crossing, Ford, Tunnel)

World_transtrl: Transportation Structure Lines (tunnels, bridges...), **planar**, filtered, database simplified (4496→10)

World_transtxt: Transportation Coverage Text, **polygonal**, DataTip is textstring

utils: Utilities (32.8 MB)

World_dqline: Data Quality Line Features, **planar**, DataTip tells type of utility

World_pipel: Pipelines, **planar**, filtered, DataTip tells whether above or below ground, database simplified (7488 records→2)

World_utill: Power Transmission/Telephone/Telegraph, **planar**, DataTip is length (km), database simplified (106,130→3, 1 blank)

World_utilp: Utility Point Features, **polygonal**, DataTip is f_codedesc (Communication Building or Tower, Power Plant, Pumping Station, Substation/Transformer)

World_utiltxt: Utility Coverage Text, **polygonal**, DataTip is txtstring

veg: Vegetation NoAmer only (41.8 MB)

croipa: Crop Areas, Canada only, **polygonal**, DataTip is f_codedesc (Cropland), grid line removed

grassa: Grass Areas, **polygonal**, DataTip is f_codedesc (Grassland, Scrub/Brush)

tundra: Tundra, **polygonal**, DataTip is f_codedesc (tundra)

treesa: Trees, **polygonal**, DataTip is vegdesc (Deciduous, Evergreen, Mixed, Other)

swampa: Swamp/Marsh, **polygonal**, DataTip is f_codedesc (Marsh/Swamp)

World Elevation. (GTOPO30)

Source.

GTOPO30 is a global Digital Elevation Model (DEM) resulting from a collaborative effort over a three year period led by the US Geological Survey's EROS Data Center in Sioux Falls, SD. Source data or funding was contributed by NASA, the United Nations Environment Programme/Global Resource Information Database (UNEP/GRID), the US Agency for International Development (USAID), the Instituto Nacional de Estadística Geográfica e Informática (INEGI) of Mexico, the Geographical Survey Institute (GSI) of

Japan, Manaaki Whenua Landcare Research of New Zealand, and the Scientific Committee on Antarctic Research (SCAR). GTOPO30 was derived from a variety of raster and vector sources (see the illustration at http://edcdaac.usgs.gov/gtopo30/source_img.html). The original data set was completed in late 1996. This global topological data has a horizontal grid spacing of 30 arc seconds (approximately 1 km).

Preparation.

The World 1 km Elevation provided on this DVD was imported from EROS' GTOPO30 DEM format into Microlimages' RVC Project File format as 33 16-bit signed integer rasters that were mosaicked into a single raster object. A color map was subsequently selected and lossless JPEG2000 compression applied. The original mosaic in RVC format was 1.85 GB. The RVC file with embedded JPEG2000 compression and a null area mask is 160 MB. Note that JPEG2000 has no concept of a null value and will slightly alter these uniform null values in large null area (which means, water areas in this dataset). Thus a null mask is necessary and is automatically used for display when pyramid tiers are used because null values are not precisely conserved in sampling.

Using in TNTAtlas.

This DVD provides a layout that will open to show the World 1 km Color Image with World 1:1,000,000 Map Features Political Boundaries overlaid. This layout is found in the WorldAtlas.rvc Project File within the WorldAtlas folder. It can be opened (File/Open Object) and viewed in the free **TNTAtlas** product available from www.microimages.com. The layout is much more complex than the simple, initial view. It groups objects by theme and uses map scale controlled visibility and hidden layers to make the layout manageable and responsive.

Using in 3D Displays.

These global geodata sets can be used directly without modifications for a 3D view of any area of the globe as illustrated in the color plate entitled Viewing Global Data Sets in 3D. The world image can be draped over the world elevation layer and map features and symbols from the vector objects added as desired. **RV6.9** introduces a new 3D option for near/far clipping of the vector objects overlaid into a 3D view. Without far ground vector clipping, vector features can pile up and obscure the horizon in long global 3D views as illustrated in the attached color plate entitled Clipping Near/Far in 3D Views. By setting the far clipping value in the 3D Viewpoint dialog you can set a far distance (which means, the scale) at which vector features will no longer be rendered near the horizon of the view.

Rendering a large area in 3D from the global elevation layer takes an excessively long time. This is because the 3D viewing process forms triangulation for the entire elevation layer before rendering regardless of the area covered by the required view. This handicap of some 3D views of this global data will be rectified in the patches to **RV6.9**.

Other Geodata Sets.

Microlimages has acquired a higher resolution coastal boundaries data set prepared by NGA (National Geospatial-Intelligence Agency). The coastal feature layer on the enclosed DVD was extracted from 1:1,000,000 maps. This new global feature layer called WVFPLUS was prepared from 1:250,000 scale topographic maps in VPF format (382 MB). Microlimages is currently initiating a similar cleaning effort to bring this new feature layer into a Project File for future distribution.

Please identify other global data sets in the public domain for possible preparation and distribution with **V7.0**.

Floating TNT Licenses

Floating licenses to the **TNT** products can now be administered on (which means, set up as the license manager) or float to any supported Mac, Windows, Linux, and UNIX on your network.

In an enterprise situation your **TNT** activity may be such that you do not conduct it on a personal computer, but share a workstation with others. This workstation uses a fixed, attached **TNT** software authorization key or uses the network to check out a temporary licensed seat from a floating **TNT** license. In either situation each user of the common workstation now has their own **TNT** user profile and default settings.

Windows 95 and Windows 98

MicrolImages clients using **RV6.9** of a **TNT** product with Windows 95 and Windows 98 for the first time will be provided with a URL to a short form at microimages.com to use to obtain a startup code. By this route MicrolImages can determine how many are still using these older operating systems. From this information it can be determined how much longer these versions of Windows will be supported by the **TNT** products. The eventual deprecation of these versions of the **TNT** products will permit MicrolImages to use network, file access and recovery, security, and other features not supported by these older operating systems.

Mac OS X

Mac OS X 10.3 (Panther).

The **TNT** products continue to operate as 32-bit applications under Mac OS X 10.2.x.

The **TNT** products now operate as either 32-bit or 64-bit applications under Mac OS X 10.3.2 or later. If you are using an earlier version of Panther (which means, 10.3 or 10.3.1), please install your free upgrade to V10.3.2 before using your **TNT** product.

Mac OS X.

A Mac OS X platform can now be used as a **TNT/FLEXIm** license server for a floating license to the **TNT** products. With this addition, any **TNT** supported platform can see as the license manager or use a **TNT** product as a client (Mac, Windows, UNIX, or Linux). It also permits a floating license to be used on an all Mac OS X networks as requested by various MicrolImages' clients.

TNTmips Does 64-bit

Background.

Previous Incarnation.

Some of you have used and others may recall that the **TNT** products were distributed for several years for the DEC Alpha 64-bit processor using OSF/1 (a variant of UNIX). These were full implementations of the **TNT** products and were fast relative to using 32-

bit based computers available at that time. This processor has gone through several ownerships (to Compaq then to HP) and incarnations and eventually it evolved into the server-only product line and quietly into obscurity by HP. While the Alpha-based desktop computer was a very powerful platform for the **TNT** products, the processor was “ahead of its time.” The general public had not yet discovered Linux, digital cameras, video, music, and the other popular applications of today. Intel’s gradual incremental improvements of the clock rate of 32-bit Intel processors satisfied their requirements at that time. Thus, desktop platforms built around the 64-bit Alpha processor suffered from a lack of wide-scale software and peripheral hardware support and it slowly died away with DEC.

Behind the scenes, MicroImages continued to build, maintain, and distribute the **TNT** products for the Alpha-based platform until just recently when it was no longer of interest to any client. Thus, it proved to be no special difficulty to provide transparent **TNT** support of the new 64-bit processors that are now making their entry into desktop platforms and the marketplace. These new 64-bit processors and the operating systems supported by **RV6.9** of the **TNT** products are illustrated on the enclosed color plate entitled **TNTmips Does 64-bits** (as well as **TNTedit**, **TNTview**, and **TNTatlas**, ...).

Memory Requirements.

TNT software processes are written entirely by MicroImages and are very conservative in the use of real and virtual memory. The total real/virtual memory limitations discussed here for desktop 64-bit platforms are only of general interest relative to their use for **TNT** projects. However, memory limitations may impact your use of these new 64-bit computers for other software. Many products must load all the required data into real memory (for example, Photoshop) or real plus virtual memory. Using only real memory guarantees maximum performance but may limit the size and scope of the non-**TNT** aspects of your project application. Thus, the notes that follow on the amount of real or real/virtual memory supported by your potential 64-bit platform is of considerable interest.

No currently available 32-bit version of Microsoft Windows can address a memory space larger than 2 GB. This limit is the sum of your real plus virtual memory! Virtual memory only simulates the availability of additional real memory up to this same limit of 2 GB. It also permits each concurrent process in a multitasking system to seem to have available up to 2 GB of real plus virtual memory. However, allowing a process to “go virtual” has a potential massive negative impact on performance (up to 100 to 1) when writing and reading all or part of each concurrent process’s memory image to and from a virtual copy on a hard drive—the so called “rollout and rollin” activities.

For the moment 2 GB of real, fast memory is expensive and is more or less a practical economic limit for most desktop systems running **TNTmips**. Adding 8 GB of real memory to an Apple G5 would cost US\$5000 and nearly triple the platform’s price. However, when libraries created by others are incorporated into the **TNT** products, we can not control their demands for memory when huge geodata sets are processed. For example, the Kakadu library used for JPEG2000 compression uses memory to accumulate and hold the characteristics of the image being compressed. Thus the 2 GB real memory limit on Windows was recently a severe performance handicap when MicroImages compressed a single 280-GB image into a single, linked JP2 file and also into a comparable JPEG2000 compressed raster object in a Project File. However, by design, the amount of real memory available has little impact on the decompression and use of this

JP2 image or JPEG2000 compressed raster object or MrSID and ECW compressed images. This activity will be discussed in more detail below in the **TNTmips** / JPEG2000 section below entitled Improved Memory Management. You have not encountered this memory limitation when compressing into MrSID (*.sid) or ECW (*.ecw) in the **TNT** products as the libraries that they provide for use without charge to other developers, such as MicrolImages, limit the size of the image that can be compressed. MicrolImages has no information about how their commercial for sale implementation of the MrSID and ECW compressor products deal with the potential memory requirements of huge input images.

Apple's Mac OS X for the G5.

The **RV6.9** CD for Mac OS X contains both the 32-bit and 64-bit versions of the **TNT** products. It took about 1 day to make the minor modifications to **TNTmips** to bring it up the 64-bit version on the G5 once its build environment was established. If you are now using an Apple G5 based platform (single or dual processors), you can install separate 32-bit and 64-bit versions of the **TNT** products and run either one with your HASP USB software authorization key. MicrolImages has both single and dual G5 based platforms running as part of its software testing and verification activities.

You will see a marked difference in speed on the G5 between the 32-bit and 64-bit **TNT** processes that are computationally intense. However, as most now know, the latest version of the Mac OS X (Panther version 10.3.2) does not provide a full 64-bit implementation. It still shares the 32-bit versions of most of its lower level libraries. Thus, you will not yet get the full capabilities of a 64-bit version of your software. The most significant limitation is that the currently available Apple platforms permit the installation of 8 GB of real memory, but due to these 32-bit libraries each **TNT** and other software process is limited to using 2 GB of real memory.

The Apple G5 platforms are extremely well designed and constructed and incorporate many other incremental hardware advances beneficial to the operation of heavy duty software such as **TNTmips**, such as Firewire 800, 1 G-bit Ethernet, fast hard drive and ATA serial drive support, lower cost for dual processors, faster memory, and so on. All these factors contribute to making this an excellent 32-bit or 64-bit platform for **TNTmips**.

Sun's Solaris 9.x of the SPARC.

The **TNT** products are now available for this full 64-bit implementation of Solaris 9.x. Both the 32-bit and 64-bit versions for this platform are provided on the **RV6.9** UNIX CD (you can use the 32-bit version for Solaris 8.x or 9.x.). This 64-bit implementation will permit the **TNT** products to address and use a much larger memory space than the 2 GB limits of every 32-bit version of Windows and Mac OS X.

AMD's Athlon and Opteron using SuSE Linux 9.x.

MicrolImages has built and will provide 64-bit versions of the **TNT** products for 64-bit SuSE Linux. Only 1 version of the **TNT** products is needed for platforms using a single F64 or FX64 or dual Opteron processors. AMD has stated, and MicrolImages has verified in its AMD FX and Opteron test machines with these processors, that a properly build 64-bit operating system and application software will run with all of these 64-bit AMD processors. Furthermore, the generic 32-bit Linux version of the **TNTmips** products is also available for these platforms.

Redhat 64-bit Linux should become available soon for platforms using AMD 64-bit processors. Microlimages Linux 64-bit support is generic and, thus, will be usable immediately or with minor patches for this platform.

SuSE Linux on these platforms can use much more real memory than the 2 GB limit. However, please carefully check the actual motherboard you are interested in to see how much real memory can be added, what type of memory is used, how much it costs, how many slots are currently occupied, and so on. Hardware vendors are not going to the added expense of supporting additional control logic and memory slots for real memory beyond what they expect their buyer to use in the machine they are currently selling (which means, they are not considering your future requirements). A typical dual AMD Opteron server type implementation used at Microlimages has 8 memory slots and can address 16 GB of real memory, whereas the low-cost desktop AMD F64 desktop models being used can only accommodate 2 GB in 2 slots.

AMD's Athlon and Opteron using Microsoft's Beta 64-bit Windows XP.

Microlimages has also built the **TNT** products for use with Windows 64-bit XP beta version to be officially released late this year. A 64-bit version of the **TNT** products is available for this platform. So far Microlimages has not experienced any particular problems with either this beta version of Windows XP or the **TNT** products running under it. Platforms using these AMD 64-bit processors can also run 32-bit Windows application software without alterations. Microlimages has also verified that the **RV6.9** of the **TNT** products for Windows will completely function with the Windows XP, 2000, and 2003 supplied with these platforms. A Windows 64-bit 2003 beta version is available for this platform but has not yet been tested with the 64-bit version of the **TNT** products.

Until recently Microlimages has been using the same AMD-based test platforms for the Windows 64-bit XP beta and SuSE Linux versions of the **TNT** products. While inconvenient, Microlimages has verified that you can set-up additional hard drives to boot into either 64-bit Linux or Windows on these platforms. However, when using this beta version of XP you will encounter the same hardware vendor imposed real memory limits as discussed above.

Itanium II using Linux or Windows XP.

TNT products are not available for this platform. Intel has targeted the Itanium II chip at the multiprocessor server market. As a result even the cheapest implementation of a desktop computer using a single Itanium II chip is US\$5000 and Microsoft's price for this version of Windows is another US\$3000. For this reason at this time Microlimages does not consider that there is a viable market for the **TNT** products on Itanium II based platforms, especially in light of the fact that a good AMD Athlon F64 desktop machine can be purchased for US\$1000 and used with the 64-bit version of SuSE (US\$300)! Recently Intel has "discovered" that AMD and Apple are aggressively pushing into the 64-bit desktop market. As a result, there are now rumors of the imminent announcement of a 64-bit Intel chip oriented in price toward your desktop that will run the same 64-bit Windows XP and all your 32-bit version applications.

TNTlite[®] 6.9

There were 5215 successful and complete downloads of **TNTlite** from microimages.com in 2003, which was up 42% over 2002.

TNTsdk™

DV7.0, the current development version of the **TNT** products has been converted to use the C++ compiler in Visual Studio .NET 2003, Professional Version. Those using **DV7.0** of the **TNTsdk** will need to convert to this programming environment.

A better public domain documentation program called Doxygen (www.doxygen.org) is now being provided for your access to the **TNTsdk** online documentation for **PV6.9** maintained at www.microimages.com/product/tntsdk.htm.

TNTsim3D™ for Windows

Introduction.

TNTsim3D continues to expand to provide you with a better and even more unique FREE product to publish, distribute, and permit free use of your geospatial products. While it lacks some of the cosmetic features of other simulation tools, it now provides even more features tailored to the presentation of your project results. The new interactive interface makes **TNTsim3D** more intuitive to operate. However, the most unique and powerful new feature is the ability of **TNTsim3D** to execute the various kinds of scripts created in **SML**. Depending upon your design, these scripts provide interactive tools during the simulation or will even operate the simulation as a movie. For example, you can add unique new interactive tool(s) using **SML** Tool Scripts, log and play back a flight path as illustrated in a new sample script, or even use a script to analyze the geo-data while it is being used by the simulation. An even more advanced capability now in development is the use of an **SML** script to allow **TNTsim3D** to communicate with and interact with a program you create in Visual Basic or C++.

TNTsim3D Interactive Tools.

The tools used to interact with the views in **TNTsim3D** have been reorganized and re-structured and are now selected from icon buttons on a toolbar in the Main View. These include the Viewpoint Tool, Point-Of-Interest Tool, TNTAtlas Tool, and the Point Overlay Tool. The first three of these were available from the menus in **V6.8**. The Point Overlay Tool is a new addition that allows you to select, move, and edit point features, show DataTips for points, and to retrieve and edit single record views for records associated with the points. The attached color plate entitled TNTsim3D Interactive Tools illustrates the user interface and use of the 4 tools.

Viewpoint Tool.

The Viewpoint tool functions as in earlier versions of **TNTsim3D**. With this tool turned on, left-click in any view with the mouse to recenter all views to that position. The input controls for moving through the simulation (joystick, keyboard, and mouse) are only active when this tool is turned on.

Point-Of-Interest (POI) Tool.

The basic functionality of this tool is the same as in earlier versions of **TNTsim3D**, but it has a new interface and several new features. As in previous versions, when you add a Point-Of-Interest, a marker symbol appears in each view window and a Point-Of-Interest view can be opened and remains centered on that location as you move through the simulation. To create a Point-Of-Interest, you now press the Create POI button in the Points-Of-Interest dialog window (instead of left-clicking with the mouse in a view, as in

V6.8). Then use the mouse in any view to drag the POI marker to the desired location. When you add a POI, a record is added to the POI table, which is shown in the Points-Of-Interest window. Use this window to edit each point's characteristics. You can change the point name (used as the title for its window) and edit its coordinate position for precise placement within the landscape. You can also pick the marker used to identify each POI (from an Arrow, Arrow-Head, Cursor, Bar, or Flag shape) and select the color of each individual marker. POI symbols can now also be toggled on and off in all views. You can also choose whether or not to open the POI view automatically for subsequent new POIs.

TNTAtlas Tool.

This tool is approximately the same as in earlier versions of **TNTsim3D**. The TNTAtlas tool's dialog shows you a list of the associated and available atlases or permits you to navigate to locate and add an atlas to this list. After an atlas has been selected, left-click with the mouse in any view to open the **TNTAtlas** program, which shows its composite view of that point in a new window. **TNTAtlas** can then be used to gain access to its extensive collection of information about that point including a linked database, to make measurements of features, and use its many interactive GIS functions.

Point Overlay Tool.

This tool presents a variety of new capabilities for use with any point overlay layers that you have selected for viewing from the Layer menu. The tool and its Point Overlay dialog window allow you to select, move, edit, insert, delete, and save point features including Billboards & Stalks and the positions of Volumes-Of-Interest. The tool can also open the standard **TNT** Single Record dialog for the point to show/edit its detailed attributes. Some of these new capabilities are illustrated in the color plate entitled Edit Point Positions in TNTsim3D.

Selecting Points.

To pick a point from any of the selected overlays, left click the mouse directly on its symbol in any of the various views. This will highlight the point with a flashing color in all views in which it is visible to show the point is selected and ready for moving, editing, and so on. You can define the highlight color in this dialog to help you determine which point has been selected against your specific landscape background. Left-click away from any overlay point to deselect the current point.

Editing Points.

After you have selected a point, turn on the Edit Point check box in the Point Overlay tool to enable any of the following editing operations for that point.

Moving Points. With the Edit check box turned on, you can move the point by dragging its symbol with the mouse. You can also reposition the point by editing its coordinates in the Point Overlay tool's dialog.

Copying Points. Press the Copy Point button to create a copy of the selected point nearby on the terrain. The copy is automatically selected and highlighted and its original version deselected. You can then use the mouse to drag this new duplicate point around on the terrain. It will be an exact duplicate of the original point in appearance and a duplicate record of it is added to the corresponding tables at this new coordinate position.

Deleting Points. Press the Delete Point button to delete the selected point from the overlay.

Editing Point Names. The name of the point in the Point Overlay tool's dialog can be selected and edited. If you have created a DataTip in another **TNT** product for this point (see section below), it will be the name of the point and can be edited here.

Saving Overlays.

None of the original Point Overlay layers you create in the Landscape Builder can be permanently deleted or altered in this tool. In other words, the original overlays are protected layers that will always appear on the Layer menu for that landscape. However, if you have altered any point or points in one of these original layers, you can save a new layer with all of these alterations.

Save Overlay As. If you press the Save Overlay As button, you can save the layer containing the selected point with a new name, creating an entirely new layer that includes all the changes you have made to any point in that layer. The new overlay will then appear on the layer selection list for this landscape. You can create as many new Point Overlay layers as you wish.

Save Overlay. You may subsequently alter a point layer that you saved within **TNTsim3D** (rather than an original overlay created in the Landscape Builder). Pressing the Save Overlay button deletes that layer and replaces it with a new layer of the same name containing the latest alterations. If the point layer being edited was created in the Landscape Builder, pressing the Save Overlay button does not replace the existing overlay, but prompts you to name a new layer (as for the Save Overlay As... button described above).

Delete Overlay. Pressing the Delete Overlay button deletes the entire point layer you have selected if it was previously created in **TNTsim3D**. It is not available if the layer you have selected was created in the Landscape Builder. This Delete Overlay button is not used to undo individual alterations to selected points.

Show Detailed Information.

The Landscape Builder transfers some attributes and derives others to build point overlay layers into the Landscape File. Within **TNTsim3D** you can gain access to all these attributes using the Show Info check box in the Point Overlay tool's dialog. It opens the standard Single Record dialog used in all **TNT** products for the point selected. If a new point is selected, this dialog will show the new point's attributes. Since this is the standard Single Record dialog, it provides the same tools found in all other **TNT** products for editing and altering the associated records in the table.

2D versus 3D Points.

In the Landscape Builder you can create point overlay layers from vector objects with either 2D or 3D point coordinates. The points in a 2D overlay are automatically locked to the terrain surface, whereas 3D overlay points are simply inserted into the volume encompassing the landscape at their XYZ positions. If you move these 3D points around with the new Point Overlay tool, their Z-value remains fixed and you might find that your point is now floating above the terrain or buried beneath it. When using vertical exaggeration in **TNTsim3D** you have the option to choose if the Z-value of 3D points is held constant or rescaled along with the terrain layer.

Regardless of the vertical exaggeration, 2D points stick to the terrain when the Point Overlay tool is used to move or add points. It is, thus, possible to position a point behind a terrain feature where it is not visible in the Main View from the current viewpoint. Moving points around in the optional Map View is a good way to insure that all possible surface positions can be directly used without having to switch back to the Viewpoint Tool to adjust your view of the landscape.

TNTsim3D DataTips.

The DataTips you have defined for a layer in **TNTmips** are processed in the Landscape Builder and passed into the Landscape File as a text string of up to 256 characters. As in the other **TNT** products, **TNTsim3D** exposes a DataTip when your cursor is near the associated point. Thus, while you use your joystick to move the view around in the simulation, you can use the mouse cursor to reveal descriptive information about a particular point. This is illustrated in the attached color plate entitled DataTips for Point Overlays in TNTsim3D.

If the DataTip defined in **TNTmips** contains virtual fields (computed fields) the Landscape Builder evaluates these fields and converts them into their equivalent character string for use in the Landscape File. You can use virtual fields to combine multiple fields and text into an attractive DataTip for display in **TNTsim3D**, including multiline DataTips.

Within **TNTsim3D** you can not permanently alter the DataTips text string for the associated original billboard overlay set up by the Landscape Builder. However, you can edit this DataTip text string or name associated with a symbol and save these changes as a new overlay layer. Simply select a symbol with the Point Overlay tool, edit the name field, and save the new overlay. You can then select either the original or altered layer to provide the DataTips for your simulation.

Using SML Scripts.

Introduction.

Microlimages' software tools enable the FREE distribution of your geospatial project results in hardcopy or in digital form via **TNTatlas**, **TNTsim3D**, and **TNTserver**. These products are part of a 3-tier approach designed to let you serve different levels of end user involvement. Microlimages creates the professional and the free publishing software. Most of you use this software to conduct complex projects. However, often you are not the end user of the results of your projects. As a geospatial analyst, your end users are usually your consulting clients or others in your company. The professional **TNT** products that you purchase provide the geodata preparation and analysis tools, and the FREE products provide a means by which you can distribute your results in an organized, more easily understood form, with some simple end-user oriented tools.

Using **SML** within **TNTsim3D** provides you with one more unique means of satisfying your client's interests. Using **SML** scripts, you can add custom effects and movement capabilities to your **TNTsim3D** simulations. A script can merely vary the environmental parameters of the scene or actually move the viewer in predetermined ways through the landscape. The simulation you build in the Landscape Builder can be distributed with your custom scripts along with the free **TNTsim3D** program. While your client can use your **SML** scripts they can not easily create or edit scripts in **TNTsim3D**—this is the area of your expertise working together with Microlimages and the professional **TNT** products.

As before, you must create your **SML** script in your professional **TNTmips**, **TNTedit**, or **TNTview** where the tools are available to access the latest functions and classes, view the documentation and samples, edit, check syntax, and so on. However, when a script is completed it can now be saved as an object within the Landscape File containing the simulation's geodata. When this Landscape File is loaded in **TNTsim3D**, these **SML** scripts appear by name and can be run from the new Script menu. This procedure is discussed in more detail and is illustrated by example scripts in the attached color plate entitled Customizing TNTsim3D with SML. These sample scripts can be downloaded from www.microimages.com/freestuf/TNTsim3Dscripts.htm.

Day-Night Cycle SML Sample Script.

