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All previous MicrolImages MEMOs, starting with **V4.00**, are available on our web site. You can use your browser to easily look up details that you recall were mentioned in a previous MEMO or to search for more information on a specific topic. All MEMOs back 11 years to **V0.90** are available upon special request.

Introduction

MicrolImages is pleased to distribute **V6.10** of the **TNT** products, which is the 46th release of **TNTmips**. A count of 221 new feature requests submitted by clients and Micro-Images' staff were implemented in **V6.10** processes. The master list now contains 1889 requests for new features. The following major features have been added:

- **LegendView**: Provides a simpler and more intuitive means of controlling layers and automatically creating legends for them.
- **Hot Keys**: **TNTedit** now provides 65 hot key combinations for popular editing operations.
- **SML**: Rapid expansion continues with the addition of 68 new classes for import and export, 9 miscellaneous classes, and 29 new functions providing the Legend-View, surface fitting, more database constraints, layer controls for layouts, slope/aspect, and others.
- **SML/W**: Try the first prototype of a new stand-alone **SML** for Windows that does not use X or Motif and currently supports about 90% of the **SML** functions and classes.
- **Mac DLLs**: The Mac version of the **TNT** products widely uses DLLs.
- **Getting Started Booklets**: Most of the booklets are now current with **V6.10** of the **TNT** products, and 3 new booklets are available.
- **C++**: All versions of all the **TNT** products are now compiled with C++.

Summary of New Features

System (peeking under the hood).

- DLLs reduce installed size for MacOS 8.x by 23 megabytes.
- New hypercube raster object losslessly compresses all hyperspectral images.
- **TNTview** and **TNTedit** have tutorial reminder/access dialogs at start up.
- Tutorial reminder/access dialog can be opened via Help menu.
- Geospatial Rendering Engine (GRE) now separated from X and Motif.

Context Sensitive Help Procedures.

- Context sensitive help system now uses HTML.
- Help is linked to section with details in reference manual.
- Add your own context help or operational notes.
- Add color illustrations of your results.
- Link/start documents (Word, PDF, MPEG, ...) from your help/notes.
- Add access to web sites from your help/notes.

LegendView.

- Completely new, alternative LegendView display panel as default providing a layer control/legend panel and a view panel.
- Combines functionality of ArcView display; the TNT Graphics Rendering Engine; measurement tools, regions, ...; and X-based remote client/server operations.
- View panel and window toolbar are the same as the familiar (now alternative) View window.
- New toolbar icon to add layers from View window.
- Place new layer/legend panel at left or right edge of view panel.
- Drag and drop layers in layer/legend panel to control order of rendering.
- Hide or show layers in layer/legend panel.
- Delete layers with right button menu.
- Show multiline DataTips for layer names in layer/legend panel.
- Interactive renaming of layers in panel.
- Display or hide drop-down legend for each layer.
- Legend shows sample for each vector, pinmap, and TIN element style used in layer.
- Attribute controlling style shown next to legend element (for example, soil type name).
- Auto-generated legends for raster layers: area sample, color scale, or color sample.

Visualization.

- Attach a flight profile with a moving viewer position to a movie.
- Attach a plan view showing a moving ground position to a movie.
- Attach a zoomed, moving window plan view to a movie.
- Use template graphic to position add-on special views.
- Create movies in the AVI format.

TNTAtlas (free!).

- LegendView is now default display providing intuitive layer control and auto-legends.
- An object or file can start another program that uses it when selected via a link.
- Use the above to link to movie file and start viewer with that movie.

Import/Export.

- Import AVIRIS and ENVI hyperspectral images into hypercube object.
- Import MapInfo databases from native TAB format.
- Create, save, and use a format description to import vectors from text files.
- Import IDRISI rasters.
- Import Arc/Info ASCII file into raster object.
- Import JPL AIRSAR and other SAR from compressed Stokes Matrix to raster objects.
- Import Finnish Airborne Imaging Spectrometer (AISA) hyperspectral images.
- Import Japanese Spatial Data Framework 1/2,500 urban maps into vector objects.
- Import Geosoft XYZ file into a raster object.

Geologic CartoScripts™.

- Sample CartoScripts provided for rendering linear and point geologic features.

Editing.

- Hot keys for frequently used operations (for example, adding element operations).
- Line label assistant provides single table/field generation option.
- Right mouse button operation now has a “redraw” option.

Database Management.

- Set a maximum and minimum value for numeric fields.
- Control upper, lower, and mixed case for string fields.
- Entry into field linked to another table checked for match to primary field in that table.
- If a match is found after a few characters are entered, autofill the field with type-over.
- Options for mismatched entry into linked field: accept, show error, or show dialog.

Hyperspectral Analysis.

- Hypercube object provides lossless compressed hyperspectral images.
- Convert single hypercube object to and from multiple separate raster objects.
- Use regular visualization and Hyperspectral Explorer features with hypercube object.
- Toggle button automatically excludes atmospheric absorption bands from processes.
- Transform and analyze spectra using “sliding” parabolic least squares fit.
- Use Pixel Purity Index (PPI) to locate spectrally pure pixels.
- Use Derivative Matched Filtering (DMF) variant of MF to reduce terrain and noise effects.
- Locally Adaptive Constrained Energy Minimization (LA-CEM) expands MF to use spatial variability.
- LA-CEM and DMF reduce noise in results compared to Matched Filtering (MF).

Mosaicking.

- Use new rubber sheeting procedure that fits every control point entered.
- Processing areas can now be hidden.

Create Geospatial Products (SML/X).

- Display using new LegendView (see above description).
- Create layers containing map grid, scale bar, text layer, raise and lower all layers.
- Adds extensive Import/Export (70 classes).
- Incorporate surface fitting.
- Compute slope/aspect/elevation.
- Sample **SML/X** script to alter map layout to create a map series.

Create Windows Geospatial Products (SML/W).

- Try prototype of direct **SML** for Windows that works with any **TNT** key.
- Stand-alone **SML/W** interpreter, no Motif or X Server, only Windows 95, 98, or NT.
- Implement object-in, analysis, object-out script.
- Currently supports about 90% of all current **SML/X** functions without alteration.
- No display or graphics functions as yet.
- Standard Windows file selection dialogs.
- Windows-like RVC object selection dialogs.
- Color Windows-based editor for preparing scripts.

New Tutorial Booklets.

- Introduction to Hyperspectral Imaging

- UNIX: Setup Guide
- Introduction to GIS
- Many booklets updated to **V6.10**

Languages.

- Japanese, Chinese, and Turkish interface for **TNT** products.

Dropping Platforms

Solaris 1.x.

V6.10 is the last release of the **TNT** products for the Solaris 1.x operating system. Sun has stated that the 1.x and earlier versions of their operating systems are not Y2K compliant and will not be fixed to make them compliant.

NOTICE! Although **V6.10** is the last release for Solaris 1.x., corrections for **TNT** products **V6.1** of Solaris 1.x will be provided until the release of **V6.20** of the **TNT** products.

Windows 3.1.

As we previously announced, **V6.10** has not been compiled for W31. It is of general interest to note that there was not a single objection to dropping this platform. Now if we could only get those using W95 to move on to the superior and more reliable W98.

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

Crashing and Burning!

Are we all jinxed? Are we busy chasing will-of-the-wisps? As you recall, MicrolImages launched into the addition of hyperspectral image analysis to **TNTmips** in anticipation of NASA's Lewis satellite. Lewis would have provided you with a sampling of high resolution, low-cost hyperspectral images around the world. It crashed. I begin to wonder what forces are at work here as now our military and intelligence communities have time to try to block and control private and public efforts in this area. We also get to wait until the new millennium at best for these 3 new "politically controlled", as opposed to "technology driven", hyperspectral satellite attempts (see section on Hyperspectral Analysis below). Finally, this is topped off by the failure of the first two attempts at 1-meter systems. I do not know about you, but this kind of slipshod work is costing me money! I guess it is on to Landsat 7 and the high resolution offerings of other nations. So much, for the moment, for this aspect of American technology!

Reviews.

More Breast Beating.

TNTmips continues to get good reviews. Furthermore, when reviewed, more and more of its unique properties are being acknowledged. The enclosed MicrolImages MEMO T-estimonials and other Tidbits (V6.10) summarizes a review of **TNTmips** against all its major competitors for image processing software from PCI, ERDAS, ENVI, and ER Mapper. In my biased opinion, upon review of the entire article, **TNTmips** again, in aggregate, comes out tops when all image processing factors and features and price are considered. But wait, now we have just been evaluated and reviewed favorably against

the most prominent and expensive Digital Photogrammetric Systems (see below and enclosed). This is a whole new crowd of competitors that has little in common, especially in price, with our image processing competitors. I suppose next we will be put up against a third set of world leaders in the GIS area, then surface modeling packages, then desktop mapping, and so on? If so, I am confident that with the features in **TNTmips** and those currently being added, we can stand the heat. I simply wish someone would do a comparative review of commercial geospatial analysis software!

Digital Photogrammetry Systems.

The latest issue of *GeoInformatics*, Volume 2, April/May 1999, has a comparative review entitled Shopping for a Digital Photogrammetric System, pages 28 to 47. In preparation for writing this review, Azubuike Nwosu, the technical editor at *GeoInformatics* in Germany traveled to several sites around the world that use the various products. Microlimages arranged for him to visit The NPA Group in the United Kingdom for a look at **TNTmips**. His review covers the following list of Digital Photogrammetry Products and includes the prices noted in US\$ in the review. I guess **TNTmips** gets the checkmark for the lowest cost on average by an order of magnitude. Conspicuous by their absence from this list are ERDAS, ER Mapper, and ENVI.

TNTmips	from \$3,600 from MicrolImages. Inc., USA
DVP	from \$15,000 from DVP Geomatique, Canada
SUMMIT PC	\$20,000 to \$30,000 from DAT/EM Systems International, USA
ImageStation-Z	\$18,000 to \$80,000 from Intergraph Corp., USA
PHODIS	none listed from Carl Zeiss, Germany
Ortho-Engine	none listed from PCI Geomatics, Canada
VirtuoZo	\$15,000 to \$40,000 from VirtuoZo Systems International, Australia
Softplotter	\$25,000 from Autometric, USA
Match-AT	none listed from INPHO, Germany
DiAP	\$50,000 from International Systemap Corp. (ISM), Spain
SOCET SET	\$20,000 to \$100,000 from LH Systems, (LH alias Leica-Helava), USA

The following are his introductory comments in the article about **TNTmips**. The rest of his review of **TNTmips** continues on in similar complimentary manner and is enclosed for your reading. [Please note that MicrolImages has never been an advertiser in this high quality publication.]

*"I thought I knew the southeast of England very well, but Edenbridge surprised me. The setting for my evaluation of **TNTmips** is a classic constable painting—picturesque rolling fields and cute homes. The NPA Group is the UK distributor of **TNTmips**, but this is a full blown mapping company specializing in mapping from satellite imagery (including*

*SAR processing). Many of their projects are for geological exploration and their clients include some oil companies. They have been using **TNTmips** for about 10 years, and have several systems installed for map production. On Windows-NT I saw a very colorful application, packed with landcover and image-processing facilities. But it has a comprehensive suite of photogrammetric software and qualifies to be in this group. You will find from the answers below that they are coming at it from a different direction—a remote sensing system with a photogrammetry 'button'.*

Geospatial Analysis Emerges.

Territorial Imperatives at Universities.

Today, more and more professionals are recognizing that the older geo-component technologies are being integrated into something that is greater than the sum of their parts. Have you noticed lately the wider and wider occurrence of the use of the term "Geospatial" in the literature, the names of institutes and academic programs, and so on? Albeit, the understanding of the concept is still relatively limited to a few, but it is most certainly growing. At the moment, it is delayed by the territorial imperatives that exist in most university programs in the United States. Since Canadian, European, and other academic programs entered this area more recently, they appear to be more progressive in its management as a single concept.

In the United States in the past 20 years, it has become a tradition that the "new" technologies of remote sensing and GIS are taught in separate and usually uncooperative academic departments. GIS and cartographic methodology is usually taught in the geography program. Remote sensing applications are often taught in the department of their application, such as forestry, agriculture, geology, and even electrical engineering. Surface modeling is the forte of geology and is just now creeping into general programs in geography and agriculture. It is hard to advance the new concept of geospatial analysis when its teaching components are scattered across departments in different colleges or faculties that must compete with each other for funds in terms of credit hour production. But, progress is being made through the use of institutes and the increasing demand for graduates who have this broader-based knowledge and technical skill. It is those universities around the world that find a way to handle this cross-department concept that will become the leading "centers-of-knowledge" in the next generation.

Simple Economic Impediments.

The trade magazines, and to some extent most of the professional publications that we all read, have a vested interest in promulgating this GIS versus image processing separatism to their and all our detriment. I have been waiting several years for some trade publication to acknowledge a more lofty and higher calling by reviewing the software available for geospatial analysis. This review would have to include and compare most of the separate image processing and GIS products, since all of them advertise and promote some level of GIS, image processing, and other geo-component technologies. Several of these publications already convey this integrated concept in the articles they publish. Their authors already show the integration of these technologies into geospatial analysis whether it is so named or not. They also originally selected or have recently changed their names away from those that imply that they report upon only one of the component technologies.

When are these editors going to lead the way and move on wholeheartedly into this integrated technology? First, most of the articles are being paid for by software and

hardware vendors, including MicroImages. Second, it is simple economics. These publications are free and paid for by advertisers. Their biggest advertisers are specialized and best known for one of the older geo-component technologies and its name (for example, the term "GIS" has become synonymous with Arc/Info). Fortunately, more and more of their advertisements for specialized, smaller, or add-on products are, when taken in aggregate, beginning to define geospatial analysis. Since their big advertisers call the shots with their money, it is still going to be a while before a review of geospatial analysis software is published. It is also a difficult review to prepare, as with many vendors, even the most basic geospatial analysis requires the assembly of several component products. It would be daunting to find someone who is willing and able to review all these component products objectively.

Where do we (MicroImages and our clients) stand?

Three years ago, **TNTmips** was favorably reviewed as the top image processing system in *GIS World*, a trade magazine. The May 1999 issue of *GeoWorld*, the same publication with a new name, has another review of the same image processing systems, wherein **TNTmips** is summarized in its last paragraph as:

"TNTmips is in a class by itself. It's modestly priced (from \$3000 to \$6000 on Microsoft Windows based platforms, depending on resolution), runs on every type of computer, provides an amazing range of functions and is a competent raster and vector GIS. Also, the amount of documentation is astonishing, but it's not well organized and indexed. The answer is there, but it's hard to find. TNTmips has good interoperability with other software and data, and, if users can limit themselves to small datasets, they can run TNTlite, which is free! For those looking for a GIS and image processing solution, TNTmips may be the best single solution."

The author of this review uses 4 of the 6 products reviewed, but not the **TNT** products. Please see the enclosed **V6.10** MEMO: Testimonials and other Tidbits for more information on this article. This same publication is now planning a separate review article on GIS systems, which may or may not appear, and may or may not include **TNTmips**.

Modeling Users of Geospatial Analysis.

Those who develop commercial products often carefully model the users of the product before its design and production. The Japanese are the world experts at this. To date, this approach has been difficult in the creation of general purpose commercial software products that are deliberately targeted to a broad world-wide audience. Remember that spreadsheets were not built in reaction to a model of what you wanted to do but exploded into use based upon some innovative, individual initiative. Many aspects of the explosion of the private and commercial uses of the Internet are similarly uncontrolled, unplanned innovative combinations of technology and initiative. In a recent article, at least 10 different distinct users were modeled for general purpose software such as word processing, page layout, and spreadsheets. It is hard to logically develop a complex software product whose existing users and potential buyers are continually evolving. MicroImages has always taken the approach of trying to gradually adjust for your changing expectations by using frequent updates, which some of you hate and others love and demand.

Over the 12 years of the development of the **TNT** products from their image processing roots, our clients have evolved and metamorphosed, and we have reacted to these increasing varied demands. Our early clients, some of whom are right here with us today,

were innovative early adopters. Most of those who have stayed with the **TNT** products over that long timeframe are now "power users" of geospatial analysis and have prospered by using the integration of GIS, image processing, surface modeling, and so on, to solve their increasingly complex problems. Other early adopters, who were only interested in image processing, have wandered off into other products, as some of MicroImages' efforts were expended in the development of the GIS, surface modeling, and other techniques that are now important components of geospatial analysis. Still others have been forced to employ other products by government procurements that promote a monopolistic approach in the so called name of "standardization".

Geospatial User Model V1.00.

Clients using **TNT** products have a very wide range of objectives in the use of geospatial analysis and in computer skills and motivation. At one extreme, there are the users of **TNTatlas**, **APPLIDATs**, and soon the new **TNTserver** products being introduced in **V6.10**. They are professionally focused on some other objective than geospatial analysis, probably do not know what it means and do not care, and generally expect to immediately accomplish a specific task without any training or previous use of the software product. Serving their needs requires the use of simple, discoverable, intuitive user interfaces or those with which they are already familiar. At the other extreme are the power users of geospatial analysis who combine image analysis, GIS, graphical relational database analysis, and so on. They prepare geospatial materials and complex analyses and request hundreds of new features for each new release, most of which must be provided through additions to the **TNT** products' interface.

MicroImages' challenge is to accommodate this wide spectrum of clients. One way this can be accomplished is by providing optional, alternative levels of complexity in the user interface. Another approach that has also been dictated by marketing considerations is stratification of the **TNT** products such as **TNTview**, **TNTedit**, and **TNTmips**. This feature stratification provides lower-cost entry points and removes the complexity and frustration of starting out with advanced processes that are more complex to operate and probably not needed. But, there are still casual users and power users employing all levels of the **TNT** products. For example, a client employing multiple **TNTview** products may want an easily used display procedure like ArcView or have a specialized power use requiring very specialized control of the view. The introduction of the LegendView does not remove any power user features from any **TNT** product. It simply allows them to be hidden, if desired, from those who are not power users, have already become experienced in using ArcView as a spatial data browser, and are confused by a lot of icons and complex controls such as those provided in the full Layer Controls window.

To aid us in the evolving design of the **TNT** products, MicroImages has been attempting to model the users of geospatial analysis methodologies. These models, coupled with marketing considerations, will help us determine what is added to the various **TNT** products and how to structure each product's interface. These models will help you understand where the various **TNT** products are going and where and how you can use them personally, in your consulting, within your organizational structure, in your studies, and so on.

MicroImages finds that we can conveniently group our current and to-be-sought clients for geospatial analysis into three types: (1) casual users of geodata, (2) focused users of geospatial analysis, and (3) power users. You may fall into one or all of these groups, especially if you have been with us for several years. But, individual users of geospatial

analyses who fit only one of these models have different expectations for their use of geospatial analysis. Gradually, the **TNT** products are being extended and altered to serve them all by:

- multiple user interface options (for example, **TNTmips** with several tiers of user interface complexity)
- abstracted but fully compatible products (for example, **TNTview** and **TNTedit**)
- customizable products (for example, APPLIDATs and **SML** for Windows)
- field data collection products (for example, an easily modified datalogger APPLIDAT)
- public products (for example, the new **TNTserver** and **SML** for Windows); and so on

Casual Users.

The casual user wants to draw on geodata layers, make and record measurements, and/or obtain information about a specific polygon. APPLIDATs, turnkey scripts, **TNTatl**, especially the pending new **TNTAtlas** for Windows, and **TNTserver**, provide the basis for serving the expectations of this user.

Casual users are busy doing some other personal or professional activity: planning a camping trip, buying a house, designing a road, siting a water well, and so on. First, they want to gain direct and easy access to one or more prepared geodata layers of a specific locale at low cost in time and money. Next, they want to make some simple measurement or simple spatial inference from the geodata. Finally, they want to print or embed these results into a report, diagram, or presentation. And, they demand to accomplish this using a familiar interface such as Windows, Mac, Internet Explorer, Netscape, Word, or one that requires no previous experience.

Focused Geospatial Analysts.

Those in this group often hold full-time staff positions as image processing and/or GIS specialists or simply have this task as part of a broader job description. They are generally employed by companies that use some specialized tools to support their principal business operation, such as marketing studies, resource inventories, specialized reference maps, real estate sales, and so on. They combine special corporate datasets, especially database materials and property holdings, with commonly available, prepackaged geodata such as county orthophotos, TIGER maps, county boundaries, census tables, and so on. Usually they want to buy existing geodata if it is available and create new geodata only for company-specific holding and interests.

ArcView, MapInfo, and **TNTview** directly target this group. These are users of geospatial analysis who do not often, but always should, "look under the hood" before they buy any geospatial analysis software to see how it organizes geodata, handles reconciling different map projections, crosses platforms, and so on. As a result, they end up requiring many software add-ons and often accomplish their tasks in circuitous and roundabout ways. They can often be most easily identified by their frequent preparation of a wide variety of theme and pinmaps. At this time, this group uses a wide variety of specialized modular add-on products. Usually, before they are done, they have spent considerable money on these add-ons. **TNTview** and **TNTedit** are targeted at this group of users. LegendView, theme and pin mapping, interactive region analysis, and other features have been added to expand further into this group.

Power Users.

Consultants, university researchers, service companies, some students, and others make up this category. They may or may not be early adopters. But, they are constantly pushing the limits of the software and hardware technology to develop or update geodata sets, find new complex combinations and applications of geodata, lobby hard for new features of personal interest, and get directly involved in inventing or guiding our development of new geospatial concepts and procedures. These are the clients the two other groups turn to when they do not have the interest, ability, or motivation to assemble the required geodata, do not know how to perform the needed analysis, have worked themselves into a technological box, have only a short time to complete a task, have run out of time, and so on.

Power users who have detailed knowledge using **TNTmips**, **TNTedit**, and other specialized products are most likely to have the solution, can get it, or know how to add it via **SML** or **TNTsdk**. They solve the hard problems that confound the other users of **TNT** or other products. These are also the clients who can provide a solution on the desired platform at the lowest cost when all the required capabilities are understood and they are permitted to use the most cost-effective approach. This has been the traditional and longest served group of MicrolImages' clients. They may complain about user interface complexity but will find and use many of the esoteric features (and therefore undiscovered errors) in a particular **TNT** process. They are also, on a percentage basis, the most likely group to request that new and often very specialized features be added to solve their specific problem.

Precision Ranching Proposal.

Alas, it is not all good news. The MicrolImages MEMO for **V6.00** outlined a proposal submitted to NASA in which MicrolImages was to participate using Landsat 7 and MODIS imagery, APPLIDATs, Internet, real ranchers, and so on. This project was not funded.

How did this all work out? Well, you can judge for yourself from these facts. 180 proposals were submitted, and 12 were funded. Of the 12, 1 was funded to a private business. 7 were funded to university laboratories. 4 were funded to other federal government agencies. There was a stipulation in this NASA call for proposals that no federal government employee could be paid from the project. Thus, 1/3 of these NASA research project funds will go into federal overhead for other federal government agencies in the form of travel, equipment, consultants, imagery, and so on. It is really unfortunate that NASA has concluded that it must allocate 1/3 of these research project funds to buy the attention and good will of other federal agencies who have huge research budgets of their own. In effect, after all the effort these scientists put into the 180 proposals, 1/3 of the funds end up as a simple intergovernmental transfer of funds!

One of the 4 projects funded to other federal agencies was to the U.S. Department of Agriculture (USDA). It was entitled Prototyping Value Added EOS Data for Rangeland Management and Assessment. It was the only project funded that would deal with rangeland applications. Based upon my 35 years of experience and observation of the application of remote sensing in rangeland management by U.S. governmental agencies, I seriously doubt that this project will create or move a single new iota of the technology into practice in actual ranch management.

The USDA has an annual budget of billions of dollars. Certainly, the USDA is capable of directly funding any research and applications of space remote sensing that it concludes have any value. Furthermore, the U.S. Department of the Interior actually manages most of the federal rangelands through its Bureau of Land Management (BLM). The BLM has just written off and totally abandoned a \$400 million dollar, 6-year contract effort to use GIS, remote sensing, document management, and related technologies in the management of federal lands, primarily rangelands.

Sour grapes, you bet! No one likes to lose out to a purely political decision. But, I guess inept government bureaucracies are the same all around the world and only vary in the amount of money available and wasted. But wait, one final quirk has appeared. I have just learned that someone in this new NASA-funded USDA project has just recommended that they use **TNTmips** as the best product for their "research".

MI/X (Microlimages' X Server)

At the present time, Microlimages is adding new features to **MI/X** for W95, W98, and NT4.0 for Intel-based platforms. This improved X Server will be referred to as **MI/X V2.00**. All previous **MI/X** versions for these platforms, including those released with **TNT** products **V6.10**, will be referred to as **MI/X V1.00**. **MI/X V1.00** will remain as is and free for all platforms. **MI/X V2.00** will be sold for a nominal cost of US\$25 by Microlimages via the Internet. **MI/X V2.00** for the Mac may also be converted into a commercial product in a similar fashion by adding additional features to it.

MI/X V1.00 is quite stable, will not be altered, and contains the features needed by users of the **TNT** products. **TNT** products and upgrades will be provided with the latest version of **MI/X**. Many of the new features added to convert **MI/X** into a commercial product may not be of particular value in the operation of the **TNT** products. However, more of them will be of direct use in the **TNT** products when a product is being operated remotely via **MI/X**.

Version 2.00 of **MI/X** for Windows products will probably contain the following new features:

- Support shape extensions
- Enable use of font servers
- Support xdm
- Support backing-store/save unders
- Move **MI/X** preferences from Setup/Preferences/**MI/X** directly into **MI/X**
- Support the ALT-GR keys
- Support third button mouse emulation via keyboard
- Show IP address in "About..." box
- Create install system using InstallShield and add an "uninstall" feature
- Set up new download system that uses a single easy download via a zip or self extracting executable
- Create a version numbering system
- Add copy protection via FLEXIm
- When downloaded, allow a test period of 15 days before payment required (Buying continued use after 15 days requires purchase of an authorization code)

Macintosh

Terminology.

Apple Macintosh computers using the 68xxx processor have disappeared from use for the **TNT** products. It is no longer practical to use **TNTlite** on these older machines. **V6.10** of the **TNT** products has not been prepared for these older Mac Platforms. Past MEMOs have distinguished between the 68xxx-based Macintosh platform (abbreviated as Mac) and the 6xx and G3 Power Macintosh platform (abbreviated PMac). From this time forward, the abbreviation "Mac" will be used to refer to all modern Macintosh computers using the PPC and G3 processors.

Introducing DLLs.

Early in the preparation for **V6.10**, work was undertaken on the Mac to integrate the new Dynamic Linked Libraries (DLLs) and shared libraries (the equivalent on the UNIX platforms). The Mac and Windows versions of the **TNT** products now both use DLLs for map projections, georeferencing, region analysis, and other commonly used features. The integration of these DLLs into the **TNT** products required checking of the many processes that use them to make sure they are correctly generalized and operate with the Mac. This caused a lot of temporary errors to enter into the operation of **TNTmips** for the Mac if patches were downloaded for **V6.00** of the **TNT** products.

These DLLs and shared libraries provide the basis for further integration of the **TNT** processes. Gradually, clients are requesting that every common feature be available in every process (for example, automatic map projection reconciliation, region creation, measurement tools, GPS access, and so on). Attempting to accommodate these requests has been bloating each process by the replication of these code sections with corresponding increases in load times. This creates problems in maintaining duplicate code and checking it in each process by individual software engineers (especially when the main process is not actively being revised). Using DLLs and shared libraries means that **TNT** features common to several processes can be loaded once by the first process to use them and then shared by subsequent processes.

Significance of DLLs. What is the impact of this on the Mac version of the **TNT** products? The most obvious result is that the installed size of **TNTmips 6.1** for the Mac has been reduced by at least 23 megabytes. Even further overall size reductions may occur in future versions as more integration takes place. Eventually, this means faster switching between processes, as the shared libraries will already be in memory. Gradually, more of the features we all consider standard in **TNTmips** will be in every process as they are rewritten to use these DLLs. Shared libraries mean that less code has to be maintained, reducing errors. Shared libraries mean that errors in shared portions of the code of a **TNT** product will be detected at MicrolImages in any process tested rather than being hidden away in some infrequently used approach.

MacOS 8.6.

Apple is just about to release a new version of the MacOS 8.6 (currently in the beta version, it is called "Veronica"). It also appears that this release will be a free upgrade to those currently using MacOS 8.5 or 8.51. It does not provide any significant features and really appears to be a bunch of patches for MacOS 8.5. **V6.10** of the **TNT** products has been tested with MacOS 8.6, and no special changes were required. To date, it appears that MacOS 8.6 is more stable than 8.5 or 8.51, which crashed at least daily in other applications and desktop operations.

Troubleshooting Macs.

Nine out of ten times when you have a general application problem with any specific application, peripheral, or **TNT** product, you will find that it is due to conflicts in extensions. On the Mac, some extensions are patches to the operating system provided by Apple or a third party as part of their add-on product. Extensions can also be required libraries that function as DLLs that the product's manufacturer is forcing to be loaded at boot up and forcing to be maintained in memory all the time to speed up the specific product's performance. For example, installing Microsoft Office 98 adds a dozen new extensions to the Mac, most of which are special libraries. Drivers for all your new equipment are added to the extensions and loaded up when you start your Mac.

The Mac I am using to write this MEMO has 30 Control Panels and 132 extensions loaded when MacOS 8.6 beta is started up. At least 25 strange new extensions were added when MacOS 8.6 was installed, and many others were updated. Whenever I have a general failure on a Mac or a Mac hangs, it is usually due to conflicts within these control panels and extensions. As soon as I loaded a beta version of MacOS 8.6, I had to go looking for such a generic problem. Using the control panel to select a monitor resolution size hung this Mac. If I turned off all extensions and control panels except the Monitors control panel, I could change the monitor's screen size. Eventually I found that Apple's control panel for monitors was in conflict with their Apple Guide. Turning off the Apple Guide only, that I do not need, solved the problem. I have found this kind of error over and over when something generic will not work on the Mac, such as a failure on the desktop, a peripheral will not work, and so on. Repeatable problems of this kind are often causing your **TNT** products to crash. To see if your problem is with some particular control panel or extensions, it is easy to simply turn all of them off, reboot, and try to repeat the error. **TNT** products do not require any control panels or extensions to operate. **TNTmips** will also operate 10 to 20% faster with zero or only minimum extensions loaded.

TNT products will operate the fastest with all control panels and extensions shut off.

LINUX

Evolving Kernels.

The following short paragraph will set the background for the situation MicrowImages has been dealing with in connection with LINUX since **V6.00** was released. It was published today in an article—**Linux: think hard before getting in deep**—by Pankaj Chowdhry of PC Week Labs, appearing in *PC Magazine*, 10 May 1999, pg. 5.

"The most vexing problem we ran into [at PC Week Labs] was with the Linux Kernel itself. There are countless revisions of the kernel available, and in tests we found that some Linux patches worked only with certain kernels or with specific versions of applications. This inconsistency could wreak havoc on departments trying to optimize a Linux server to run multiple applications."

"Companies such as Red Hat Software Inc. and Caldera Inc. have tried to bring some stability to the Linux world by updating their Linux distributions only once every six to 12 months."

Chasing LINUX's compatibility with the **TNT** products has consumed significant time at MicrowImages over difficulties in the use of **V6.00** and the release of **V6.10**. Those of you

who use LINUX or follow it in the technical news know that a new version of the LINUX kernel (2.0.36) was released in late 1998, and after **V6.00** of the **TNT** products was shipped! Redhat LINUX V4.1 with an earlier kernel (2.0.27) was used to check **TNT V6.00**. Redhat LINUX V5.2 required changes that were significant enough to require it to be prepared, at least for the time being, as a different and new platform. As a result, the **V6.10** "B" CD contains 2 LINUX versions of all the **TNT** products, one for Redhat 4.1 through V5.1 (in other words, for a kernel before 2.0.36) and one for Redhat 5.2 (kernel 2.0.36). While Redhat 5.2 LINUX was used to prepare the **TNT** products for the newer 2.0.36 kernel, it is highly likely that they will also work with LINUX as distributed by others with the same kernel, such as Caldera's OpenLinux and S.u.S.E.

Surprise, another new 2.2.5 kernel has become available as Caldera's OpenLinux 2.2 and has just begun shipping as Redhat LINUX 6.0. Yes, that is 3 different kernels to deal with in 5 months. Among other new things, this newest 2.2.5 kernel supports Symmetric MultiProcessor (SMP) for use with PCs with 2, 4, and 8 processing chips. It also provides the basis for the implementation of the "Beowulf" concept of using distributed processing to build a parallel processing system. Beowulf uses many inexpensive stand alone computers and a high speed network to assemble a single powerful parallel processing computer which, with enough processors, can approximate the performance of a current expensive super computer.

Do any versions of the **TNT** products work with the newest 2.2.5 kernel and Redhat V6.0 in particular? Do not simply assume so! Microlimages does not know at this time, so proceed forward in this area with caution if you have production work to complete with your **TNT** product(s). Redhat 6.0 has just been shipped, and we have acquired a copy for our tests.

Be Cautious.

The strength of LINUX may be in its free-form approach, but its weakness may be that changes within it are not closely controlled by a single entity. As a result, variability can occur. By now you know that **TNTmips** is one of the largest and most complex software systems you own. Do not assume that because you already know that the other products you use do work on a version of LINUX that the **TNT** products will also. If you want to know if the **TNT** products work with a particular version of LINUX, it is a simple matter to download **TNTlite** and try it, since it is free and requires no key. The LINUX system you are using is also basically free, so you can see if the newest LINUX version, your other tools, and the latest **TNT** products are working on a newly bought, inexpensive desktop PC costing less than \$1000. Is your frustration and expense in an untested switch to a new LINUX operating system on your operational systems worth \$1000?

And Even More Versions.

[Extracted from *PC Magazine*, May 25, 1999, page 89.] *"Another LINUX vendor, S.u.S.E. is also now shipping V6.0 and giving away V6.1 beta CDs [kernel unknown]. The U.K. edition of PC Magazine bundled a copy of V6.0 with a recent edition. When you buy the whole package, you get a 450-page manual and 900 software programs, all for \$49.95. It is CD-bootable. Call S.u.S.E. at (510)835-7873 to order a copy or go to www.suse.com."*

Microlimages will acquire copies of OpenLinux 2.2 and S.u.S.E. 6.1. However, the critical question that you and we have to address is: how many different machines can be set up and maintained to test the **TNT** products for these versions? The most significant

cost is not the hardware, but the personnel cost to set up LINUX, add all the development tools, get it working on the network, debug the setup, and then test the **TNT** products.

Speed.

In the Microlimages MEMO for **V6.00**, the summary of a client's report of high performance was reported for LINUX versus Windows for the **TNT** products. Microlimages has been so busy chasing the complications imposed by the various LINUX kernel versions that we have no additional first hand information on this topic. However, **SML** scripts are currently being developed that you can run to benchmark a variety of platforms you have or wish to "try out at the dealer's location". Since these scripts will run within **TNTlite**, they can be used to produce reports that compare the operation of the **TNT** products compiled from identical source code on each platform.

TNTsdk™ 6.1

Those using **TNTsdk** who switch to the **V6.10** functions library should now switch to the appropriate C++ compiler for your platform. The following C++ compilers are used for **TNTmips**:

Windows 3.1x	use Watcom C 9.5b, but discontinued with V6.00
Windows 95 (with Intel)	use Microsoft Visual C++ 6.0
Windows NT (with Intel)	use Microsoft Visual C++ 6.0
Windows NT (with Alpha)	use Microsoft Visual C++ 6.0
UNIX platforms	use latest version of C++ from GNU
Mac (with PPC)	use Code Warrior Professional 1.0

TNTlite™ 6.1

Prices.

The cost of a **TNTlite** kit, containing a CD and black and white printed copies of the 48 tutorial booklets making up the Getting Started series, has been increased to US\$60. The price for the CD is unchanged at US\$10. Both these prices include shipping anywhere in the world by airmail.

TNTatlas[®] 6.1

Changes.

The addition of the new LegendView into **TNTatlas** is a very significant new feature. Clients using the free **TNTatlas** products can now control layers and legends in a very familiar way. LegendView makes a free, unique product even more unique. It is explained in more detail in the LegendView section below detailing new features of **TNTmips**. It now has a familiar set of layer controls and can automatically show legends. Be sure to see how LegendView works in the Display process and therefore in **TNTatlas** as illustrated in the two attached Color Plates both entitled LegendView in the Display Window. Your **free** upgrade to **TNTatlas V6.10** is a must for anyone who is using an earlier version to gain access to this powerful feature.

As usual, in addition to LegendView, other changes made in **TNTmips** processes are provided as part of **TNTatlas**. These changes are explained in detailed descriptions provided in the **TNTmips** New Features section and in the attached color plates. These improvements, which also migrated into **TNTatlas**, include:

- new context sensitive personal notes and help
- adding plan and profile panes into 3D simulations
- extensive **SML** additions
- a stand-alone Windows **SML** interpreter
- use of new geologic CartoScripts
- significant new import options

View-in-View.