The simple sample **SML** script (daynight.sml) is illustrated and provided with comments on the attached color plate entitled Customizing TNTsim3D with SML. While you are moving about in the main view, running this macro script repeats a day-night or diurnal lighting cycle. It cycles the sky color from blue to black and cycles the terrain from 0 to 100% black fog to simulate day/night lighting. The sun angle is also varied during the daylight portion of the diurnal cycle. Please note from the back of this plate that all of this can be accomplished for every frame in the simulation using an **SML** script of about 25 lines.

Orbit Sample Script.

The simple sample **SML** script (simorbit.sml) is illustrated and provided with comments on the attached color plate entitled Customizing TNTsim3D with SML. When this script is selected from the menu, it suspends motion in the simulation and orbits the main view around its current center point. At any point the operator can break out of this orbit and continue motion controlled by the input device by toggling off the script on the Script menu. Again please note that this Macro Script is about 20 lines long. Using this script as a starting point, you could easily modify it to move the simulation through other kinds of preprogrammed motions such as panning the view outward from the current nadir position, zooming in and out, book marking views, jumping from view to view, and so on. All these lead to an even more complex script that records a flight path and plays it back.

Flight Recorder Sample Script.

You have previously requested that a flight recorder be added to **TNTsim3D**. This has now been implemented using an **SML** script that is reviewed in the attached color plate entitled Create Flight Paths in TNTsim3D via SML. This flight recorder is controlled by a simple Recorder dialog box set up in **SML**. This dialog provides simple buttons to Record, Play, Pause, and Stop. The plate illustrates and annotates important sections of this script.

You can use this completely open script as a starting point to develop unique flight controls. For example, the parameters recorded for each view are clearly identified. Thus, you can obtain flight coordinates from some other external device (truck, plane, ...) or mathematical or empirical expression, process them into this format, and play them back in a simulation probably compressing time. Now you can use the **SML** skills you have honed in preparing "2D" **SML** scripts in real time in **TNTsim3D**.

Miscellaneous.

Depending upon your requirements **TNTsim3D** can render symbols at 3 different quality levels. The options panel now provides Good, Better, and Best for symbol rendering. A comparison of the results for the Good and Best setting is provided in the attached color plate entitled Symbol Rendering Quality in TNTsim3D. Both are acceptable, but for faster rendering and thus higher frame rates, the good setting may be more than satisfactory.

A toggle is now provided on the MapView to show/hide Point-Of-Interest locations.

Holes in polygons (for example, courtyards in buildings) are now represented in their extruded shapes.

DV7.0—Action Points.

Current developments in using **SML** in **TNTsim3D** are focused on implementing the concept of “Action Points.” These are points in the Landscape that may or may not be represented by overlay symbols. Action points will define an XYZ position, a radius of action in ground units (e.g., meters), data describing the points, and the event to execute. The radius defines a sphere of influence around the points within which that event will be invoked. Action points might be used in many ways and many different kinds of events defined for subsequent use in **SML** or in an exterior program. For example, the action might be triggered when the viewers XYZ position, nadir position, center line view projected to the ground, ... enter or leave the point’s action sphere. The **SML** event triggered by this might vary widely. The initial example event that will be illustrated in a color plate will be the action of starting an external Visual Basic program. This VB program will expose a separate dialog window containing a record describing the point in a non-**TNT** database. This could be a database whose records are being maintained and updated by some other system(s).

TNTatlas 6.9 for X

Customizing the User Interface.

Introduction.

Groups and layouts are used to define and maintain the relationships between collections of **TNT** geodata objects in various Project Files or linked external files in other formats. Creating a layout organizes a collection of specific geodata into a meaningful unit and defines how it is used together in your atlas. **RV6.9** permits the layout(s) you use to define the menu items and icons used in a **TNTatlas** to simplify its view. They are now also the means by which your custom tools (Macro Scripts and Tool Scripts) are included and conveyed in a specific atlas and automatically loaded by the **TNTatlas**.

Simplifying the View.

Periodically there have been requests to permit a **TNTatlas** to have a simpler user interface. **V6.3** introduced the use of the Customize window to globally control the options presented in your **TNT** product’s menu and icon tool bar. Now in **RV6.9** you can use this same approach to attach these customization preferences to individual groups and layouts. Whenever you are viewing a group or layout you can now choose Options / Customize / Window and check off or on every icon on the icon tool bar or menu entry. This is illustrated in the attached color plate entitled Customize Your View Interface. This will change the interface for all subsequent groups or layouts in **TNTmips**. To

change the icons and menus present in **TNTAtlas**, you must run **TNTAtlas** and choose Options / Customize / Window in the **TNTAtlas** window and make the desired changes. These will be transferred by the Wizard to your **TNTAtlas** if you so choose and will determine the specific user interface presented for each layout as it uses them. This is illustrated in the attached color plate entitled Providing a Customized Interface for TNTAtlas/X.

* Adding Custom Tools.

The special tools (Tool Scripts) and queries (Macro Scripts) you create in **SML** to extend the capabilities of **TNTAtlas** are usually very "data dependent." For example, you might create a Tool Script that pops in a window presenting a form. This form collects the information from the user to populate a query acting on the attributes of a vector layer in the atlas. The Tool Script menu can present these as a list of these named, "canned" or predefined queries, each presenting such a form or dialog box. For example, you might have a series of Tool Scripts accessed via the menu entries of "Find Your House," "Find Your Street," "Find Your Nearest Public Park," and so on. The content, appearance, constraints, and other features of these forms might be implemented directly in **SML** using X/Motif or XML or as an ActiveX component program using C, Visual Basic, or Java. Each can present a different form window of your design to collect input from the user to populate and execute these specific queries on the atlas.

To streamline the use of different scripts for data dependent custom tools in each **TNTAtlas**, Macro Scripts and Tool Scripts can now be stored with a specific group or layout. When a layout with saved Macro and/or Tool Scripts is selected in your **TNTAtlas** these associated scripts are added for your use to the menu bar or additionally as an icon to the toolbar of the View window. Unlike the previous approach, which is still available, these menus and icons are not always part of every view in your **TNTAtlas**, whether they apply or not. Now they are only presented when the layout to which they are attached is displayed. These new procedures for managing and applying custom tools are illustrated in the attached color plate entitled Use Layouts to Customize TNTAtlas/X.

Delivering scripts with the layouts used in a **TNTAtlas** is a particularly effective way to add unique tools related to the specific contents of the atlas and have them automatically installed for use in any **TNTAtlas** software. For example, you may have a local copy of **TNTAtlas** installed on your hard drive and select from a variety of atlases located elsewhere on a network. Each atlas you select will load the tools associated with it to your view as you use that atlas.

Miscellaneous.

ActiveX.

Your **TNTAtlas** can now be accompanied by, launch, and communicate with separate programs using **SML** Tool and Macro Scripts via ActiveX. This is discussed in more detail in the **SML** section below.

HyperIndex Navigator for X and Windows.

HyperIndex links are used to connect areas in the current view of your atlas to new layouts, which define completely new geospatial layers. These link areas may or may not be visible and often do not cover the complete area of the view. For example, perhaps you are viewing an image of a state or province and the link areas are not showing but

represent counties, grid squares, or some other subunits. Often the state boundary is irregular and perhaps you do not have the geodata to build layouts for every subarea. Now as you move the cursor around in the view, the cursor will be the selection arrow if you are not in a link area and will change to the pointing hand if you are over a HyperIndex link and can click the mouse and navigate to it. This is illustrated in the attached color plate entitled Link-Sensitive Cursor with Navigator Tool. Please note that the shape of the pointing hand cursor used in **RV6.9** and shown in this plate has been changed to the more widely recognized pointing hand cursor. This is now the same cursor that Microsoft's Explorer and Apple's Safari shows to indicate that a view position has a URL attached for navigation to another page. This new cursor will be installed as part of your next patch.

TNTserver/clients 6.9

TNTserver will now use the same version numbering scheme as the other **TNT** products.

New Formats Served.

Previous versions of **TNTserver** responded with the JPEG version of the composite view to a **TNTclient**. Now the **TNTclient** can request that the server respond with content in several new formats. The atlas data does not necessarily have the objects stored in these formats and which one is requested depends on what the client will do with the response.

JPEG2000 Compressed (JP2) Rasters.

The raster requested for a complex view can now be a JP2 file of any specified lossy or lossless compression ratio. A JP2 file can be of better quality and smaller size than a JPEG file. This provides a better view using less bandwidth. However, the temporary disadvantage that the browser user must install a free plug-in, such as the one provided by Adobe. This plug-in could be installed automatically like many others, but this adds the disadvantage of significantly slowing down the initial use of the **TNTclient**. Eventually browsers will add decompression and use of JP2 files. Apple's Safari V1.2 browser already supports JP2 files as well as JPEG and PNG and using their implementation in QuickTime. Morgan, a French company, provides a good plug-in for JP2 support for Internet Explorer at www.morgan-multimedia.com/JPEG2000/.

Portable Network Graphics (PNG) Rasters.

The raster requested for a complex view can now be a PNG file with lossless compression, a transparency layer (which means, an alpha or RGBA layer), embedded text, and other features. PNG files are widely used in connection with HTML and do not require a plug-in for the browser. Just as with JP2, requesting PNG from **TNTserver** rather than JPEG, can return lossless images and the browser's client and its end user can control the scale of the view and, thus, the degradation of the image it renders.

Scalable Vector Graphics (SVG) Content.

TNTserver can now respond with SVG content incorporating vector or CAD elements accompanied by embedded attributes, images, and javascript tools. Additional details on the new process used by **TNTserver** and the other **TNT** products to create interactive SVG layouts and its new capabilities are provided in the section below entitled Render to SVG.

Serving up an SVG layout, *just as with Flash*, requires that end users' web browser have an SVG plug-in to interpret it. SVG plug-ins, actually called SVG viewers, are available from several sources such as Adobe, Corel, and others. Adobe's SVG Viewer (ASV) and Batik, a Java based suite of SVG applications including a standalone viewer, are probably the most fully implemented of the SVG viewers currently available. The SVG content returned from **TNTserver**, including the latest sample embedded javascript tools, work in the Adobe and Corel viewers as well as Batik's standalone viewer.

MicroImages recommends the Adobe SVG Viewer 3.0 (which means, browser plug-in) that can be downloaded from www.adobe.com/svg/# for Windows and the Mac OS X for use in 14 languages. Corel's SVG Viewer can be downloaded from www.corel.com/svgviewer/. Batik's standalone viewer can be downloaded from xml.apache.org/batik. Konqueror (Linux KDE environment), Mozilla and several Mobile phones and PDAs are implementing built-in or plug-in based SVG support as well. A detailed list of SVG viewers, conversion tools, and editors is provided by the World Wide Web Consortium at www.w3.org/Graphics/SVG/SVG-Implementations.

HTML-based TNTclient.

MicroImages' HTML-based **TNTclient** can request an SVG layout from **TNTserver**. While this client was highly and easily customizable, since it used only HTML, many of its features are not needed or are just not as useful in the context of receiving an SVG layout. In other words, the existing interactive features of this **TNTclient**, and many more, could now be assumed by the combination of using an SVG layout with its associated javascripts and its linked content. The following examples will clarify this. Additional information and illustrations of these SVG features are also discussed in the section below entitled Render to SVG.

Layer Control.

Adding and deleting layers using the sample HTML-based **TNTclient**'s layer control panel require a new request to **TNTserver** and the return of the revised raster view. Using SVG content provides this control of the graphic layers and embedded images to the **TNTclient**. This sample client can now use either both or one of these methods.

DataTips.

Using the sample HTML-based **TNTclient**'s InfoTips panel requires a request to be sent to **TNTserver** to retrieve the database (which means, attribute) information about the selected feature. Database information can be encapsulated with the graphical features requested as part of the SVG content returned from **TNTserver**. This means that the client can now interactively expose this same information as DataTips for each graphical element. In addition, if desired, the element (for example, line or polygon) to which the DataTip applies can be automatically highlighted, filled, or blinked).

Measurement Tools.

Measurement tools in the HTML-based **TNTclient**'s measurement panel do not require a return trip to the **TNTserver** since they can be made using only HTML and acting on the georeferenced raster in the view. However, interactive javascript measurement tools can also be provided to a client as part of the SVG content returned by **TNTserver**.

Limitations.

Current HTML/SVG incompatibilities in the sample HTML-based **TNTclient** are that zoom requests made from within the HTML do not take into account zoom levels in the SVG layout and HTML interface elements cannot overlap the display area used by the SVG viewer.

DV7.0—Supporting OpenGIS's Web Map Service (WMS).

Introduction.

Microlimages is currently extending the **TNTserver** to implement the protocol specified for the Open GIS Consortium's (OGC) Web Map Service (WMS) V1.1.1 (see www.opengis.org/specs/?page=specs). When this is available, **TNTserver** will still access a **TNTatlas** layout and return either a JPEG, JP2, PNG file(s) or an SVG layout, but will then respond to requests issued using either the WMS or the current **TNT** protocol .

What Does It Add?

A browser-based client, or any client can issue requests to any available server implementing this WMS protocol and expect it to respond correctly if it has implemented that particular feature of the protocol. As a result, this next version of **TNTserver** will also respond to any of these clients written by others that issue WMS requests. Conversely, a client you write or sample **TNTclients** written by Microlimages can issue requests to any WMS site as well as **TNTserver** and combine the results as appropriate. Furthermore, supporting requests using only the WMS protocol will not require the use of the Tomcat service with **TNTserver**.

Clarifications.

Supporting WMS protocol indicates that a server will respond to requests that come to it using its documented protocol. The designation that a server (for example, **TNTserver**) implements WMS 1.1.1 protocol does not mean that it will respond to every possible WMS request to it. It also does not prevent that server from responding to requests in any other additional protocol it may support as an alternative to or extension of the WMS. Whether or not a server responds correctly or at all to a specific request can vary widely. Almost all server products listed as supporting WMS are in category on the OGC site (see www.opengis.org/resources/?page=products) designated as *"Implementing Products, that is, software products that implement OpenGIS Specifications but have not yet passed a compliance test."* Thus a close inspection of this OGC listing of server products reveals that at present, only 3 commercial server products are certified by OGC as WMS 1.1.1 *"Compliant Products, that is, software products that comply to OGC's OpenGIS® Specifications."* These must be further qualified by OGC adding that *"Compliance tests are not available for all specifications."*

It is also important to understand that a server's implementation of WMS 1.1.1 may also be restricted to responding to requests in that protocol. Thus, the designations that a product implements WMS does not mean that the server can issue requests in WMS or any other protocol to other WMS sites either locally or over a network such as the internet. To issue such requests, the server must support the additional capability of acting as a client to other WMS sites.

Cascading Service.

The use of the term clients used in servers in this context can be confusing because it is popularly used to indicate the software implementation for the end users, such as the party using the browser or other human interfacing product. However, in a generic computer sense, being a client indicates a source of information that will respond to an inquiry. Thus, if the server product supporting WMS has an embedded client capable of issuing requests, in WMS protocol it is called a Cascading Web Map Service (CWMS). The WMS 1.1.1 specification states:

“A ‘Cascading Map Server’ is a WMS that behaves like a client of other WMSes and behaves like a WMS to other clients. For example, a Cascading Map Server can aggregate the contents of several distinct map servers into one service. Furthermore, a Cascading Map Server can perform additional functions such as output format conversion or coordinate transformation on behalf of other servers.”

Current Activity.

At this time MicroImages is implementing the client level capability in **TNTserver** to enable it to respond to requests from other servers. Eventually this will enable **TNTserver** to act as a CWMS. As is the current case, **TNTserver** will continue to be available for Windows-based platforms.

TNTview[®] 6.9

TNTview is a subset of **TNTmips** and is available on every supported platform including the new **RV6.9** 64-bit options introduced above. The processes in **TNTview** and **TNTmips** use the identical code. **TNTview** provides all of **TNTmips** that deals with the management and 2D and 3D visualization of geospatial data, but does not support its creation. As a result **TNTview** provides more than 1/2 of all the code and features making up **TNTmips**. Your software authorization key or floating license determines the subset of **TNTmips** that will be installed and available for use with your **TNTview** license. In fact, various sites are using single floating licenses to serve out their independently licensed seats for **TNTmips**, **TNTedit**, and **TNTview**.

Inherited New Features.

TNTview V6.9 provides all the following new features introduced in detail in the appropriate sections indicated in parentheses for **TNTmips**.

All of the system level changes. (see System Level Changes.)

Expanded TIFF support, which links and imports more varieties of TIFF files. (see TIFF Support.)

Huge raster objects that now use JPEG2000 compression can be displayed in seconds regardless of their size. You can now also link to, and display equally huge GeoJP2 files (compressed with JPEG2000 and georeferenced). Linking to external JP2 files was provided in **V6.7**. (see JPEG2000 Compression.)

All the new 2D display improvements are available including antialiasing of thin lines, a more compact LegendView, revised Macro and Tool Script installation, linear color transparency in color palettes, dual coordinate readout, and zooming to a specific position. (see 2D Display.)

All the new 3D display improvements including the new faster, better dense ray casting and variable triangulation terrain rendering models. (see 3D Display.)

The new leader and frame controls for labels can be used. (see [Label Frames and Leaders.](#))

Tabular views can be refreshed for database tables that may be continuously changing, such as those linked via ODBC. (see [Refreshing Tabular Views of External RDBMS.](#))

Importing Arc shapefiles will include their point styles. (see [Arc Shapefile Point Symbols Import/Export.](#))

Monitor and printer color can be calibrated using the ICM (Microsoft) or ICC (Apple) color management profiles provided for your hardware. (see [Color Management.](#))

All the extensive changes and additions to SML scripting are available. These include improved documentation, examples, and management of functions and classes; debugging including execution timing; interface design in Visual Basic; and many other new technical features. (see [SML Scripting.](#))

Upgrading TNTview.

If you did not purchase **RV6.9** of **TNTview** in advance and wish to do so now, please contact MicroImages by FAX, phone, or email to arrange to purchase this version. When you have completed your purchase, you will be provided an authorization code by FAX. Entering this authorization code while running the installation process allows you to complete the installation of **TNTview RV6.9**.

The prices for upgrading from earlier versions of **TNTview** are outlined below. Please remember that new features have been added to **TNTview** with each new release. Thus, the older your version of **TNTview** relative to **RV6.9**, the higher your upgrade cost will be.

Within the NAFTA point-of-use area (Canada, U.S., and Mexico) and with shipping by ground delivery. (+50/each means US\$50 for each additional upgrade increment.)

<u>TNTview Product</u>	<u>Price to upgrade from TNTview:</u>					<u>V6.30</u>
	V6.80	V6.70	V6.60	V6.50	V6.40	and earlier
Windows/Mac/Linux	US\$175	275	400	500	555	+50/each
for 1-user floating	US\$210	330	480	600	667	+60/each
UNIX for 1-fixed license	US\$300	475	600	675	725	+50/each
for 1-user floating	US\$360	570	720	810	870	+60/each

For a point-of-use in all other nations with shipping by air express. (+50/each means US\$50 for each additional upgrade increment.)

<u>TNTview Product</u>	<u>Price to upgrade from TNTview:</u>					<u>V6.30</u>
	V6.80	V6.70	V6.60	V6.50	V6.40	and earlier
Windows/Mac/Linux	US\$240	365	465	545	605	+50/each
for 1-user floating	US\$288	438	558	654	726	+60/each
UNIX for 1-fixed license	US\$350	550	700	800	850	+50/each
for 1-user floating	US\$420	660	840	960	1020	+60/each

TNTedit™ RV6.9

The standalone **TNTedit** product is increasing in popularity as it is recognized as a superior spatial data editor. It is being used to create or import and improve complex spatial data for subsequent export and analysis in other products. **TNTedit** is a subset of **TNTmips** and is available on every supported platform including the new 64-bit **RV6.9**

options introduced above. The processes in **TNTedit** and **TNTmips** use the identical code. Your software authorization key or floating license determines the subset of **TNTmips** that will be installed and available for use with your **TNTedit** license. In fact various sites are now using single floating licenses to serve out their independently licensed seats for **TNTmips**, **TNTedit**, and **TNTview**.

Inherited New Features.

It has become repetitious and perhaps confusing to summarize for each new release the many new features **TNTedit** has in common with those added by virtue of its shared code with **TNTmips**. Those who own and use **TNTedit**, but not **TNTmips**, can read the complete new descriptions of their new features in their detailed introductions and supporting color plates in the major **TNTmips RV6.9** section below. Almost everything that has been added in **RV6.9** for **TNTmips** is available for use in **TNTedit RV6.9** with the following exceptions.

All aspects of the use of JPEG2000 compression detailed for **TNTmips** can be used in **TNTedit** and **TNTview** except that raster extract is an image analysis feature of **TNTmips** and is not included in either of these products. Therefore you can not use raster extract as described below to reduce the size of your JPEG2000 compressed raster or any other raster object or divide it into tiles in smaller raster objects.

TNTedit and **TNTview** do not provide the **TNTatlas** Assembly Wizard. However, this does not prevent users of **TNTedit** from assembling and making layouts and assembling them into atlases for use in **TNTatlas**. Thus, all the new features detailed below can be applied to atlases you assemble in **TNTedit**. These atlases can then be used with the FREE **TNTatlas** product.

You can add and test Ground Control Points (GCPs) with the new Rational Polynomial Coefficient (RPC) image model. However, since **TNTedit** does not include image analysis processes, you can not use raster resampling and the various image transformation models it provides including the new RPC satellite image orthorectification model. As a result as a user of **TNTedit**, you can skip the long section below entitled Rectification of QuickBird and IKONOS Images explaining this new **TNTmips** feature.

Upgrading TNTedit.

If you did not purchase **RV6.9** of **TNTedit** in advance, and wish to do so now, please contact MicroImages by FAX, phone, or email to arrange to purchase this version. When you have completed your purchase, you will be provided an authorization code by FAX. Entering this authorization code while running the installation process allows you to complete the installation of **TNTedit RV6.9**.

The prices for upgrading from earlier versions of **TNTedit** are outlined below. Please remember that new features have been added to **TNTedit** with each new release. Thus, the older your version of **TNTedit** relative to **RV6.9**, the higher your upgrade cost will be.

Within the NAFTA point-of-use area (Canada, U.S., and Mexico) and with shipping by ground delivery. (+\$50/each means US\$50 for each additional upgrade increment.)

TNTedit Product	Price to upgrade from TNTedit :					V6.30
	V6.80	V6.70	V6.60	V6.50	V6.40	and earlier
Windows/Mac/Linux	US\$350	550	700	800	875	+50/each

for 1-user floating	US\$420	660	840	960	1050	+60/each
UNIX for 1-fixed license	US\$650	1000	1350	1600	1750	+50/each
for 1-user floating	US\$780	1200	1620	1920	2100	+60/each

For a point-of-use in all other nations with shipping by air express. (+\$50/each means US\$50 for each additional upgrade increment.)

TNTedit Product	Price to upgrade from TNTedit:					V6.30
	V6.80	V6.70	V6.60	V6.50	V6.40	and earlier
Windows/Mac/Linux	US\$400	750	950	1100	1200	+50/each
for 1-user floating	US\$480	900	1140	1320	1440	+60/each
UNIX for 1-fixed license	US\$750	1200	1550	1850	2000	+50/each
for 1-user floating	US\$900	1440	1860	2220	2400	+60/each

Tutorial and Reference Booklets

There are now 76 **TNT** Tutorial and Reference booklets. These booklets provide more than 2000 pages and over 4000 color illustrations. The most important of these booklets are up-to-date with the features in **RV6.9** of the **TNT** products. However, others still show minor differences primarily in the user interface illustrations of earlier **TNT** versions. For a quick overview of the added and revised booklets please see the attached color plate entitled New Tutorials. Additional revised booklets, will be provided as completed for your downloading via microimages.com as part of the patches issued for **RV6.9**.

Each new professional **TNTmips** ships with 3 thick notebooks containing a color printed copy of these 76 booklets. Those of you receiving your **RV6.9** upgrade on CD can view and refer to all of these booklets using Adobe or Acrobat Reader. If you install all these booklets as part of any **TNTmips** product, you can access these booklets directly from the Display menu, by choosing Help / Tutorial Overview and selecting the booklet, or via Help / Search and use the index this provides.

Searching with Indexes.

RV6.8 and **RV6.9** provide Adobe PDF indexes for direct access to all the **TNT** products written material in the 76 tutorials and reference booklets and the reference manual via your Adobe Reader. From the index you could go directly to viewing that position in the PDF versions of these documents in Reader. Unfortunately, Adobe Reader for the Macintosh did not support using these indexes until the recent release of version 6.x. If you will now upgrade your free Adobe Reader to this current version for the Macintosh you will be able to use this indexing feature illustrated in the attached color plate entitled Searching with the Index in Adobe Reader.

New Booklets Available.

Building Dialogs in SML.

TNT's SML scripts continue to gain your wider use within the **TNT** products. As a result the reference material to support your use of this **TNT** feature has been greatly expanded and divided into 2 booklets. You still have available the booklet Writing Scripts with SML but it has been completely revised and expanded to 64 pages. Many new topics are now covered including the latest new features such as how to use **SML** to communicate between **TNT** products and your Visual Basic programs. Since the material in this topic area has been expanding rapidly, some of it was moved to a second and new

booklet entitled Building Dialogs in SML. This new booklet is focused upon how to build your SML control dialogs using either of the approaches: the older X Windows/MOTIF approach and the newer XML approach. Please also note that now you can also use your own Visual Basic programs to create forms and other user interface components for your **SML** scripts and to communicate with the **TNT** products.

Orthorectification Using Rational Polynomials.

Note: This tutorial booklet entitled Orthorectification Using Rational Polynomials was completed after the CD for **RV6.9** was duplicated, therefore, you are being provided a printed copy.

As introduced in the major section below entitled Rectification of QuickBird and IKONOS Images, **TNTmips** now provides a simple procedure to produce orthorectified images from full or partial QuickBird and IKONOS images ordered as Rational Polynomial ortho ready kits. This procedure requires a good quality DEM of the area covered and several well distributed, accurate XYZ ground control points (GCPs). This new booklet covers the procedures available in this new process. It outlines how to obtain and evaluate GCPs and test points of varying quality. Significant modifications of the **TNT** georeference procedures were required to enter and use these XYZ GCPs and test points for this process and are discussed. The various methods built into this process to measure the map accuracy of the ortho images produced are reviewed. A sample exercise is provided using a color IKONOS 4-meter resolution image of La Jolla Mesa, San Diego County, California and the corresponding DEM, which will fit within the size limits of **TNTlite**. The PDF version of this booklet and the sample data can be downloaded for addition to your **RV6.9** system from www.microimages.com/getstart/rpcortho.htm.