By popular request, the view-in-view option is now available in **TNTatlas**. Many unique and practical applications of this seemingly innocuous addition have been reported by users of the beta versions of **TNTatlas 6.1**. Be sure to see how view-in-view works in LegendView, and therefore **TNTatlas**, as illustrated in the attached color plates entitled LegendView in the Display Window.

Installed Sizes.

Loading **TNTatlas 6.1** processes onto your hard drive (exclusive of any other products, data sets, illustrations, Word files, and so on) requires the following storage space in megabytes.

PC using W95 and W98	23 MB
PC using NT (with Intel)	23 MB
PC using LINUX (with Intel) kernels prior to 2.0.36	24 MB
PC using LINUX (with Intel) kernel 2.0.36	22 MB
DEC using NT (with Alpha)	23 MB
Mac using MacOS7.6 and 8.x (with PPC)	40 MB
Hewlett Packard workstation using HPUX	23 MB
SGI workstation via IRIX	27 MB
Sun workstation via Solaris 1.x	22 MB
Sun workstation via Solaris 2.x	23 MB
IBM workstation via AIX 4.x	25 MB
DEC workstation via Tru64 UNIX (with Alpha)	26 MB

TNTview[®] 6.1

Changes.

No specific changes were made just for **TNTview 6.1**. The addition of the new Legend-View into **TNTview** is a very significant new feature. Clients using **TNTview** products are those who are also likely to be familiar with and use ArcView or MapInfo. Legend-View moves **TNTview** out in front of these other basic products. It now has a familiar set of layer controls and can automatically show legends. However, all the powerful image management and region analysis tools in **TNTview** are now integrated into this commonly recognized motif. Upgrading **TNTview** to **V6.10** is a must for anyone who is using an earlier version.

As usual, in addition to LegendView, other changes made in **TNTmips** processes are provided as part of **TNTview**. These changes are explained in detailed descriptions provided in the **TNTmips** New Features section and in the attached color plates. These improvements, which also migrated into **TNTview**, include:

- new context sensitive personal notes and help
- adding plan and profile panes into 3D simulations
- extensive **SML** additions
- a stand-alone Windows **SML** interpreter
- use of new geologic CartoScripts
- significant new import options

Upgrades.

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

<u>TNTview Product</u>	<u>Price to upgrade from TNTview:</u>					<u>V5.50</u>
	V6.00	V5.90	V5.80	V5.70	V5.60	and earlier
W95 and NT	\$95	170	225	275	325	+50/each
Mac	\$95	170	225	275	325	+50/each
LINUX	\$95	170	225	275	325	+50/each
DEC/Alpha via NT	\$125	225	300	350	400	+50/each
UNIX single user	\$155	280	375	425	475	+50/each

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

<u>TNTview Product</u>	<u>Price to upgrade from TNTview:</u>					<u>V5.50</u>
	V6.00	V5.90	V5.80	V5.70	V5.60	and earlier
W95 and NT	\$115	205	270	320	370	+50/each
Mac	\$115	205	270	320	370	+50/each
LINUX	\$115	205	270	320	370	+50/each
DEC/Alpha via NT	\$150	270	360	410	460	+50/each
UNIX single user	\$185	335	450	500	550	+50/each

Installed Sizes.

Loading **TNTview 6.1** processes onto your hard drive (exclusive of any other products, data sets, illustrations, Word files, and so on) requires the following storage space in megabytes.

PC using W95 and W98	36 MB
PC using NT (with Intel)	36 MB

PC using LINUX (with Intel) kernels prior to 2.0.36	36 MB
PC using LINUX (with Intel) kernel 2.0.36	31 MB
DEC using NT (with Alpha)	31 MB
Mac using MacOS 7.6 and 8.x (with PPC)	45 MB
Hewlett Packard workstation using HPUX	35 MB
SGI workstation via IRIX	44 MB
Sun workstation via Solaris 1.x	31 MB
Sun workstation via Solaris 2.x	32 MB
IBM workstation via AIX 4.x (with PPC)	38 MB
DEC workstation via Tru64 UNIX (with Alpha)	40 MB

TNTedit™ 6.1

Changes.

The major changes in **TNTedit** are its use of LegendView and incorporation of hot keys, both of which are explained in detail in the sections below.

Upgrading.

If you did not order **V6.10** of your **TNTedit** and wish to do so now, please contact Micro-Images by FAX, phone, or email to arrange to purchase this upgrade or annual maintenance. Entering an authorization code when running the installation process allows you to complete the installation and immediately start to use **TNTedit 6.1** and the other **TNT** professional products it provides to you.

If you do not have annual maintenance for **TNTedit**, you can upgrade to **V6.10** via the elective upgrade plan at the cost in the tables below. Please remember that new features have been added to **TNTedit** each quarter. Thus, the older your current version of **TNTedit** relative to **V6.10**, 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.

<u>TNTedit Product Code</u>	<u>Price to upgrade from TNTedit:</u>		
	V6.00	V5.90	V5.80
D30 to D60	\$175	\$275	\$375
D80	\$200	\$325	\$450
M50	\$175	\$275	\$375
L50	\$175	\$275	\$375
U100	\$300	\$450	\$600

For a point-of-use in all other nations with shipping by air express.

<u>TNTedit Product Code</u>	<u>Price to upgrade from TNTedit:</u>		
	V6.00	V5.90	V5.80
D30 to D60	\$200	\$315	\$430
D80	\$225	\$350	\$475
M50	\$200	\$315	\$430
L50	\$200	\$315	\$430
U100	\$325	\$525	\$725

Installed Sizes.

Loading the **TNTedit 6.1** processes onto your hard drive (exclusive of any other products, data sets, illustrations, Word files, and so on) requires the following storage space in megabytes.

PC using W95 and W98	56 MB
PC using NT (with Intel)	56 MB
PC using LINUX (with Intel) kernels prior to 2.0.36	59 MB
PC using LINUX (with Intel) kernel 2.0.36	50 MB
DEC using NT (with Alpha)	51 MB
Mac using MacOS 7.6 and 8.x (with PPC)	55 MB
Hewlett Packard workstation using HPUX	57 MB
SGI workstation via IRIX	74 MB
Sun workstation via Solaris 1.x	49 MB
Sun workstation via Solaris 2.x	51 MB
IBM workstation via AIX 4.x (with PPC)	64 MB
DEC workstation via Tru64 UNIX (with Alpha)	68 MB

Getting Started Booklets

Status of Booklets.

NOTE: Printed black and white versions of new and updated Getting Started, Introductory, and miscellaneous booklets are no longer being shipped with **TNT** product upgrades. If you want a complete set of the current collection of booklets, please order a **TNTlite** kit. However, you are encouraged to simply use them on-line in color.

Japanese.

All the Getting Started booklets are being translated into Japanese by OpenGIS, who will also distribute them. As of this time, approximately 50% of the booklets are available in Japanese. The target of OpenGIS is to have them all translated and current with **V6.20**.

Previously Completed Booklets. [45 booklets already in your possession]

Introduction to TNTlite	Surface Modeling
Displaying Geospatial Data	Georeferencing
Feature Mapping	Theme Mapping
Editing Vector Geodata	Image Classification
Editing Raster Geodata	Navigating
Making Map Layouts	Mosaicking Raster Geodata
Importing Geodata	Building and Using Queries
3D Perspective Visualization	Interactive Region Analysis
Pin Mapping	Acquiring Geodata
Managing Relational Databases	Making DEMs and Orthoimages
Style Manual	Vector Analysis Operations
Spatial Manipulation Language	Using Geospatial Formulas
Exporting Geodata	Creating and Using Styles
Editing CAD Geodata	Filtering Images
Editing TIN Geodata	Getting Good Color
Combining Rasters	Sketching and Measuring
Digitizing Soil Maps	Managing Geoattributes

Rectifying Images	Constructing a HyperIndex
Introduction to Map Projections	Changing Languages (Localization)
Analyzing Hyperspectral Images	TNT Technical Characteristics
Network Analysis	Sharing Geodata with other Popular Products
Windows 3.1x, 95/98, and NT: Installation and Setup Guide	
Macintosh: Installation and Setup Guide	
Windows 3.1: Optimizing Windows 3.1x	

New V6.10 Booklets. [2 new booklets added to **V6.10** CD, total now 47]

Introduction to Hyperspectral Imaging UNIX: Installation and Setup Guide

Partial New Booklet. [1 new booklet added in incomplete form to **V6.10** CD, total 48]

A partially complete booklet entitled Introduction to GIS has been installed. As usual, you can find successive versions of this booklet posted for downloading at www.micro-images.com/getstart/ as additional pages are added.

Updated Booklets.

The following Getting Started booklets have been updated to be current with **V6.10**, and the new versions are on your **V6.10** CD.

Sketching and Measuring	<i>major revisions</i>
Using SML	<i>major revisions</i>
Making Map Layouts	<i>major revisions</i>
Managing Relational Databases	<i>miscellaneous changes</i>
Changing Languages (Localization)	<i>added new utilities</i>

The following Getting Started booklets have been updated since the production of the **V6.10** CD. They can be downloaded now from our web site in PDF format. Replace the version installed by these new PDF files if you wish to have direct access to the Getting Started Booklet that is current with **V6.10**.

Displaying Geospatial Data	<i>minor revisions</i>
Introduction to Digitizing Soil Maps	<i>minor revisions</i>
Analyzing Hyperspectral Images	<i>minor revisions</i>

Out-of-Date Booklets.

The following Getting Started booklets are not current with **V6.10** products.

Feature Mapping	<i>rewrite hole filling process</i>
Vector Analysis Operations	<i>minor revisions</i>
Interactive Region Analysis	<i>added GeoToolbox changes</i>
Creating and Using Styles	<i>added hatch patterns</i>
Making DEMs and Orthoimages	<i>miscellaneous changes</i>
Importing Geodata	<i>minor revisions</i>
Interactive Region Analysis	<i>major revisions</i>

Possible Future Booklets. [19 possible units]

Priority is still being placed on upgrading all existing booklets, and this is expected to be accomplished with the release of **V6.20**. Meeting this objective will allow more effort to be expended on several of the following new booklets.

Scanning	Vectorizing Scans
Using the Software Development Kit	Surface Analysis Operations
Using the Electronic Manual	Introduction to Hazard Modeling
Modeling Watersheds and Viewsheds	Extracting Geodata
Introduction to APPLIDATs	Introduction to Remote Sensing
Introduction to RADAR Interpretation	COGO
Enterprise Installations	Using CartoScripts
Introduction to Digital Photointerpretation	Introduction to the MERLIN System
Introduction to Automatic Mosaicking via GGR	
Introduction to Creating Management Zones for Precision Farming	
Introduction to PseudoDOQs from 35 mm Slides	

TNT Reference Manual

Status.

The Reference Manual this quarter has 2502 single spaced pages distributed as:

- | | | | |
|---------------------------|-----------|------------|------------|
| • Basic System Operations | 195 pages | • Display | 706 pages |
| • Edit | 287 pages | • Process | 1113 pages |
| • Support | 90 pages | • Glossary | 92 pages |
| • Appendix | 19 pages | | 2502 total |

The HTML version of the Reference Manual installs into 35 MB with the illustrations or into 7 MB without them. The Microsoft Word version of the Manual is 74 MB. Last minute supplemental sections that do not occur in the on-line HTML version or Microsoft Word version were created for new processes and features. These sections were completed for **V6.10** after the master CDs were created for the reproduction process. These 36 additional pages are included in supplemental, printed form as follows.

The LegendView Menu (6 pages)
 3D Simulation (19 pages)
 Personal Notes with Quick Help (4 pages)
 Hot Keys in the Spatial Data Editor (2 pages)
 Database Constraints (5 pages)

Help.

A new Help procedure has been added that will be used to provide direct access to related topics in the on-line reference manual. More information on this can be found in the Features section immediately below entitled Adding Personal Notes and New Help System and also in the enclosed supplemental printed manual section entitled Personal Notes with Quick Help.

New TNT Features

* Paragraphs or main sections preceded by this symbol “*” introduce significant new processes or features in existing processes released for the first time in **TNTmips 6.1**.

System Level Changes.

Installation.

Installation instructions for UNIX versions of the **TNT** products have been assembled in the Getting Started booklet: UNIX: Installation and Setup Guide. It will be installed in

the **V6.10** Getting Started PDF booklet library and shipped in printed form with new product shipments.

Macintosh DLLs.

V6.00 of the **TNT** products introduced the use of DLLs for the Windows platforms. **V6.10** extends the use of DLLs to the Mac platform. The MicroImages MEMO that accompanied **V6.00** provided details on the value of switching to the use of DLLs, which now extends to the Mac platform. In summary, DLLs on the Mac result in smaller and faster loading times for the **TNT** products for the Mac, since DLLs enable greater code sharing between processes. Even more important, the use of DLLs overcame a limit peculiar to the Mac—the number of functions a program can have. The **TNTedit** process hit that limit after **V6.00** and would not compile until DLLs were introduced.

* Adding Personal Notes.

Introduction.

When we are intimately engaged in a project, we acquire a special kind of short term personal knowledge or “lore”. We all know that months, or even days later, many of the details will be lost from our short term memory. As a result, most of us take notes when we work out the approach to a new project, study a new subject, attend a lecture, or even study a technical book. These notes assist us in reacquiring those special ideas and procedures for reuse later in a similar situation.

Geospatial analysis has many components, some of them complex. Perhaps you use many of them periodically in a cursory fashion on a project, or perhaps you use only a few in a very detailed and complex fashion. You may experiment with a process to learn about how you might use it in your activity, or you may be engaged in a complex project with it. However, in either extreme you are expending effort and need a means of retaining your ideas in a context sensitive fashion.

Scope.

The **TNT** products, and **TNTmips** in particular, now contain a new help procedure that allows you to create personal notes in context. It enables you to quickly and easily add and keep your own notes in context where you can easily find them again for that process. These notes can be as simple as a few lines in your own words about how you accomplished a particular step in the process. You could save snapshots of your current results and save them as samples for your future reference. You can start a movie viewer and see your 3D simulation as illustrated in the attached color plate entitled Adding Personal Notes to Quick Help. They can also be as complex as links (in other words, URLs) that will start your browser and take you to someplace on a web site. For example, you could check microimages.com to see if the Getting Started booklet on that **TNT** process has been updated from the version you currently have installed. You might even want to check microimages.com to see if any errors have been reported in the process and new versions posted.

An interesting pending use of personal notes is in a new edition of an existing textbook on the use of remote sensing in geology. This revised printed edition scheduled for publication in 2000 will be supplied with a **TNTlite** CD and appropriate sample geodata. This new personal notes feature is being used by the author to provide special tutorials that use his sample geodata to illustrate the images and image processing applications in geology. Using this approach, many additional color illustrations can be provided that

could not be economically included in the printed book to illustrate the application of each image processing approach in geology. And, even more important for the student's understanding, references can be provided back into the printed text where the principles and concepts are elucidated.

Operation.

The personal help feature is embedded in a revised help system released in **V6.10**. To add your personal notes to a process, simply choose Help/On Window via a menu or click on a Help button, and this new Help window will appear, showing help for that process, which will be provided by MicroImages' writers. Use the "Edit" icon it provides to open the **TNT** multilingual text editor. This will open the Text File Editor window. To make notes, simply type them in this window in your language. When you save this text and exit the editor, your notes will appear at the top of all other information in the help window, bracketed in colored bars. This and other features of the new procedure are illustrated in the attached color plate entitled Adding Personal Notes to Quick Help.

If you wish to use personal notes for more complex actions, you will need to learn a little about HTML (HyperText Markup Language). HTML can be entered in the same Text File Editor window to provide instructions and links in your notes to start other software you have installed to display a word processing page, show a movie, go to a web site (URL), and so on. Even if you are a beginning user of HTML, you can easily add these features into your notes using the information provided in the enclosed supplemental documentation entitled Personal Notes with Quick Help. Please also remember that products like Microsoft's Word 97 for the PC and Word 98 for the Mac allow you to create text and layouts that can then be saved as HTML and added into your tnhelp.usr file (the file where all personal notes are maintained). You may find that creating HTML layouts automatically in these products is easier for you than learning to create HTML scripts in the Text File Editor window.

Backup Your Notes.

All the personal notes or more complex reference procedures you have added for any process are saved in your own personal tnhelp.usr file. Only one file is created for all your uses of a **TNT** product. **V6.10** keeps your tnhelp.usr file in the same **TNT** directory as everything else. At this time, this file is not locked so that you can add new materials into it. Be careful that you do not erase this valuable and irreplaceable accumulation of your personal knowledge, examples, and procedures. Future versions of the **TNT** products will provide for protection of this file so that you do not inadvertently erase your notes. However, for the time being, please periodically create a locked copy of this file in some other directory, or even better, copy it off to your backup media to protect against the failure of your system or hard drive.

New Help System.

Previously, it was not easy to provide and maintain on-line help for the **TNT** products. Prior to **V6.10**, the provisions to make help context sensitive, right down to the interface component level, resulted in the help being embedded in the code for the process. This meant that the software engineer was required to add the help. With a frequent upgrade cycle, this proved difficult. Furthermore, embedded help could not be translated.

Gradual evolution in MicroImages' programming procedures, along with HelpTips on icons, DataTips on features, metadata, and other features, began to provide quick help in other ways. Furthermore, the on-line reference manual was converted to HTML, and

it became possible to search it for specific information. MicroImages implemented an embedded HTML interpreter. Finally, pressure increased to provide a means of recording personal notes. As a result, a new help system has been added that is context sensitive only to the process level, but that can be readily maintained by the writers, and is internationalized so that it can be implemented in any language.

The contents of the `tnthelp.txt` file used in the new **TNT** help system are structured in HTML. They will provide you with brief synoptic help and then link you to the appropriate section in the on-line reference manual for more detailed information. A sample of this kind of help is provided in the attached color plate entitled Adding Personal Notes to Quick Help. Since the help file is in HTML, just like personal notes, links can be inserted to start other programs, to a web site, and so on. **V6.10** provides the new help system but uses the older help text. The next task is to rewrite the help file to modernize it. Also, the reference manual must be edited to insert frequent reference codes so that links to specific, useful sections can be embedded in the help. This will provide help as a direct, interactive electronic index for the on-line manual.

Booklet Links.

At startup, **TNTedit** and **TNTview** now present the two reminder screens that provide synoptic information about individual Getting Started booklets and the link to start each one in Adobe Reader. When **TNTedit** is started, these screens will deal only with those booklets pertinent to **TNTedit** and similarly for **TNTview**. As with **TNTmips**, these two wizard screens will be shown every time a **TNTlite** product is started but only once every 20 times a **TNT** professional product is started.