Installation and Setup Guide.

With so many platforms supported by the **TNT** products and constant changes in operating systems and network environments, permissions, multiple users, it is difficult to keep this kind of material current. It has to cover historical situations such as W98 and older Linux flavors, language setup issues, as well as a wide variety of network designs and user authorizations extending to floating licenses. This completely revised booklet reflects the latest information we can provide on this volatile topic for the **TNT** products for Windows, Mac OS X, Linux, and UNIX. Please contact MicroImages support if you need further assistance in installing your **TNT** product or configuring it on your network to meet your specific requirements.

Glossary for Geospatial Science.

A MicroImages client brought to our attention that we had a good glossary of terms but that it was buried in an appendix of the reference manual and hard to get at and search. Responding to this input this glossary has been extracted, reviewed, updated, and reformatted into a standard reference booklet and is now indexed and provided with the standard tutorial materials directly available from within your **TNT** product via Adobe Reader.

Revised Tutorials with Major Changes.

The following tutorial booklets have been revised since the release of **RV6.8**. They were selected for update since they represent areas of significant recent changes in the **TNT** products. The added functionality of newly released features is introduced by the addition of new pages and examples as noted. As part of this update their user interface illustrations, terminology, default parameters, and sample data have also been adjusted to be current with **RV6.9** of the **TNT** products.

Making Map Layouts has the following new pages:

- Toggle Tick Mark Colors—how to toggle between two selected tick mark colors;
- Using the Placement Tool—general use of the new Placement tool including context sensitive cursors, DataTips, and the right mouse button menu;
- Other Legends from Database Tables—making formatted text legends from a computed field in a database table;
- More on 3D Groups in Layouts—more information about 3D groups in layouts including how to insert them.

Creating and Using Styles has the following new pages on the new style assignment and style editor interface, and other new features.

- Symbols from Other Sources—select symbols from another style object, from CAD, from CGM, or from a TrueType font;
- Are You Exporting?—presentation of style components that may not be supported by external formats;
- Symbols with CartoScripts—modifying scripts and using different scripts to generate point symbols;
- DispParmView and DispParmEdit—setting up and saving display parameters for use in Spatial Data Display and the Spatial Data Editor.

Writing Scripts with SML has the following new pages on debugging, batch processing, and Tool Scripts.

- Be Creative with SML—outlines how to use different types of scripts to perform tasks with differing levels of complexity and interactivity (Process, Macro, Tool, and other types of scripts).
- SML Debugger and Script Timing—using the SML Debugger window to track down script errors and analyze execution times for each part of the script.
- Batch Import with SML—provides an example of using **SML** to automate a repetitive task such as importing hundreds of files with the same format.
- Sample Tool Script—a sample Tool Script that can be used to select point, line, or polygon elements (user choice via a dialog) from a vector object in a view.
- Modify and Extend Tool Scripts (I and II)—these 2 pages show how an existing Tool Script can be modified to perform a different task.

Sharing Geodata with Other Popular Products has been revised so that the exercise on EPS focuses on converting to Adobe Illustrator's native format (.ai). The Database and ODBC exercise are changed from linking through the import process to use of the new Link to Data Source feature in Spatial Data Display. Additional new topics are also introduced in the following new pages.

- Convert Layouts to PDF—conversion of a layout to PDF using the print process;
- Direct Use of MrSID, ECW, and JPEG2000—download JPEG2000 files from MicroImages' web sight and display them;

- Layouts to SVG—download SVG viewer and convert a **TNT** layout to an SVG layout using the print process;
- Import/Export Oracle Spatial—import and display vector objects from Oracle Spatial.

Using TNTAtlas for X Windows was updated to include additional features.

- Customization of the TNTAtlas Interface—how to change what appears on menus and toolbars;
- Adding and Using Custom Tools—how to detect if the atlas you are using has Macro Scripts or Tool Scripts available, how to use them, and how to add your own;
- Introduction to the GeoToolbox—seamlessly switch from sketching to measuring to selection to region generation;
- Using the TNTAtlas as a Viewer—in addition to individual objects in the **TNT** products' Project File format, **TNTAtlas** can directly view TIFF/GeoTIFF, JP2, MrSID, ECW, shapefile, and TAB formats.

Constructing an Electronic Atlas has been updated to include additional features available and the discussion of the TNTAtlas Assembly Wizard has been expanded. The additional new topics are introduced with the following new pages.

- Custom Tools with Layouts—include layout-specific tools for use with that layout only;
- Launch TNTsim3D from TNTAtlas—use a Macro Script to launch **TNTsim3D** from **TNTAtlas**;
- Additional Map Scale Control Methods—discusses map scale control by group and by element;
- Customizing the TNTAtlas Interface—how to remove/add items to the menus and toolbars;
- Permissions for Use of Atlas Files—determine what **TNT** products can be used to view your atlas and how the data can be used;
- JPEG2000 Compression for Atlases;
- Additional Parameters for ATL Files—all parameters that can currently be specified in a *.atl file, such as position, zoom, background color, and number of views open when the atlas launches;
- Launching TNTAtlases/W from CD—the steps necessary to autorun a specific **TNTAtlas** for Windows when the CD is inserted.

Navigating has been updated to provide information on the Windows Desktop and other interface / X Window System features. It also has new pages on

- Host System Differences. **MI/X** under Windows, the Windows Desktop interface, X11 with Mac OS X, and the X Window System under Linux/UNIX all have slight variations. More than ever the **TNT** products now blend in with the conventions of the host operating system.
- Geospatial Catalogs. How to set up and use GeoCatalogs, which let you visually select from thumbnails of project materials that are in the same geographic location as your current view.

Floating License Setup and Management Guide has been completely revised and now also covers the topics of system configuration, installing the license manager, the software license, and **TNT**'s checking of the software authorization key.

Changing Languages has been completely rewritten and simplified to reflect the simpler procedures now available.

Note: The following 3 booklets: Managing Relational Databases, Printing and Vector Analysis Operations were revised with major changes after the CD for **RV6.9** was duplicated. To use them, either install the latest **PV6.9** or download the specific booklet.

Managing Relational Databases has been updated to include shape objects and changes to tabular view. The illustrations were updated throughout the booklet and terminology was adjusted to reflect the current interface and defaults. The following new pages were added.

- Changing Related Only to Directly Linked—how to use directly attached tables to make related only tables into directly attached tables so a database can be simplified;
- Database Validate and Attachment Types—introduces database validation and discusses importance and implications of various attachment types;
- Link to ODBC Data Sources—presents the Link to Data Source feature in Display and contrasts it with linking during import; and
- Many Ways to Associate Tables—summarizes the many ways to associate database information with objects in the **TNT** products.

Printing has been updated to include color management and newly supported external formats. The following new pages were added.

- Color Management—color profiles (ICM and ICC) and how to proof to the screen;
- Printing to External Formats—converting layouts to TIFF, Adobe Illustrator (*.ai), PDF, EPS, and SVG;
- Options When Printing to SVG—compression and layer controls; and
- Hints for Reliable Printing—setting printer defaults and page orientation, do not dither twice, printing transparency efficiently.

Vector Analysis Operations has been updated to include material on creating and using grids with accompanying exercises. The following new pages were added:

- Grid Analysis—generating grids within reference objects;
- Grids for Extraction—using generated grids to extract from raster objects;
- Grids and Surface Properties—getting surface properties for generated grid polygons; and
- Vectors and Surfaces—converting 2D vectors to 3D vectors and using 3D views in editing.

Revised Tutorials with Minor Changes.

Displaying Geospatial Data has been updated to reflect interface and terminology changes.

Georeferencing has been updated to reflect interface and terminology changes.

Editing Vector Geodata now covers the “Undo” operation and has been updated to reflect interface and terminology changes.

Editing Raster Geodata has been updated to reflect interface and terminology changes.

Theme Mapping has been updated to reflect interface and terminology changes and changes in the default naming procedures for theme map style assignment tables.

Using TNTAtlas for Windows has been updated to reflect interface changes for newer operating systems.

Precision Farming provides corrected links to web site references for use in obtaining its sample data.

Technical Characteristics has been updated to cover new operating systems, X Server changes, localization, and the revised patching system.

Making Image Maps now provides additional information on map scale controlled display.

Translating Tutorials had a minor change for clarification.

New TNTmips Features

Main or subsections preceded by the asterisk "*" symbol introduce significant new processes or features in existing processes released for the first time in **TNTmips RV6.9**.

System Level Changes.

Miscellaneous.

Recovering Project Files.

Project Files in **V6.8** and earlier used the first 4-KB block to store the pointers to the location in the file of its other components. When areas other than the first 4 KB are damaged, Support / Recover Project File can often recover or repair all or most of the contents of the Project File. However, a Project File would have serious problems if any of the data in this first 4-KB block was damaged in any way such as during writing, storage, reading, transmission, or by some aberrant **TNT** activity.

The most common kinds of file damage occur at the start or end of a file when it is read, written, or moved. **RV6.9** duplicates the 4-KB pointer, or index block, at the beginning and end of the Project File. Now, when any **TNT** process accesses any Project File it compares these two blocks. If they do not compare the process returns an error message to you that the Project File may be damaged and that you should repair it using the Recover Project File process. This process can often determine which of the two blocks is correct by examining their contents and comparing them to the actual data they point to in the rest of the file. The recovery process can then reset both blocks.

Vector Topology.

Element ID tables can be optionally created or recreated when a vector object is validated.

A toggle is available to optionally create an element ID table for corresponding to the primary links to the attributes of a vector or CAD object. Use this table with care as these element IDs are **TNT** internal data and are altered by many **TNT** processes. However, this table may be useful to advanced users when it is made as the last step just before the object is exported, used in an external process, or within **SML**.

Project File Maintenance.

The Object Information window now shows the cumulative cell count and cumulative area for the histogram in addition to the cell count and area for each cell value (Support / Maintenance / Project File / *select file* / *select raster* / *select histogram* / Info). This information is provided for floating point as well as integer raster object types.

The Object Information panel displayed for a raster object now includes the cell size and scale computed from last-used georeference object (Support / Maintenance / Project

File / *select file* / *select raster* / Info). It also displays the date and time for the last modification of all objects and subobjects.

Viewing Object Extents.

The extents of any selected object can now be viewed in the units and projection you choose in the Object Extents dialog. If you choose to display in latitude/longitude in this dialog, you can select the preferred DMS format for their presentation. Any or all of the text in this dialog box can be selected with the mouse and copied to the clipboard so that it can then be pasted into Microsoft Word or some other application.

DataTips.

The Z value for contours will automatically become the default DataTip when the contours are created in a **TNT** surface modeling process.

Database Attachments.

In addition to raster, vector, CAD, and TIN, database records can now be attached to elements in shape objects.

TIFF Support.

The auto-link system now allows linking to any **TNT** supported TIFF file for direct use. **V6.8** provided only links to grayscale and RGB. If more than one "image" exists in the TIFF file you will be shown its hierarchy to select from. To permit these and other improvements, the link file (*.rlk) created for auto-linked TIFF files in **RV6.9** can not be used in **V6.8 TNT** products or earlier. If you wish to use **V6.8** to link to a TIFF file created in **RV6.9**, delete its companion RLK file and autolink to it in V6.8.

Import or linking now prompts for a single raster object for each TIFF file selected. If the TIFF file contains multiple images, it then imports and puts the multiple images into separate raster objects at the corresponding location. As in **V6.8**, if the TIFF file contains a single image, the raster object will be named the same as the TIFF file. If the TIFF file has 3 components these raster objects will be named Red, Green, and Blue. If it has more than 3 components they will be named Component 1, Component 2, Component 3, Component 4, and so on. This new approach for TIFF files is similar to HDF import and overcomes the issue of having a potentially complex hierarchy that would require you to individually enter the names of multiple rasters for a TIFF file containing multiple components. In the case that you do not want to use the automatically assigned names, you can edit them after the link or import has been completed.

Export now permits any number of same-sized numeric (signed, unsigned, or floating-point) raster objects to be placed in the same TIFF file. The option requiring you to specify 16-bit grayscale/48-bit color for export to TIFF has been removed. These types of raster objects are now automatically selected for export to TIFF if the raster object's data type exceeds 8-bits. Export of a floating-point raster object to a floating point TIFF is now also automatic. You can also specify the desired DPI setting during export to TIFF as other image editing software such as Photoshop often expects this information.

For your future reference, **RV6.9** uses an earlier version of the TIFF libraries. **DV7.0** will use the newest available TIFF libraries (V3.6), which support various new additional features (which means, new tags) such as the ICM/ICC color profiles described below in the section entitled Color Management. **DV7.0** also has added the ability for you to view metadata for the TIFF file based on the contents of all of the tags in the file.

JPEG2000 Compression.

Use for Internal Raster Objects.

Wide Ranging Use.

Lossless or lossy JPEG2000 compression can now be used for raster objects in any **TNT** Project File. You can choose from lossless, lossy best quality, or specify a fixed lossy ratio in all the **TNT** products, just as previously available in **V6.7** and **V6.8** for the creation and use of external JP2 files. Now all of the **TNT** processes support the use of internally compressed JPEG2000 raster objects while continuing to provide full pyramid-ing and all associated subobjects and characteristics. For example, you can use JPEG2000 compression with a raster object from import through analysis, resizing, re-projection, editing, mosaicking and on into a **TNTatlas**. **TNTserver** can even send a JP2 compressed raster out to a **TNTclient**—all of these uses will often be even faster than using uncompressed raster objects.

No Performance Penalty.

Most of the projects you undertake will be small enough that the time to compress a raster into JPEG2000 will not be noticeable. The use of JPEG2000 compression in connection with huge rasters of hundreds of gigabytes will be discussed in detail in a section below. After compression, there is no decrease in performance when these rasters are decompressed in Display and other **TNT** processes. In fact, they can often be displayed and accessed faster since the amount of data to be read from your hard drive, CD, or DVD may be significantly reduced for lossless and markedly reduced for lossy JPEG2000 compression.

Cautions for Lossy Compression.

Care must given to deciding where to use a lossy compressed raster object. If you elect to use lossy compression to reduce your Project File size, it may adversely impact your subsequent use of this raster object. For example, applying lossy compression of any kind to an image and discarding the original, larger image will prevent you from ever re-gaining access to all the detail in the original image. Never apply any form of lossy compression to a raster to which you intend to apply further quantitative analysis—for example, never to multispectral images that will be subjected to unsupervised or supervised automatic interpretation. In other words, know what you are doing and where you are going before applying lossy image compression of any kind. However, lossy compression has many benefits when used for its intended purpose for large reductions in file size to conserve communication bandwidth or storage media requirements for images in their final, user-oriented form. Lossy compression is very useful to drastically reduce file size and access time in a **TNTsim3D**, **TNTatlas**, **TNTserver**, and at other steps in the final publication of your result. For example, a 40 GB raster object can easily be reduced to a 4 GB or smaller raster object for use as an image reference layer in a **TNTatlas** distributed on a DVD, which still leaves room for vector and database layers.

Benefits of Lossless Compression.

The availability of JPEG2000 lossless compression in the **TNT** processes has much wider utility in potentially saving considerable space in all the Project Files created during your analysis projects. You will be surprised how much the application of lossless JPEG2000 can reduce an image that has large areas of similar data values, limited data range, or null areas (or all 3) with no apparent impact on **TNT** performance and often improving processing times in subsequent uses. An irregularly bounded image repre-

senting just the area of the United States, such as the MODIS 24-bit world color mosaic provided on your **TNT** Global Reference Geodata DVD, yielded almost 7:1 lossless JPEG2000 compression. Grayscale images or DEMs can yield equally good results since they typically only represent 8 bits or less of variation or in 16-bit raster objects seldom actually have data values that vary over the complete 16-bit range (typically only 11 or 12 bits of actual data range). In another case a mostly rectangular, 24-bit color, 30 centimeter resolution (1 foot), image of Lincoln, Nebraska yielded 3:1 lossy compression. Some of this reduction was due to the fact that it was only available as a lossy 10:1 MrSID compressed image, which permanently reduced its variability, as well as having null areas over about 5 percent of the image. A typical image (full rectangle, high resolution therefore high spatial variability, and no null areas) will lossless compress only to about 2:1.

Georeferencing using GeoJP2 Files.

Overview.

JPEG2000 was not created specifically for use in remote sensing or other geospatial applications. Thus its initial, official, adopted ISO definition providing the basis for a standalone JP2 image file does not contain any specifications for including georeference information. JPEG2000 compression now used internally for your MicroImages Project Files uses the same georeference subobjects as for all other raster objects.

The ISO standard does provide for the inclusion of custom blocks of information. Thus various software developers can add and promote their own approaches for georeferencing a standalone JP2 file. These are being added to the **TNT** processes as they are encountered. The strategy of exporting and using an external auxiliary J2W georeference file in the ArcWorld format was part of the initial **TNT V6.7** support of JP2 files. **RV6.9** adds another method for directly embedding this information within the JP2 file to create what is called a GeoJP2 file.

Last Minute Addition: All comments about GeoJP2 and Mapping Science in this MEMO are now subject to uncertainty. LizardTech, the developers of MrSID and related products have now taken possession of the assets of Mapping Sciences via a lawsuit. For more information on this topic see www.lizardtech.com/solutions/ms/ or www.mappingscience.com/msi.htm.

Concept.

There are provisions in the official JPEG2000 structure for including custom information (metadata blocks) in the standard structure of a JP2 file. These blocks can be used for anything as long as they can be automatically ignored by any and all other JPEG2000 compliant programs without invalidating the ISO standard and the general use of that JP2 file. A file that complies with these requirements is still a JP2 file. However, software created to use JP2 files and to be aware of, and act on, these custom blocks (for example, the **TNT** products) can use them for their special purpose.

Mapping Science (www.mappingscience.com) is promoting the use of a custom block to provide georeferencing for an ISO compliant JP2 file thus yielding what they have named a GeoJP2 file (in parallel to the naming extension of TIFF to GeoTIFF). They use a specific metadata block in the JP2 file to store data blocks that are actually a GeoTIFF file. This GeoTIFF file has all its TIFF tags but only 1 raster cell. When this meta-

metadata block is available, the **TNT** products read the embedded GeoTIFF information and use them as the georeference for that GeoJP2 file.

Implementation.

MicrolImages JP2 files created since **V6.70** are accompanied by an auxiliary "ArcWorld" (*.j2w) file of the same name as the JP2 file. This strategy conforms to the design first used by ESRI to georeference imagery and now used in many other products. The disadvantage of this approach is that the map projection of the data file is not included in the ArcWorld file. Use of ArcWorld georeferencing therefore requires that the user of the imagery specify the projection when using the image.

The advantage of the GeoJP2 file is that the georeferencing is embedded and can not get separated from the raster contents of the JP2 file. It also provides a more complete georeferencing including map projection and datum information. **TNT** products can now directly link to and use a GeoJP2 file and its associated georeference information. The **TNT** Import process converts this georeference information to the appropriate internal form. The **TNT** Export process now automatically includes the GeoJP2 metadata (as well as optionally creating an ArcWorld file) so that the GeoJP2 file can be used by those programs that use it for a georeference.

Performance.

MicrolImages has conducted 2 tests to determine how rapidly typical images can be compressed with JPEG2000 in **RV6.9** of the **TNT** products using Windows. The results of these tests are presented here. Both tests were conducted on a computer with a single 2.4 GHz Pentium 4 processor with 1 GB of real memory using Windows XP and a single, slow 4800 rpm hard drive. Remember that in all large raster to raster operations, using 2 drives (one as a source and one as a destination) may yield better performance. It is also important to continue emphasizing that once JPEG2000 compressed, these images can be viewed at any zoom scale in the **TNT** products in 1 to 3 seconds.

140 MB Test Image.

The smaller test compressed a typical 140.4 MB image representing a 24-bit natural color composite of a Landsat TM image of 7000 lines by 7000 columns. The Raster Extract process was used to access the uncompressed raster object and create the new raster object using JPEG2000 compression with these results.

- using lossless compression 51.6 MB in 40 seconds
- using lossy best quality 25.0 MB in 26 seconds

Using the Export to a JP2 file available in V6.8 and now for the export to a GeoJP2 the times are:

- using lossless compression 51.4 MB in 40 seconds
- using lossy best quality 24.8 MB in 43 seconds
- using 10:1 lossy 14.0 MB in 42 seconds

A final test on the same computer and a single hard drive used the Raster Extract process to extract the entire typical 140.4 MB raster object and recreate it. The new raster object was also not compressed and was placed in a new **TNT** Project File. This required 40 seconds. From this and the above compression tests you see that using lossless JPEG2000 compression to reduce this test raster object to 1/3 its original size has no performance impact on this or other **TNT** processes. Furthermore, using the best quality lossy JPEG2000 compression where appropriate would reduced the raster object to 1/6 its size and is actually faster (which means, 26 seconds) than writing the

uncompressed raster object (which means, 40 seconds) since the compressed output raster object is smaller and thus requires less time to write.

IMPORTANT NOTE: A TNT process that is acting on an uncompressed raster and applies JPEG2000 compression to the output can be faster since it is writing a smaller raster object.

IMPORTANT NOTE: Using JPEG2000 compressed raster objects can increase performance when they are read by a TNT process since they are smaller.

2.78 GB Test Image.

The larger test used the uncompressed 2.78 GB version of the NASA MODIS color image on the sample Global Reference Geodata on the DVD provided with **RV6.9**. When you view this image you will note that most of its cells contain the single uniform value representing the area of the oceans. As a result the lossless compression is almost 6:1. The Raster Extract process was used to access the uncompressed 2.78 GB raster object and create the new raster object using JPEG2000 compression with these results.

- using lossless compression 484 MB in 34 minutes
- using lossy best quality 358 MB in 32 minutes

Using the Export to a JP2 file available in **V6.8** and now for the export to a GeoJP2 the times are:

- using lossless compression 481 MB in 34 minutes
- using lossy best quality 357 MB in 37 minutes
- using 10:1 lossy 267 MB in 37 minutes

A final test on the same computer and a single hard drive used the Raster Extract process to extract the entire large 2.78 GB raster object and recreate it. The new raster object was also not compressed and was placed in a new TNT Project File. This required 116 minutes. From this and the above compression tests you see that using lossless JPEG2000 compression to reduce this test raster object to 1/6 its original size was about 3 times faster in this and in other TNT processes when lossless JPEG2000 compression is applied to the new raster object. As you can see from these tests, any reduction in file size (linked or for a raster object) is translated to performance increases due to reduced read operations when using JPEG2000 compression. Thus, subsequent TNT operations that need to read this JPEG2000 lossless or lossy compressed object would also be similarly faster using this smaller raster object.

IMPORTANT NOTE: A TNT process which is acting on an uncompressed raster and applies JPEG2000 compression output can be substantially faster since it is writing a smaller raster object.

IMPORTANT NOTE: Using JPEG2000 compressed raster objects can significantly increase performance when they are read by a TNT process since they are smaller.

Improved Memory Management.

Background.

The entire JPEG2000 concept is optimized for decompressing its result—this is what controls its performance from the end user's perspective. The time-to-compress is the responsibility of the data preparer who is usually not working under the same time constraints. As a result, the fastest decompression possible is usually the goal and slower compression will be accepted to meet this objective.

Compression takes computer processor time and memory to hold the JPEG2000 compressed data as it is built up from the specific data set. The process can not simply look at the first part of the image and determine a good model for the entire image. For example, the corners of the image might be all nulls or water thus producing a model unsuitable for the rest of the image. Furthermore, the procedure can not sample the image to set up the compression model. Sampling would not correctly represent the high frequency and noise components of the image. Sampling also requires reading a lot of a potentially very large image in some other potentially cumbersome format.

What's the Problem?

Microworks' clients using **V6.8** have not reported reaching its memory limitation during JPEG2000 compression into JP2 files. However, a number of clients are now discussing the capability of the **TNT** products to apply JPEG2000 compression to huge images in the range of 50 to 300 GB on 32-bit Windows based platforms using XP, 2000, and 2003. Examples of these kinds of projects are:

- a client's mosaic of several hundred, 1-meter ortho-IKONOS images;
- DigitalGlobe's 15 meter, 24-bit color Landsat mosaic of the United States of 275 GB; and
- a 30 centimeter (1 foot) USGS color image mosaic of Lincoln, Nebraska and surrounding area of 1350 square kilometers (525 square miles) and 47 GB.

These projects are all testing the robustness of the **TNT** JPEG2000 compression implementation as well as other **TNT** processes, such as mosaic. Microworks has used two of these as internal projects to determine how big of an image/raster can be handled in **TNTmips** and how fast.

Current Approach.

Fortunately the developer of the Kakadu JPEG2000 libraries used by Microworks and many others for the JPEG2000 compression and decompression has released a new library with even better memory management (www.kakadusoftware.com). This has been incorporated into **RV6.9** and is more conservative on the use of memory than the previous Kakadu library used in **V6.8**. The impact of the amount of real and virtual memory available to this decompression process will be discussed in detail below as it is significant for massive images.

Exceeding the real and virtual memory permitted by Windows during compression can not be predicted in advance and may even cause Windows to crash. Thus, the **TNT** compression control dialog now lets you set the maximum real memory limit to be used during compression and correspondingly slows it down. To further improve the handling of huge input images, an option to choose "Automatic" progression order has been added to the control dialog and is the default. It will keep your operation within your specified memory limitations. To avoid confusion, this setting and others used to control

the advanced technical characteristics of **TNT**'s JPEG2000 compression have been moved to an Advanced Settings window and appropriate defaults provided.

Why Create Single Massive Images?

Avoid Edge Effects.

Why make these huge, massive single images that are far bigger than any media on which they can be readily distributed and are also impractical for movement on the Internet or a LAN? Why not simply chop the large images into smaller geographically related tiles that fit on multiple CD or DVD media. The issue is that JPEG2000 lossy compression (and we would assume those of MrSID and ECW) can not produce the identical losses when applied separately to pieces of a larger image. Consider the case of applying 10:1 lossy compression on 2 adjacent tiles making up a larger image where one has a very large uniform color lake and the other does not. The result is that the amount of detail lost in the image containing the lake for a 10:1 lossy compression will not be as significant as those in the 10:1 lossy compression of the tile containing only detailed land features. Thus, when you apply fixed ratio lossy or best quality lossy, the detail lost will vary slightly from piece to piece of your total image. Thus, when these tiles are mosaicked or displayed together, horizontal or vertical seams will show as the human eye is a wonderful comparator and detector of lines.

At some future time, it may be that the developer's of the JPEG2000 compression libraries will make provision for somehow developing a lossy compression model for the entire large area of interest from pieces and then permit it to be applied to these tiles one-by-one. However, this may not be possible as JPEG2000 lossy compression works on removing spatial noise and high spatial frequency features. As a result, any kind of sampling of a large area can not be used. Correspondingly, if a small subarea is used to develop the compression model it might arbitrarily hit a lake or a null area. Anyway, those developing and promoting JPEG2000 are not yet that concerned with handling huge images and images that are not rectangular (which means, irregularly bounded or contain null areas)—these are common characteristics of the images used in remote sensing and geospatial analysis.

Recommended Procedure.

With these limitations in mind, the most appropriate approach to this problem, since you own a **TNTmips**, is to keep your original image in a lossless condition until it is mosaicked. This means you will be starting with many large images and ending up mosaicking it into a huge single image. Next use the Raster Extract process to copy the entire mosaicked image to a lossy JPEG2000 compressed raster object. Then use this single lossy compressed raster object or cut it into the appropriate pieces for distribution. Alternatively you could export the lossless mosaicked image to a single large or multiple smaller pieces in lossy JP2 or GeoJP2 files. By these steps you can produce a JP2, GeoJP2, or **TNT** raster object that will fit on CD or DVD and will not produce visible seams and artifacts at the joining edges.

At this point you might wonder why not simplify the above procedure by adding JPEG2000 compression to the Mosaic process. Eventually this will be provided, however, it would not save any drive space. The large, lossless raster would still have to be created by mosaic as a temporary file on your drive so that the JPEG2000 compression could be applied to the total image for the reasons outlined above.

Testing Memory Management.

MicrolImages has conducted 2 tests to determine how large of an image can be compressed with JPEG2000 in **RV6.9** of the **TNT** products using Windows. The results of these tests are presented here. Both tests were conducted on a computer with a single 2.4 GHz Pentium 4 processor with 2 GB of real memory, Windows XP, and about 1 terabyte of hard drive space.

The smaller test compressed a 46.6 GB image and did not "go virtual." It built up and kept the JPEG2000 compression model characteristics within the available real memory and completed in 3 to 4 hours. The test using a 275 GB input image did "go virtual." It constantly swapped data in and out from virtual memory and took 2 weeks to finish, but it did finish! While the ratio of the sizes of these input images is about 5 to 1, the time to compress differed by about 100:1. Observations of Windows memory management during the 275 GB tests indicated that about .5 GB of additional real memory would have been required to complete this task in 20 to 24 hours. This is just about the proportion of the 2 GB of real memory that was being used directly by Windows and was not available as real memory to the **TNT** process.

47 GB Test Image.

The following test case completed within the 2 GB total memory limitations of Windows XP, 2000, and 2003. During each of the tests it was observed that the critical compression activities stayed within and used the available real memory.

The test used a 24-bit color composite image of an area of 1350 square kilometers (525 square miles) centered on the city of Lincoln, Nebraska. This image was collected in the spring of 2002 by a camera for USGS in several hundred frames and then orthorectified and mosaicked. Its ground resolution is 30 centimeters (1-foot) yielding 145,000 lines and 115,000 columns.

This image was purchased by MicrolImages and was provided as 4.66 GB delivered on 2 DVDs in many MrSID tiles using lossy 10:1 compression. These MrSID images were batch imported by **TNTmips** into decompressed raster objects and mosaicked yielding a single raster object of 46.6 GB. The Raster Extract process was then used to compress this raster into a new JPEG2000 compressed raster object with these results:

- using lossless compression 15.36 GB in 3 hrs 45 min
- using lossy best quality setting 8.42 GB in 3 hrs 10 min
- using 12:1 lossy to fit on a single DVD 3.97 GB in 2 hrs 45 min

The 46.6 GB raster object was also exported to a JP2 file as follows.

- using 12:1 lossy to fit on a single DVD 3.88 GB in 3 hrs 41 min

Decompression of this large 46.6 GB raster object or any of the JPEG2000 compressed test results is not memory or size dependent. Viewing any of these test results (which means, raster objects or linked JP2 files) at any scale in a **TNT** product requires 1 to 3 seconds from a hard drive and from 1 to 6 seconds from DVD in a 16X reader. Side by side comparisons at full 1:1 zoom shows that the original 10:1 MrSID images are almost identical to the 12:1 JP2 file.

275 GB Test Image.

The following test case was also completed within the 2 GB total memory limitations of Windows XP, 2000, and 2003. Although the test platform had the maximum of 2 GB real memory, Windows and associated system operations captured and was using at least .5 GB of this real memory. Thus, during each of these tests it was observed that

the critical compression activities required more than the available real memory and extensive use of virtual memory was needed.

The test used a 24-bit color composite image of the area of the 48 "lower" or conterminous states of the United States (only the area inside the borders of the United States excluding Hawaii and Alaska). The large areas of Canada, Mexico, and the Oceans inside the rectangle bounding this area are represented by null cells. The image represents thousands of mosaicked Landsat frames with a ground resolution of 15 meters. It is the property of DigitalGlobe and is used in assisting their clients in locating ground areas of interest for ordering other products. The image was provided on a hard drive in 2 by 2 degree uncompressed TIFF files. It was mosaicked in **TNTmips** for this test into a single raster object of 180,393 lines and 513,699 columns. The Raster Extract process was then used to compress this raster into a new raster object with these results:

- using lossless compression 81.5 GB in 313 hrs

The 275 GB raster object was also exported to JP2 file as follows:

- using lossless compression 81 GB in 283 hrs
- using 100:1 lossy compression 2.5 GB in 23+ hrs

Decompression of this huge 275 GB raster object or any of the JPEG2000 compressed test images is not memory or size dependent. Viewing any of these test results (which means, raster objects or linked JP2 files) at any scale in a **TNT** product requires 1 to 3 seconds from a hard drive and from 1 to 6 seconds from DVD in a 16X reader for the 100:1 compressed JP2. Side by side comparisons at full 1:1 zoom and larger show that the original TIFF images do contain high resolution details that are slightly smoothed in the 100:1 lossy compression, but that the result is still very satisfactory for use as a reference background on DVDs for many other kinds of geospatial overlays of the "lower" United States. This would include reference to individual property parcels.

Discussion.

It is now appropriate to consider how this 275 GB JPEG2000 compression test will perform if more real memory is made available. Alas, every 32-bit version of Windows is limited to addressing 2 GB of real or real plus virtual memory. It does not matter if it's all real memory or some of it is virtual memory on the hard drive. As a result, adding more real memory on the motherboard of a 32-bit Windows machine is not a workable approach if you want to compress images exceeding about 200 GB in size in **TNT** products and are unwilling to wait weeks. However, **TNT** products are now available for several different 64-bit platforms, which use more real memory and are also inherently faster. The following larger memory options are available for use with the new 64-bit versions of the **TNT** products for this and other large projects.

64-bit Linux on AMD Opteron. Linux kernel V2.4.0 supports the use of 16 GB of real memory. The newly released kernel V2.6 supports the use of 64 GB of memory on 32-bit processors and 1 TB on 64-bit processors. MicrolImages has available a platform using dual AMD 64-bit Opteron processors (US\$2000 without a monitor) and 8 memory slots each capable of using up to 2 GB memory modules. The platform comes with SuSE 8, which uses kernel 2.4 and will address up to 16 GB of real memory (SuSE 9 for kernel 2.6 and 1 TB memory support is now also available). Arrangements are underway to increase the memory of this test platform beyond the original 1 GB so that the 275 GB compression test can be rerun without going virtual. With 16 GB of real memory, this platform should permit the **TNT** products to apply JPEG2000 compression to a terabyte image although this would take several days.

64-bit Solaris on SPARC. A Sun SPARC platform running Solaris 8.x or 9.x with adequate real memory would be ideal for TNT's JPEG2000 compression of the 275 GB or larger images. All but the entry level Sun platforms using Intel processors would have more real memory and thus are excellent choices for compressing 275 GB or even larger images.

64-bit Linux on AMD Athlon. SuSE 8 and the beta of Windows 64-bit XP run well on the AMD Athlon F64 and F64X platforms (US\$800 without a monitor). However, only a few motherboards are available for these chips at this time and all seem to limit real memory to 2 GB.

64-bit beta Windows XP on AMD. The **TNT** products are available for use with this 64-bit version of Windows on both the 64-bit AMD Opteron and Athlon based platforms. At this time Microlmages can not report upon the maximum real memory supported by this beta Windows. However, the hardware available to run this Windows is the same as that outlined above for use with Linux so the same practical limits would apply (16 GB for Opteron and 2 GB for Athlon) until new motherboards are released.

64-bit Mac OS X on G5. You can populate the mother board of the latest Apple G5 dual processor platform with up to a maximum of 16 GB. Some Mac OS X operating system actions will utilize this much memory. However, V10.2.3 of Mac OS X still uses 32-bit libraries, which the **TNT** products also share. This limits each **TNT** process to a maximum of 32-bit or to using 2 GB real or real plus virtual memory.

64-bit beta Windows XP on Itanium II. The **TNT** products are not yet available for this version of Windows on the Itanium II platform. Current Itanium II desktop platforms and this version of Windows cost about US\$10,000 and are not worth this price on a comparative basis.

DV7.0—Faster Massive Files.

Just as this MEMO was being printed, a new Kakadu JPEG2000 library was released that provides Microlmages the basis for testing further memory management improvements. These should provide the basis for improving the performance of **TNTmips** for compressing massive images on computers with 2 GB or less of real memory and within the memory management limitations of 32-bit versions of Windows.

Use of JPEG2000 in "Photo" Viewers.

NOTE: Few software products, image viewers, and plug-ins claiming to use JP2 files can handle large JP2 files.

Size Limitations.

Popular application software (for example, QuickTime, Preview, and Photoshop) can not handle JP2 files of much greater than 2 GB. Most viewers and plug-ins for browsers also do not support large JP2 files for similar reasons. It appears they all decompress the JP2 file into memory, probably because they do not support pyramided rasters for rapid direct access or use a JPEG2000 library optimized for this purpose. In many of these products, selecting a large JP2 file causes a memory overflow and they crash or slow down so much that the program is effectively hung. Doubly bad is that you will get no warning when you select these large files since the product does not check and predict in advance how big the uncompressed image will be.

Determining Which Product is Responsible.

Improper behavior of **TNT** produced JP2 and GeoJP2 files in other software does not mean that there is a problem in the **TNT** produced JP2 or GeoJP2 file. **TNTatlas** can be used as a viewer to link to, and view any correctly formed JP2 and GeoJP2 file or JPEG2000 compressed **TNT** raster object of any size. The creator of the Kakadu library used by MicrolImages and many others provides a FREE standalone JP2 viewer. It can also be used to view and verify that a JP2 and GeoJP2 file of any size is correctly structured according to the JPEG2000 options and standard. This viewer is kdu_show.exe and can be obtained by downloading the WIN32 Executables along with its manual from www.kakadusoftware.com/downloads.html. Mapping Science also provides a free MSI Viewer that can deal with very large JP2 or GeoJP2 images. It can be downloaded from www.mappingscience.com/msi.htm.

Compressed Images from Personal Cameras.

A few personal cameras will optionally save pictures as large, lossless TIFF files. More cameras can optionally save pictures into large lossless RAW rasters. Unfortunately, these RAW (*.raw) pictures are in fact the "raw," uncompressed data collected by the imaging sensor. Thus, the RAW format is not standardized in any way and can even vary from model to model from a single manufacturer and can only be used in each camera's proprietary off-line image enhancement and processing software. There is also a discussion underway in that industry that the best way to standardize the access to the RAW formats is by using a manufacturer supplied TWAIN driver, the same TWAIN driver concept used in standardizing access to scanners.

The use of a lossless format in personal cameras is not of immediate wide scale interest since they create such big files. The camera's flash memory could only hold a few lossless images. It also takes quite a long time after the image capture to write these large images into the flash memory. MicrolImages has not yet encountered any personal digital camera that will save pictures into the standard lossy or lossless JP2 file. This seems to be only in the discussion phase because fast JPEG2000 compression takes more computing resources than JPEG, which is simple and well entrenched. The replacement of JPEG and PNG as a replacement for the storage and archival of photographs is well underway. A good place to start reading about this is the short article [JPEG2000: the Killer Image File Format for Lossless Storage](http://www.oreillynet.com/pub/a/javascript/2003/11/14/digphoto_ckbk.html). Ken Milburn. 11/2003 at www.oreillynet.com/pub/a/javascript/2003/11/14/digphoto_ckbk.html.

MicrolImages would be pleased to hear from you with further information on this topic.

2D Display.

Antialiasing.

Thin lines (for example, 1 screen pixel wide) can now optionally be drawn with antialiasing and/or hinting applied. By default both these options are on and can be toggled off/on for all new views on the Display/View Options dialog on its View tabbed panel. Both options can also be independently toggled off/on for each view using the View window's Options menu. A color plate (1/2 page) is attached to illustrate these effects and is entitled Antialiasing and Hinting of Thin Lines.

LegendView.

Unnecessary vertical spacing has been removed from the LegendView so the individual entries are closer together. Now more legend entries are visible without requiring scrolling of the LegendView panel.

Installing Scripts.

In **V6.8** the **SML** Macro Scripts you installed to act on your current view or for any other analyses were added to the menu bar as named entries under the heading Macros. They were also automatically added to the view's icon bar as a new icon using the same name as their ToolTip. Some of you have added many Macro Scripts resulting in so many icons that the icon bar became confusing. In these circumstances, omitting the icons and providing access only via the cascading Macros menus is recommended. In **RV6.9** during installation of a Macro Script, you have the option of omitting the icon. This and other adjustments to the process of gaining access to the **SML** development tools and installing Macro Scripts is discussed and illustrated in the attached color plate entitled Macro Script Setup.

Linear Transparency in Color Palettes.

In **V6.8** you could manually set the transparency of each color cell by cell in a new or existing color palette in the Color Palette Editor dialog. This can be tedious if you want to create a color palette with a smoothly varying transparency from a low cell value to high or vice versa. This dialog now lets you select the transparency values for the upper and lower cell values in the palette or any intermediate pair of cell values. You can then specify that you wish the transparency of the color of all the intermediate cell values to vary linearly between your selected end settings.

An example of the use of linearly varying color transparency would be to assign a color palette with high transparency (95%) to the low elevations in a DEM and low transparency (40%) to the top of the mountains. When this DEM is overlaid onto a grayscale image of the same area the complex land cover detail will show in the flat areas without color and the mountains are color coded in altitude with increasing opacity. This sample application is illustrated in the attached color plate entitled Automatically Vary Transparency in Raster Color Palettes.

Zooming Directly to Positions in a View.

A new Zoom to Location icon on the View window's toolbar provides a Zoom to Location dialog to enter the coordinates to reposition the center of the view. These coordinates can be in any of the coordinate systems or projections supported by the **TNT** products. You can also specify the zoom at the new position by setting a scale or the height or width of the view in the selected ground measurement. These new capabilities are illustrated in the attached partial color plate entitled Zooming to a Specified Location.

Dual Coordinate Readout.

The automatic coordinate readout at the bottom of every View window now, by default, displays coordinates in two systems. By default these are set to display coordinates in UTM and latitude/longitude. You can independently toggle off/on either of these position reports, select their projections, set their units, and choose the desired latitude/longitude (DMS) format from the View window's Options menu. This dual readout is illustrated in the attached partial color plate entitled Viewing Two Position Reports.

* Adding Custom Tools to Groups and Layouts.

Background.

Groups and layouts are used to define and maintain the relationships between collections of **TNT** geodata objects in various Project Files or linked external files in other formats. Creating a group or layout organizes a collection of specific geodata into a meaningful unit and defines how it is used together in a display group or layout, a map layout, an edit session, in an atlas, and so on. **V6.8** permitted you to add these **SML** tools (Macro and Tool Scripts) to every View window where they are always presented until manually removed. This approach is suitable if your special tools can be generically applied to any view, or at least to any raster object, any vector object, and so on.

Implementation.

SML can also be used to create complex analysis tools that are dependent upon one or more objects in a specific group or layout. To streamline this application of scripts for data dependent custom tools in **RV6.9**, Macro Scripts and Tool Scripts can now be stored with a specific group or layout. When that group or layout is selected these associated scripts are added to the menu bar for your use or additionally as an icon to the toolbar in the View window. Unlike the previous approach, which is still available, these menus and icons are not always part of the view. They are only presented when the group or layout to which they are attached is displayed. These new procedures for managing and applying custom tools are illustrated in the attached color plate entitled Use Layouts to Customize TNTatlas/X.

Delivering scripts with the layouts is a particularly effective way to add unique and data dependent tools related to the specific contents of an atlas. When they are part of the atlas layout, any copy of **TNTatlas** software which accesses and works with that data content will also have its special tools. This is even the case if the platform using the **TNTatlas** varies from Windows, to Mac OS X, to Linux since these embedded tools are written in **SML**, which is a platform independent feature of all **TNT** products. This is also illustrated in the attached color plate entitled Use Layouts to Customize TNTatlas/X.

A good example of a data dependent tool is a Tool Script created in **SML** that makes use of the attributes of a particular vector layer in the group. The Tool Script implements an **SML** query for the element selected in the script by the cursor. It might combine and test data from a number of attributes and return a variety of results. While this Tool Script can be very useful, it is data dependent and, thus, works best if associated with a group or layout that loads the selected layer(s) for which it was designed. This type of data dependent Tool Script acting on selected element's attributes is used for the examples in the attached color plate entitled Modifying SML Tool Scripts for New Applications.

Reusing Your Tools.

Using a template can be a convenient way to assemble geodata into a series of similar layouts, for example creating a series of maps. By design these new layouts will usually contain similar geodata layers merely covering a different ground area. As a result specialized scripts can be developed to provide tools for use with the specific data in the master layout and then transferred as part of the template process to each new daughter layout in the series.

Data dependent scripts can also often be easily modified to operate on quite different data layers. A script providing a tool used to query attributes attached to elements in

one vector object can be easily modified to change both the query and the attributes. For example, a Tool Script designed to locate and select streets by name can be adapted with a few simple changes to select cities by name in an entirely different area and vector object. These simple changes are illustrated in the attached color plate entitled Modifying SML Tool Scripts for New Applications.

DV7.0—Styled DataTips.

Add Styles. DataTips can now be set up to use the same **TNT** embedded text style codes as any single text layer. You can use these style codes to greatly enhance the appearance of your DataTips. Just a few of the styles that can now occur in your DataTips are control of the frame fill color and each text element's color. The text element's font, size, rendering style (bold, italics, outline,...) can also be set and rendered in the DataTips. Tabs can be set and text alignment set to left, right, center, and justify.

Advanced Applications. Using these style codes you can add a new kind of interactive information flow to your DataTips. For example, the floodplain zone attribute for hidden polygons can be used in a virtual field to set the background color of the frame for the DataTip to be light green, yellow, or red. Using this approach the DataTip could show a property's ownership information in text and use the frame's background color to provide an alert of its floodplain zoning (for example, light red means subject to frequent flooding). Using a similar approach, even the color of a text element retrieved from a field can be varied using a virtual field.

Color Plates? **DV7.0** already supports using these new Styled DataTips. Illustrations of this application will be some of the new color plates posted on microimages.com.

DV7.0—GraphTips.

What Are They? Those clients who have prepaid for **RV7.0** can download **DV7.0** and gain access to a new and innovative 2D visualization feature. 2D views can now be set up to use Graphical DataTips or GraphTips for short. GraphTips pop in and out just like the DataTips, ToolTips, and HelpTips.

How Did They Evolve? The idea for GraphTips came about from discussions of how to provide you with the styled DataTips also now available in **DV7.0**. Eventually this discussion lead to the realization that it was not difficult to provide you with a means to set up something that behaves like a DataTip but is graphical in design. It simply uses the same familiar **SML** scripting language, including queries, to pop in a graphic based upon attributes of the nearest feature. Conceptually it permits your information flow designs to go beyond complex, multiline DataTips that use virtual fields to model the values presented. Now you can also create a script that will use simple drawing tools to draw and popin GraphTips.

Why Are They Needed? If you create a large paper map product, **TNTmips** provides you with a variety of means of drawing graphical pins all over it. A large map can easily portray hundreds of symbolic pins and graphs each representing the information at a point. Pie diagrams and histograms are simple examples and CartoScripts provide the basis for many others.

GraphTips are the interactive equivalent of the printed pin map. When your product is interactive, such as a display layout or a **TNTatlas**, the pin map approach is usually limited to a few points and variables in the view and requires careful control of layers by scale. If you are zoomed out with relative scaling set for your pins they can become too

small to “read.” If you are zoomed out with absolute scaling set for your pins, you can only use a limited number or they will cover everything else in the viewing area. If you are zoomed in with relative scaling set, the few pins in the current view can obscure it.

Clearly pin mapping has limitations in a highly interactive, user-driven display oriented to visualization. Pin mapping can use interactive view scale control features but is still limited in the complexity and number of pins you can provide. The ultimate control is thus to print the map, which fixes the relative scale of the features and layers it provides. GraphTips allow you to present complex information at any view scale for every point in the view, to control how it will relate to the image and map features in that view, and to dynamically present changes in the database information being used.

Examples? Some examples of the easily understood and easily created GraphTips will assist you in understanding this new and powerful visualization feature. A GraphTip could be a color pie diagram of the 4 principle ethnic groups (which means, 4 fields) of a city with its radius determined by the population from another field. To see this diagram for any city you simply move the cursor to each city. This is a very simple GraphTip script.

Another GraphTip could use a group with a minimum of 2 layers: an image layer and a DEM, which is not visible. A GraphTip could then pop in for any point in the view with a viewshed overlay computed out to some radius from the DEM layer. This GraphTip is a simple example of interactive visual information flow for every point in your view that can not be done with TNT’s previous pin mapping capabilities. Since a viewshed function is available in **SML**, this is also not a complex script. A radius is used to limit the extent of the computation for the viewshed so that the GraphTip can be responsive. A wide range of types of GraphTips can be implemented across platforms using the extensive, spatially-oriented tool kit provided by the functions and classes in **SML**.

Color Plates? **DV7.0** already provides this new GraphTips procedure. Illustrations of this application will be some of the new color plates posted on microimages.com.

*** 3D Display.**

Considerable effort continues in this process as 2 more advanced terrain rendering models are available: Dense Ray Casting and Variable Triangulation. Both these models provide better rendering speed and quality than any earlier models. While the available terrain models now total 7, older models such as ray casting are being superceded by these newer, better models and will eventually be purged, probably in **DV7.0**. However, at this time these older methods still provide some optional features not yet implemented in the newer methods such as transparency and relief shading.

All 6 of the texture filters for raster drape layers can now be selected for use with any of these 7 surface rendering models. The combination of the texture method and terrain model you select will control the speed and quality of the rendering. Please refer to the corresponding section in the release MEMO shipped with **V6.8** for more details on the other earlier new models and all the new texture rendering methods (see www.microimages.com/relnotes/v68/rel68.htm).

Dense Ray Casting.

Dense Ray Casting uses dense triangulation to render the foreground of the view and ray casting for the background area. This hybrid method has good performance and the best terrain rendering, and you do not see the transition between methods. Choose the

MipMap Anisotropic texture rendering method from the Raster Layer Controls dialog for the best quality, but it will have an impact on rendering speed.

Variable Triangulation.

Just as its name suggests, this terrain triangulation method varies the size of triangles from the front of the view to the rear as the relationship between terrain detail and screen pixel size changes. In other words, small triangles are needed in the foreground to represent topographic details that are rendered over many screen pixels. In the background, these fine details may be compressed into a single screen pixel, and would not be visible, so larger triangles can be used there to represent a more generalized model of the terrain. In this fashion, the number of triangles needed to render the terrain is optimized to produce the best possible representation of the terrain based on cell size and the current viewpoint. Combining this surface rendering mode with the MipMap Anisotropic texture filter option yields the fastest performance of any of the current **TNT** 3D rendering methods with good quality terrain rendering.

DV7.0—Faster Variable Triangulation.

Repositioning a view in **V6.9** using variable triangulation is fast because at startup it creates a temporary file with all needed triangles at the most detailed level. It then extracts the variable triangular structure from these small triangles for each new viewpoint. This temporary file is not saved. **V7.0** will improve this aspect of using this terrain model by introducing a procedure that computes and saves these triangles in a pyramid like structure. This will not only improve the overall performance of this method when a 3D view is opened, but will also reduce the computations needed to compute the variable triangulation model for each new viewpoint. Much of the effort in 3D in recent **TNT** releases has been pointed toward improving 3D performance so that concurrent **TNT** 2D and 3D views can be used together more interactively, especially when combined with the new manifold display features.

DV7.0—Manifolds.

What Are They? Those clients who have prepaid for **RV7.0** can download **DV7.0** and gain access to a new 3D display capability. 3D displays can now contain manifolds, which are curved 2D surfaces rendered in 3D space. A dictionary's mathematical definition of manifold is "*a topological space that is connected and locally Euclidean*".

What Are They Good For? The practical implications of adding support of manifolds in the **TNT** products is that you can now display these curved surfaces in their proper spatial orientation using any viewpoint for your **TNT** 3D view (for example, seismic profiles as raster objects or geologic cross sections as vector objects). These manifold surfaces can not only represent sinusoidal profile shapes that curve in 2 dimensions (for example, profiles in X and Y) but also surfaces that curve in all 3 dimensions such as spherical, folded, overlapping, or intersecting.