Professional clients expressed a desire to use these same reminder screens on demand to access and read a Getting Started booklet in addition to the dropdown menu access. Selecting Help/Getting Started on the main menu bar will expose these two reminder windows.

Mixing Languages.

Modifications to the **TNT** Text Editor now switch between your languages if the font being used contains both sets of characters (for example, Japanese and English). UNICODE-based fonts have provisions for many languages' character sets, but most fonts contain only the characters for one or a small selection of languages. However, most of your fonts will contain the simple 26 upper and lower case letters of English.

Another Floating License Platform.

IBM RS6000 platforms using the PPC processor versions of the **TNT** products now support multiple and floating license users via FLEXlm.

Display Spatial Data.

* LegendView (new prototype feature).

What Is It?

LegendView is a new, optional window pane that is attached to the right or left of the View window. Adding this optional pane expands the **TNTview** to appear similar to ArcView but retain all the powerful visualization features in **TNTmips**. The new view still uses the powerful **TNT** Graphics Rendering Engine (GRE); measurement tools; interactive region analysis; and so on; and X-based remote client/server operations. Differences will first appear when you take a closer look at the icons in the toolbar and/or dis-

cover the added analysis, measurement, and image management functionality they have available in the similarly priced **TNTview** product. Use all the **TNT** products now with LegendView to visualize your geodata, including turnkey and APPLIDAT scripts prepared with the geospatial programming language (**SML**).

Consulting the two attached color plates both entitled LegendView in the Display Window will help considerably in understanding this new display option in connection with the following description. In addition, a separate color plate of the Hawaiian Islands illustrates this new feature as part of a screen capture of the display. LegendView provides a simpler and more intuitive control of the layer structure of the current view and more information about the layers in it in the form of automated legends. LegendView follows a general design first introduced in CAD programs and subsequently in products such as ArcView, whereby view controls and legends are attached to the edge of the view. Until recently, small monitors and expensive display board memory meant that this approach robbed display area and forced a smaller spatial view. Today, cheaper and larger monitors, display board memory buffers, and multiple monitor systems have offset these impediments.

LegendView provides new and simpler ways to build and control your geospatial view. At first glance, LegendView looks similar to ArcView. It first differs when you notice that your view retains all the **TNT** control icons across the top of the view. All the advanced view control features are also still available via the Group Controls window. Simply think of LegendView as an add-on pane that adds a widely familiar look and feel to the powerful visualization tools unique to all the **TNT** products, such as a fully integrated fast and efficient handling of raster layers. The LegendView option is now available in all **TNT** products starting with the free **TNTatlas**, the cost-effective **TNTview**, **SML** scripts and APPLIDATs, **TNTedit**, and **TNTmips**. It will also be a fully functional component of **SML** for Windows when added to it (see major section **SML** for Windows) below.

Why Have It?

The legend/layer/view graphical presentation has been widely popularized by its use in ArcView. In fact, frequently you will see advertisements showing this popular means of viewing geodata and its descriptive legends. At present, you associate advertisements containing this View window with ArcView. It seems surprising that no other GIS-oriented software has provided a similar viewing tool. At present, each vendor seems to be interested in using their display interfaces as a means of competing rather than adopting features that have been proven to work and have become widely accepted.

Learning to use LegendView to set up and alter a view and present legends is easier for beginners and casual users of geospatial software and **TNT** in particular. Thus, the LegendView pane is the default option for viewing geodata in **V6.10** of the **TNT** products. If you do not want to see the LegendView pane, simply toggle it off with its prominent menu option. It will remain off until you want to see it again.

Layer Features.

Checkbox. A checkbox is used to toggle a layer between showing or hidden from view. The checkbox icon is the default layer show/hide indicator, but it can be changed to the same eyeglasses icon that is used for the same purpose in the Group Control dialog. To change to these icons, use LegendView/Visibility Indicator/Glasses. "Hidden" as used here does not mean that the layer is simply obscured by another layer. Hidden means that the layer is not currently being rendered in the view. Many clients now add multiple hidden layers to a view. These hidden layers are not rendered in the display, but they still provide DataTips for their features. For example, a vector layer containing land property ownership can be added as a hidden layer. If an orthoimage and other layers are viewed, the DataTip that appears as you move the cursor around in the view can show the name of the owner of the property. Many layers can be added, hidden, and provide multiple line DataTips. The advantage in this approach is that the hidden layers do not complicate the spatial view or lengthen its display time, yet the database information in the tables associated with these layers is dynamically presented in Data-Tips as you move the mouse.

View-in-View. When you select the view-in-view icon in the toolbar, a second set of layer checkboxes will appear in the layer name line using pink checks. If you have substituted the blue eyeglasses for the checkbox, then this second set of layer eyeglasses will be pink. These pink icons control the layers that will be shown or hidden in the inside of the view-in-view window. Assuming that the black/pink checkboxes are being used, if both are checked, first one in black and the second in pink, then that layer will show in the view both inside and outside the view-in-view window. If only the black check is shown, then the layer will appear only outside the view-in-view box and will be hidden inside. If only the pink check is shown, then the layer will appear only inside the view-in-view box and will be hidden outside. Checking these icons on and off will allow you to quickly alter which layers are shown inside and outside the view-in-view box.

When you are in the view-in-view mode, clicking the right mouse button (Command + mouse button on the Mac) anywhere in the View window switches the layers selected for view-in-view (pink check) between the inside and outside of the box. In other words, all checked boxes will uncheck and all unchecked boxes will check.

Layer Type Icon. The color icon you have learned to associate with the various geospatial object types can be optionally shown in the layer name line. These layer type icons are shown by default but can be removed or added to the layer name by toggling on the LegendView/Show Layer Type Icon button. For example, when this option is selected, the small color checkerboard icon will be shown next to the layer control name to indicate that the layer represents a raster object. Since these icons are only part of the layer name and can be absent, clicking them with the mouse will produce no special action.

Layer Name. The layer name is a new editable string of text stored with the layouts and groups and associated with the layer and the object it represents. If no layer name has been previously created, it will default to the object description you entered, imported, or accepted by default for each object. However, a new layer name can be created or changed at any time. Simply click the right mouse button (Command key + mouse button on the Mac) and select the layer name line. Choose Change Layer Name from the pop-in menu, and then a Prompt window will open to permit you to change the layer name from the object description to something easily understood in the context of the

other layer names. The new layer name will be saved if the layout or group is saved. Layer names can also be edited or changed in the same fashion at any time.

Removing Layer. A layer can be removed from the visualization. Simply click the right mouse button on the layer name and select Delete Layer from the menu presented.

Layer Metadata. If the mouse cursor is placed on the layer name, a 3-line ToolTip will pop in to give you metadata about that layer. Line one is the extended path from the hard drive name to the RVC Project File name. Line two is the long, full name of the object used for the layer. Line three is the full description of that layer.

View Controls.

The Raster Layer Display Controls dialog, Vector Object Display Controls dialog, and control dialogs for other layer types are the same when using LegendView. They can be accessed just as before using the Group Control window. However, they can also be accessed from within the LegendView pane. Simply use the right mouse button (Command + mouse button on the Mac) and select the layer name and choose Control... from the menu presented.

The same right mouse button menu also provides direct access to the dialog with which DataTips can be set up. Simply select Setup DataTips from the layer's menu. A Redraw layers option is also provided on the same menu.

Several popular basic display controls can be easily accessed using this same right mouse button menu. These include Zoom to Extents, View Metadata, View Extents, and View Object Coordinates.

Using Legends.

Hiding and Showing. Legends can be shown or hidden for each layer. Turn on the legends for all layers by selecting LegendView/Show All Legends from the menu. Hide all legends using LegendView/Hide All Legends. The legend of an individual layer can be exposed if the layer name is selected with the right mouse button and Show Legend is selected from the pop-in menu that appears. To hide the legend of a layer, select its name with the right mouse button and use Hide Layer from the same menu. Using these controls, the legends can be exposed and hidden for any and all layers that are not hidden. Legends cannot be exposed for layers. If a layer with a legend that is exposed is then hidden using the checkbox or eyeglasses, the legend will also automatically be hidden. It will then automatically appear if the layer is subsequently unhidden or if you select LegendView/Show All Legends.

Vector and TIN Legends. The legend for a vector or TIN layer shows a point, line, and/or area sample for each element type rendered for that layer in the view. Thus, the appearance or style of a legend entry is just the same as for that element type in the spatial view. If you want to change what an element type looks like in the legend, then you will need to change its style using the Vector or TIN object control panel that can be selected from the pop-up menu exposed by the right mouse button. For example, if you want a legend box showing a polygon fill style to be bounded in black, then these polygons should be bounded in black in the view. The purpose of a legend is to identify what is being viewed, no more, no less.

The label shown for each legend entry is the style assignment key for that graphical element. In **V6.10**, this cannot be changed. This will be altered soon so that the label can be any field or computed field in any related attribute table that has a one-to-one relationship with a primary key. When this is available, many kinds of useful legends can

be created. For example, a computed field could be used as a label that contains the name of each polygon type followed by its total area in that layer. The name, acreage, and proportion of the total area occupied by any individual polygon in that layer could then be shown as a multiple line DataTip.

Raster Legends. **TNTmips** has many kinds of raster data types, and these rasters can represent a variety of spatial concepts. For example, a raster layer can represent an image as a continuous tone monochrome, 3 RGB layers, or a composite color. Another raster represents a continuous surface such as an elevation map, while a third contains discrete polygon information. Three types of legends may be selected for raster layers, as applicable: Area Sample, Color Scale, and Color Sample. To select or change among these three types of legends for a raster, use the right mouse button on the layer name and select Controls from the menu. This will expose the Raster Layer Display Control dialog. Next, choose the tab panel headed Legend. At the top of this tab panel is an option button that can be used to select the raster legend type for that layer. If the raster legend type for the layer you have selected is not appropriate, it will be grayed out, and you cannot select it. For example, a layer representing a single black and white image (for example, a SPOT pan image) that has no contrast table or database table attached can only be represented by an Area Sample legend. Whereas, a color layer representing a raster obtained by automatic image classification might have a color table and attribute table representing its classes. Any of the 3 raster legend types could be picked from the legend pane for this layer.

Area Sample. The Area Sample legend for black and white or color image layer is simply a 64 by 64 pixel sample box containing the center of the image layer at a 1X zoom. The Legend tab panel will not allow the selection of a Color Scale or Color Sample legend for images in raster objects that do not have a color table or a contrast enhancement table. The Sample Area From tab panel can be used to relocate the small sample box to present the area sample from one of the 4 corners or the midpoints of each side. This allows one of nine positions to be selected where some recognizable image features are present. For example, an Area Sample legend for a coastal line image whose center and one edge fall in the water may be better represented if the sample area is moved to the landward edge.

Color Scale. This legend displays as a vertical color scale. It is generally used with surface raster layers that have had color spread applied. The best example would be a DEM layer that has a color spread applied to attractively represent elevation. The numeric values for the maximum and minimum elevations (top and bottom of legend spread) will automatically be inserted as legend labels. If you want to show a color coded DEM with an elevation for each elevation range (color level), then an attribute table will be needed with these elevations and the Color Sample legend option selected.

Color Sample. This legend is a vertical stack of boxes filled with each color in the raster layer as defined in its color table. It is typically used for image classification maps, vector objects converted to raster objects, or other types of categorical rasters created in GIS operations. The labels next to each box can be any field in any attribute table attached directly to the cells in the raster. The Legend tab panel's label button opens the standard Select Table/Field... dialog. Use this dialog to select the table and field to be used as the text label for the color reference boxes.

LegendView Pane Control.

Placement. The legend pane can be positioned to the right or left of the spatial data in the View Window. Use LegendView/Show/Right, Left, or None to position the pane to the left of the view, right, or do not show at all, thus reverting to the View window used in **V6.00**.

Size. The text descriptions you choose to name a layer or legend entry can be of varying lengths but should generally be kept short. The size of the view pane, and inversely, the size of the view area, can be adjusted at any time. Some legend entries and layer names can get long and require a larger legend pane. To enlarge the legend pane, simply place your cursor between the spatial view and the Legend pane. A double ended horizontal arrow cursor will appear, and you can use it to drag the legend pane's width larger or smaller.

Scrolling. A vertical scroll bar is available to scroll the layer/legend list vertically. A horizontal scroll bar can be used to scroll the entire legend left and right within the pane.

Drag and Drop. Individual layers and their legends can be repositioned up or down in the layer display order using a drag and drop procedure. Locate the layer to be repositioned, and use the left mouse button to select it anywhere on the layer name or legend area. The layer and legend will be inscribed in a box to show what you have selected. Keeping the left mouse button depressed, drag the layer up or down the pane. When you are dragging, the layer/legend area will not move, but each possible new position between layers will be indicated by a horizontal black line. When the horizontal black line is in the desired new position between layers, release the left mouse button, and the selected layer will immediately relocate to the position of the black line. Your layer/legend list may be long and extend beyond the top or bottom of the legend pane. When you are dragging a layer to a new position and reach the top or bottom of the pane, it will automatically scroll up or down the layer/legend list.

NOTE: The **V6.00** MEMO omitted the information that the View window would, by default, be redrawn after each layer change. As many of you then asked or discovered, you can toggle back to the state where redraw occurs when the Redraw icon is pushed. To do this, use the Options icon on the Spatial Display toolbar window and select the View tabbed panel and the "Redraw after any change" toggle button. With the new "checkbox" layer control provided by LegendView, your preference for the setting of this redraw toggle will become even more important.

3D Simulation.

AVI Movies.

3D simulations can now be saved as movies in the AVI format on Windows platforms only. AVI is a movie format created by Microsoft and played back by their products in addition to the MPEG format. Using AVI can provide improved results, as it has the option of omitting compression, which MPEG cannot. AVI without compression means that each frame of your simulation is saved and can be used as a still. Uncompressed AVI also has no losses due to compression, which can be important if subsequent processing is required. Some products require uncompressed AVI files as input in editing procedures that create broadcast video.

Panes.

It was noted in the **V6.00** MEMO that the **TNT** products will focus on providing simulation methods that support and reinforce your quantitative geospatial analysis, not general purpose 3D simulations. The first examples of these types of features are the introduction of panes. Simulations you prepare in the **TNT** products and other products (see World Construction Set below) do not provide a subsequent viewer with explanatory or other correlating graphical information. Unless you are present to verbally explain the movie, embed it in a PowerPoint slide with text, or add an audio track, your viewer is usually lost. Using simulations as a means of reporting the results of your geospatial projects requires more, and the use of inserted panes is a first step in this specialization. Panes are special simulations that can be optionally inserted into the principal theme of your simulation to help explain it. **V6.10** provides panes that can add a moving window profile and/or a plan view to your trip. The use of both of these panes is illustrated in the attached color plate entitled Profile and Plan Panes in 3D Simulations. Panes define a special area in your movie using options on the Profile/Plan tab panel. When the movie is computed, it includes these panes that show moving views.

Recently, I had occasion to view a nice orbit movie of an area in central Australia created by one of you from a SPOT image. Out of curiosity, I attempted to correlate it with a 1/250,000 scale topographic map of the area. It took quite some time to do this. This effort clearly demonstrated to me the need for additional panes, as I did not know the direction of the start of the movie or any subsequent view, nor did I have a good feel for the general scale of any area in the movie. To help the viewer understand such a simulation, future panes will provide such inserts as rotating north arrows, a dynamic scale bar, a movie marquee, and so on. I am sure many of you will have additional suggestions along these lines. It also turns out that the first users of panes needed more control on where the panes were being placed relative to the pane containing the main theme of the movie. Thus, a template method for sizing and placing each pane around the central movie theme is underway. The need for this placement procedure becomes obvious as more and more panes become available for insertion into the simulation.

Profile Pane.

The Profile pane shows movement along your path relative to the terrain at any time in the movie. The vertical scale of the profile can be set, effectively zooming in and out. Your current view position above/below the terrain can be represented by any symbol you select or add to the **TNT** point symbols (for example, a space craft, plane, or submarine). Similarly, the path followed, the terrain profile, and pane border can be any line style you create or select. The background colors of the areas above and below the terrain profile can also be selected. For long flights, the profile can be set to automatically scroll through the pane.

Plan Pane.

The Plan pane inserts a small planimetric view of the 2D surface and the path over it used in the simulation. Again, you can control how these elements are rendered by styling the vehicle and path. The map scale of the 2D view in the pane can be set, and it will scroll as the flight progresses. Remember, it is possible that your flight path will take you off the actual 2D image area, and thus only your vehicle symbol and path will be rendered. For example, an orbiting movie may have a viewpoint that is never vertically above any part (the extent) of any of the area viewed.

Advanced Simulation.

Producing the most complex content in simulations is not the main purpose of a geospatial analysis process. Excellent simulations can already be prepared in other inexpensive, yet specialized, software products. If you wish to go into even more realistic detail in your simulation, MicroImages would like to recommend a product called World Construction Set (WCS). This product can add trees, lighting changes, changes with time, reflections, and many other characteristics into your simulations using geodata prepared by the **TNT** products. WCS V4.5 is available for about \$600 from:

Questar Productions
1058 Weld County Road 23.5
Brighton, CO 80601
(303)659-4028
FAX (303)659-4068
questar@questarproductions.com
<http://www.questarproductions.com>

Geologic CartoScripts™.

Clients who attended AUW10 who work with geological applications placed a high priority on examples of how to use CartoScripts to create the line and point symbols commonly used on geologic maps. A collection of CartoScripts has been created that you can use or modify. A color plate entitled Geologic Map CartoScripts is attached and provides a legend of these new scripts, including a sample of their appearance and their file name. Two additional color plates entitled South Sierra Geology and CartoScript Sample Map are attached showing attractive examples of the use of some of these new scripted symbols plotted over a satellite image and a contour map. The actual scripts did not make it onto the **V6.10** CD, so you will need to download them from www.microimages.com/freestuff/CartoScript.

Please note that these new forms of geologic symbolism use the standard CartoScript functions that have been available in the **TNT** products for some time. Also note that most of these CartoScripts were written by a geologist on MicroImages' staff, not a software engineer. While these scripts are samples, you should be able to reapply them and create others for your own special objectives in geology or other mapping applications. An impediment to doing this is that little written reference material has been provided by MicroImages on this subject. The attached sample scripts and attached color plates are designed to spur more interest in this capability. MicroImages has also scheduled the preparation this quarter of a tutorial in the Getting Started booklet series entitled Using CartoScripts.

Import/Export.

New Library Based Process.

All the import and export capabilities in the **TNT** products have been converted into a library. This was done to enable all of these extensive capabilities to be conveniently added as classes in the geospatial programming language. **SML** scripts and **APPLI-DATs** can now read and write from other formats by importing and exporting them. Also, this rewrite of all the import and export functions improved and standardized their interface and features. For example, all import processes that can be set up to import or export multiple files will now do so using a common approach.

You will find that **V6.10** provides you with 2 menu options: Process/Import/Export and Process/Import/Export (old). The choice labeled (old) is the same interface and process that was released in **V6.00** but contains all the upgrades and corrections made for **V6.10**. The other Import/Export menu item will provide the same capabilities but uses the new library based process and a new user interface. The old process will be removed in **V6.20** but is provided here just in case you encounter some special problem in importing or exporting a particular unusual format.

Importing Vectors from Text Files.

This useful new feature introduced in **V6.00** permits you to define the properties of the conversion of the text file to a vector object, then save and use it. It can now import, in one operation, many separate text files of the same type into different vector objects.

Hypercube Import.

All hyperspectral image import processes (AVIRIS, ENVI, AISA, ...) in the new import/export process provide the option of creating the conventional 1 image band in 1 raster object or the new, single, special compressed hypercube object. Hyperspectral images stored as conventional raster objects can also be converted into a hypercube object and vice-versa. Please find a detailed discussion of the nature, advantages, and use of the hypercube object in the section below that details the new **V6.10** features in the **TNT** hyperspectral process.

MapInfo Database Import.

MapInfo databases can now be imported from the native .dat file format.

Import Arc/Info ASCII Rasters.

Rasters created in Arc/Info in ASCII format can be imported.

AgLeader Import and Export.

AgLeader is a manufacturer of popular precision farming equipment. Their PF3000 Precision Farming System is a general-purpose monitor/controller. When mounted on almost any combine manufactured in the past 20 years, the PF3000 system displays and records yield, moisture, combine speed, grain flow, acres, distance, wet bushels, dry bushels, and acres per hour, plus more. The PF3000 logs this data on a memory card from which it can be imported as vector points from a text file.

The PF3000 can also be mounted or retrofit to nearly any type of agricultural application equipment, such as planters and sprayers to control application rates. **TNTmips** can now export raster object(s) containing precision application information in the format needed for the memory card used in the PF3000 controller.

For additional information on the PF3000 and its use in precision farming, please see <http://www.agleader.com>.

CAUTION: There is an error in the export to AgLeader. DO NOT use the version distributed as part of **V6.10** of the **TNT** products. Contact Kevin in software support to obtain the corrected export process.

AISA Import.

Hyperspectral images from the Finnish Airborne Imaging Spectrometer (AISA) can be imported.

Spatial Data Framework (SDF) Import—Japan.

Digital Map 2,500 (Spatial Data Format) can now be imported. This geodata is at a scale of 1/2,500 and covers Tokyo and environs (18 CDs), Osaka (12 CDs), Nagoya, and is expanding to other cities. The SDF data structure contains polygons, arcs, points, nodes, attributes, connectivity, and buildings in raster form.

AIRSAR Import.

The Jet Propulsion Laboratory distributes considerable aircraft and spacecraft SAR imagery in a compressed Stokes Matrix format. POLSAR and TOPSAR images distributed by the JPL AIRSAR program in this format can now be imported. Their matrix representation is decoded and stored into several different raster objects, each as a double precision floating-point number.

Geosoft XYZ Import.

Geosoft XYZ files can be imported into raster objects.

Planned New Import/Export Formats.

The export to the MapInfo native format requires additional effort.

The following geodata format conversions are now at the top of the list but in no particular order of priority: import ODBC tables into vectors, export DTED, export GIF, import Arc/Info GRID, import GIRAS, and export BHP.

Raster Combinations.

You can now use an unlimited number of input rasters when preparing a linear combination of rasters.

Map Layout Templates.

Producing a series of similar maps is a common application of **TNTmips**. Another related activity is to use a previously completed project as a model for a current project. The addition of layout manipulation functions to **SML** in **V6.00** and **V6.10** have made it possible to use scripts to recycle existing layouts. This use of **SML** to produce a series of maps from an existing design is not that complex if it is the content of each map that is changed and not the overall layout. A color plate is attached entitled Using **SML** to Make Maps in a Series to illustrate this approach.

The sample script used in this illustration prompts you to choose the original layout or template. Next, you enter the Project File location of the replacement raster and vector objects. You can then enter the name of the new imagemap and the name of the print file to be created. The **SML** script used to produce the changes from the input to output map in this plate was left off the **V6.10** CD but can be obtained from the **SML** Script Exchange at www.microimages.com/sml. You can experiment with this **SML** layout “template” approach, as the input and output geodata used is now part of the **TNTlite**

sample geodata sets. You can then modify and expand this sample script to use with your layout template to produce similar map series.

Database Constraints.

A wide variety of data entry constraints can now be placed on how data is entered into each field in the Single Record View dialog or in an **SML** script, including an APPLIDAT. These data field constraints can be set up in any situation where you or other staff are creating attribute records or editing existing records. By assigning the appropriate constraints to each field in the table, not only will the subsequent data capture go faster, but it will also be more accurate. The constraints for each field can be set up by using the Database Constraints window accessed by selecting the Constraints button on the Table Definition window. A color plate is attached entitled Constraining Database Field Values to illustrate some of its features. A section of supplemental documentation is also included entitled Database Constraints.

Controlling Fields.

The Database Constraints dialog will let you set up the following restrictions on the data entered into a field. Some of these constraint options were listed in the **V6.00** MEMO. They are repeated here, as they are now easily used in **V6.10** along with the new additions.

- valid range of values for numeric fields
- default value or choice for that field
- restrictions on letter case (all upper case, all lower case, capitalize first letter, and no restrictions)
- multiple choice with an associated list of choices such as numbers, state names, and so on
- mandatory or optional field entry when that record is completed

Controlling Links.

Constraints can also be used to control the special fields used to link tables in a relational structure. For foreign key fields, you can specify how the field should be presented in a Single Record view, such as an option menu listing only the valid values from the primary key table or a text field with a button to the right, which will pop up a scrolled list of valid values derived from the primary key table. When you make entries into these special fields, these are the options you can specify for any attempt to enter an invalid value:

- if a field is a key field, you can specify that the value entered must exist in the primary key table
- accept it anyway (default old behavior)
- pop up an error dialog and reject the value
- substitute the closest match
- create a new record in the primary key table and add a popup dialog to fill in the other fields in that record
- create a new record in the primary key table and just fill in the default values in the other fields

Autocompletion.

Setting this constraint option will permit you to start typing a value into a field that is linked to a primary key, and as you type, the closest match will be filled in for you. If this

Add Arc	K	Add Polygons	A
Add Arc Chord	H	Add Rectangle	R
Add Arc Wedge	W	Add Rectangle (filled)	I
Add Ellipse	E	Add Circle	C
Add Text	T	Add Circle (filled)	H
Add Block Insert	B	Add Ellipse	E
<u>TIN Tools Window.</u>		Add Ellipse (filled)	J
<u>Tools Panel.</u>		Add Text	T
Edit Elements	Ctrl+E	Paint	P
Add Node	N	Flood Fill	F
Add Edge	L	Numeric Edit	N
<u>Raster Tools Window.</u>		Grid	G
<u>Tools Panel.</u>		Cut Copy Paste	O
Add Line	L	Restore From Source	U
		Grab Color	B

Mosaicking.**Rubber Sheeting.**

Mosaicking has a new rubber sheeting procedure for use with images and maps that contain a significant amount of geometrical distortion of an unknown nature that cannot be easily corrected. The piecewise transformation procedure you have been using produces discontinuities (in other words, breaks in slope) along all the edges that connect points. This new rubber sheeting transformation produces a result that is smooth and without discontinuities and is capable of approximating very complex distortions.

Rubber sheeting provides a generic transformation that is capable of approximating more of the irregular distortion of subareas by the manual or automatic introduction of more control points into those subareas. The transformation fits all control points so that there are no residuals between control points in the original coordinate framework and their transformed positions in their new coordinate framework. The error introduced by holding all control points in the same relative positions is redistributed all over the new raster.

The method employs a two-layer transformation that models the conformal relationship between the two coordinate systems and the residuals left after applying the conformal transformation. If no distortion is present in the image, then the changes will only be in scale and orientation, and the transformation is equivalent to conformal.

When you apply rubber sheeting, your result will be controlled by 2 basic factors: your weighting function and distribution of the control points. You can adjust and improve the results in highly distorted subareas by introducing more control points and/or by varying the weighting function that controls how the influence of every individual control point declines with the distance from it. The practical choice for a weighting function is an "inverse distance". It adjusts the position of each cell in the output inversely with the power of the distance to every control point. In other words, close control points will significantly push or pull other close cells away or closer, while remote control points will have very little effect on these cells. You can choose from a number of optional inverse distance functions which weight the distance = D to each control point as $1/D$, $1/D^2$, $1/D^3$, and so on.

Processing Areas.

Processing areas, the areas selected for use in each raster, can now be optionally hidden from view for cosmetic purposes.

SML for X.

Introduction.

LegendView.

SML scripts can take full advantage of the new LegendView display appearance. Your script can designate whether the display should present the conventional view window (the default) with or without the new LegendView view. By this choice, you can now decide which level of complexity you want to provide in the displays you present. As has been demonstrated with APPLIDATs, very easy-to-use geospatial products can be built for specific general public use. If LegendView is used, it will provide a relatively simple set of view controls that are familiar to those who have used ArcView. Finally, the simpler generic view with the complex control panel provides the basis for a script for power users with **TNT**'s extensive control of layers via the complex layer control panel.

Import/Export.

The extensive capabilities of the **TNT** products to import and export a wide variety of geospatial data formats have been added to **SML**. Scripts can now be written that start by importing some other vector, CAD, raster, database,... geodata into objects into a temporary Project File, perform complex analyses with these objects, and export them to some target format.

For example, an ESRI shapefile, an orthophoto, and Oracle database tables (via ODBC) could be imported into objects. Next, the script could display the database table as a pinmap over the vector and image layers using the new LegendView display features. The script could then allow the pins to be selected and their associated records updated or new pins created. The script could then finish by exporting the new table in Excel format. This can all be accomplished in a single script without concern for the map projection and extents of the source materials, which remain unaltered.

If this example sounds and looks like an ArcView add-on product, then you are following the logic of the way in which the **TNT** geospatial programming language is evolving. However, this **SML** script provides direct use of data in competing formats, reconciles projections, scale, extent, and other source data differences, provides **TNT**'s rapid display of images, and provides the final result in the desired format for some other product or system. These are steps not readily accomplished in ArcView, MapInfo, or other competing products.

There are some marketing related constraints imposed by MicroImages on the use of the new export functions in **SML**. Please understand that with the powerful import and export classes now included in **SML**, it would be a simple matter for someone to create and circulate a single script that would provide all the import and export capabilities built into **TNTmips**. **TNTview** is not sold as a product to create new geodata for use in other systems, and as a result cannot export geodata. Thus, and until further notice, **SML** scripts run in a **TNTview** or **TNTlite** product that try to export geodata will simply return an error. If you want to create **SML** scripts to export geodata in connection with **TNTview** or the pending new "stand alone" Windows version of **SML**, please contact MicroImages to discuss quantity licensing arrangements.

Layer Creation.

Functions and classes are now available to create, and classes to modify Map Grid, Scale Bar, and Text layers. These new features, together with related functions and classes to control layer types released first in **V6.00**, allow **SML** to create map layout templates. See the section above entitled Map Layout Templates and the color plate attached entitled Using **SML** to Make Maps in a Series for an example of the use of these additions to **SML**.

Functions and classes for 3 layers—Legend, GeoFormula, and **SML** layers—are not provided in **V6.10**. However, they will be available in the **SML** process you can download by the time you receive and install **V6.10**.

Database Entry.

SML provides the additional new features outlined in the Database Constraints section above to control entry of values into database fields. Use these features in your scripts and APPLIDATs to provide forms that reduce errors by constraining entry of values to the correct range, numeric type, string types, multiple choice, and so on.

Surface Fitting.

All the surface fitting procedures in **TNTmips**, except Kriging, can now be incorporated into **SML** scripts using a suite of 8 new functions. Your script can now generate a raster object by fitting a surface to points and/or lines in a vector object or nodes in a TIN object. These surface fitting methods include the bi-directional, inverse distance, minimum curvature, polynomials, profiles, linear, quintic, and triangulation methods.

Slope/Aspect.

A single function is available to produce a slope and/or aspect raster object from an elevation raster object.

New Functions.

Significant expansion of the **TNT** geospatial programming language continues with the addition of 28 functions and 78 classes in **V6.10**, bringing the total number of functions to 807 and classes to 187. The most important functionality added in **V6.10** is the large collection of classes to import and export geodata in **SML** scripts.

Object Functions. (1)

GetObjectSize

Get the number of bytes in an object.

Miscellaneous Functions. (2)

ReadMetaData

Read an object's metadata as a string.

WriteMetaData

Write metadata to an object.

Conversion Functions. (1)

ComputeSlopeAspectShading

Compute slope/aspect/shading from elevation raster.

File Functions. (2)

ScriptResourceReadFull

Read a text file from a text subobject under the script or a file in the same directory.

TextFileReadFull

Read an entire text file into a string (keep the size "reasonable").

Drawing Functions. (1)

DrawTextSetHeight

Set text height in coordinate units.

Display Functions. (7)

GroupAddMapGridLayer

Add a MapGridLayer to a group.

LayoutAddScaleBarLayer

Add a ScaleBarLayer to a layout.

LayoutAddTextLayer

Add a text layer.

LayerLower

Lower a layer. Returns 1 if moved, 0 if already at bottom of group.

LayerRaise

Raise a layer. Returns 1 if moved, 0 if already at top of group.

LayoutPageSetupDialog

Popup page setup dialog.

LayoutPrint

Print a layout.

Import/Export Functions. (6)

ExportCAD

Export a CAD object using class derived from MieCAD class.

ExportRaster

Export a raster object using class derived from MieRASTER class.

ExportVector

Export a vector object using class derived from MieVECTOR class.

ImportCAD

Import a CAD object using class derived from MieCAD class.

ImportRaster

Import a raster object using class derived from MieRASTER class.

ImportVector

Import a vector object using class derived from MieVECTOR class.

Surface Fitting Functions. (8)

- SurfaceFitBidirectional
Surface fitting by bi-directional method.
- SurfaceFitInverseDistance
Surface fitting by inverse distance method.
- SurfaceFitMinimumCurvature
Surface fitting by minimum curvature.
- SurfaceFitPolynomial
Surface fitting by polynomial method.
- SurfaceFitProfiles
Surface fitting by profiles method.
- SurfaceFitTINLinear
Surface fitting by linear method.
- SurfaceFitTINQuintic
Surface fitting by quintic method.
- SurfaceFitTriangulation
Surface fitting by triangulation method.

* Classes. (78)

The list of the additional 78 classes added with **V6.10** follows. Obtain new versions of the **SML** process from microimages.com to obtain the new functions and classes that are being added weekly. You can see a complete list and descriptions of available classes from the scrolling list in the top pane of the Insert Class window.

Miscellaneous Classes. (9)

GPSSymbol	MapGridLayer	REGION
REGIONDATA	ScaleBarLayer	TextLayer
LEGENDVIEW	ELEMSELECTPARMS	
DBEDITOR_SingleRecordWidget		

Import/Export Classes. (68)

MieADRG	MieAGLEADERTARGET	MieALDEN
MieAISAHyperspectral	MieARCASCII	MieAVIRIS
MieASCIIRASTER	MieAVHRRBIWEEK	MieBIL
MieBMP	MieCAD	MieCCRS
MieCLEMENTINE	MieCOQ	MieDEM
MieDISIMP	MieDMDFCAD	MieDOQQ
MieDMDFVECTOR	MieDTED	MieENVI
MieEPPL7	MieERDASGISLAN	MieERDASIMG
MieERMAPPER	MieFORMAT	MieGACLAC
MieGEOSOFTGRD	MieGEOSOFTGXF	MieGGR
MieGEOSOFTXYZ	MieGRASSVECTOR	MieGIF
MieHANDLE	MieI2SPS	MieIDIMS
MieIDRISI	MieJPEG	MieJPL_SAR
MieLANDSATCCRS	MieLASERSCAN	MieLVT
MieMACPAINT	MieMICROBRIAN	MieMIFCAD
MieMIFVector	MieMRLC	MieNEXRAD
MieNITF	MieNLAPS	MiePCI

MiePCX	MiePHOTOCD	MieRADARSAT
MieRASTER	MieRESOURCE21	MieSDTSDEM
MieSCANCADIMG	MieSCANCADRLC	MieSPANS
MieSIMPLEARRAY	MieSPOT	MieSPOTVIEW
MieTERRAMAR	MieTGA	MieTIFF
MieTMFAST	MieVECTOR	

Expanded Classes. (13)

GPSPort	Group	Layer
OBJECT	PinmapLayer	Number
PrintParms	TextStyle	TOOLTIP
VectorLayerLines	VectorLayerPoints	View
VectorLayerPolys		

Modifications since V6.10 CDs.Additional Import/Export Functions. (2)

ImportTIN

Import a TIN object using a class derived from MieTIN.

ExportTIN

Export a TIN object using a class derived from MieTIN.

Additional Import/Export Classes. (6)

MieTIN	MieVRMLRASTER	MieTMTIPS
MieASCIIXYZRASTER	MieVRMLVECTOR	MieVRMLTIN

* SML for Windows (new prototype process).Introduction.What Is it?

SML is being adapted to provide a parallel geospatial programming language for use in Microsoft Windows (W95, W98, NT, and W2000). This new process runs native on platforms equipped with Microsoft Windows. It does not use the X server or Motif libraries and provides a native Windows-based **SML** interpreter, editor, functions and descriptions, and other features of **SML**. It will be referred to as **SML/W** (Spatial Manipulation Language for Windows). **V6.10** provides the prototype release of this new "stand-alone" **SML/W** interpreter that runs **SML** scripts directly on Windows-based platforms, is compiled with C++, and uses Microsoft Foundation Classes (MFC). A color plate is attached entitled New SML for Windows to illustrate some of its features.

Where Is It?