How Are They Created? To provide this new capability, the Georeference process has been extended again to provide you with the ability to add manifold georeferencing to an object. The georeference points you enter define the XYZ curvature of the object. The 3D view uses this georeference to drape this layer into the 3D view along with any of the other layers you could add in **RV6.9**. The Spatial Data Editor has also been extended to permit you to modify the flattened 2D view of the object while viewing the results in 3D.

Color Plates? **DV7.0** already provides this new surface rendering. Thus, by the time you read this, the first color plate(s) will be posted illustrating some manifold surfaces at microimages.com. These examples will be simple as MicroImages as yet has very limited access to suitable geodata of this type.

Label Frames and Leaders.

Using the appropriate styling for labeling features can be an important design decision. At one extreme where you wish to emphasize the labels over other content you can choose an elliptical shape, bright background color, larger lettering, triangular (which means, balloon) leaders. This design draws the readers' attention to the labels over other content. On the other hand, when content is important you can use outline boxes that are transparent or lightly color shaded to help you, or your client, locate them only when needed in a complex image background. We are all also familiar with the traditional labeling of conventional maps whose simple text labels are borderless, vary in size, and may follow the feature or refer to it with a leader line.

Earlier versions of the **TNT** products have introduced a variety of features to improve labeling including a new multilingual text editor, easily controlled text and font styles, text placement, language selection, and so on. Now in **RV6.9** you can add styled frames and leaders to enhance your final products. These new label options are introduced below and the use and appearance of some are illustrated in the attached color plate entitled Label Frames and Leader Lines.

Frame Box.

Shapes.

Use frames that are rectangular, rounded rectangular, circular, or elliptical.

Margins.

Independently set the top, bottom, right, and left margins as a % of the font size to control the size of the frame and position the label's text in any language anywhere within its frame. Descending and ascending characters, multiple diacritical marks above and below, and other language specific characteristics are automatically handled in setting a default for all 4 margins.

Styles.

Set the style of the outline of the frame for the label to determine the thickness and color or omit the outline.

Fill.

Choose a fill color and transparency for the inside of the frame to provide a background for the label text.

Limitations.

All labels for a specific element type within a layer must have the same frame style. You may wish to mix frames and other label display characteristics (for example, have more than 2 colors of frames). To do this, extract the data for the various groups of features to be labeled into separate objects and set up separate label styles for each object. Then add the original object and each of the extracts displaying labels only for the extracted pieces.

Leader Lines.

Type.

Select the leader line type from simple or triangular (balloon) lines. They connect to a point that is always located inside the polygon and not its centroid, which may not be inside the polygon (for example, a “U” shaped polygon). Both types of leaders connect from that point to a position somewhere along the nearest side or end of the frame and not to corners.

Styles.

When line leaders (not triangles) are used, they are rendered in the same fashion as other **TNT** lines. Thus, they can have varied width and color.

Position.

As displayed the labels and frames can be automatically positioned in or out of their polygons with the following options:

- Always Inside,
- Fit Inside or None (no label if its frame does not fit inside its polygon),
- Fit Inside or Outside with Leader (outside only if its frame will not fit inside the polygon), and
- Fit Inside or Outside without Leader (outside only if its frame will not fit inside the polygon).

Shape Object.

The appearance of this new geospatial object structure in the **TNT** products should be considered as a work in progress. It does appear as a new primary object type right along side raster, vector, CAD, and the others. However, unless you are working with Oracle Spatial you will have no direct use of it in **RV6.9**.

Why Is it Needed?

In addition to CAD and vector data structures, spatial data is now being stored in Relational Database Management System (RDBMS) oriented structures, such as Oracle Spatial, ESRI's shapefile, and MapInfo's TAB approaches. For some time you have been moving these ESRI and MapInfo geodata in and out of a **TNT** vector object, analyzing, and editing it in **TNTmips** processes including those requiring topology, and exporting it back to these data structures. **V6.8** added similar vector import, edit, analysis, and export capabilities for use with Oracle Spatial layers.

Vector and CAD objects in a **TNT** Project File or other product's files have formal structures related to their original design objectives: to store topology and drawings, respectively. Importing and using database structured spatial information in a CAD or vector object can quickly change its structure. For example, maintaining topology during some operations on a vector object could alter the structure of the attached attributes to the extent that a complex database structure is created if there is a requirement to export it back to the external RDBMS. Furthermore the uncontrolled, freeform structure of CAD data does not match up well with that of a rigorous RDBMS's structure and use.

Directly Use Oracle Spatial Layers.

Using the **TNT** import and subsequent export is appropriate if the object is topologically based and editing and analysis are not too complex in structure as in a shapefile. If complex changes are made in an Oracle Spatial layer, then subsequent cleanup of the

tables in Oracle may be required. However, the best way to directly view these kinds of RDBMS objects as a **TNT** layer and to do non-topological editing would be to perform these operations on them directly in their native RDBMS system. To this end, for **RV6.9** a new object type called a “shape” object has been added to the **TNT** primary object types (now raster, vector, CAD, shape, TIN, and RDBMS) in a Project File. As yet, this shape object has limited use and only Oracle Spatial is as yet supported in **RV6.9**.

The new object has a structure that is designed to be parallel to and to better accommodate the non-topological, table-oriented graphical data structures defined in such file structures as ESRI’s shapefile, Oracle’s Spatial (OS) layers, and MapInfo’s TAB files. Via this new spatial object, these spatial database structures can be directly linked to for direct use in the **TNT** processes. When the links are formed a spatial object is created in the Project File to contain the information (subobjects) that **TNT** processes need to use that object. This is called a “stub” or “link” shape object since it does not contain the original spatial data. Often however, you merely think of it as a shape object since it functions just as if the shapes contents were stored directly in the internal shape object. This is similar to the direct links **TNT** makes to raster objects. For example, when a link is made to a JP2 raster object the contents of the original JP2 raster are not imported or changed. The stub or link raster object merely collects and maintains all the descriptive data (for example, row, column, data numeric type, histogram, ...), which the RVC read/write process needs to access to read that JP2 file and present it to a higher **TNT** process just as if it were stored as an internal raster object. The new shape object functions in this same fashion. It permits you to autolink directly to the supported external database structures and stores within the link the properties RVC needs to describe this new, shape-oriented, external data structure as if it were actually imported as a **TNT** shape object. As work progresses, these data types will be also imported into and used as this shape object in addition to directly linked and used via this shape object structure.

Progress to Date.

The initial and primary objective in **V6.9** is to permit you to autolink to Oracle Spatial layers and immediately use and display them as a layer in a **TNTmips** composite view. When this ability is available for ESRI’s shapefiles and MapInfo’s TAB files, modifications will be made so that these structures can be directly imported and exported from this spatial object. This will subsequently lead to the modifications of the higher level **TNT** processes to support other uses via the direct link or in the internally stored shape object.

The RVC Project File structure has been expanded to define and store shape objects. Oracle Spatial can be directly linked to, and displayed as a layer or component in a **TNT** composite view (without styles or attributes). Development effort is now focused upon supporting **TNT** actions on these shape object layers such as selecting elements and displaying attributes. Linking to shapefiles and TAB files is also a priority.

Raster Import.

TNT support for the SDTS, ENVI, and NITF formats has been updated and improved.

A raster object can be created by importing XYZ text strings. Now values can be missing and result in null cells. You can now also set the raster objects cell size by specifying the cell spacing.

Arc Shapefile Point Symbols Import/Export.

TrueType Fonts Required.

The styles for points in ESRI Arc shapefiles are stored as TrueType glyphs in the AVL (ArcView Legend) file associated with the SHP file. In ArcView a multiple color/component point style is defined by compositing multiple glyphs. You can now import these styles and export them to an AVL file created as part of the shapefile export process. The attached color plate entitled Converting Symbols to/from Shapefiles provides additional details and illustrations in Arc and **TNT** views.

Since the AVL file references and, thus, uses glyphs from TrueType fonts, this import and export of point styles works if you have the TrueType fonts available. If you have ArcView installed, you will have these fonts available or you can use any other TrueType font that your **TNTmips** system and the user of the Arc shapefile have in common. This is the same old TrueType license issue encountered in many other import, export, or print-to operations and in all portable data formats.

Handling Relative Scale.

If a style element used in a **TNT** product has a map scale assigned, all styles are exported using a map scale. ArcView can only handle the conditions of "no" mapscale or "all" where all the elements must use the same relative map scaling. If all **TNT** style elements use a design scale, they are exported as non scaling symbols for ArcView. Similarly one reference scale is set for all styles imported from an AVL file that has one. Latitude/Longitude should be used to export a style based on map scale.

Oracle Spatial Layer Import.

When an OS Layer is imported, you can now specify which **TNT** topology you want to have in the vector object being created: planar, network, or rigorous polygonal topology). As with other imports you can also optionally create standard attribute tables and element ID tables.

Autonaming is now available if multiple Oracle Spatial layers are being imported into multiple vector objects.

Open DataBase Connectivity (ODBC).

ODBC is supposed to provide a convenient and standard means to communicate with another software vendor's RDBMS. This is fine in theory but not so well implemented in practice. Each RDBMS developer must provide their own ODBC driver as part of their product. No one certifies that each version of each vendor's ODBC driver is 100% correct. As a result, there are multiple versions of each RDBMS's ODBC driver, which are frequently changed, and all can have subtle, but often fatal consequences to other products such as the **TNT** products.

An additional characteristic of using the ODBC driver, instead of the RDBMS's internal proprietary control protocol, is that back communications are weak. Key in this is that the ODBC connected database system will not notify a linked system when any of its myriad of tables has been changes. **TNTmips** can keep track of the changes it has made in linked databases and attributes and redisplay, rebuild indices, and so on. However, when some other program or the RDBMS manipulates a table or many tables, most do not provide notification of these record changes to ODBC linked software. Since the RDBMS to which the **TNT** products link can be complex, it is not practical to

constantly check all these tables to determine when and if they have been changed. The simplest example of this is that a **TNT** tabular view of an ODBC linked table is not updated for a change you or someone else makes to that table via a program external to your **TNT** product. **RV6.9** introduces several new options concerning updating the tabular view and other **TNT** actions.

Refreshing Tabular Views of External RDBMS.

Background.

TNT products sense changes to tables in the **TNT** internal RDBMS and automatically refresh the Table View or take other appropriate actions. **TNT's** connections to Oracle Spatial layers use OO4O and are direct. This direct connection to Oracle can also be used to inform a **TNT** process that tables have been changed.

A table being viewed in a **TNT** product may also reside in some other external RDBMS and is being used and viewed via a link to it using its ODBC driver. Unfortunately, ODBC can not notify the linked program (in this case any **TNT** process) that the source table has been altered by some activity in that external RDBMS.

It would be possible for the **TNT** processes to constantly reexamine the external tables or their indices via ODBC to see if they have changed, but this would be time consuming and slow. Thus, for use with ODBC connections, a button has been added to the tabular view to refresh the table at any time. An option is also available to automatically refresh the table at an interval you can specify in the preferences you set for each table. These features are illustrated in the attached color plate entitled Refresh Tabular Views of Linked Tables.

Manual Refresh.

Each **TNT** tabular view now has a "Refresh" button, which will refresh that table showing any changes that have been made to the corresponding ODBC linked table. Nothing else will happen in **TNTmips** when you do a refresh except the table will refresh and show any changes in its contents.

Automatic Refresh.

Each specific **TNT** tabular view has a Preferences option setup dialog. An option has been added to it to designate a time interval that you wish that tabular view, whenever open, to be auto refreshed from its ODBC linked table. Nothing else will happen in **TNTmips** when you do a refresh except the table will refresh and show any changes in its contents.

Visual Basic Refresh.

To automatically refresh a **TNT** tabular view, you can now put a member in your VB class that **SML** checks to see if the external database has been changed by your VB program.

If you detect in **SML** that your VB program indicated that it changed the external table, call the new **SML** function TableTriggerRecordChangedCallback (table, record number) where record number is optional. This will notify RVC that the table has changed and it will trigger redraws of table views, pin map pins, and so on. If you identify and specify the record number, it will only redraw the pin for that record. If you can not determine a record number, omit it and the whole tabular view, pin map, and so on, will redraw.

Similar programs could be written in C++ or Java to use this ActiveX callback via **SML**. Refer to the detailed **SML** section below for more information on this topic.

Map Projections and Coordinate Systems.

Datums.

The following new datums are supported:

- European Libyan Datum 1979 (Amal),
- Nahrwan 1967 Qatar including conversions,
- Hermannskogel datum for Croatia, Serbia, and Bosnia-Herzegovina, and
- Japan-19 Plane Orthogonal system can now be used with multiple datums

DV7.0—Supporting OpenGIS's Spatial Referencing Coordinates Specifications.

DV7.0 will soon support the OpenGIS Consortium (OGC) Spatial Referencing Coordinate Specifications which can be found in abstract form at www.opengis.org/specs/?page=abstract. This OGC standard is now incorporated into the ISO standards, which contain its technical specifications.

Abstract: ISO 19111:2003 Geographic information—Spatial referencing by coordinates.

“ISO 19111:2003 defines the conceptual schema for the description of spatial referencing by coordinates. It describes the minimum data required to define one-, two- and three-dimensional coordinate reference systems. It allows additional descriptive information to be provided. It also describes the information required to change coordinate values from one coordinate reference system to another.

“ISO 19111:2003 is applicable to producers and users of geographic information. Although it is applicable to digital geographic data, its principles can be extended to many other forms of geographic data such as maps, charts, and text documents.”

Virtual (Computed) Database Fields.

Implied one-to-one table attachments are now permitted for nodes to allow the use of virtual (computed) fields with nodes.

*** Orthorectification of QuickBird and IKONOS Images.**

Introduction.

A new capability has been integrated into **TNTmips** to permit you to produce accurate orthoimages from a single satellite image that is provided with a file containing its Rational Polynomial Coefficients (RPCs). Both IKONOS and QuickBird images can now be ordered with this file containing the RPCs for that specific scene or subscene. If an accurate DEM is also available for the area of the satellite scene, the RPCs can be used in **TNTmips** to convert the original images into orthoimages. This procedure can be used with IKONOS and QuickBird images only, repeat ***only***, if they are obtained from their respective vendors in the correct format with these RPCs.

IKONOS IMPORTANT NOTE: Order only Space Imaging's Geo Ortho Kit Product for use in this operation!

QUICKBIRD IMPORTANT NOTE: Order only Digital Globe's Ortho Ready Standard Product for use in this operation!

Using this new **TNT** process can produce satellite orthoimages whose ground surface positional accuracies can approach the image's cell size for areas of bare terrain. A qualitative examination of the results achieved in **TNTmips** using this approach in comparison to conventional airphoto-produced orthophotos as illustrated in the attached color plates.

The color plate entitled Orthorectification Results for QuickBird compares the results for a portion of an RPC corrected scene acquired on 9 July 2002 from an elevation angle of 77.5 degrees of the foothills near Castle Rock, Colorado. The small area of the orthoimage illustrated in this comparison has topographic relief of 150 meters (492 feet) and the relief of the total scene is 526 meters (1726 feet) and an elevation range from 1756 meters to 2282 meters. The Ground Control Points (GCPs) used were provided by DigitalGlobe.

The color plate entitled Orthorectification Results for IKONOS compares the results for a portion of an RPC corrected coastal scene acquired on 8 January 2001 from an elevation angle of 81.2 degrees of the La Jolla Mesa area a few miles north of San Diego, California. The small area of the orthoimage illustrated in this comparison has about 250 meters (820 feet) of relief, and the surface elevation of the total scene ranges from 0 meters MSL along the Pacific Ocean coastline to 250 meters at the top on Soledad Peak near the illustrated subportion. The GCPs used in building the RPC model for this orthoimage were collected by this writer using a hand-held GARMIN sportsman's GPS.

IMPORTANT NOTE: You do not have to know anything about photogrammetry to use this procedure!

This new **TNT** procedure can be used to rectify these images without requiring any of the complex inputs and considerations of a traditional photogrammetric solution using a rigorous sensor model. These kinds of complex photogrammetric analyses are being constantly changed and improved by those who own and operate the satellite. With the RPC approach, the photogrammetry required to use the rigorous sensor model becomes the responsibility of its designer and who else could do it better? One of the references cited below (Hu and Tao, 2002) expresses this idea in its abstract as follows:

"The rational function model (RFM) is a sensor model that allows users to perform ortho-rectification and 3D feature extraction from imagery without knowledge of the physical sensor model. It is a fact that the RFM is determined by the vendor using a proprietary physical sensor model. The accuracy of the RFM solution is dependent on the availability and usage of ground control points (GCP). In order to obtain a more accurate RFM solution, the user may be asked to supply GCPs to the data vendor. However, control information may not be available at the time of data processing or cannot be supplied due to some reasons (e.g., politics or confidentiality)."

MicrowImages can readily extend this new **TNTmips** image rectification to more image types when other image satellite operators begin to supply their scenes/subscenes with RPCs. It is likely that this RPC approach to image rectification will also be adopted by other image satellite operators to permit you to orthorectify their products at your desktop. Why? Because the operators of these satellite imaging systems can not readily ob-

tain the accurate DEMs and XYZ GCPs that you can acquire and use for your local areas. For a variety of reasons, acquiring accurate GCPs and an accurate DEM may be restricted in many locations and nations. However, you have direct access to your project areas to collect the GCPs or you can work in your native language with local collaborators who do. Thus, this new RPC approach to modeling image distortion permits these sensitive, restricted, and/or classified GCP and DEM data to be used locally within the restrictions imposed upon them. Furthermore the RPC approach, as contrasted to the rigorous model approach, can be applied to the partial image scenes now sold by both these satellite image operators.

Background.

Digital orthorectification of any aerial or satellite image requires a mathematical model of the imaging system, so that the position of each cell in the raw image can be related mathematically to its corresponding three-dimensional position on the ground. Using an accurate imaging model and an accurate digital elevation model (DEM), a satellite image can be processed to create an orthorectified image in which each image cell has been restored to its correct geographic position.

Remote sensing satellites, such as IKONOS and QuickBird, build up each image sequentially, scanline by scanline, as the satellite moves forward in orbit. Different parts of a single image are thus captured at different times from different satellite positions. As a result, a rigorous photogrammetric description of the imaging geometry that models all of the physical elements of the system can be exceedingly long and complex. For example, the IKONOS rigorous sensor model is 183 pages long. The actual orthorectification procedure using such a rigorous model, which is typically proprietary, requires many image-specific parameters and an extraordinary amount of computation.

Space Imaging (IKONOS) and DigitalGlobe (QuickBird) have, therefore, both adopted the Rational Polynomial approach to distribute the image geometry model with their ortho-ready images (images suitable for orthorectification by the customer). A rational polynomial model is a simpler empirical model relating image space (line and column position) to the coordinates of corresponding points on the ground (latitude, longitude, and surface elevation). All of the various physical effects of the imaging system are boiled down into two mathematical functions: one relating these sets of coordinates in the image line direction and the other for the image column direction. Each of these functions is a ratio of two cubic polynomial expressions, which leads to the name Rational Polynomial method. The image providers compute the unique rational functions for each image using the satellite's orbital parameters and their rigorous sensor model and distribute the coefficients of these rational functions (RPCs) as a text file accompanying the ortho-ready image. Computation of the orthorectified image using a DEM and these RPC coefficients is fast and accurate.

Both these satellite operators sell their lowest-cost ortho-ready images for use in this process. The georeference information provided with their images is computed by these companies using only the sensor model and satellite orbital parameters to project the image onto a reference WGS84 ellipsoid at a reference elevation. These are the map coordinates for the resulting computed image corners are then provided with the image. Small errors in the satellite position information, or the choice of an inappropriate reference elevation, can have a large effect on the geometric accuracy of the rectified image. Research has shown that the RPC model supplied with an image can be adjusted to correct such errors by using a small number of accurate 3D ground control points. The

adjustment improves the overall positioning of the raw image with respect to the DEM, so that each raw image cell is more likely to be processed with an appropriate elevation value and, thus, projected to a more accurate position in the rectified image.

General Approach.

Introduction.

The first release of the RPC orthorectification capability in **TNTmips** had several prototypes prior to this official **RV6.9** release. Initially the procedure was designed and implemented as a new and separate photogrammetric-like process since that is how competing products have presented it. However, through a series of iterations, ultimately it was realized that the procedures could be provided for you as simple modifications to the existing **TNT** Georeference and Raster Resampling processes. As a result, this official release is elegant and simple to follow, and to apply it, you need only adjust to a few changes in these 2 familiar and frequently used **TNT** processes. An overview of this approach is illustrated in the attached color plate entitled Rational Polynomial Orthorectification of IKONOS/Quickbird Images.

Georeferencing.

You begin this procedure in the Georeference process. This is the same **TNTmips** process that you have been using to associate 2D or 3D GCPs with image pixels and evaluating how well they fit. In **RV6.9** the Georeference process has been expanded to allow you to evaluate the fit of your control points into the RPC model defined by its parameters supplied with these images. You can then add, delete, make active, or make inactive any control point to test its impact on the current fit of the RPC model to the ground. You can also test the adjusted model against sets of points that you enter as independent test points. This is where the real setup activity is conducted as in this fashion you carefully add a few accurate GCPs to define the RPC model for the specific input scene. All these new georeferencing capabilities are discussed in detail in the section below entitled Georeferencing.

All the latest sensor and photogrammetric changes and complications are reflected in the specific RPC file these satellite operators provide for with each specific image. Thus, the photogrammetric aspect of this new RPC approach can be improved with time, but is beyond your control. The accuracy of the orthoimages you produce using their RPC image kit in this new **TNT** approach depends primarily upon the accuracy and cell size of your DEM and how carefully and accurately you collect your GCPs and identify their positions in the original image. A few, highly accurate GCPs and associated positions will suffice. Once you acquire these GCPs, you can reuse them along with your DEM for each new RPC image that you acquire for this area from any imaging satellite.

If you can not acquire survey quality GCPs and/or their exact pixels are hard to find in the image, then you will need a larger, well distributed collection of GCPs. You can then use the new statistical RPC model evaluation procedures added to the Georeference process to help you evaluate your points, decide if they are adequate and which to use, and predict the accuracy of the RPC model they produce. This strategy is covered in more detail in the new tutorial entitled Orthorectification Using Rational Polynomials, which has been printed and shipped with your release of **RV6.9**.

Input. The GCPs you collect might number from 6 to 25—accuracy, key topographic features, and a good distribution of the points over the scene are more important than a

large number of points! When you are using the RPC model, the residual errors for your GCPs show the departure of each point from the actual rectification model that will be used later to orthorectify the image. You can also view a list of the same points and residuals projected to that hypothetical orthorectified image. The attached color plate entitled Evaluating Control Points for Rational Polynomial Orthorectification introduces some of these new features and feedback information incorporated into the revised Georeference process to help you establish an accurate RPC model. They permit you to experiment while you are adding GCPs with the potential accuracy of the RPC solution achieved using any selected subset of your GCPs for model control (which means, it solves the model only on these active points).

Testing. The Georeference process permits you to determine which of the points you add are used in determining the fit of the RPC model to the image and which are used only in testing the result. At any point the georeference process can immediately test your current RPC model by applying it to those GCPs you have designated for use only as test points, and it then reports how the current model predicts the unknown positions of the test points. These concepts are illustrated in the attached color plate entitled Testing Rational Polynomial Orthorectification. You can even determine how well your current RPC model would fit the selected model or test points if the Z values for the corresponding DEM cell were used instead of the measured Z values you entered for the GCPs. Why? Because ultimately the RPC model will only have the Z values from the DEM cells to correct the positions of all the image pixels. To provide this comparison, and to use the control points to adjust the RPC model, Georeference requires that you identify the DEM to be used in the orthorectification. All these activities happen in the familiar but now considerably modified Georeference process.

Raster Resampling.

Simplicity. After your GCP input, testing, and model evaluation are complete, the final collection of GCPs and the RPCs are saved by the Georeference process as subobjects of the input image's raster object. The actual full restitution of the scene or subscene is then performed as a new Rational Polynomial resampling option added to the **TNT** Automatic Raster Resampling process. Simply select the raster object of the source image setup in the Georeference process (and, thus, the automatically identified RPCs and GCPs), select the correct DEM, and select the Rational Polynomial option from the list of other models (instead of Affine, Plane Projective, Bilinear, or one of the other polynomials). The time to complete the restitution is fast and similar to that for the other familiar **TNT** resampling procedures. The final X-Y positional accuracy of each pixel in your orthoimage relative to the ground surface depends heavily upon the pixel ground size, the X, Y, and Z accuracy of your DEM, the X, Y, and Z accuracy of your GCPs, and your accurate placement of them in the input image.

Flexibility. You are using the familiar **TNT** Automatic Raster Resampling process, not some specialized photogrammetric approach and process. Thus, you are able to use any of the many options this flexible process provides. The input image and DEM do not need to be trimmed or converted to a common projection or cell size. However, the orthoimage can only be produced for the common input area and any mismatched area requested will be filled with the selected null value. For the output image you can choose the output cell size, projection, orientation, clipping extents, JPEG2000 lossless compression, and so on.

Summary of the Input Requirements.

It is important that you understand the following about this new **TNT** process. These same considerations apply to other software packages that use the Rational Polynomial method to produce orthorectified satellite images.

You must purchase the correct QuickBird or IKONOS ortho-ready product type; RPC orthorectification can not be used on any other of the product types supplied by these image vendors.

You must have available, or create, an accurate DEM of the area to be orthorectified. **TNTmips** provides several methods of producing a DEM ranging from digitized contour maps to surface modeling other data sources. Obviously the quality of the resulting orthoimage produced by **TNTmips** will depend upon the cell size and accuracy of this DEM.

Even with a highly accurate DEM you will only achieve the highest accuracy from this process if you can collect accurate ground control points well distributed over the image. The control points can be reused repeatedly for the same area. You can acquire GCPs with a hand-held sports GPS unit, survey quality GPS unit, or from survey monuments or other positions determined from detailed contour maps.