The **SML/W** interpreter is being provided to all clients who have a license to operate **V6.10** of any **TNT** professional product or who are using **TNTlite 6.1**. It is installed automatically in your **TNT** products folder when you install any **TNTmips** professional product or **TNTlite**. Executing **SML/W** scripts requires that a **TNT** products hardware key be attached to the Windows platform (**TNTmips**, **TNTedit**, or **TNTview**) or it will limit your scripts to those that can function within **TNTlite**, which must also be installed. While **SML/W** does not use any part of any other **TNT** process, a **TNT** products key must be installed to permit operation of the **SML/W** composer/interpreter. Similarly, the same constraints apply as would apply to operating **SML/X** within the associated **TNT**

product. For example, if **TNTview** or **TNTlite** is installed, **SML/W** cannot use the export functions.

Running It?

Select the **SML** Script icon (the “gear-like” icon) labeled **SML 6.1 for Windows** from the same folder as the icons for your other **TNT** products. This will not start any other **TNT** professional product, only the **SML** for Windows interpreter that you can use to load and run a script, edit a script, or create a new script. When the interpreter is running, you also have the option to use the new Color Editor it provides, access the function libraries, cut and paste functions, view function descriptions, and so on.

The X/Motif-based **SML** embedded in the **TNT** professional products that you have and can continue to use will hereafter be referred to as **SML/X**. Scripts created with the **SML/X** interpreter will run in this new **SML/W** interpreter only if they omit functions that have not yet been converted (see details below). Scripts created in **SML/W** interpreter will run in the **SML/X** interpreter. For the time being, the same **SML** Script icon (the “gear-like” icon) will be shown to represent scripts that you created with either version of **SML**. Clicking on this **SML** Script icon with the left button will launch the script using only the **SML/X** interpreter. In **V6.10**, to launch **SML/W** scripts in the **SML/W** interpreter, start the interpreter as a Windows program from your desktop, and then select your **SML/W** script and run it. [Note that if you update to the latest **V6.10+ SML/W** interpreter from microimages.com, you can click the right mouse button on any **SML** Script icon and a pop-in menu provides a choice of launching that script with either the **SML/X** or **SML/W** interpreter.]

Which Functions Work?

Currently, all **SML** functions will show up in the lists available when you are using either the **SML/X** or **SML/W** to write a script. When you select any **SML** function using the familiar **SML/X** editor, its description is presented. At the bottom of this description, where you look for the function’s date, you now also find a statement “Available in **SML** for Windows” followed by a black “YES” or a red “NO”. When you select any **SML** function using the new, colorful **SML/W** editor, its description is also presented. Across the top, the statement “Function Not Available in **SML** for Windows” will be displayed as a red banner if it is not yet supported by **SML/W**.

Can You License It?

It is possible to purchase quantity licenses to use **SML/W** that would operate without using a **TNT** products key. This will provide only the smaller portion of **SML/W** that is required to run and interpret your unencrypted or encrypted scripts as Windows programs. As noted above, preparing scripts, turnkey products, and APPLIDATs requires a **TNTmips** key. But, they can be distributed in unencrypted form or encrypted and tied to your specific **SML/W** interpreter.

Why License It?

When installed under a license, your unique **SML/W** interpreter and script(s) would constitute a licensed product(s) that runs in Windows and accesses geodata to provide a unique geospatial capability. It could be a turnkey product in which its user selects the appropriate geodata. It also could be an APPLIDAT that comes with and is tied to a site-specific geodata set. No **TNT** product, hardware key, X server, or Motif library would be required to operate such licensed products. Due to its significantly reduced

size, the interpreter portion of **SML/W** could be easily downloaded with the script via the Internet. Subsequently, the new **TNTserver** could be integrated to help a user locate the appropriate geodata of a specific site, extract it, and download it with the selected **APPLIDAT** and the **SML/W** interpreter. A commerce server will eventually be interfaced with the **TNTserver** to collect payment for these kinds of low cost automated transactions.

Disadvantages.

Incomplete.

V6.10 of **SML/W** does not provide the display process or the graphical tools available in **SML/X**. It also does not yet contain the new import/export and surface modeling functions released for the first time in **V6.10** of **SML/X**. A separate programming effort has been underway for several months to use the platform independence of the Geospatial Rendering Engine (GRE) for a Windows-based geospatial display process with features paralleling those provided under the X/Motif approach in the **TNT** products. This activity has proceeded far enough so that a Windows-based **TNTatlas** will be released in the next few weeks (see section above on **TNTatlas** for details). This **TNTatlas/W** will run in native Windows without a key and will be free, as is the current **TNTatlas**.

During the next quarter, a high priority is being placed on producing a **TNTatlas/W** product and moving on to a full equivalent Windows-based display process. This process will be the basis for some new **TNT** products and during the quarter, will appear incrementally in **SML/W**. Some of the examples described below will require the use of this, as yet incomplete, display process and will have to await its availability. Since it takes time to learn **SML** and build scripts, **SML/X** can be used now to create an imaginative geospatial process and identify any missing functions your project might require. MicroImages is again in a position to add individual functions to either or both versions of **SML** that you might require that are reasonable in nature and of potential general use.

Even though the display/graphical tools are not yet in **SML/W**, you can immediately use 90% of the total **SML/X** functions. You can immediately use **SML/W** to prepare any script that reads geodata objects, analyzes them, and creates output objects, as long as that script does not require a geospatial display window or graphical editing and selection tools. The dialogs used to select objects for reading and writing are available, as well as all the functions that do not have anything to do with display.

Not Yet Cross Platform.

For the time being, if you want your display-oriented **SML** script to operate on all platforms, you should continue to use **SML/X**, as not all **SML/X** functions are available for use in **SML/W**. A script created in **SML/W** interpreter launched on the Mac or UNIX based platforms will automatically use the **SML/X** interpreter. However, when used on the Windows platform, the same **SML/W** script will have the familiar Windows graphical interface. Therefore, your script's user will be able to use past experience, learned the hard way with other Windows products, to operate your script.

More than 90% of the functions and classes making up **SML** are common to both versions of **SML**. Those that relate to displaying and providing tools will be system specific. However, eventually the same functionality will be provided in both versions of these functions. As a result, considerable effort is being expended to allow scripts developed with one version of **SML** to be converted easily to run in the other. For many

functions, it will simply be a matter of substitution of a Windows function for an X/Motif function or vice-versa, and this might eventually be automated. Your effort in coming up with a logical project design is most of the effort in writing a sophisticated **SML** script. As a result, recreating the same script with the second **SML** function set will be simple.

Advantages.

Familiar Interface.

Since the new **SML/W** composer/interpreter uses MFC (Microsoft Foundation Classes), it will provide the user of a script with the familiar Windows interface components, approach, and appearance. For example, the dialogs that are used to navigate to the location of a Project File to open it for reading or writing are provided by MFC standard classes. MicroImages has extended these classes so that navigation to the object level within the file continues on with a similar procedure. Newcomers and beginners using a script will immediately understand how to navigate to a Project File and into it to locate a suitable object. However, the past advantages of the **TNT** approach are also being preserved. In this example of navigating to the object level, as before, only the specific type of geodata file(s) that are sought will be presented to the users. That is to say, if the script is to continue on to process a raster object, then this Windows type of navigation into the Project File will present only those objects that are rasters. This procedure is now also familiar to those using products such as Microsoft Word, which defaults to files it has created in its current version but can be set to show "all files" which include text, text with line breaks, and so on.

LegendView and Import/Export.

The new classes for importing and exporting from a wide variety of other geodata formats are already operational in **SML/W**. It is easy to construct a geospatial analysis process that looks like a Windows program but directly uses geodata produced by some other system. The first step in such a script would be to simply import the geodata into a temporary Project File. As has been explained above, this script would present familiar Windows dialogs to navigate to the geodata to be used.

Since LegendView will be available in **SML/W**, when the Windows display functions and classes are available in **SML/W**, your script's display of geodata will appear similar to that of ArcView and provide similar functionality. However, it will retain and use the efficient and powerful raster capabilities (as well as TINs, CAD, ...), of the **TNT** products—for example, pyramiding for speed, view-in-view, region analysis, and so on. Thus, your script can produce a product that is familiar in operation and appearance to ArcView, but that can provide a full suite of geospatial analyses without using other add-on products. Finally, your script can save the results of geospatial analyses in the desired format and map projection.

A sample Windows-based script might do the following, which represents a common current application of **TNTedit** by many clients. A MapInfo file is located and imported, including its projection and georeference information. Since a MapInfo file is a CAD file, it has no topology, so it is imported into a temporary vector object that creates topology for it. A georeferenced image is then located and imported into a raster object with some other map projection and overlapping extent. The view function is then used to superimpose the vector object over the image with the extent of the view determined by the vector object. The LegendView option is selected for this composite display. Next, the script presents the vector filter options that can be used to clean up the topology of

the original MapInfo line data. This may be all the script does to the source MapInfo geodata, or it may present some simple editing tools. Finally, the script exports the topologically correct vector object to a shapefile with a new projection, suitable for direct use in ArcView. As an option, it might also extract the corresponding area from the raster object, change its cell size and map projection, and export it as a geoTIFF file with the altered projection and georeference. This raster can then also be directly used in ArcView.

Why create such a product when **TNTmips** can accomplish the same task and provide a much wider suite of available editing tools? This kind of specialized script would provide an efficient way to set up a procedure that is more restrictive in scope, but can be applied by lower-cost personnel with a minimum of training. It would be appropriate when the task might be to take hundreds or thousands of similarly prepared MapInfo files, correct their topology, update them with orthophotos, and use them in some ArcView process.

SML products can now be created that operate like a Windows-based ArcView add-on product but cost less by using the licensed version of the **SML/W**. Even if **TNTview** is used to operate a single copy of this kind of script in a production setting, it is still much cheaper than using ArcView and the several add-on products. A typical precision farming product might use an ArcView license, a separate surface fitting product (for converting yield points to a raster), some means of georeferencing, and the add-on product that makes it all work together. As a result, its user buys 3 or 4 different products, interfaces, and upgrade programs. Typically, this will cost 3 to 5 times more than a procedure or product that can be developed with **SML/W**.

Programming Familiarity.

At least 90% of the functions and classes provided in **SML/X** are available now for use in **SML/W** without alteration. Only 1 **SML** function library is provided to support both **SML** interpreters. A different editor is provided for creating programs for each version of **SML**. These editors provide access to the single **SML** function library. All **SML** functions have been encoded so that they contain identification as to "for X/Motif", "for Windows", or "for both". Using the encoding, each editor will allow you to select only functions (to copy, paste, read descriptions, ...) appropriate for use in their corresponding **SML** interpreter. Existing **SML/X** scripts and APPLIDATs run as before, and you cannot use their editor to add Windows functions into them and vice-versa for those created for **SML/W**.

Preparing scripts is no more difficult in **SML/W** than previously, as **SML/W** uses the same interpreted approach as **SML/X**. At any point, you can run your script to test its behavior. Creating a script can be approached much like writing a Basic program. Get something started, run it, see what it does, and then iterate to add to or improve it. Many **TNT** clients with only self-taught computer skills have written useful scripts in this way using simple logic. Of course, a single course in computer programming in Basic, C, or C++ helps a lot.

Recently, a client reported that over Christmas week he really got into creating an **SML/X** based commercial product for interpreting geologic stratigraphy in 1 week of intensive effort. This individual is not a professional programmer, has an academic background in geology, and has only the normal class and project exposure to programming many years previously. His script uses sophisticated interface components such as DataTips, drawing tools,... He also reported that after his initial getting started frustra-

tion, he felt a high degree of self-satisfaction in creating an advanced product in a short time. It also follows that he incorporated into it his unique understanding and experience in how it will be applied by others in his profession. His experience about how his fellow professionals go about their work cannot be readily incorporated into scripts prepared independently by professional programmers.

Both versions of **SML** now use DLLs. Modifications are planned so that you can use DLLs to extend **SML**. Experienced programmers with whom you are working can use C++ to add completely new functions for use in either version of **SML**. The MFC and extensive collections of free or low-cost extensions of MFC are available, and they could be repackaged into **SML/W** functions. Most of these low-cost function libraries require no payment of "run-time" fees and could be provided with your private DLLs for a script that uses them.

Reduced Size.

SML scripts are small, as are APPLIDATs (exclusive of their geodata) and turnkey products created with them. However, to operate them on Windows platforms, the X Server must be installed, and the Motif libraries must be licensed and present. The interpreter for **SML/W** scripts uses MFC that are already present and Windows graphics functions. As a result, **SML/W** is and will continue to be smaller than **SML/X**.

Speed.

Since no X Server is used, the translation of the X graphics calls into Windows graphics functions will no longer be necessary. Direct Windows graphics calls and functions are being used in **SML/W**. As a result, the Windows user interface of these scripts should be faster.

The licensed, run-time version of **SML/W** will also be smaller and thus faster to start up, as it will not require the loading of the X Server, the Motif libraries, or the portion of **SML/W** editor needed to create new scripts. As a result, the run-time version of **SML/W** will load and start up the script significantly faster. Since total size is also reduced by the omission of all of these components, the run-time version and script will be faster and easier to download via a network.

Single Clicking.

Just as with scripts produced in **SML/X**, **SML/W** based scripts will show up on the Windows desktop as an **SML** Script icon. When a new icon is available to differentiate **SML/W** from **SML/X** scripts, clicking the left mouse button on an icon will load the appropriate **SML** interpreter and launch the associated script. If the script is an APPLIDAT, the geodata will also be loaded. This approach is not as familiar to those using UNIX products but is the most common procedure for starting up a task on Windows or Mac platforms. It is easier in **SML/W** to set up a script to start from an icon.

Free Sample Products.

Just as has been the case with **SML/X** scripts, **SML/W** scripts that operate within the limits of **TNTlite** can be used wherever a free **TNTlite** is installed. However, when an **SML/W** script or APPLIDAT is run, it will not open the X server and will operate as a Windows product. It will expose a credit screen pointing to MicrolImages' web site and contain information on how to contact us by other means.

Training Course.

MicrolImages is preparing a detailed outline for a week-long course on using and programming with the Spatial Manipulation Language. This course will be presented by the software engineers involved. It will be held in Lincoln, Nebraska. If you are interested in such a course, please let us know.

Hyperspectral Analysis.

* Hypercube Objects (a prototype feature).

What is It?

A new object type called a hypercube object has been implemented for use in the Project File. A hypercube object contains 4 primary components as well as the usual assortment of modifying subobjects, such as histograms, georeference, and so on. These 4 primary subobjects are all created when the hypercube object is imported, created in a process, or converted from the conventional 1 band per raster object form. The **V6.10** display process can rapidly decompress this hyperspectral object to use any of the original spectral bands. By the time this MEMO reaches you, the Hyperspectral Explorer, n-dimensional vizualizer, and other hyperspectral analysis processes will also be able to rapidly decompress and use any or all of the original spectral bands in this object.

Class Subobject. This is a 16-bit raster object that can be displayed. It contains a class number derived from a special unsupervised classification of the original HSI as it is imported. This classification groups similar materials into class numbers of similar magnitude since they have related spectral curves. For example, classes 45 through 50 might represent various vegetated surfaces. It is optimized to pick the 256 classes that are representative of the majority of the spectra in the images. In other words, if a large number of pixels have a similar spectra, a class will be created to represent them. The single spectra that most closely represents each of these classes is called the base spectra.

Base Subobject. This is a small raster subobject that is used to store the 256 (or higher) base spectral curves corresponding to each class. It contains a packed matrix-like encoding of each class number and its base spectra.

Residuals Subobject. Every image cell in the class object has a base spectra. A residual spectra is the spectra that results when an image cell's original spectra is compared to its base spectra on a band by band basis. This residual spectra has numbers of low magnitude that can be compressed. How well they compress depends on the range in these residual spectra +/- away from zero.

This subobject is the big component of the compressed hypercube object and is responsible for preserving the lossless nature of the hypercube. How much this residual subobject has compressed determines the compression ratio between the original HSI

and the hypercube object. The characteristics of an HSI that affect the range of these residuals and thus the amount of lossless compression are discussed below.

Average Subobject. This is a single 16-bit raster object containing—for each pixel—an average intensity of all the spectral values for that pixel in the original HSI. It can be displayed for a quick look at the area imaged. This average subobject must be present, as it is used in the decoding of the hypercube object.

Creating It.

The **TNT** products now import a variety of HSI file formats (AVIRIS, ENVI, AISA, PCI, and so on). During import, a subarea of the total HSI can be selected. All these imports permit the creation of a hypercube object or the conventional array of standard single band raster objects in any Project File. An existing array of hyperspectral objects in a Project File can also be converted to a hypercube object.

Factors Affecting Compression. The lossless compression ratio achieved varies depending upon several factors. Some of these factors are:

Significant Bits. The number of significant data bits for each data value. For example, 6 significant bits are often used to represent images in an 8-bit data type and 12 or 13 significant bits used in a 16-bit data type.

Noise. Perhaps the most significant factor is image noise. This is often a significant factor in many compression schemes. For example, bands in the atmospheric absorption windows are noisy and can be skipped if they will not be used. Obviously, this shrinks the overall hypercube object proportionally, but also provides significant gains in lossless compression.

Spectral Complexity. The ratio will be a function of the variability in spectral radiance or spectral reflectance of the materials imaged. For example, the classic AVIRIS HSI image of the Cuprite area is a complex ground area picked to represent considerable spectral variability. An HSI image of an agricultural crop area represents only a few similar materials and has less spectral variability and will compress more.

Image Size. The number of pixels (rows times columns) in the HSI affects the compression ratio achieved. This is due to the increase in spectral variability with increasing pixel count in the area imaged. From a practical viewpoint, and for the foreseeable future, most HSIs, especially those from satellite, will only provide postage stamp sized HSIs.

Resolution. Increasing the spatial resolution can increase or decrease the compression ratio by increasing or decreasing total spectral variability in the scene. Decreasing resolution may have a similar effect either way.

The widely used 1997 AVIRIS spectral radiance image of Cuprite, Nevada of 614 by 512 pixels and all 224 spectral bands will compress from 142 MB to 97 MB. If only 16 noisy atmospheric absorption bands are omitted, the compression ratio of the remaining 208 spectral bands will be more than 2 to 1. Other images will compress further. More information on the amount of compression and the use of the hypercube object will be provided in future MicroImages materials.

Lossy Compression.

Lossy compression can be added to the hypercube approach by controlling how much of the actual variability is preserved in the residual's subobject. If losses are allowed, the 224 band Cuprite scene could be compressed up to 400 times. The hypercube that

results from a 40 to 60 compression ratio would produce HSI displays of good quality from a visual interpretation viewpoint in the display process, the Hyperspectral Explorer, or other qualitative processes. However, these compressed images should not be used in most of the quantitative hyperspectral analysis procedures. As a result, these procedures will be modified to warn you if you attempt to select a lossy hypercube object. At that time, you will be permitted to create a lossy hypercube with some control of the compression ratio permitted.

Displaying it.

The raster selection in the display process now provides 2 new pop-up menu choices: Quick-Add Hyperspectral... and Add Hyperspectral Images. Both of these are used to access compressed hypercube objects exclusively. Of particular significance is that the Add Hyperspectral Images option provides a tab panel that uses RGB sliders for picking the bands by wavelength as well as by entering a band number.

Why Have It?

Big Images. Even with plentiful hard drive space, HSIs are still hard to manage, so any compression helps. A 2 or 3 to 1 compression ratio is thus significant when images are moved via the Internet or kept on a hard drive at several different levels of processing. Our research will continue to improve this and to determine where and how lossy compression might be allowed.

Faster Access. Making images smaller tends toward their faster access and use. Creating a hypercube object is slow. The compression approach used is optimized to rapidly decompress and provide **TNT** analysis processes with the spectra of each pixel (faster than the pixel-interleaved formats of other image processing software). But, it will also serve up a single band or RGB display as fast, if not faster, than our band-sequential method of keeping each raster in a separate object. Computers with lots of memory can load entire HSIs in memory for fast random access to spectra of individual cells and also the display of entire images. However, reading these HSIs into memory takes time (for example, note the delay when the Hyperspectral Explorer loads a 256 by 256 subarea of an HSI image into memory). The hypercube object provides fast access without loading the HSI into memory.

Image Screening. Pyramiding and tiling provide little advantage when using a lossless hypercube or with the standard array of raster objects, as the spatial extent of an HSI is small. The compression scheme used will decompress any subarea of an image or a zoomed or sampled image without the need to decompress any but the required pixels. Furthermore, every lossless hypercube object has a lossy, fast hypercube component built into it. The display processes can simply render the RGB or single band values of the base subobject (a 400 to 1 compression ratio).

Network Use. A powerful use of lossy hypercube objects would be as browse images. Any RGB combination of the original spectral bands can be rapidly viewed, even over slow network modems. Once an image has been screened and explored, its equivalent lossless hypercube object can be ordered.

Currently, web sites such as JPL's AVIRIS site provide only 1 or a few bands of each image for browsing due to the storage requirement and download times involved. A web site using lossy hypercube objects could provide for rapid browser color review of any combination of spectral bands and area. When these images have been reviewed,

a lossless hypercube could be downloaded together with a utility to decompress any or all of it into a variety of other formats.

Planned Work.

Integrating It. **V6.10** supports the use of the hypercube object in the display process. As **V6.10** is being distributed, the necessary modifications are being completed to allow all **TNT** processes, especially the hyperspectral analysis and display processes, and the Hyperspectral Explorer in particular, to use this new object type.

Direct ENVI. Work is underway to permit **TNT** processes to directly read and process a variety of raster image formats without any requirement for importing or linking to them. This new feature will be applied first to ENVI HSIs so that they can be directly analyzed in all the **TNT** hyperspectral analysis procedures. This bypasses the pyramiding and tiling scheme of standard raster array objects. As has been noted, this has little impact on images of small spatial extents such as the currently available HSI.

* Pixel Purity Index (PPI).

A "Pixel Purity Index" (PPI) procedure is now available. It is used for finding "spectrally pure" pixels in an HSI and is the first step in building a collection of endmembers for different spectral classification and unmixing algorithms. As implied by the name, it searches out and identifies cells in the HSI that probably represent pure samples of the surface materials present in the scene. It accomplishes this by looking for cells that have unique spectra. The approach is best understood by consulting the diagram in the attached color plate entitled Pixel Purity Index and Masking Aid Endmember Selection.

The subset of the pixels in the PPI raster that have high purity values can be isolated by a threshold and used as a mask. When this mask is superimposed over a single or RGB image of the original scene, it pinpoints those clusters of pixels that trend toward representing homogenous materials. However, it does not identify those materials or separate them one from another.

When the PPI raster is used as a mask in the n-dimensional visualizer, you will be able to distinguish or separate groups of pure pixels representing unknown but spectrally different surface materials. Using the n-dimensional visualizer, you can mark these small clusters of pixels as endmembers and assign them a class and color. You should carefully use the n-dimensional visualizer to find and mark all the different endmember or class types. This produces an endmember class raster that preserves the location and class of all cells marked as belonging to each endmember class. This procedure is analogous to forming training sets in other supervised image classification procedures, although it is also like unsupervised classification, as you do not yet know the identity of these surface materials.

The endmember class raster can be used in the Spectral Profile tool to view the spectra of each endmember class and edit and combine them. These endmember spectra are then saved to a private spectral library. Next, these spectra can be labeled and ready for use in further analysis of the original HSI. If the original HSI had been calibrated to represent spectral reflectance, these endmembers can be identified and labeled by comparison to standard spectral libraries of others or that you have assembled. If the original HSI still represents spectral radiance or DN's (digital numbers), then before or after the spectral library is used in other processes, some form of ground truthing will be needed to identify any endmember spectra. However, only spectra representing surface materials and of subsequent interest need to be identified.

* Derivative Matched Filtering (DMF).

The "Derivative Matched Filtering" algorithm has been implemented. This is a variation of the popular Matched Filtering method that uses the first derivative of the spectra instead of the spectra themselves. The algorithm reduces the amount of noise in the output abundance image and is less sensitive to the topographic illumination effects and additive noise. The attached color plate entitled New Matched Filtering Options illustrates the results of this procedure.

* Locally Adaptive Matched Filtering (LA-CEM).

A new Locally Adaptive Matched Filtering (Locally Adaptive Constrained Energy Minimization—LA-CEM) procedure is available. This concept was developed in part from materials found in the literature and concepts and programming methodologies developed by MicrowImages. Its use in **TNTmips** was introduced at the 8th JPL Airborne Earth Sciences Workshop, 8-11 February 1999. An equivalent of LA-CEM is not available in the current version of ENVI.

LA-CEM introduces a spatial variability factor into the matched filtering technique. It has been successfully applied in test circumstances to a number of high altitude AVIRIS images and demonstrates superiority over traditional CEM based matched filtering methods in detecting small targets obscured by spectrally complex backgrounds. LA-CEM is suitable for detecting multi and sub-pixel occurrences of the non-dominant materials with a significantly reduced number of false alarm pixels and high spectral contrast between target and background. The abundance images produced by the LA-CEM method are less plagued by noise and provide more spatially accurate mapping of the target materials than the traditional CEM-based matched filtering methods. The attached color plate entitled New Matched Filtering Options illustrates the results of using this procedure.

Parabolic Curve Fit.

A parabolic curve fitting spectral transformation is now provided as an option for use with spectral libraries. The algorithm uses a least squares fitting technique to fit a special parabolic curve for every N consecutive points in the original spectra and replaces the original value with a computed coefficient. It provides a convenient way to find and enhance narrow absorption/emission bands in the spectra and reduces spectra into the form suitable for automated spectral matching. This technique might be viewed as an alternative to the optional continuum removal technique and is still experimental.

Excluding Absorption Bands.

A toggle button is provided in the analysis processes for automatically skipping atmospheric absorption bands in the interval of 1.3 to 1.5 μm and 1.8 to 1.99 μm . These bands were selected while working with high altitude AVIRIS HSIs. They contain a significant amount of noise and are not used for most land surface applications. Removing atmospheric absorption bands from the processing significantly improves the performance of algorithms that compute image statistics or use different "spectral proximity" measures such as the MNF transform, Matched Filtering, Spectral Unmixing, and so on.

More Hyperspectral Background.

Who Are You?

An astrophysicist who can gain access to spectrometry and images of his lifeless planet or moon goes straight to reflectance calibration and surface material identification. A physicist or geologist may understand how his materials behave in the laboratory, and to

some extent insitu. But, every plant biologist knows their materials exhibit wide variability with time due to many factors. Some land areas of geologic interest are relatively free of vegetation, natural or cultural. These bare areas still hold geologic and mineral secrets that can be probed with HSIs. But, most of us are going to be dealing with HSIs of land areas that have varying mixtures of biological and geological materials.

What is Reflectance?

It must be very clearly understood that the spectral reflectance of a surface, from the viewpoint of analyzing HSI and collecting field spectral curves, is a time-variant bio-physical property of the surface, not a simple physical property. This must be carefully considered in determining when to build a spectral library and the extent to which it can be applied to your HSIs. Only under special circumstances, such as those found in searching for geologic materials, can the spectral reflectance of surface materials be treated as a physical property. However, if you are careful in their application, spectral libraries built with the PPI/endmember procedure and other **TNT** processes can be applied in a wide variety of situations, including agriculture. Just remember that the more variable the surface and radiance conditions during the collection of your HSI, the more limited the applications of your library. Even something as innocuous as a change in the direction of flight can have a profound effect on spectral radiance caused by changes in sun angle and the surface structure (for example, viewing along the crop rows versus across them).

Recycling Reflectance.

If you have obtained or converted your HSI into a reflectance HSI, **TNTmips** can be used to build a spectral library of materials that can be reused. How much reuse will depend on how closely your HSIs have been converted to represent the reflectance of the surface materials. This kind of calibration preprocessing has proven effective for HSIs of geologic, bare soil and sands, man-made materials, and other surfaces that are not changing spectral reflectance during the time frame of interest and do not exhibit significant bi-directional reflectance. Under these special circumstances, building a library of spectral reflectance curves from these images can provide the basis for searching for specific materials or mapping an area. Whether or not this library applies only to that single hyperspectral data collection mission or to last year's images depends on how well you have reduced all your images to represent a time invariant surface reflectance. How time invariant can you get? Well, consider that for a physical surface, its reflectance is the same in the noon sun as in the middle of the night!

TNT hyperspectral analysis methods can be applied to the mapping of biological surfaces and detection of their conditions. However, it is important that you understand the limitations and "extensibility" of the various approaches. Let us examine the other extreme. Your HSI may only be a "raw" local radiance image from a sequence of images taken over a short period in a single flight mission. It may not have been processed further to remove atmospheric effects, variations in incoming irradiance, and other factors to obtain a reflectance HSI. You can still use **TNT** methods on these "raw" HSIs to build a "local" library of the surface materials. This spectral radiance library can then be manipulated with the **TNT** tools and used in other hyperspectral analysis processes to map these materials and locate anomalies within them. However, this is a local library and should only be applied to images in a particular flight line collected in a short period of time. It might be applied to several parallel flight lines flown over a short period of time in the same direction with clear sky conditions.

Everyone Talks About It.

It is also going to take time for most of us to understand the concepts involved in this new field and how to profitably apply them to our products. I will continue to repeat this premise over and over in varying forms: "everyone is talking about the magic use of HSI, but very few know how to do it". HSI analysis is still pretty much a "black box" approach. It is the tool of a consultant or specialist. It is the task of MicroImages and others to widen the understanding and use of this technology. Without this broadening out, only a very limited supply of expensive or limited area experimental HSI will be available, such as from the 3 pending experimental satellite programs noted below. At this moment, only 2 companies in the world are seriously engaged in supplying broad-based, low-cost, commercial software products for HSI management and analysis (**TNTmips** and ENVI). This is clearly pointed out in a May 1999 *GeoWorld* review article as follows:

"ENVI, TNTmips, and PCI have a substantial emphasis on hyperspectral data, ERDAS has less, and ER Mapper and Image Analyst have none. It seems clear that ENVI currently has a dominant position in this area, and it provides an extensive suite of tools to handle hyperspectral data. TNTmips also has a good suite of tools for hyperspectral analysis. In fact, the free version of TNTmips, TNTlite, can process and fully analyze AVIRIS scenes."

"Bottom-line advantage for hyperspectral data processing and analysis: This area will be one of great competition, but ENVI currently leads with TNTmips second."

The author of this review uses 4 of the 6 products reviewed, but not the TNT products. Please see the enclosed **V6.10** MEMO Testimonials and other Tidbits for more information on this article. Of course, MicroImages thinks **TNTmips** is number one in this area and incorporates all the hyperspectral processes in ENVI and some more they do not provide. As noted, the price is also right, as it is all free via **TNTlite**. But competition aside, both companies approach the technology in a similar fashion. We diverge in implementation (user interface) and distribution, with ENVI being supported by an excellent training program, and **TNTmips'** capabilities free for experimentation via **TNTlite**. Certainly we both have our work cut out for us.

But, It Is Not All Software!

Biological "prospecting" with HSI, whether to find anomalies in crops or minerals in vegetated areas, has just gotten underway with a modest beginning and level of understanding. It is not all going to be done with more and more complicated processing methods. At this time, we could profit significantly in agricultural applications of remote sensing by having a reliable source of high resolution, narrow spectral discrimination, and more significant data bits provided by AVIRIS types of sensors. (See the 2-sided color plates enclosed on the impact of resolution on the simple use of biomass assessment in detecting agricultural problems.)

Source Materials.Upgraded Booklet.

You were previously supplied with a Getting Started booklet entitled Analyzing Hyperspectral Images. It covered in synoptic form all the hyperspectral analysis tools now built into **TNTmips**. You will find some new tools have been added in **V6.10** (see below) that are not yet covered in the booklet you have. However, this booklet has been re-

vised since the **V6.10** CDs were duplicated to add several new pages on these new analysis topics. Please download the latest version of this booklet from www.microimages.com/getstart/hypanly.htm.

New Booklet.

The first Getting Started booklet deals in brief form with the complicated tools used in HSI analysis. MicroImages also determined that many of you needed more background information of what HSI was all about. **V6.10** provides a second booklet entitled Introduction to Hyperspectral Imaging written by the same MicroImages author. In it, he provides those of you who are interested with a brief introduction to the concepts involved in this futuristic remote sensing topic. You will find this booklet on your **V6.10** CD, along with all the other booklets.

NOTE: The new Getting Started booklet entitled Introduction to Hyperspectral Imaging was erroneously left off the getting started reference screens and the Getting Started menu. You will find it on your CD or you have installed it on your hard drive as the Adobe Reader file `hyrspec.pdf`.

Training Course.

MicroImages is preparing a detailed outline for a week-long course on the concepts of HSI and analysis by **TNTmips**. This course will be presented by the author of the above booklets and the software engineers involved. It will be held in Lincoln, Nebraska sometime in the next several months. If you are interested in such a course, please let us know. Everyone will be sent a copy of the course outline and further information as they become available.

Advanced Reference.

The recently published Remote Sensing for the Earth Sciences, Manual of Remote Sensing, Third Edition is a must purchase for anyone who is interested in detailed information on HSI and its analysis. It is published in cooperation with the American Society of Photogrammetry and Remote Sensing by John Wiley and Sons, Inc., 1999, 707 pages, Andrew N. Rencz, editor. Each edition of the Manual of Remote Sensing is published in small quantities due to this rapidly changing technology, and thus goes out of print quickly, so do not wait if you are interested. The first and second editions are already out of print even though they contain considerable reference information.

About 1/2 of this new third edition deals with topics directly related to HSI. These are the chapter titles that cover hyperspectral topics and materials in detail:

- Chapter 1: Spectroscopy of Rocks and Minerals and Principles of Spectroscopy. Roger N. Clark. pp. 3-59.
 [A recent email communication from someone related to this USGS laboratory in Denver experimenting with **TNTlite** noted that they are preparing to release a new spectral curve library with some curves going out to 150 μm !]
- Chapter 2: Multispectral Thermal Infrared Data in Geological Studies. Simon J. Hok, Elsa A. Abbott, Cindy Grove, Anee B. Kahle, and Frank D. Palluconi. pp. 59-110.
 [Only known detailed treatment of spectral emissivity and spectral reflectance in the thermal IR bands.]

- Chapter 3: Soil Reflectance. Eyal Ben-Dor, James R. Irons, and Gerrit Wpema. pp. 111-188. Spectral reflectance of soils and extensive reference list. [Has many references, including papers of the writer of this MEMO and several of his former students.]
- Chapter 4: Geobotany: Vegetation Mapping for Earth Sciences. Susan L. Ustin, M.O. Smith, S. Jacquemoud, M. Verstraete, and Y. Govaerts. pp. 189-248.
- Chapter 5: Spectral Analysis for Earth Science Investigations. John F. Mustard and Jessica M. Sunshine. pp. 251-306.
- Chapter 6: Strategies for Mineral Exploration. Charles Sabine. pp. 375-448.
- Chapter 11: Visible-Infrared Sensors and Case Studies. Fred A. Kruse. pp. 567-611.

Updates of Spaceborne Hyperspectral Imagers.

NEMO (Naval EarthMap Observatory).

From a press release in *Aviation Week and Space Technology*, April 12, 1999, pg. 70.

"SPACE TECHNOLOGY DEVELOPMENT CORP (STDC) in Alexandria, VA, is working with the Office of Naval Research on a dual-use hyperspectral imaging satellite, scheduled for launch next year. The Navy will have priority to 25% of the mission time. STDC will sell the remaining image time commercially. Science Applications International Corp. is assembling the sensor for the Naval EarthMap Observatory (NEMO) satellite, using a commercial LS-400 bus developed for Global Star satellites. NEMO's imagery will cover a swath 30 km. (18 mi.) wide and will pass over any point on the Earth except equatorial regions every 2.5 days. NEMO covers the spectrum from 0.4 to 2.5 microns (visible to shortwave IR), divided into 210 channels of 10-nanometer bandwidth. Hyperspectral data will be downlinked on each orbit to stations in Alaska and Norway. All the data will be archived, but Eastman Kodak Co. will process images only in the wavelengths of interest to the customer. Primary uses are expected to be for mineral exploration, environmental concerns, agriculture and for littoral studies."

Warfighter (U.S. Air Force).

From a press release in *SPACE NEWS*, April 19, 1999, pg. 14.

"Orbimage Gets Go-Ahead To Sell Hyperspectral Data. Orbital Imaging Corp. (Orbimage), Dulles, Va., won U.S. Department of Commerce approval to sell hyperspectral data commercially on a restricted basis. The company's OrbView 4 satellite, slated for launch next year, included a hyperspectral capability developed under partnership with the U.S. Air Force. Orbimage intends to sell the data to the Air Force as well as commercial customers."

"The spatial resolution of hyperspectral data sold to customers besides the U.S. government will be limited to 24 meters. The restriction stems from Pentagon concerns that the widespread availability of hyperspectral data might threaten U.S. national security."

[From the **V5.80** Microlimages MEMO, the actual resolution for "the government" will be 8 meters. In other words, we are only going to get 3 by 3 cells at 24 meter resolution. Launch also planned for next year.]

NEMO and Warfighter.

From a press release in *SPACE NEWS*, April 12, 1999, pg. 2.