You can optionally use a collection of additional independent test points to evaluate the accuracy of your GCPs, which will in turn determine how accurate the orthoimage's pixels are relative to their actual ground position. However, this will not evaluate how the cell size and accuracy or inaccuracy of your DEM will affect the positional accuracy of pixels in your final orthoimage.

Tutorial Booklet.

A tutorial booklet providing more background and a detailed step-by-step approach to producing an orthoimage from an RPC satellite image kit is available but was not finished in time to be included on the **RV6.9** CD. To help introduce you to this new capability, this booklet entitled Orthorectification Using Rational Polynomials has been printed and accompanies this MEMO. One of the example exercises in this booklet uses a small IKONOS image as sample data. This image sample and the associated DEM needed for this tutorial are part of the sample data provided with **TNTlite**. This sample data and the online PDF version of this new tutorial can be obtained from microimages.com.

Pan Versus Multispectral Issues.

QuickBird and IKONOS use separate detector arrays for collecting their panchromatic and multispectral images. In addition to having different cell sizes, these detector arrays are offset from each other and image the ground cells from somewhat different angles. Thus, the parallax introduced by the terrain relief will be different for the pan and multispectral representation of each ground cell. In areas of large relief this difference can be significant, amounting to a meter or more, which is a whole cell or more in the pan image. These two types of images will come with their own separate RPCs. Each must be rectified separately into orthoimages. However, if an accurate DEM and GCPs are available, they can be processed in **TNTmips** into a common cell size and projection and accurately overlaid.

If pan and multispectral images are to be combined into a color image using pan-sharpening, this step should be performed after each component has been orthorecti-

fied. If you pan sharpen before the rectification is applied, one of these image sets will end up being rectified using the RPCs of the other and this will introduce positional errors.

Your collection of GCPs can be used in both the pan and multispectral images. You will need to separately enter them into the pan and multispectral images in the Georeference process. If you are acquiring GPS points for control, plot your GCPs in the field on enlarged sections of prints of the pan image or any higher resolution images (neither of which need to be orthorectified). Then use these prints in the office to assist you in locating these points on the pan image in the Georeference process. You can then use their location in the pan image to assist you in finding their corresponding position when georeferencing the lower resolution multispectral image.

References.

Since this is a new and technical image concept of wide interest, the following are some additional references describing the use of the rational polynomial approach to rectifying satellite images.

QuickBird ... Geometric Correction, Processing and Data. by Phillip Cheng, Thierry Toutin, Yun Zhang, and Mathew Wood. EOM, May 2003, pp. 24-30.

Block Adjustment of High-Resolution Satellite Images Described by Rational Polynomials. by Jacek Grodecki and Gene Dial. Photogrammetric Engineering and Remote Sensing. Vol. 69, No. 1, January 2003, pp. 59-68.

Abstract: "This paper describes how to block adjust high-resolution satellite imagery described by Rational Polynomial Coefficient (RPC) camera models and illustrates the method with an Ikonos example. By incorporating a priori constraints into the adjustment model, multiple independent images can be adjusted with or without ground control. The RPC block adjustment model presented in this paper is directly related to the geometric properties of the physical camera model. Multiple physical camera model parameters having the same net effect on the object-image relationship are replaced by a single adjustment parameter. Consequently, the proposed method is numerically more stable than the traditional adjustment of exterior and interior orientation parameters. This method is generally applicable to any photogrammetric camera with a narrow field of view, calibrated, stable interior orientation, and accurate a priori exterior orientation data. As demonstrated in the paper, for Ikonos satellite imagery, the RPC block adjustment achieves the same accuracy as the ground station block adjustment with the full physical camera model."

Bias Compensation in Rational Functions for Ikonos Satellite Imagery. Clive S. Fraser and Harry B. Hanley. Photogrammetric Engineering and Remote Sensing. Vol. 69, No. 1, January 2003, pp. 53-57.

Abstract: "A method for the removal of exterior orientation biases in rational function coefficients (RPC) for Ikonos imagery is developed. These biases, which are inherent in RPC's derived without the aid of ground control, give rise to geopositioning errors. The 3D positioning error can subsequently be compensated during spatial intersection by two additional parameters in image coordinates. The resulting bias parameters can then be used to correct the RPC's supplied with Ikonos Geo imagery such that a practical means is provided for bias-free ground point determination, nominally to meter-level absolute accuracy, using entirely standard procedures on any photogrammetric workstation that supports Ikonos RPCs. The method requires provision of one or more

ground control points. Aside from developing the bias compensation method, the paper also summarizes practical testing with bias-corrected RPCs that has demonstrated sub-meter geopositioning accuracy from Ikonos Geo imagery.”

Error Tracking in Ikonos Geometric Processing Using a 3D Parametric Model. Thierry Toutin. Photogrammetric Engineering and Remote Sensing. Vol. 69, No. 1, January 2003, pp. 43-51.

Abstract: *“Thirteen panchromatic (Pan) and multiband (XS) Ikonos Geo product images over seven study sites with various environments and terrain were tested using different cartographic data and accuracies with a 3D parametric model developed at the Canada Center for Remote Sensing, Natural Resources Canada. The objectives of this study were to define the relationship between the final accuracy and the number and accuracy of input data, to track error propagation during the full geometric correction process (bundle adjustment and ortho-rectification), and to advise on the applicability of the model in operational environments.*

“When ground control points (GCPs) have an accuracy poorer than 3 m, 20 GCPs over the entire image are a good compromise to obtain a 3- to 4-m accuracy in the bundle adjustment. When GCP accuracy is better than 1 m, ten GCPs are enough to decrease bundle adjustment error of either panchromatic or multiband images to 2 to 3 m. Because GCP residuals reflect the input data errors (map and/or plotting), these errors did not propagate through the 3D parametric model, and the internal accuracy of the geometric models is thus better (around a pixel or less).

“Quantitative and qualitative evaluations of ortho-images were thus performed with either independent check points or overlaid digital vector files. Generally, the measured errors and a 2- to 4-m positioning accuracy was achieved for the ortho-images depending upon the elevation accuracy (DEM and grid spacing). To achieve a better final positioning accuracy, such as 1 m, a DEM with an accuracy of 1 to 2 m and with a fine grid spacing is required, in addition to well-defined GCPs with an accuracy of 1 m.”

Rational Functions and Potential for Rigorous Sensor Model Recovery. Kalchang Di, Ruijin Ma, and Rong Xing U. Photogrammetric Engineering and Remote Sensing. Vol. 69, No. 1, January 2003, pp. 33-41.

Abstract: *“Rational functions (RFs) have been applied to photogrammetry and remote sensing to represent the transformation between the image space and object space whenever the rigorous model is made unavailable intentionally or unintentionally. It attracts more attention now because Ikonos high-resolution images are being released to users with only RF coefficients. This paper briefly introduces the RF for photogrammetric processing. Equations of space intersection with upward RF are derived. The computational experimental result with one-meter resolution Ikonos Geo stereo images and other airborne data verified the accuracy of the upward RF-based space intersection. We demonstrated different ways to improve the geopositioning accuracy of Ikonos Geo stereo imagery with ground control points by either refining the vendor-provided Ikonos RF coefficients or refining the RF-derived ground coordinates. The accuracy of 3D ground point determination was improved to 1 to 2 meters after refinement. Finally we showed the potential for recovering sensor models of a frame image and linear array image from the RF.”*

3D Reconstruction Methods Based on the Rational Function Model. C. Vincent Tao and Yong Hu. Photogrammetric Engineering and Remote Sensing. Vol. 68, No. 7, July 2002, pp. 705-714.

Abstract: *"The rational function model (RFM) is an alternative sensor model allowing users to perform photogrammetric processing. The RFM has been used as a replacement sensor model in some commercial photogrammetric systems due to its capability of maintaining the accuracy of the physical sensor models and its generic characteristic of supporting sensor-independent photogrammetric processing. With RFM parameters provided, end users are able to perform photogrammetric processing including orthorectification, 3D reconstruction, and DEM generation with an absence of the physical sensor model. In this research, we investigate two methods for RFM-based 3D reconstruction, the inverse RFM method and the forward RFM method. Detailed derivations of the algorithmic procedure are described. The emphasis is placed on the comparison of these two reconstruction methods. Experimental results show that the forward RFM can achieve a better reconstruction accuracy. Finally, real Ikonos stereo pairs were employed to verify the applicability and the performance of the reconstruction method."*

Updating Solutions of the Rational Function Model Using Additional Control Information.

Yong Hu and C. Vincent Tao. Photogrammetric Engineering and Remote Sensing. Vol. 68, No. 7, July 2002, pp. 715-723.

Abstract: *"The rational function model (RFM) is a sensor model that allows users to perform ortho-rectification and 3D feature extraction from imagery without knowledge of the physical sensor model. It is a fact that the RFM is determined by the vendor using a proprietary physical sensor model. The accuracy of the RFM solution is dependent on the availability and usage of ground control points (GCP). In order to obtain a more accurate RFM solution, the user may be asked to supply GCPs to the data vendor. However, control information may not be available at the time of data processing or cannot be supplied due to some reasons (e.g., politics or confidentiality). This paper addresses a means to update or improve the existing RFM solutions when additional GCPs are available, without knowing the physical sensor model. From a linear estimation perspective, the above issue can be tackled using a phased estimation theory. In this paper, two methods are proposed: a batch iterative least-squares (BILS) method and an incremental discrete Karman filtering (IDKF) method. Detailed descriptions of both methods are given. The feasibility of these two methods is validated and their performances are evaluated. Some results concerning the updating of Ikonos imagery are also discussed."*

A Study on the Generation of the Komsat-1 RPC Model.

Hye-jin Kim, Dae-sung Kim, Hyo-sung Lee, Young-il Kim. no date. 4 pages. see <http://www.isprs.org/commission3/proceedings/papers/paper129.pdf>

Abstract: *"The rational polynomial coefficients (RPC) model is a generalized sensor model that is used as an alternative solution for the physical sensor model for IKONOS of the Space Imaging. As the number of sensors increases along with greater complexity, and the standard sensor model is needed the applicability of the RPC model is increasing. The RPC model has the advantages in being able to substitute for all sensor models, such as the projective, the linear pushbroom and the SAR."*

"This report aimed to generate a RPC model from the physical sensor model of the KOMPSAT-1 (Korean Multi-Purpose Satellite) and aerial photography. The KOMPSAT-1 collects 510~730 nm panchromatic imagery with a ground sample distance (GSD) of 6.6 m and a swath width of 17 km by pushbroom scanning. The iterative least square solution was used to estimate the RPC. In addition, data normalization and regulariza-

tion were applied to improve the accuracy and minimize noise. This study found that the RPC model is suitable for both KOMPSAT-1 and aerial photography.”

Rational Mapper: A Software Tool for Photogrammetric Exploitation of High Resolution Satellite Imagery. C. Vincent Tao, Yong Hu, Wanshou Jiang. no date. 6 pages. see <http://www.geoict.yorku.ca/project/rationalmapper/rationalmapper.htm>

Background: “The Rational Function Model (RFM) has gained considerable interest recently in the photogrammetry and remote sensing community. This is mainly due to the fact that some satellite data vendors, for example, Space Imaging, Thornton, CO, USA, have adopted the RFM as a replacement sensor model for image exploitation. The data vendor will supply users with the parameters of the RFM instead of the rigorous sensor models. Such a strategy may help keep the confidential information about the sensors and on the other hand, facilitate the use of high-resolution satellite imagery for general public uses (non-photogrammetrists) since the RFM is easy to use and easy to understand.”

Continues on with a easily understood description of the general idea.

An Update on the Use of Rational Functions for Photogrammetric Restitution. Ian Dowman and Vincent Tao. ISPRS. September 2002, Vol. 1, No. 3. pp. 22-29.

Extraction: “During the past four or five years the photogrammetric community at large has become aware of the use of rational functions for photogrammetric restitution. This has been due largely to the need to use these for setting up Ikonos data, as Space Imaging does not provide a physical sensor model with the image data. Rational functions have been used for some time for military use and their widespread acceptance in that area has led to the proposal to the OGC for a standard for image restitution based on rational functions on the basis of its universality: it can be used with any sensor.”

For the complete article see: http://www.isprs.org/publications/highlights/highlights0703/22_HL_09_02_Article_Dowman.pdf

Geometric Information from IKONOS. Zhigu Hu. GIM International. Vol. 17, No. 9, September 2003. pp. 42-45.

“Since pixel size of panchromatic IKONOS imagery is one meter it is desirable that the planimetric and height error after georeferencing be smaller. Which method provides the high accuracy requirement? The author tested three processing methods: (1) IKONOS RPC parameters only, (2) an associated adjustment of RPC parameters with control points and (3) a strict geometric model based on affine transformation. The adjustment of RPC coefficients with one or two control points improves accuracy significantly, especially in elevation. Using only five control points, the strict model yields very high accuracy of 5 to 12 cm in X, Y, and Z with one pair of stereo images covering. The method does not need RPC coefficients, whilst the coordinate system can be any independent one. The strict model represents a new step forward, both in theory and application, for high-resolution IKONOS imagery processing.”

[In the first sentence of this paper the author states: “The stereo pair of panchromatic IKONOS images with 1-meter spatial resolution used in the test covers over 20 square kilometers of a **quite flat** Beijing suburb.” It is possible that a DEM was not even used and the solution was performed using an average elevation. How well will these results extend to areas with typical topographic relief?]

*Georeferencing.

The user interface for the Georeference process has had a significant upgrade for **RV6.9**, and it also provides a new Rational Polynomial model for use in georeferencing images supplied with an orthorectification model in the form of rational polynomial coefficients (RPCs). These changes are part of the new **TNTmips** procedures that allow you to produce accurate orthoimages from satellite images distributed with RPCs. A broader discussion of these changes can be found in the major section above entitled Orthorectification of QuickBird and Ikonos Images. They are also outlined in more detail in the new tutorial booklet entitled Orthorectification Using Rational Polynomials that is distributed in printed form with this MEMO.

Control Point List.

The list of control point position coordinates and residuals entered in this process has been updated to use a grid interface like that used in tabular views of database tables. In the previous text listing, headings could become misaligned with their column entries depending on the interface font you were using and on which units you had chosen for coordinates and residuals. The new grid listing automatically keeps headings and columns aligned and also gives you much more control over the layout and appearance of the list. You can easily change the width of columns by dragging the column boundary in the heading row to the left or right or rearrange the order of columns by dragging a column heading to another position. These improvements in the layout of this list can be seen in the attached color plate entitled Evaluating Control Points for Rational Polynomial Orthorectification.

As in **V6.8**, the status of control points can be toggled between Active and Inactive states. Inactive points are temporarily removed from the mathematical computation used to find the best fit of the active points to the selected geometric transformation model and to compute the error residuals for each point. In the **V6.8** text listing, the status of inactive control points was indicated only by a minus sign ("-") next to the control point number. The new grid listing uses the background color for each row in the list to indicate the point status. The colors for active, inactive, and the current selected point listings are subdued versions of the colors used to draw the control point symbols in the Georeference views. These colors can be modified by selecting Colors... from the Options menu on the Georeference window. These improvements in identification of the status of each control point can also be seen in the attached color plate entitled Evaluating Control Points for Rational Polynomial Orthorectification.

Point Set Statistics.

The information and statistics listing at the bottom of the Georeference window has been expanded to give you more information about the entire set of control points. This is illustrated in the control point lists in the same color plate noted above. In addition to the previous cell size and projection data, the listing now also includes computed RMS (Root Mean Square) Error values for the set of points that are currently active and a separate listing for the inactive points. Separate listings of Mean Deviation values are similarly shown for both sets of points. Both of these statistics provide measures of the average positional error for the active and inactive point sets. You can use these measures along with the error residuals for individual points to assess the accuracy of your georeference control. As always, these summary statistics are immediately updated when you add, delete, or change the status of any control point. You can therefore

freely experiment with different combinations of points, designating suspect points as inactive to see the resulting effect on the error statistics and on the individual control point residuals.

Inactive point status also has an additional use. If you have a sufficient number of accurate control points, you can reserve some of them as test points. Enter the main set of control points as active points as usual to set up the georeference control, then enter the test points as inactive points. Since you are presented with separate error statistics and residuals for each set, you can readily assess the fit of the independent test points to the georeference control provided by the active control points.

Rational Polynomial Model.

In **TNTmips** you use the Georeference process to add these ground control points to the image prior to rectification. This new feature in the Georeference process now allows you to use the RPC model supplied with an ortho-ready image to compute the control point error residuals and statistics, and it also uses your control points to adjust the rectification model to provide a more accurate rectified image.

Implementation.

To regeoreference a satellite image supplied with RPCs, choose the new Rational Polynomial geometric transformation model from the Model menu in the Georeference window. You are then prompted to select the text file containing the image-specific rational polynomial coefficients. The process can read the standard RPC text formats for files supplied with IKONOS and QuickBird images. These files have RPCs as part of the file name (IKONOS) or RP as part of the file extension (QuickBird). When you save the regeoreferenced image, the coefficients are stored as a subobject of the georeference object. When you subsequently open the image in the Automatic Resampling process to perform the orthorectification (or reopen it in the Georeference process), this RPC subobject is automatically detected and the model menu set to Rational Polynomial, so you are not prompted again for the RPC text file.

After you have selected the RPC text file, you are also prompted to select a DEM, which is used to compute residuals and to adjust the rational polynomial model. The digital elevation model you use need not match the image area or cell size. If there is only partial overlap between the DEM and the image, only the common area is processed during the rectification phase, and only the control points in the common area are used to position the image and adjust the RPC model. Since the accuracy of the final rectification in the Automatic Resampling process depends in part on the elevation values assigned to individual image cells from the DEM, the cell size of the DEM you use in georeferencing and rectification should be as close as possible to that of the image. For example, if you are working with a 4-meter multispectral IKONOS image, a DEM with 10-meter cell size should produce more accurate rectification results than a 30-meter DEM.

The solution or adjustment of the rational polynomial functions in the Georeference process requires that all elevations be referenced to the WGS 1984 ellipsoid. However, elevations in the DEM you use for georeferencing or rectification are instead most commonly referenced to the undulating geoid surface that represents a global approximation of mean sea level. The geoidal DEM elevations can be converted to ellipsoidal elevations by subtracting the geoid height, the local height of the geoid (positive or negative) relative to the ellipsoid. The Georeference process performs this conversion for you using the geoid height you enter in the final prompt dialog during setup. Because geoid

heights vary only gradually on a regional to continental scale, a single average geoid height value can be used for a typical IKONOS or QuickBird scene. You can find the appropriate geoid height for your image area by entering the latitude and longitude of the image center in one of several free geoid height calculators available on the World Wide Web. Links to these sites can be found in the [Orthorectification Using Rational Polynomials](#) tutorial booklet.

3D Control Points Required.

All of the usual georeference tools are available when you work with the Rational Polynomial model, including manual entry of map coordinates for points collected in a GPS survey and use of a Reference View for transferring control point positions from another accurate planimetric map or orthoimage. In order to adjust and refine the RPC rectification model, however, the control points you provide must have 3D coordinates—an elevation value (Z-coordinate) in addition to the usual map (X and Y) coordinates. Control point elevation values are not shown by default in the control point list, but a selection on the Georeference window's Options menu turns on the Elevation column.

You can acquire and manually enter the elevation values for your control points from GPS survey data or from a topographic contour map. If these elevations are referenced to the geoid (as in the case of contour elevations), you will need to subtract the local geoid height value in order to determine and then enter the required ellipsoidal elevation. You also have the option of using the Set Z from Surface icon button to set the point elevation from the corresponding cell value in the DEM you have already selected at the beginning of the process. In this case, the correction to ellipsoidal elevation is applied automatically using your previously-entered geoid height. If you have multiple sources of elevation values, you will need to evaluate them to choose the most accurate source. Keep in mind that these 3D control points are used to adjust the overall RPC rectification model, so their accuracy affects the accuracy of the orthoimage you finally produce.

When you open an RPC image in the Georeference process, its nominal georeference information is converted to control points at the four image corners. Only map coordinates are supplied for these points, so their elevations default to 0. If you plan to retain these corner points, you should assign elevations to them from the DEM. If you have at least 4 or 5 accurate control points, it is probably best to delete the nominal corner points so that you have a consistent set of points from a single source.

Most published research on rational polynomial rectification models indicates that even a few accurate ground control points can significantly improve the rectification result. A large number of control points is not required. Your control points should be well-distributed over the image, and a representative sampling of different elevations may be desirable as well. Although a small number of points may be sufficient in theory, it is difficult to provide points with equal accuracy, and evaluating the relative quality of control points is a somewhat subjective process. Using a larger number of points can minimize the negative impact of one or a few less accurate points that may be difficult to positively identify and eliminate. MicroImages is still investigating the impact of the number of control points on the accuracy of the final orthorectification result.

Residuals.

When you use the Rational Polynomial model for georeferencing, the horizontal control-point residuals are computed from the best fit of the adjusted model to the set of active points. The Z residual is simply the difference between the control point value and the

ellipsoidal elevation from the DEM cell at that map location. (If you set Z values from the DEM, the Z residual will therefore be 0.)

If you have georeferenced unrectified images of high-relief areas, you know that even accurate control points can produce high error residual values when you use the simpler geometric transformation models (Affine, Plane Projective) typically used with images not intended for RPC orthorectification. These models cannot account for the fact that image cells are displaced from their correct relative positions by different amounts and in different directions due to their elevations and locations in the scene. When you use the Rational Polynomial model to georeference an image, the model explicitly accounts for the effects of view geometry and elevation on the horizontal positions of your points in the unrectified image. So even though you are viewing an unrectified image, the horizontal residuals effectively show how well each point would fit the resulting orthorectified version of the image. You can, thus, use the residuals and summary error statistics to directly gauge the accuracy of the orthorectified image you would produce with the current adjusted model. You can also change the point status and/or use a set of test points, as discussed above, to evaluate the accuracy of individual points and the overall set of active control points.

The column and line positions in the control point list in the main Georeference window refer to the unrectified image. The horizontal residuals in this list likewise are computed from the original control point line/column positions in this image space (with displacements compensated for by the model as noted above). When you use the Rational Polynomial model, a second control point list window opens, called the Control Points Projected to Orthorectified Image window. As the name implies, the list in this window and its summary error statistics show the result of mathematically projecting the control point positions forward through the rational polynomial rectification model into the orthorectified image space. The column and line values in this second window indicate the positions the points would occupy in this output rectified image. The horizontal residuals are computed using a global affine best fit between image and map coordinates in the orthorectified image. This second window, thus, shows you the control point list that would result if you opened the actual rectified image in the Georeference process. The horizontal residuals for the rectified version are almost identical to those shown in the main Georeference window for the corresponding points, though there may be slight differences due to the round-off errors that can occur in such a complex computation. You can therefore use the residuals and statistics in either window to evaluate the relative accuracy of your control points.

Tutorial Booklet.

A tutorial booklet providing more information on georeferencing and rectifying an RPC satellite image is available but was not completed in time to be included on the **RV6.9** CD. To help introduce you to this new capability, this booklet entitled Orthorectification Using Rational Polynomials has been printed and accompanies this MEMO. The sample exercises in this booklet use a small IKONOS image and an associated DEM that are part of the **TNTlite** sample data provided with the **TNT** products. This sample data and the online PDF version of this new tutorial are available online from microimages.com.

Spatial Data Editor.

Line Labels.

Auto labeling of lines will now filter lines or adjoined lines based on a minimum specified length measurement and suppress the label for these lines under this length. This helps keep busy areas with many short different road names or other labels from becoming unreadable at the current display scale.

Miscellaneous.

A vector object being edited might have been optimized before it was loaded but you have the option to optimize a vector layer with save turned off for faster saving. To avoid omitting the step to optimize the edited vector object, and compromise future performance, a dialog now asks you to determine if you want to optimize this vector object.

The Reverse Line Points tool can now be applied for "selected" lines and "all" lines. You no longer have to select each line when the collection of lines can be selected by query or some other means or when you wish to reverse the point order in all lines.

Map Layouts.

Print To Illustrator.

When converting a **TNT** layout to ADOBE Illustrator (*.ai) format, you can now choose between CMYK and RGB options for better color control .

PDFs Using SVG.

Advantages.

You can embed an SVG layout prepared by **TNT** products into an Adobe PDF file that you create in Acrobat. The ubiquitous Adobe Reader without modification will use its built in version of their SVG viewer with this content. This is an excellent method of publishing an interactive SVG layout and its embedded tools in a form everyone can use via their Adobe Reader without acquiring a plug-in for their browser. These embedded SVGs will provide their interactive features so that the coordinate readouts, DataTips, and measurement tools, and other javascript tools will be available. If you wish your SVG layout to carry images into a PDF then you must choose the Embed Images option when rendering this SVG layout from a **TNT** layout.

Setup.

To add an SVG layout to a new or existing PDF file for Windows or Mac OS X you must have the SVGAnnots plug-in installed in Adobe Acrobat and downloadable from www.planetpdf.com/mainpage.asp?webpageid=3250.

Limitations.

An SVG layout embedded in a PDF can not be printed by Adobe Reader. This can be advantageous if you do not want the content distributed outside of an encrypted password protected PDF file.

At this time the custom layer control visibility menu is accessed via a right mouse click (control key and click for Mac OS X) does not work for embedded SVG content. Layer control was only recently added to PDFs so this may simply be something that is yet to be supported by the SVG plug-ins for Reader.

Render to SVG.

Introduction.

Converting between layouts of various vendors is a complex task since they are not well defined file formats that can simply be exported or imported. Layouts, including those prepared in the **TNT** products, are designed as containers for a specific end use in electronic publication or for printing. Popular layouts such as SVG and PDF go even further by providing means of controlling layers, using tools, and other similar functionality. **RV6.9** continues to expand the functionality of preparing maps for distribution in an SVG layout that is a completely open layout standard. Now a new Render To SVG process is available on the Layout menu in addition to the Print to SVG approach. As a separate process, it provides a direct way to make conversions to an SVG layout. It is used by **TNTserver** to return SVG content to a browser.

Embedding Images.

Images and other rasters used in the SVG layout can either be embedded or linked according to your objectives. Whichever option is selected, the format of these rasters can now be selected to be either PNG or JPEG (V6.8 supported only PNG). Each has its advantage depending upon the content of the raster and your choice of lossless or lossy compression. Remember when making this selection that choosing JPEG will create lossy rasters while PNG rasters will be lossless compressed.

Embedding in HTML.

You can now select Embed in HTML (ActiveX) on the Render to SVG dialog. This option will integrate the SVG layout into HTML by encapsulating it with normal HTML. You should only use and exploit this feature if you are sure your target audience will use the SVG layout you produce with Microsoft's Internet Explorer or other Windows applications that support ActiveX. Do not use this option if the SVG layout will be widely disseminated, such as via the Internet. However, the controlled conditions can often be met when it will be used with proprietary or company-wide applications via a private intranet or virtual private network over the Internet.

Stylesheets.

You can now create and reference external stylesheets (**V6.8** supported only internal stylesheets). Using an external stylesheet is particularly useful if you wish to have more than one SVG file reference the same stylesheet. The Adobe SVG Viewer and Batik support gzip to compress these external files.

Optimize for Adobe Illustrator.

This option ensures that the SVG is organized to be more compatible with the import process in Adobe Illustrator.

Clip to SVG.

The option to Use View 1 Extents on the Render to SVG dialog will convert to SVG only that portion of the **TNT** layout that matches the extent of its 1st view. This will clip the **TNT** layout to that extent and produce a smaller SVG that is focused on the area of interest. This is particularly appropriate where a smaller SVG will be faster to download from your web site. This feature is also used by **TNTserver** to clip an SVG to the smaller extent requested by a **TNTclient**.

Sample Tools.

You can choose which sample javascript tools to embed and supply with the SVG content. **V6.8** provided sample javascripts for layer controls and coordinate displays.

DataTips.

If you have set up a DataTip for your uppermost vector layer, it can now also be defined in SVG. DataTips are not supported for raster objects, thus if the upper most layer is a raster, the vector layer supplying the DataTips (for example, street names) can be hidden under a raster layer. If you choose the Show DataTips option on the Render to SVG dialog the javascript tool to use your DataTips will be added to the SVG. The SVG viewer or browser will then interactively expose these DataTips for each associated graphical element. In addition, the element (for example, line or polygon) to which the DataTip applies can be optionally set to show up (a so called “mouse over event”) in an inverse color highlight or by blinking in inverse color.

SVG Versus Flash.

Many web sites now use the Shockwave Flash (SWF) plug-in from Macromedia. You may be aware that some serious patent legal wrangles are appearing that may impact on this approach. SVG, an open World Wide Web Consortium standard, has many useful features, especially for cartography, including some that are not present in SWF. To review these advantages in tabular format please see [Comparing .SWF \(Shockwave Flash\) and .SVG \(Scalable Vector Graphics\) file format specifications](http://www.carto.net/papers/svg/comparison_flash_svg/) at www.carto.net/papers/svg/comparison_flash_svg/.

ABSTRACT: “The comparison is based on both file format specifications Macromedia Flash, Open SWF Filespec and SVG. Not all Viewer/Plugins support the full range of the specifications yet. Macromedia compensates some of the missing functionality through its authoring systems - thus preventing developers to use advanced features by just writing the file-format itself. So far I haven't found any link to the Flash MX .swf file-format spec—if you have a pointer, please tell me. This means that this comparison might not be complete regarding the newest swf version.

“Please note that this a comparison for people dealing with integrated dynamic content generation systems. We are aware, that both .SWF and .SVG have their particular advantages/disadvantages—in some parts they are concurrencing each other, in some not. There is an interesting verbal summary on reasons why one should consider using SVG over MM Flash by Pete Schonfeld: SVG is real Flash. Eric Mauvière wrote a paper about flash and SVG in cartographic context: Flash, SVG et les autres (french).”

DV7.0—Tools and Font Management.

Measurement Tools.

You can use a toggle on the Render to SVG dialog to add a javascript to your SVG to permit its user to make interactive measurements by drawing lines and polygons with their mouse. This tool is activated by an icon added to the view of the SVG. When the line or polygon drawing is complete, a pop in window will show its length or area. Since you have started with a **TNT** layout, these measurements will be calibrated to georeferenced layers in SVG and will readout in the linear or area units you set up in your **TNT** layout.

DataTips.

Multiline DataTips defined for vector layers in your **TNT** layout can now be defined in the SVG content. The new text styling that can be used in your DataTips in the **TNT** layout is used to style the DataTips in the SVG layout. The Mount Saint Helens sample SVG provided in the Gallery at www.microimages.com/documentation/SVG.htm demonstrates this kind of DataTip and styling. In this example, the DataTip for the polygons representing water bodies shows their description, area, and circumference and uses a transparent color fill.

Text.

Managing the conversion of text blocks in a **TNT** layout to SVG content is complicated for the same reasons reviewed in earlier issues of this MEMO. Many fonts are proprietary and can only be used locally in a **TNT** layout and not provided with the SVG. This means that you can not guaranty that a specific font is available on the platform using the SVG. This is further complicated by the international nature of a **TNT** layout, which can create SVG content in any language for a user who may not have the corresponding multilingual font installed. Font management by conversion to a portable representation of the font is currently being added to Render to SVG.

* Color Management.

Background.

Until recently only empirical methods were available to manage color calibration from a scanner to computer display to a color printer, thus, most software handled this as a trial and error process. For example, you created color swatches or patterns on the monitor with known RGB values and then printed them on a specific printer. From this, specific RGB colors could be assigned to features in your project based upon the RGB identities in your printed samples or by visual interpolation between selected samples. This worked well for categorical data like polygon fills and line work and only crudely for images where wide interpolation was required. For images, since you owned only 1 expensive color printer, it worked better to gradually develop skill in how to color balance an image on a screen so that it created a suitable color print. In other words, by trial and error you learned how to adjust the color balance settings of the monitor and in the color balance process to produce the desired color print regardless of how it looked on the screen. This was definitely an art and had little computer science in it.

Next some graphics-oriented software passed through a transition period where a color monitor and printer could be interrelated with a spectrometer with difficulty and patience. Color samples on a color monitor could be characterized with a spot spectrometer or reference color swaths and then printed on a color chart with many in between colors. Using this approach some of the "art" could be removed from the task of reproducing what was on the monitor on the color print. The procedure was most successful in faithfully defining spot colors for commercial graphics.

Until recently all but the most expensive color monitors gradually changed in color with age or simply were constantly readjusted by each user. Scanners used illumination bulbs that faded in intensity. Most of our first color printers produced color only marginally and did not maintain a consistent color balance. For example, until recently color laser printer's color balance drifted as various amounts of each color toner were used—the 100th identical print did not have the same color balance as the first!

Now, with wide consumer interest in digital photography and good stable monitors and color printers, easy and reliable color management is important. This has forced hardware and software developers to widely adopt some standard color calibration approaches for color management. These standards have to apply across your many color image data sources and color devices ranging from cameras, to triple monitors, multiple online color printers of several sizes, and even to commercial printers. To keep pace with these opportunities, color calibration has been introduced into the **TNT** products.

General Methodology.

Your color monitor inherently operates in an RGB color space. It produces color by filtering out the selected wavelengths of white light or directly emitting light of the appropriate RGB combination. The CMY and black inks used by your color printer act in an inverse sense to absorb the incident white light and reflect back only the desired RGB wavelengths. The latest photo printers using 6, 7, or more inks are simply providing variations of CMYK inks such as light or diluted cyan ink. Part of color calibration is to move data between the RGB data used by your monitor into the CMYK data required by your printer. To do this, data is moved in and out of RGB color data values. The scanner calibration creates RGB, your monitor modifies RGB for its particular response curves, and your printer converts from RGB to its dithered CMYK dots. Analysis software, such as the **TNT** products, work with and create color as RGB values, such as in a **TNT** color composite raster object. It is then the responsibility of the hardware vendors producing color input and output devices to interact with these RGB values and create the corresponding correct and consistent color with their product.

To meet these color calibration requirements, standard procedures have been gradually adopted in the computer and print industries to assist you in moving the color image you create on your display to a reasonably good color representation on paper. Many color monitors and printers now use this standard color calibration scheme, even low cost devices aimed at desktop digital photography. Microsoft calls their scheme Image Color Management (ICM) while Apple uses a similar approach called International Color Consortium (ICC). In fact the color ICM and ICC profiles for a physical device can be used by either Windows or Mac OS X only requiring a change in their file extension. Even the latest TIFF libraries, whose support is currently being integrated into **DV7.0** of the **TNT** products, support tags to include these color profiles as a component of your TIFF files. At the moment it is unclear how these will be used with TIFF files. One possibility is that they will be used to translate the data stored in the TIFF to sRGB or to various other color models. This would permit raw color values created by some device to be stored in a TIFF file to which is added the ICC/ICM or other color profiles needed to translate these values into sRGB.

Software is now expected to create, store, and manage color using the standard-Red-Green-Blue (sRGB) color model, which most analysis software including the **TNT** products has long used. These color profiles are translation tables that specify how that particular input or output device (for example, printer, monitor, scanner, camera ...) will translate the sRGB color values it receives into industry standard colors! For example, if an sRGB red color of 200,20,20 is sent to a variety of color printers via their ICM or ICC profiles, they will all more or less reproduce the same red by translating it via their respective profiles. The concept is applied to monitors in the same fashion. It is the responsibility of the hardware manufacturer to provide a good ICM/ICC profile for their

device. As a result, most printers and good quality monitors provide them and your operating system deals with providing **TNT** products access to them. The sRGB color model has become so standard that some devices have built the color profile translation to or from sRGB directly into their devices. Many new, low-cost printers, such as those from Hewlett-Packard, directly accept the sRGB data and translate it internally into standard color. If you are using a Windows driver, it expects sRGB as its input. Thus, if you are using an older HP printer, especially if it is large format, to take advantage of **TNT**'s color management you must choose to let its Windows driver do the dithering (see section below entitled Printing).

All color is not equal. As a result, a variety of different color representations were developed earlier in the photographic printing and color proofing/printing fields. Thus, expensive color printers may come with a variety of profiles. For example, MicroImages' Xerox solid ink color printers used to print the attached color plates provide profiles for Vivid Color, SWOP Press, Euroscale Press, Commercial Press, SNAP Press, DIC, Toyo, Fuji Proof, and of course direct sRGB. Printers developed specifically for color proofing will supply even more color model choices.

You have probably also noticed that you no longer get to adjust RGB, HIS, or equivalent color balance knobs on your monitor. Now you select in your operating system or application software which color model, from a variety of color models, to use to determine the color balance of your monitor to please your eye and to load the proper profile to relate it to the sRGB data color model. This is usually done in the display preferences provided by your operating system by choosing from those it has stored for your specific monitor or were installed separately with the monitor. Similarly, you can choose the color model to use in the conversion of sRGB by the printer. This is provided as an option somewhere on the print dialog from the choices installed for that printer or provided by the operating system.

All of this sounds wonderful even if a bit confusing. Alas, not all color devices are created equal. The human eye can distinguish a myriad of subtle color variations, next comes the computer monitor and display board combination, and trailing far behind is the color printer. All these have a measurable color space called a gamut, which is a map of their color sensitivity or range. So the key problem is that you can easily create or acquire sRGB data within the gamut of your color monitor that falls outside the color gamut of any printer. Thus your software must have a means of dealing with sRGB colors that can not be reproduced on your printer and it will be useful if you know what these colors are and where they occur in the image on your monitor (which means, exactly which area and cells). Many articles supplying more details on this topic can be found on the internet. It is interesting to note that if you search Google for ICM Color Calibration from sRGB the first entry of 775 is to microimages.com to the MicroImages MEMO of December 2003 announcing this capability for **RV6.9** and if you search for International Color Management for sRGB the first entry of 707 provides access to microsoft.com and their white papers on the subject.

Calibration.

X Server.

The **TNT** professional products for Windows use an X Server that must be set up to use a color profile. For Windows this is set in the X Server Preferences dialog on the Options panel by choosing to let the display driver do the color management or choose a specific ICM color profile. For Mac OS X select Colors: From Display on the X11 Pref-

ferences dialog. Illustrations and more details are provided on the attached color plate entitled Color Management for X Server and Views. UNIX and Linux have similar procedures for setting up your X Server preferences. Please see their specific vendor's reference materials for assistance.

Monitor.

RV6.9 introduces the use of ICM/ICC color calibration into the **TNT** products. You must make Windows aware of your monitor's ICM color profile by selecting it in the advanced settings for your display. Often you can select from more than one, which will set your preference for the tints and tones on our monitor and establish the appropriate ICM translation between your preference and sRGB color space. In the Mac OS X your viewing preference and its ICC translation is selected using System Preferences / Displays / Color. If you are using an Apple monitor you have only a few choices including the direct sRGB option.

Printer.

The color profile used for your printer can be selected in the Printer dialog where you select the specific printer to use and all the many other characteristics of your print job. For Windows you select the ICM profile on the Color Management tabbed panel of the printer's Properties dialog. Mac OS X provides your choices for ICC profiles for each printer you select under File / Print on its Printer Features dialog. For Epson, Xerox, and many other manufacturers, you may have many choices of named ICM/ICC color profiles matching various commercial color printing standards or personal preferences. You may also have 1 or 2 standard choices or none for an older printer or an HP printer that expects direct sRGB input. For most new HP printers you will have no choices in either case as they directly accept only sRGB.

Managing Out-of-Gamut Colors.

As has already been mentioned, you can use the import, linking, data manipulation, and color balancing tools in the **TNT** products or any other product to produce some sRGB colors in your objects and/or on your monitor that can not be reproduced on your printer. These are often the most saturated sRGB colors that are described as "falling outside the color gamut of your printer," in other words they are outside its color range. You like the color results on your screen, but the printer simply can not produce all of the colors you are viewing or have created in an object or a layout. The ICM/ICC color calibration procedure has to be told what to do about this—how to map those out-of-gamut colors into the gamut of the printer! Depending upon the rendering method selected, sRGB colors outside your printer's gamut will always be changed and those within its gamut may be changed. Now in **TNTmips** you can select your rendering intent for your **TNT** print on the Rendering Intent option menu in the Profile tabbed panel of the Page Setup dialog.

Perceptual Rendering (best for images).

Use this method for your images and other direct screen prints. These sources will have a wider gamut, or range of colors, than your printer. It compresses every sRGB color proportionally to fit within the gamut of the printer, thus, preserving the chromatic relationships between colors. This will typically desaturate all your colors since your printer's gamut is not large enough to reproduce saturated colors. However, once you are satisfied with what you are viewing as the current sRGB representation of your image on the screen, this method will reproduce it as faithfully as is possible on the printer.

This is the method set at installation by MicroImages until you change it to your preferred method.

Saturation Rendering (best for graphics).

Use this method for your maps made up of styled graphical elements (for example, roads, rivers, solid filled polygons, and so). These kinds of prints are made up of a few distinct colors, many of which you deliberately selected to be saturated. This method will modify the source or sRGB colors to exactly fill your printer's gamut while preserving the saturation of the colors such that some parts of the modified RGB color space are expanded and others are compressed. Since saturated colors are part of your objective in the graphical representation of features, this method meets that objective.

Rendering Complex Layouts.

Gradually **TNTmips** and other products have made it convenient to integrate raster and vector and other graphical materials not only in analysis, but also in publication. Typically the printed product you now produce is from a map layout combining color and grayscale images, saturated graphics drawn separately or over the images, color legends, black crisp text, and significant areas of white paper. Choosing either the perceptual or saturation rendering methods is not optimal for this kind of complex, composite layout. The relative (a compromise method) and absolute colorimetric (the hard work method) methods are available to print complex layouts.

Relative Colorimetric Rendering (try first for composite map layouts).

This method will adjust the brightness of all colors in the sRGB source so that every possible sRGB color is within the gamut of the destination printer. The white point of the sRGB input data (for example, 255R, 255G, 255B) is converted into the printer's white or what is called destination white (for example, 0R, 0G, and 0B). For this reason, this method is also called the "graphics" or "logo color" method in the printing industry. All other sRGB colors are then shifted in brightness relative to the change in the white point. The resultant print may be lighter or darker than its representation on the monitor. When a complex map layout is printed, this rendering method will insure that the white areas within its graphics, text blocks, and margins are white. It will also make an overall brightness adjustment of all the areas of a complex map so that all the source images, graphical lines and fills, logos, and other components are inside the gamut or color reproduction range, of the printer. This is also the method of choice when your printer has a narrow gamut.

Absolute Colorimetric Rendering (a more complex approach for map layouts).

This method does not change any source sRGB color that falls within the gamut of the destination printer or other device. Colors that are outside the gamut of the destination device are transformed to the closest color at the gamut's edge. White areas may or may not be reproduced as no-ink, paper white. Obviously this is a good method to apply to any printing device with a large gamut such as a 6, 7, or more ink color photograph printer; sublimation printer; and especially if the destination is a film printer. This is the reason it is referred to as the "proof," "match," or "colorimetric" method in the printing industry since it attempts to provide a print that for the most part can be compared absolutely from printer to printer.

If you are using this method and some component of your map layout, for example an inset image, is not reproduced appropriately, you need to alter it before this proof printing. Using other processes in **TNTmips** you can adjust, stretch, edit, and otherwise

change the sRGB color of any of your layout's components until this method prints that component and all other components to your satisfaction. This may produce the best single print of the map for your uses. However, you can also require that any commercial printing process produces results that match this proof print when supplied this same sRGB file in TIFF or some other lossless raster format.

Soft Color Proofing.

At this point you are wondering how to determine if you have all the calibration pieces in the right places, if your **TNT** color management is set up correctly, and which color rendering method works best. Furthermore, you are going to encounter a wide variety of data sources and color printers on your network requiring periodic reexamination of these same questions.

Visual Inspection.

The **TNT** products now provide you a print preview method called soft color proofing. After your ICM/ICC color calibration is setup, soft proofing will show you how your sRGB data currently displayed in a view of an object, group, or layout will be reproduced in color on your printer with the selected rendering method. Soft proofing assumes you have set up the ICM/ICC calibration of your monitor and that your monitor has a significantly larger color gamut than your printer. There are exceptional output devices such as color film writers, internet processing labs, and others that can have a larger gamut than your monitor. However, soft color proofing makes the assumption that all the colors your printer can reproduce can be reproduced on your monitor.

The procedure maps all sRGB color values in the objects in the current view through your selected rendering method and your printer's ICM/ICC color profile and redisplay them. In this View window, which you can zoom, alter, and so on as you choose, you can check how the printer will preserve or alter the sRGB colors you have created. For example, you can take a look at how well various water colors will be separated or how saturated your graphics will be. Use the toggle "Proof to Screen" on the **TNT** printing Page Setup dialog to redraw your current view as a soft color proof. The attached color plate entitled Color Management for Printing and Proofing illustrates how a display of a well color balanced sRGB image is redisplayed to demonstrate several soft color proofs.

Using Out-of-Gamut Alarming.

As an option, your soft color proof can substitute an alarm color for every one of the color cells making up input to the current view that will be changed from their true sRGB value during printing because they fall outside the gamut of the printer. The soft proof procedure maps all sRGB color values through your selected rendering method and your printer's ICM/ICC color profile. From this all sRGB colors that are outside the gamut of the printer can be identified. Thus, via this option, your color view is redisplayed assigning an alarm color to every pixel in the view representing cells whose sRGB colors cannot be printed. The default alarm color is red, but you can change it to any other color you prefer.

The optional, alarmed soft color proof permits you to quickly check in advance which sRGB colors are impossible for your printer to reproduce and will be altered in your print. You can also use the alarmed soft color proof after printing to locate and review the significance of these areas of color change in the print.

The illustrations in the attached color plate entitled Color Management and Printer Profiles compare the vastly differing areas of alarms produced by a printer with a wide

gamut and one with a narrow gamut. This plate also illustrates how you can use this alarm system to point you toward possible adjustments to your image before printing. It illustrates how adjusting a single RGB value of the ocean portion of this image to a different, but satisfactory, blue moves that color representing this vary large area into the gamut, or color reproduction range, of the color printer. You can always alter the sRGB value of any large alarmed area in the image (for example, water or desert) to a slightly different and perhaps equally suitable color of your choice that is within the color gamut of the printer. If you do not do this then, as explained above, your choice of rendering method will do this for you automatically and perhaps produce a less desirable result.

Printing.

Support for 6, 7, and more color printers has been implemented by sending sRGB to their drivers. These printers improve the range of the color gamut by adding black, light cyan (dilute cyan), light magenta (dilute magenta), and light gray (dilute black) inks.

The **TNT** products provide you with 3 different approaches to do the dithering for color printing. These are to select between dithering with the **TNT** product, the printer via its driver, or the operating system. The tutorial booklet entitled Printing was revised to cover more material on this subject after the **RV6.9** CDs were reproduced. Download the PDF for this revised booklet from www.microimages.com/getstart/printing.htm. Depending upon the printer and operating system you will need to select the method that produces the best results. The following are some of the advantages and disadvantages of each approach.

Via the Operating System.

You can choose to let the operating system do the color management and dithering.

Advantages. This method will provide the **TNT** products access to ICM/ICC color profiles and let the operating system optimize the color management. It can take advantage of the higher resolutions supported by the printer. For example, most new HP printers have a native resolution of at least 1200 by 1200 dpi or higher, but only accept input at 600 by 600 dpi and internally dither it to produce the higher resolutions that match their fixed printing resolution. This reduces computation on the host and provides for faster communication of the input to the printer.

Disadvantages. This method can create large files and may be slow. Also, commonly available drivers are automatically installed with Windows but may not be available in other operating systems. Furthermore, if they are available for other operating systems they often are provided later in that product's life cycle, can be more error prone, and lack features.

Via TNT Using the Printer Driver.

This method lets the printer use its manufacturer's driver to do the dithering.

Advantages. This method permits **TNTmips** to use the ICM/ICC color management and works with every operating system for which the printer's driver is available directly from the manufacturer and not via the operating system. It can also take advantage of the higher resolutions supported by the printer. For example, most new HP printers have a native resolution of at least 1200 by 1200 dpi or higher, but only accept input at 600 by 600 dpi and internally dither to use the higher resolutions. This reduces computation on the host and provides for faster communication of the input to the printer.

Disadvantages. This method also creates a large temporary file.

Via TNT's Dithering.

This is a legacy approach dating from earlier years when each software vendor had to support each printer.

Advantages. A small temporary file is created and often faster. Also this may be the only method or method of last resort especially with older printers.

Disadvantages. This method can not use the ICM/ICC profiles as well as other related options since color is affected by the dither pattern selected in the **TNT** product. The resolution can also be limited in some printers. Furthermore, it is now difficult for Micro-Images to add new printers for this method as printer manufacturers aren't interested anymore in documenting their printer formats.

* SML Scripting.

Introduction.

Improving and expanding **SML** has continued to receive considerable attention for **RV6.9**. A complete overhaul of the function/class descriptions has been completed and all functions now link to at least 1 example of their use.

The **V6.8** tutorial booklet for **SML** has been divided into two: Writing Scripts with SML and Building Dialogs in SML. These new PDF booklets are now installed as part of **RV6.9** of your **TNT** products and provide twice the number of pages as the previous single booklet.

The ability of your **TNT** products to be linked to other VB, C++, or Java programs has been expanded. This provides a means of using your programs to establish 2-way communications between your **TNT** products and other programs and products.

Macro and Tool Scripts can now be attached as script objects to groups and layouts for automatic access as part of these containers. Tools and information for customizing existing Tool Scripts and Macro Scripts are available.

The **SML** Debugger has been improved. It now also provides a step timer mode for running scripts, which will help you pinpoint where your script's operation is being slowed by inefficient script code.

In **V6.8** you could use the internal X Windows approach or the XML approach to creating your dialogs. If you use your preferred XML editor to create dialogs you can now use **SML**'s Document Type Definition (DTD) to validate that XML. You can even use Visual Basic to create separate programs to provide your dialogs and forms for use with **SML**.

Important new classes have been added such as GUI_CANVAS to support drawing within custom windows created by a script, GRE_LAYER_SCRIPT to provide access to **SML** script layers in a view window, and TNTSIM3D to permit the use of **SML** during simulations, and others.

Caveats.

All the efforts discussed here to increase the usefulness of **SML** have for several months restricted efforts to promptly add new functionality (classes, methods, and functions) to **SML** in response to your individual needs and requests. Now that the usability of **SML** has been greatly improved, your requested code additions can be added and new requests can be more promptly addressed as received. Sometimes we receive requests that will take a lot of effort (for example, array handling) or are not appropriate for

SML (for example, image classification), and these will be assigned a lower priority. However, continuing additions to **SML** are a good reason why you should periodically apply the free patches to your **RV6.9** to gain access to them.

Expanded Reference Booklets.

The online tutorial booklet to help you learn how to use **SML** has been doubled and divided into 2 booklets. You still have available the booklet Writing Scripts with SML but it has been completely revised and expanded to 60 pages. Many new topics are now covered including the latest new features such as how to use **SML** to communicate between **TNT** products and with your Visual Basic programs. Since the reference material for **SML** has been expanding rapidly some of it was moved to a second and new booklet entitled Building Dialogs in SML. This new booklet is focused upon how to build your **SML** control dialogs using either of the approaches: the older X Windows/MOTIF approach and the newer XML approach. Please also note that now, although not yet covered in this booklet, you can also use your own Visual Basic programs to create dialogs and forms and other user interface components for your **SML** scripts and to communicate between the **TNT** products and other products.

* Expanded Documentation/Examples of Functions/Classes

A software engineer has been reviewing the online documentation for all the **SML** functions and classes to determine if each has a description of purpose and definitions for its parameters and methods. This documentation is now available for every class and its member variables and for every function and its parameters.

The script examples in the online function documentation have been combined with all of MicroImages available "public" scripts into a large single library. This collection of 206 files provides standalone scripts, Tool Scripts, Macro Scripts, APPLIDATS, movie scripts, **TNTsim3D** scripts, sample queries, and script fragments that contain example uses of **SML** functions. Although the online function documentation is presented to you in the same form as before, the script examples shown are now drawn from this unified script library. This work was not complete in time to be included on the **RV6.9** CD. The **PV6.9** has been modified to use this sample script library, but you will need to separately download the script library itself from microimages.com. The **SML** Editor in **PV6.9** will detect the absence of this library when you access the online function documentation and attempt to view the sample script for a function. In place of the missing example you will find instructions on where to download the library and where to install it for use with **PV6.9**.