"Space Technology Development Corp.'s planned Naval EarthMap Observer hyperspectral data satellite was licensed without resolution restrictions by the U.S. Commerce De-

partment. However, commercial sales of hyperspectral data from Orbital Imaging Corp.'s OrbView 4 satellite likely will be restricted to data with a spatial resolution of 24 meters or lower [in other words, greater than 24 meters].”

Hyperion (Lewis Sensor Resurrected).

From the Random House Unabridged Dictionary, the word “Hyperion” means a *titan*. A natural satellite of the planet Saturn. from the Greek *hyper* = hyper and *ion* = going, or taken literally, it means going above or higher.

The following is extracted from a currently active NASA request for proposals.

“...NASA had planned to provide a technology demonstration for imaging spectrometer instrumentation and exploration of hyperspectral science, commercial, and educational applications through the Lewis mission under the Small Satellite Technology Initiative (SSTI). This opportunity was lost with the loss of the satellite in September, 1997 shortly after launch. The hyperspectral imaging spectrometer to fly on EO-1 [current launch date December 1999] will allow NASA to recover and expand this opportunity, albeit in the context of a mission with somewhat different objectives. ...”

“The Hyperion hyperspectral imager is a pathfinder to benchmark the potential of space-based imaging spectrometers for Earth observation applications, both for direct hyperspectral data analysis and as a flexible means for creating Landsat-equivalent multispectral data sets. The instrument is a 220-channel imager with 10 nm wide contiguous bands and a swath width of 7.5 km. Its spatial resolution of 30 m matches that of Landsat. Its spectral coverage from 400-2500 nm will allow investigators to address a broad range of Earth science and research and applied uses. ...”

Updates/Aircraft Hyperspectral Imagers.

VIFIS Hyperspectral System. Someone working with **TNTlite** on LINUX for HSI analysis brought their aircraft sensor to our attention. It has been assembled over the past several years by the Department of APEME, University of Dundee, Dundee, Scotland, U.K. (email guyan@rs.dundee.ac.uk). For more information, see the article: Approach to the spectral and radiometric calibration of the VIFIS system. *International Journal of Remote Sensing*, 1999, Vol. 20, No. 3, 535-548. U. Gu, J. M. Anderson, and J.G.C. Monk.

Spectral Range:	64 contiguous bands from 0.42 μm - 0.87 μm
Spectral Resolution:	10 to 12 nm
Spectrometer Type:	Variable interference filter
Detector:	2-D CCD array, 752 pixels by 582 pixels
IFOV:	1.0 mrad
FOC:	+/-21 degrees
Output Quantization:	8 bits

Internationalization and Localization.

Background.

Over the past several years, MicroImages has invested considerable money, effort, and thought converting the **TNT** products into an international format suitable for use in all the widely used languages, regardless of their complexities. Most of this effort is now complete. Another required component is now in place whereby popular operating systems such as Windows, MacOS, and the UNIXes have been internationalized, use the same UNICODE font encoding, and are now concurrently released in many languages.

Recently, adjustments have been completed to add utility software and an Internet system to enable the release of concurrent **TNT** products in popular languages. An updated Getting Started booklet entitled Changing Languages (Localization) is installed as part of **V6.10**. Several tools to assist in the localization are on the **TNTmips** menu at Support/Localization. These utility tools and reference materials are provided to expedite the process of preparing and keeping the language resource kits that create the **TNT** interface in your language up to date.

Implementation.

MicroImages is now working out the arrangements to create the human network required to expeditiously create the frequent upgrades of the **TNT** products in many languages. This will require 2 to 6 months, depending upon the language required. For example, Chinese, Russian, and Turkish resource files for **V6.00** have been available for a month. Russian resource files for **V6.10** are already posted on the web site. Japanese and Turkish will be available for **V6.10**, perhaps by the time you read this. German will be posted for **V6.10** during the quarter.

At the present time, MicroImages is locating parties experienced in using the **TNT** products or geospatial analysis as official translators. Agreements are being offered and/or signed now with clients or other experienced technical specialists. In the next 6 months, additional languages will become available and will be maintained.

All localizations of the **TNT** interfaces that are posted and distributed via MicroImages' web site (www.microimages.com/l10n) are encrypted so that their contents cannot be altered. All these interface language kits posted on the web site are also automatically usable in **TNTlite** without charge! The use of a localization kit for a professional **TNT** product may or may not be free. Those translations specifically sponsored by MicroImages are free for all professional clients. Those translation products sponsored by others may have nominal charges associated with them and their upgrades for professional clients only.

Status.

The following is the current and forecasted situation with localization kits for the **TNT** user interface and translations for other materials.

Japanese.

The **TNT 6.1** localization kit for Japanese will be provided by OpenGIS (Japanese dealer) and will be posted in May.
[see www.microimages.com/l10n/locales/Japanese]

OpenGIS has translated many of the Getting Started booklets to Japanese, and they are available in printed and Adobe Reader PDF format. Contact OpenGIS to purchase these translated materials.

Chinese.

The **TNT 6.0** localization kit for Chinese was provided by GEODATEC (South African dealer) and posted in April. We expect that the localization kit for **TNT 6.1** will be posted sometime in the next 2 months.
[see www.microimages.com/l10n/locales/Chinese]

Turkish.

The **TNT 6.0** localization kit for Turkish was provided by HAT (Turkish dealer) and posted in February. We anticipate HAT will provide a Turkish **TNT** kit for **6.1** in May.
[see www.microimages.com/l10n/locales/Turkish]

Russian.

The **TNT 6.0** localization kit for Russian was prepared by MicroImages and posted in February. The kit for **TNT 6.1** was posted in April at that same location.
[see www.microimages.com/l10n/locales/Russian]

German.

All but the message file for **TNT 6.0** is being translated by Team GIS (German dealer) but was not posted. We anticipate that the complete localization kit for **TNT 6.1** from this same source will be posted in May.

French.

Negotiations are being conducted to obtain a French localization kit for **TNT 6.1**. We do not anticipate that this will be available until June or July.

Portuguese.

Negotiations are being conducted to obtain a Portuguese localization kit for **TNT 6.1**. We do not anticipate that this will be available until June or July.

Spanish.

Negotiations have been initiated to obtain a Spanish localization kit for **TNT 6.1**. We do not anticipate that this will be available until June or July.

Polish.

A discussion of obtaining a Polish version of the **TNT** interface has been initiated but is tenuous at this time.

Slovakian.

A discussion of obtaining a Slovak version of the **TNT** interface has been initiated but is tenuous at this time.

Others.

Obvious by omission from the above are languages for nations where **TNTlite** is becoming popular, such as Italian, Finnish, Greek, Thai, Indonesian, Hindu, and others.

Additional Internationalization Required.

Hebrew.

Using Hebrew in the **TNT** products requires that the **TNT** Text editor be modified to support bi-directional text entry. Hebrew (and Arabic) require that text be entered right to left, but insertions in English and other languages require temporary left to right entry. MicrolImages is currently making the modifications necessary to permit the entry of bi-directional mixed language text.

Arabic.

Arabic is one of the few common languages for which the **TNT** products do not yet provide sufficient internationalization. Arabic support is now of particular interest at MicrolImages. It required additional software modifications to handle its use of ligatures, cursive lettering, and glyph substitutions. This step has been completed since the release of **V6.10**. Arabic also requires the bi-directional text entry solution needed for Hebrew, and the **TNT** Text editor is being modified now for this purpose.

Installed Sizes.

Loading a full installation of **TNTmips 6.1** onto your hard drive (exclusive of any other products, data sets, illustrations, Word files, and so on) requires the following storage space in megabytes.

PC using W95 and W98	88 MB
PC using NT (with Intel)	88 MB
PC using LINUX (with Intel) kernels prior to 2.0.36	118 MB
PC using LINUX (with Intel) kernel 2.0.36	98 MB
DEC using NT (with Alpha)	80 MB
Mac using MacOS 7.6 and 8.x (with PPC)	74 MB
Hewlett Packard workstation using HPUX	116 MB
SGI workstation via IRIX	157 MB
Sun workstation via Solaris 1.x	100 MB
Sun workstation via Solaris 2.x	104 MB
IBM workstation via AIX 4.x (with PPC)	130 MB
DEC workstation via Tru64 UNIX (with Alpha)	138 MB

V6.10 of the HTML version of the Reference Manual including illustrations requires 35 MB. Installing all the sample geodata sets for **TNTlite** and **TNTmips** requires 198 MB. The 48 Getting Started booklets require a total of 61 MB.

Upgrading.

If you did not order **V6.10** of your **TNTmips** and wish to do so now, please contact MicrolImages by FAX, phone, or email to arrange to purchase this upgrade or annual maintenance. Upon receipt of your order and processing, MicrolImages will supply you with an authorization code by return FAX only. Entering this code when running the installation process allows you to complete the installation and immediately start to use **TNTmips 6.1** and the other **TNT** professional products.

If you do not have annual maintenance for **TNTmips**, you can upgrade to **V6.10** via the elective upgrade plan at the cost in the tables below. Please remember that new features have been added to **TNTmips** each quarter. Thus, the older your version of **TNTmips** relative to **V6.10**, the higher your upgrade cost will be. As usual, there is no additional charge for the upgrade of your special peripheral support features, **TNTlink**, or **TNTsdk** that you may have added to your basic **TNTmips** system.

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

<u>TNTmips Product Code</u>	<u>Price to upgrade from TNTmips:</u>					<u>V5.50</u>
	V6.00	V5.90	V5.80	V5.70	V5.60	and earlier
D30 to D60	\$250	450	600	750	900	+150/each
D80	\$375	675	900	1050	1200	+150/each
M50	\$250	450	600	750	900	+150/each
L50	\$250	450	600	750	900	+150/each
U100	\$450	800	1000	1200	1400	+200/each
U150	\$615	1100	1450	1700	1950	+250/each
U200	\$780	1400	1875	2175	2475	+300/each

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

<u>TNTmips Product Code</u>	<u>Price to upgrade from TNTmips:</u>					<u>V5.50</u>
	V6.00	V5.90	V5.80	V5.70	V5.60	and earlier
D30 to D60	\$300	560	750	900	1050	+150/each
D80	\$425	800	1050	1200	1350	+150/each
M50	\$300	560	750	900	1050	+150/each
L50	\$300	560	750	900	1050	+150/each
U100	\$500	850	1050	1250	1450	+200/each
U150	\$665	1150	1500	1750	2000	+250/each
U200	\$830	1450	1925	2225	2525	+300/each

MicroImages Authorized Dealers

Three new dealers were added during the past quarter. Most of MicroImages' product sales are made through our excellent dealers to, or by referrals, from our current valued client base. As a result, new dealers are being aggressively sought, especially in nations without any. Additional dealers are also sought in larger nations where our current dealer(s) have specialized in one particular application area of geospatial analysis. Any MicroImages client or anyone else interested in becoming a dealer, please contact Terry Peterson. Inquiries are welcomed from anyone, big or small.

Saskatoon—Digital Environmental Management, Inc.

MicroImages is pleased to present Digital Environmental Management Inc. (DEMI) as a new MicroImages dealer located in Saskatoon, Prince George, and Calgary in Canada. DEMI is a consulting firm providing services in environmental management, planning, mapping, remote sensing, GIS, impact assessment, predictive modeling, and related areas. For additional information on DEMI and the projects they have completed, please see their web site at www.digitalenvironmental.ca. DEMI was previously a client using MicroImages' products and has been in operation since 1995, completing projects from

Ontario to British Columbia. For further information, please contact Jim Finnigan, Bill Ferris, or one of the other nice DEMI folks at voice (306)975-3867 or FAX (306)934-2572 or mail at 702 2nd Avenue North, Saskatoon, SK S7K 2E1, Canada (email wiliam.ferris@whsi.com or <http://www.whsi.com>).

Bolivia—GEOTEC s.r.l.

MicrolImages is pleased to present GEOTEC s.r.l. as a new MicrolImages dealer located in La Paz, Bolivia. They have offices in La Paz, Bolivia and Asuncion, Paraguay, and are affiliated with the agroforest company NAHONI s.r.l. GEOTEC has used **TNTmips** as well as PCI's EASI/PACE and Ortho Engine and MicroStation products for several years. They provide digital cartography, GIS, GPS, remote sensing, digital photogrammetric, geodetic, and related consulting and geodata preparation services in planning, forestry, and environmental monitoring. They also operate a NOAA-HRPT satellite receiving station in La Paz. For further information, please contact Jurgen Storl or one of the other nice people at voice (591)277-0903 or FAX (591)277-0903 or mail at Av. Arequipa, Shopping Sur, Postal Box Office 6, Casilla 14218, La Paz, Bolivia (email geotec@coord.rds.org.bo).

California—WorldGIS LLC.

MicrolImages is pleased to present WorldGIS LLC as a new MicrolImages dealer located in San Diego, California, USA. WorldGIS provides consulting, training, and web site development in geospatial analysis projects and has used **TNTmips** for several years. WorldGIS also prepares specialized geospatial products and product developments using **SML**, C++, and other programming languages. For further information, please contact Amy Harris at voice (619)530-2717 or FAX (619)530-2717 or mail at 10299 Scripps Trail, San Diego, CA 92131 USA (email aharris1@san.rr.com or <http://www.worldgis.com>).

Discontinued Dealers

No MicrolImages Authorized Dealers were discontinued since the shipment of **V6.00**.

Computers

This continues a string of recommendations for increasingly powerful Gateway computers suitable for running the **TNT** products for under \$4000.

Top Power for the Price.

Gateway Performance 550XL

- Intel 550 MHz Pentium III Xeon
- 128 MB SRAM
- 512 KB internal cache
- 18 GB 9.5 ms ultra ATA 66 7200 rpm hard drive
- 19" VX900 color monitor (.26 dp)
- AGP display board with 16 MB memory
- 4.8X DVD-ROM drive with MPEG2 Decoder
- Philips CD-RW CD-Rewritable Drive
- 3.5" diskette drive
- TV/FM tuner card
- Soundblaster sound card and 3-piece speaker system

56K modem
Tower case
Keyboard and MS Intellimouse
W98, MS Office 97 (w/o Access)

Prices

The price of the **TNTlite** kit containing printed versions of all 48 booklets (1000 pages) is now increased from US\$50 to US\$60, which includes shipping by airmail anywhere in the world.

Papers on Applications

*** TNT Reviews.**

Image Processing Software: System Selection Depends on User Needs. by W. Fredrick Limp. *GeoWorld*, May 1999, pages 36 to 46.

Shopping for a Digital Photogrammetric System. by Azubuike Nwosu. *GeoInformatics*, April/May 1999, pages 28 to 47.

Rewarded Papers.

Publishing Spatial Data in an Interactive Atlas: Adding Real Value for Property Managers. by Kevin Royal. *Crop Decisions*, February 1999, pp. 32-34.

[This paper by Kevin is posted on microimages.com in Adobe Reader PDF format, and a printed copy will be mailed if requested.]

Identifying Villages at Risk of Malaria Spread: Researchers are using GIS in Belize to locate and map mosquito behavior. by Kevin Corbley. *Geo Info Systems*, Vol. 9, No. 1, January 1999, pp. 34-38.

Algorithm for Estimating Length of Bent Objects. by Edmond W. Holroyd III. *Journal of Computing in Civil Engineering*, Vol. 13, No.2, April 1999, pages 130-134. Technical Note 19833, ISBN 0887-3801/99/0002-0130. Describes a method used to estimate the length of fish larvae from binary images.

The True Picture: Hampton Tree Farms refine timber mapping with panchromatic imagery from latest remote sensing satellite. by Kevin Corbley. *Timber Harvesting*, March 1999, pp. 20-27.

Presentations.

Free Software for Analyzing AVIRIS Imagery. by Randall B. Smith and Dmitry Frolov. To be published in *Proceedings of the JPL-AVIRIS Annual Meeting*. 1999. 10 pages.

[This paper by Randy and Dmitry is posted on microimages.com in Adobe Reader PDF format, and a printed copy will be mailed if requested.]

Locally Adaptive Constrained Energy Minimization for AVIRIS Images. by Dmitry Frolov and Randall B. Smith. To be published in *Proceedings of the JPL-AVIRIS Annual Meeting*. 1999. 4 pages.

[This paper by Dmitry and Randy is posted on microimages.com in Adobe Reader PDF format, and a printed copy will be mailed if requested.]

Promotional Activities

Several promotional color plates are included in the **V6.10** shipment to illustrate new TNT features.

Madagascar Map.

This poster shows a cartographic product that can be created without significant manual manipulation of the labels and other components. [This 100% coverage color plate was printed on the Tektronix Model 840 color printer using a resin-based ink at an estimated materials cost of 35¢. The printer, with duplexing option, can be purchased for about \$3200, \$2700 without duplexing. It is rated at printing 65,000 prints per month.]

Hawaiian Islands LegendView.

This plate illustrates how a simple snapshot of a view window can provide an attractive result when the advanced visualization features of **TNTmips** are employed. Even though this is a screen shot of a 1600 by 1200 pixel display screen, it provides a very acceptable photo-like result. [This 100% coverage color plate was printed on the Hewlett-Packard color laser printer. This printer with duplexing is about \$3000. It is rated at about 25,000 prints per month.]

Lettuce Fields Plate.

This plate was prepared as part of a project report on the effect of resolution on detection of anomalies in small lettuce fields. [This plate also illustrates the use of automatic color printing on both sides of the paper. This duplexing feature is now available on the new generation of color printers, including the latest introductions of the HP models 4500 and 8500 color lasers and the Tektronix model 840 solid resin ink printer.]

TNT products Brochure.

Most of the content and illustration work on a new **TNT** products promotional booklet with many color illustrations has been completed. An Adobe Reader PDF version (~10 MB) of the latest draft of this material is available with all the other promotional material at www.microimages.com/product/products.pdf. A PageMaker version could be made available for downloading on special request, but it is about 100 MB due to its extensive use of high resolution illustrations, so it would be better to request it on a CDR.

Appendix: Abbreviations

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

W31 = Microsoft Windows 3.1 or 3.11. W95 = Windows 95. W98 = Windows 98.

W2000 = Microsoft Windows 2000, which is the new generic name for what has been called NT 5.0 until recently. W2000 is now available in a beta 3 release.

NT or NT4 = Microsoft NT 3.1, 3.5, or 4.0 (3.1 is error prone, and thus the **TNT** products require the use of 3.5 and its subsequent patches). NT4 now has a patch 5.

Mac = Apple Macintosh using PowerPC 60x or G3 processors and MacOS 7.x or 8.x.

MIX = MicroImages' X Server for Mac and PC microcomputer platforms and operating systems.

HSI = Hyperspectral image or imagery. This is imagery simultaneously collected in at least 25 or 30 spectral bands.