All of these sample scripts are now being parsed automatically every night. This helps to insure that the daily changes in the **TNTsdk** that may impact **SML** are promptly detected and repaired. The link between each function and its example is also being tested nightly.

These efforts for **PV6.9** have significantly improved **SML**'s supporting information as follows.

- All of the 324 classes, 557 class methods, and 794 method parameters have descriptions.
- All of the 976 functions and their 3074 parameters have descriptions.
- There are examples for the use of 692 functions that are automatically checked daily to insure that they are parsing and produce no warnings.

- There are 192 functions that do not need examples as their use is obvious (e.g., mathematical, logical, ...).
- There are 92 functions that have no examples but these are all being implemented at this time to shortly reduce this to 0.

Installing Scripts.

In **V6.8** the **SML** Macro Scripts and Tool Scripts you installed to act on the spatial objects in your current view (or on any other specified objects) were automatically added to the View windows icon bar with your specified icon button and ToolTip. Tool Scripts were also added by name to the Tool menu in the View window. The installed Macro and Tool Scripts were then available from any View window throughout **TNTmips**. Some of you are adding many Macro and Tool Scripts, with the result that there are so many script icons that the icon bar becomes confusing, and some of the installed scripts might not be useable with the data currently being viewed. During installation of a Macro or Tool Script in **RV6.9**, you now have the option of omitting the icons and providing access only via the Tool menu (for Tool Scripts) and a new Macros menu. These and other adjustments to the process of gaining access to the **SML** development tools and installing Macro and Tool Scripts are discussed and illustrated in the attached color plates entitled Macro Script Setup and Tool Script Templates. As discussed in the following sections, you also have the option of limiting the scope of the installation of Tool and Macro Scripts.

Adding Custom Tools to Groups and Layouts.

Background.

Groups and layouts are used to define and maintain the relationships between collections of **TNT** geodata objects in various Project Files (or linked external files in other formats). Creating a group or layout organizes a collection of specific geodata into a meaningful unit and defines how it is used together in a display group or layout, a map layout, an edit session, an atlas, and so on. **SML** can also be used to create complex analysis tools (Tool and Macro Scripts) that are tailored to the data in 1 or more objects in a specific group or layout. In **V6.8** **SML** Macro and Tool Scripts were added to every View window, where they were always presented until manually removed. This approach is suitable if your special tools can be generically applied to any View, or at least to any raster object, any vector object, and so on. However, this approach did not let you limit the installation of your specialized tools to the specific groups or layouts that contain the appropriate target data.

Implementation.

To streamline this application of scripts for data-dependent custom tools in **RV6.9**, you can optionally install Macro Scripts and Tool Scripts for use only with a specific group or layout. The installed scripts are then stored within the group or layout object. When that group or layout is selected, the associated scripts are added for your use to the menu bar or the icon and menu bar of the View window. Unlike the previous approach outlined above (which is still available), these menus and icons are not always part of the view. They are only presented when the group or layout to which they are attached is displayed. These new procedures for managing and applying custom tools are illustrated in the attached color plate entitled Use Layouts to Customize TNTatlas/X.

Delivering scripts as part of the layouts used in a **TNTatlas** is a particularly effective way to add unique tools related to the specific contents of the atlas and have them automati-

cally installed for use in any **TNTAtlas** software. This is also illustrated in the attached color plate entitled Use Layouts to Customize TNTAtlas/X.

A good example of a data-dependent tool is an **SML** Tool Script that makes use of the attributes of a particular vector layer in the group. The Tool Script can prompt the user for specific attribute values (for example, street name or other parts of an address) and then execute an **SML** selection query for the corresponding element type. The script might combine and test data from a number of attributes and return a variety of results. While this Tool Script can be very useful, it is data-dependent and, thus, works best if associated with a group or layout that loads the selected layer(s) for which it was designed. This type of data-dependent Tool Script acting on selected element's attributes is used for the examples in the attached color plate entitled Modifying SML Tool Scripts for New Applications.

Modifying Scripts.

A new, larger **SML** sample script collection is now provided as part of **PV6.9** and updated via the weekly patches. These provide some of the examples of how individual functions are used. A function example may be a whole script or script subsection you can insert and easily modify. However, it is also important to become familiar with and search all of the sample script categories to determine if one exists that can simply be modified to suit your application. Minor modifications that can even be undertaken by non-programmers can often change a sample script into a useful tool, especially those that are data dependent. The simple alterations to change a Tool Script to work with your specific geodata are illustrated in the attached color plate entitled Modifying SML Tool Scripts for New Applications (2 sided).

Debugging Scripts.

Operations.

The debug procedure has been expanded to assist you in perfecting your **SML** scripts. If you have a script loaded in the **SML** Edit window and select Debug on the **SML** File menu, the same script is loaded into the additional **SML** Debugger window. The icon bar for this window permits you to Run the script, Step through, Pause, Stop, Show Pseudo Code, and Show Timing. Each time you choose the Step icon the next line in the script is executed as indicated by an arrow to the left of the line. This Debug window and the following new features are illustrated and discussed on the attached color plate entitled SML Debugger and Script Timer.

Breakpoints.

If your script is long you might want to insert break points by clicking to the left of the script line. A red ball symbol is inserted to mark the breakpoint (you can remove the breakpoint later by clicking on this symbol). When you run the script, it stops at the first breakpoint. You can then use the Step icon to try the suspect lines following the break point, or press Run again to have it run to the next breakpoint. If your script includes other **SML** scripts a square symbol is shown in the left margin next to each include statement. Selecting this icon expands the script (or pseudo-code) listing in the **SML** Debugger window to show the included script code and permit you to step through it.

Timing.

When you press the Time icon, a Time column is inserted in the **SML** Debugger window to the left of the script listing to show the time (in seconds) required to execute each

script line. If you run the entire script, times are shown for each line. If you step through the script, the time to execute each line is added in sequence as you progress through your script. In many cases carefully studying these times can lead you to areas where you can improve the overall script performance by changing the logic in your script (for example, to identify excessive and unnecessary nested loops, inefficient computations, and so on).

Creating Dialogs and Windows.

Template for XML.

V6.8 introduced the use of XML as an alternate means of creating custom dialogs for user interaction in your scripts. These user interface components were introduced in detail in that Release MEMO (www.microimages.com/relnotes/v68/rel68.htm) and are now the subject of your new Building Dialogs in SML tutorial booklet. Some of you have expressed an interest in using Xerlin, a free open-source XML editor (www.xerlin.org) to compose your **SML** dialogs. This in turn led a client to request that a widely used XML document model be provided with the **TNT** products to use in Xerlin and other editors. The sample data directory (SMLDLG) accompanying this tutorial booklet now includes a Document Type Definition (DTD) file (smlforms.dtd) that provides an **SML** template for use in Xerlin and other editors. The DTD file enables an XML editor to show the attributes available for each interface component so you can set up the desired characteristics. Using this template permits you to use all the many features of your preferred XML editor while targeting your result toward creating the interface for your **SML** script. The use of this DTD template is discussed and illustrated in the attached color plate entitled Validating SML Dialogs Created in XML.

Visual Basic.

You can now also use a separate Visual Basic program to create all the same dialog boxes and interface features permitted by XML directly in your **SML** script. This may provide you with several benefits. 1) You may already be familiar with Visual Basic. 2) You can use the interactive layout tools provided by Visual Basic (Form Layout window) or some other software to design your interface. Since the VB program can run independently from your **SML** script, it can be used as a means of providing input and output from the **SML** script, thus controlling some activities in the main **TNT** product such as updating a table, redrawing, and so on. However, this same interface program can be used to gain access to, display, or edit data from some other source. In the simplest use of this type it might simply retrieve and display information from some other RDBMS to assist the user in responding to the form or dialog required by the **SML** to communicate with the **TNT** product.

The use of Visual Basic (or C++ or Java) to create **SML** interface elements has only recently been developed. As a result, it is not yet included in the Building Dialogs in SML booklet. However, the next revision of this booklet will cover these topics. In the meantime, the attached color plate entitled Build SML Dialogs Using Visual Basic illustrates and discusses the identical dialog created in a Visual Basic program and within **SML** using XML.

SML Accepts Callbacks from Other Programs (via ActiveX).

Introduction.

You can now write a program in Visual Basic, Java, C++, ... that runs concurrently with and communicates with an **SML** script using a callback procedure via ActiveX. This external program might be used for a wide variety of purposes. A simple example would be to use a form presented by a Visual Basic program to collect or edit data for a record from its user. When the user selects OK to log this record, the VB program can continue to run for new input or other communications with this user. Meanwhile, the **SML** script has been notified to update the Tabular or Single Record View in **TNT**. This approach can be used to resolve the issue described in the section above (Refresh Tabular Views of External RDBMS) that ODBC does not automatically notify its clients (which means, **TNT** via the ODBC link) that a table has been changed. In this case, the Visual Basic program notifies the **SML** script that it has changed a record in that RDBMS and **SML** redraws the Tabular or Single Record View.

This table refresh application is an easily understood example of what might be accomplished with this callback approach. A simple extension of this approach would be to have the **SML** script redraw a pin mapped layer in the current **TNT** View window to update it for the new or edited record created by the Visual Basic program. This expanded Visual Basic program could be used to track something that is moving and the **SML** script could add pins for each new position (often called "dropping breadcrumbs or string"). Those writing **SML** scripts should also realize that a total redraw of the view is not needed in **SML** to add or move a single pin!

Those interested in using this new callback feature in their **SML** scripts should keep in mind, as noted above, that you are not restricted to using Visual Basic programs. The examples showing modification of records in a table via a Visual Basic dialog are simply easily understood applications. You may be experienced in using a variety of other higher level programming languages. This extension of **SML** will permit you to implement complex specialized operations in your non-**TNT**, non-**SML** programs that can now take advantage of the supporting features provided by **SML** and the visualization capabilities of a concurrently-running **TNT** product (for example, TNTview).

Simple Example Use.

Additional discussion of this concept can be found in the attached color plate entitled ActiveX Callbacks to SML. The Visual Basic program in this example creates a form populated from a **TNT** database record (for example, the ownership of a parcel). The record is supplied to the form by an **SML** Tool Script when the user selects a polygon in the **TNT** view. This form can then be used to edit the ownership data for the selected parcel. You can download the materials to run this example (VBDEMO2.zip) from www.microimages.com/freestuf/tool¯o.htm. The Visual Basic dialog in this example is a modified version of the database form used in a previous example discussed and illustrated in the plate entitled Communicate with Visual Basic Programs using SML (available at www.microimages.com/documentation/68visbasic.pdf).

The VBDEMO2 directory contains two sample **SML** Tool Scripts and the Visual Basic materials. To install (which means, register) the sample Visual Basic component program, double-click on the file `MicroImages_SML_OLE_Demo_EXE.exe`. The new sample **SML** script `ParcelToolModeless` illustrates the use of callbacks between concurrently-running **SML** and Visual Basic programs. This script imports the Visual

Basic class called VBform that defines the database form and associated ActiveX events that are triggered by pressing the Apply or Close buttons on the form. The VBform class also has a class member for each of these buttons (SetOnApply and SetOnClose) that are used in the **SML** script to register the name of the **SML** function (defined by the script writer elsewhere in the **SML** script) to be activated when that button is pressed. It is these callback functions in the **SML** script that define what actions are to be taken by the **SML** script when the respective control in the Visual Basic form is activated. In this example, editing the database information shown for the selected polygon on the Visual Basic form and pressing the form's Apply button updates the polygon database, notifies **TNT** that the update has occurred, and turns off polygon highlighting during the ensuing redraw of the **TNT** view.

Additional Examples.

Additional examples of using Visual Basic to communicate with **SML** and the **TNT** products have been developed but are not yet illustrated or documented. These include several modified versions of the parcel polygon application described above. In one version the parcel information is in an Access database linked to the **TNT** parcel layer via ODBC. The Visual Basic form in this example gets the parcel ID for the selected polygon from the **SML** Tool Script and uses it to retrieve the ownership data from the Access database via ODBC. The user can then use the form to modify the ownership record for that parcel, and these changes are also communicated back to the view via the **SML** Tool Script as in the previous example. Another variation of this Visual Basic example uses the direct link, not ODBC, between Microsoft's Visual Basic and SQL Server to obtain and alter the ownership records in SQL Server tables. Another version of the Parcel Tool Script has been modified to zoom in on the selected parcel polygon. If you are interested in these additional sample procedures please contact MicroImages software support staff.

Sample Scripts.

Batch Imports.

Global image and elevation coverage, high resolution images of a large area, and map features released in map series units are some of the examples of geodata that are available to you in 100s or even 1000s of small pieces. Examples of this would be sets of orthophotos of a city, SRTM or USGS DEMs, USGS DLGs, Vector Map Level 1 (VMap1), and other feature sets. These materials are parceled out in bite-sized pieces so that they can be sold in these small units, delivered on CDs or DVDs, conveniently downloaded via the Internet, and/or used in free but limited software. They are also delivered in small units to facilitate their use in commercial software products that can not handle large integrated geodata sets.

As a professional geospatial analyst, you are encountering project opportunities in assembling these data sets in **TNTmips** for use as a base for a project in a larger area, or to modify, improve, or add to them. Often the most efficient approach would be to import them into many objects in a Project File and then mosaic or merge them into a single object prior to any further activity.

Some formats can be linked to and then directly mosaicked into a single raster object. However, if the data tiles are in a new and unusual format, you can automate their repetitive import using an **SML** script. You may also want to automate additional processing (changing their cell size, map projection, georeferencing, ...) in this same script if it is

more conveniently accomplished on these small units as they are imported. Using an **SML** script is a good way to automate this kind of import, especially if the source geodata are periodically changing, in a unique format, require a change in data type (for example, 8-bit to 16-bit integer), and/or are in many tiles each of differing data ranges.

The preliminary release via the Internet of the Space Shuttle SRTM elevation data in 1201 by 1201-cell tiles is a good example of this kind of **SML** application. These tiles are being released by continent. South America has 1813 tiles and these can be downloaded easily via the Internet (<ftp://edcsgs9.cr.usgs.gov/pub/data/srtm/>). However, these tiles are subject to periodic changes as some large no-data areas and details in mountainous areas are filled in from other data sources, smaller flaws are corrected by further analysis of the source SRTM data or by filtering (smoothing) the tiles. This is the kind of situation where writing or modifying a standalone **SML** script is the best way to repetitively import these raster objects by continent. The attached color plate entitled Automate Batch Imports Using SML describes an **SML** script created as a model for your batch import scripts. The script is explained on the reverse side of this plate. This short script can be downloaded from the MicroImages' **SML** Sample Scripts collection at www.microimages.com/freestuf/smlscripts.htm. Use it as a model to create your own batch import script for any raster, vector, or other geodata import supported by the **TNT** products. It is also a good shell or model for any script you must create to import some unique geodata format you encounter or a format not handled by the **TNT** products.

Large Complex Scripts.

For Process Applications.

Not all **SML** scripts are compact and simple. Some large scripts have been created to handle repetitive "production line" approaches where a long repetitive proprietary sequence of steps is automated to create a production line process requiring little or no human intervention. An example of this is one satellite image acquisition company's implementation of a large **SML** script that starts with access to their original image archive, ingests their customer's local area of interest, adjusts local georeference if needed (requires human intervention), calibrates to reflectance, processes into very specific application products, applies contrasting and color calibration, and exports to TIFF and other formats as well as bundled with a linked **TNTatlas**.

The final product produced in this application is time sensitive, and prompt delivery is critical. This **SML** production line approach, including any human input, is completed and the product available for Internet access or shipment on a CD 2 hours after the newly acquired satellite image is processed and made available in the company's image archive. It has been in use for more than a year and is repeated multiple times a day using more than 1 **TNTmips** system. It is continually being improved by its authors to improve their products and as new **SML** capabilities are added.

For Experimental or Scientific Applications.

The largest public script made available to MicroImages has been written by Mr. Ralf Koller, a graduate student in geography, for his masters thesis at Friedrich Alexander Universität, Erlangen-Nurnberg, Germany. He has his own **TNTlite** installed at home on his Mac OS X computer and also uses the professional **TNTmips** Windows version available via this university's Special Academic License. Ralf was very effective at communicating and interacting with MicroImages' support software engineers while creating this script and gets an "A" grade from MicroImages for this. His **SML** script has

about 83,000 lines and is designed to calibrate and normalize a collection of four multitemporal Landsat multispectral images. Any one of the four scenes can be in one of several possible formats, and accommodating these processing options contributed to the length and complexity of the script. Despite this complexity, the script runs equally well in Windows, Mac OS X, and Linux since all use the same **SML**. Ralf reports that he has processed a 1309 by 2081-cell extract of four scenes in about 2 hours and 15 minutes on an older Pentium III computer (866 MHz, 156 MB of RAM and 4 GB of virtual memory). This script is introduced and illustrated in the attached color plate entitled Calibrate Multitemporal Landsat Scenes via SML. The complete script can be downloaded from the MicroImages' **SML** Sample Scripts collection at www.microimages.com/freestuf/smlscripts.htm. The script can be run in **TNTlite** provided that none of the input image bands exceed the raster dimension limits imposed in **TNTlite**.

SML Additions.

New Functions.

Database functions. (1)

TableTriggerRecordChangedCallback()

Allows an **SML** script to notify an RVC database that a linked table was modified by an external source.

Raster functions. (3)

RasterCopy()

Copies a raster or a subarea and all its subobjects (georeference, contrast, color-maps, etc).

RasterFloodFill ()

Flood fill an area of a raster.

RasterGetSolidAreaSize()

Compute the size (in pixels) of a raster area that would be filled by a flood fill.

Geodata Display functions. (1)

GroupQuickAddRGBRastersVar()

Add a GRE_RASTER_LAYER to a GRE_GROUP given 3 raster variables (one for each RGB component).

Drawing functions. (1)

LineStyleSetRect()

CartoScript function to draw a rectangle.

Modified Functions.

CreateHistogram() function now has a parameter to set a sampling interval.

The RenderToRaster function now renders to a 4-bit or 8-bit palette, color raster for use in color separation.

Navigate to and select a table (see POPUP functions).

Refresh a database table view (see Database functions).

GroupQuickAddRGBRasters has been modified to create an RGB raster layer in a display group from 3 separate rasters.

New Classes.

BITSET

- An array of bits that can be resized.
- BITSET_ITERATOR**
An iterator to step forward through all selected items in a BITSET.
- BITSET_UNOWNED**
An array of bits.
- CONTRAST**
A contrast object for raster display.
- GRE_LAYER_SCRIPT**
Script layer.
- GUI_CANVAS**
Canvas control to support drawing.
- LABELFRAMEPARMS**
Frame for displayed labels.
- TNTSIM3D**
The interface class for TNTsim3D.

Modified Classes (new methods added).

- DBFIELDINFO can now get the field type, its width, and the number of decimal places.
- VECTORLAYER can now get the currently selected (highlighted) elements.
- MieUSERDEFINEDRASTER now permits setting lines, columns, data type, ...
- MieTIFF can now export 16-bit grayscale rasters to TIFF.
- Generate a contrast subobject (see Contrast class)

Miscellaneous.

The documentation has been altered to help you locate all of the geospatial rendering engine classes for layers, groups, and views that now start with GRE_. For this purpose old classes were renamed with the prefix GRE_ so that the old and new classes will be presented together when the class list is sorted alphabetically. However, older scripts that use the old class names will continue to work in existing scripts.

C-style syntax can be used in “for” loops.

Upgrading TNTmips.

If you did not purchase **RV6.9** of **TNTmips** in advance and wish to do so now, please contact MicrolImages by FAX, phone, or email to arrange to purchase this version. When you have completed your purchase you will be provided with an authorization code by FAX. Entering this authorization code while running the installation process lets you to complete the installation of **TNTmips RV6.9**.

The prices for upgrading from earlier versions of **TNTmips** are outlined below. Please remember that new features have been added to **TNTmips** with each new release. Thus, the older your version of **TNTmips** relative to **RV6.9**, the higher your upgrade cost will be.

Within the NAFTA point-of-use area (Canada, U.S., and Mexico) and with shipping by UPS ground. (+150/each means US\$150 for each additional upgrade increment.)

<u>TNTmips Product</u>	<u>Price to upgrade from TNTmips:</u>					<u>V6.30</u>
	V6.80	V6.70	V6.60	V6.50	V6.40	and earlier

Windows/Mac/Linux	US\$500	750	950	1100	1250	+150/each
for 1-user floating	US\$600	900	1140	1320	1500	+180/each
UNIX for 1-fixed license	US\$800	1250	1650	2000	2250	+200/each
for 1-user floating	US\$960	1500	1980	2400	2700	+240/each

For a point-of-use in all other nations with shipping by air express. (+150/each means US\$150 for each additional upgrade increment.)

<u>TNTmips Product</u>	<u>Price to upgrade from TNTmips:</u>				<u>V6.30</u>	
	V6.80	V6.70	V6.60	V6.50	V6.40	and earlier
Windows/Mac/Linux	US\$600	900	1150	1400	1600	+150/each
for 1-user floating	US\$720	1080	1380	1680	1920	+180/each
UNIX for 1-fixed license	US\$900	1400	1850	2200	2500	+200/each
for 1-user floating	US\$1080	1680	2220	2640	3000	+240/each

Internationalization and Localization

Maintaining Translations.

The 5 language resource files (interface, messages, help, ...) have been merged into 1 reference file for easier management.

A new multilingual editor is provided to official translators for maintaining this reference file. It is illustrated and discussed in the attached color plate entitled New Text Localization Utility.

Available Languages.

The current chart of language interface packages for the **TNT** products is at www.microimages.com/i18n/locales/. These packages for **RV6.9** are just now becoming available due to the changes MicroImages has made to streamline the process of maintaining these translations which in turn created temporary impediments for our official translators.

Pending Languages.

Afrikaans. An agreement has been signed with a **TNTmips** user in South Africa to provide a **TNT** language resource file for the use of the **TNT** products in Afrikaans.

Norwegian. Discussion is underway for a possible translation of the **TNT** language resource file into Norwegian.

Note! If your language is missing for **V6.8** or earlier please contact MicroImages if you wish to discuss becoming its official technical translator.

Microlimages Authorized Resellers

The following 6 new Resellers were authorized to sell MicroImages' products since RV6.8 shipped.

SLOVAKIA.

Spisska Nova Ves

Koral s.r.o.

Slavomir Daniel

voice: (4219)6544-11834

Sladkovicova 5
Spisska Nova Ves 05201
Slovakia

FAX: (4219)6544-11834
email: daniel@koral.sk

SERBIA and MONTENEGRO.

Belgrade

PrimaRes d.o.o.

Jasmin Babic
Njegoseva at Maksima Gorkog
Belgrade 11000
Serbia and Montenegro

voice: (3811)1444-4302
FAX: (3811)1444-4302
email: office@primares.co.yu
web: www.primares.co.yu

BOSNIA and HERZEGOVINA.

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Geo-centar d.o.o. - BiH

Vladimir Petrovic
Veselina Maslese 1
Banja Luka 78000
Bosnia and Herzegovina

voice: (3875)121-1580
FAX: (3875)121-1580
email: geo-centar@spinter.net
web: www.geocentar-bih.com

CANADA.

Richmond

GlobalPoint Technologies

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FAX: (604)207-9552
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EGYPT

Cairo

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179 El Nozha Street
Heliopolis, Cairo
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FAX: (202)635-7288
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UGANDA

Kampala

MGGS Ltd. (Muienr Geo-Graphics Service)

Samuel Mugisha
P.O. Box 6072
Kampala
Uganda

voice: (2564)153-0135
FAX: (2564)153-0134
email: smugisha@muienr.mak.ac.ug

Discontinued Resellers

The following resellers are no longer authorized to sell Microlimages' products. Please do not contact them regarding support, service, or information. Please contact Microlimages directly or one of the other Microlimages Authorized Resellers.

Argentina.

PROCON. [Ruben Actis Danna] located in Cordoba is discontinued.

Brazil.

Geosat Ltda. [Oscar Hoogenboom] located in Sao Paulo is discontinued.

India.

Physical Planning Consultants. [Dilip Kumar Paul] located in Calcutta is discontinued.

MicroNet Solutions. [Dheerja Mehra] located in Nagpur is discontinued.

Landends Solutions. [Praveen Ummadi] located in Hyderabad is discontinued.

Slovakia.

GeoComplex. [Jaroslav Gretschi] located in Bratislava is discontinued.

Appendix: Abbreviations

For simplicity, the following abbreviations were used in this MEMO:

RV6.9 = the official and first release of **V6.9** of the **TNT** products matching the version on the CDs distributed.

PV6.9 = any version of the **TNT** products created subsequent to **RV6.9** to which patches have been applied to update **RV6.9** or a **PV6.9**.

DV7.0 = The partially complete development version of the **TNT** products which will be eventually be officially released as **V7.0** when complete.

W95 = Microsoft Windows 95.

W98 = Microsoft Windows 98.

WME = Windows Millennium Edition.

NT or NT4 = Microsoft NT 4.0 (the **TNT** products require the use of NT4.0 and its subsequent Service Packs). NT4 now has a Service Pack 6a available. Windows 2000 now has Service Pack 4, which is recommended if you are working with large files.

W2000 = Microsoft Windows 2000.

XP = Microsoft Windows XP.

Mac 10.3.2 = Apple Macintosh using Mac OS X version 10.3.2.

MI/X = MicrolImages' X Server for Windows platforms and operating systems.

GRE = MicrolImages' Geospatial Rendering Engine, that is at the heart of most MicrolImages products. The current **GRE** will respond and render requests from either X/Motif or Windows.

rpm : revolutions per minute.

KB = kilobyte (1,000 bytes or 1,024 [2¹⁰] bytes)

MB = megabyte (1,000,000 bytes or 1,048,576 [2²⁰] bytes)

GB = gigabyte (1000 megabytes or 1,073,741,824 [2³⁰] bytes)

TB = terabyte (1000 gigabytes or 1,099,511,627,776 [2⁴⁰] bytes)