20 January 1995

Release of V4.90 TNT products

Introduction

Status of Client Base.

MicroImages is pleased to distribute **V4.90** of the **TNT** products and the 34th consecutive quarterly release of the Map and Image Processing System. *(Previous MEMOs stated that both **V4.70** and **V4.80** were the 32nd quarterly releases.)* MicroImages is also pleased to report that **V4.80** of the **TNT** products was widely used around the world with only minor difficulties. However, the focus for the last quarter has continued to be to increase the reliability in all **TNT** products.

Improved Reliability.

Considerable effort was expended this quarter to further increase the reliability of **V4.90** over that of **V4.80**. This special effort is now complete, and this will allow most effort in the next and future quarters to be focused upon new features and promptly repairing any operational problems which clients report.

One exception is the processes for interactively editing vectors and **CAD** objects which still have some idiosyncrasies. Some portions of the code for these processes date back 5 years as converted from **DOS MIPS**. Thus it is now difficult to maintain and especially difficult to extend to accommodate the many new features you are requesting. However, the implementation of a totally new **TNT** object editor was initiated upon completion of **V4.90**. It will integrate **CAD**, vector, TIN, database, and text editing into a single new advanced process. While corrections to the existing edit processes will be made where readily possible, most new effort will focus on their complete rewrite so that the new and advanced features which you are requesting can be provided in **V5.00** and **V5.10**. Please be patient a little longer with the problems in these particular processes.

New Features.

The most important new features added in **TNTmips 4.9** include the creation of a suite of capabilities to introduce and use the concept of **TIN**s (Triangulated Irregular Networks). A **TIN** object is now defined for the **RVC** Project File structure. A vector or **CAD** object can be converted to a **TIN** object. The initial applications using the **TIN** object include converting it to an elevation raster object, which is an efficient way to convert points in a vector or **CAD** object into an elevation raster object. A **TIN** can also be converted to contours in a vector object. Voronoi diagrams providing a 2D polygon structure can also be computed from a **TIN** object and placed in a vector object.

All the classification algorithms and the general input and output processes supporting them were completely renovated and extended providing many new features and improvements.

The database editor used in many processes can now create a new field and hide an existing field.

Several new line oriented **GIS** processes were added including: <u>**CAD** Copy</u>, providing flexible ways to extract elements from an existing **CAD** object into separate **CAD** objects; <u>Transfer Attributes</u>, to transfer records from elements in one vector object to elements in another vector object; and <u>Vector Merge</u>, to combine several overlapping or adjacent

vector objects into a new vector object. All these have the extensive query, attribute, and area selection features present in other similar **TNT** processes.

An important, and long promised, San Francisco **TNTatlas** is also being released on **CD-ROM** for the first time concurrent with the shipping of **V4.90 TNT** products. These Project Files provide new, larger, and more interesting test data for experimenting within **TNTmips**. Working with the large new objects in this test data will allow the demonstration of advanced performance of the **TNT** processes (e.g. display, buffering, printing, etc.) compared to using these same data sets in competing products.

The MicroImages' **X** Servers (**MI/X**), effective with **V4.90**, no longer check the **TNT** hardware authorization key and may be used for remote multiple **X** terminal operation of the **TNT** products.

Plans for V5.00.
Completion of the quality improvement phase for the **TNT** products now allows increased availability of our experienced software engineers to implement new features. Over the past two years, MicroImages has accumulated from you and the MicroImages staff a long list of over 500 requests for new features in the **TNT** processes. Similarly, entirely new directions or approaches to the management of spatial data have been encountered. The addition in **V4.90** of the new **TIN** object and associated applications is an example of an entirely new software initiative.

MicroImages can now focus partially upon adding the enhancements to existing processes which you have asked for. Some of these are easily added and some are not. Generally those which are easiest and provide the most benefit to the largest number of users will receive highest priority. Correspondingly, a portion of the effort will be devoted to new initiatives.

Some of the more significant changes which may be demonstrated at the Advanced Users' Workshop and released in **V5.00** are as follows:
- <u>pyramiding:</u> the use of raster pyramiding to drastically reduce the time required to display sampled views of large rasters;
- <u>user interface:</u> the expanded use of icons and tool bars;
- <u>vector filters:</u> new ways to filter vector objects to find and remove artifacts (spurs, undershoots, sliver polygons, ...);
- <u>vector combinations:</u> expanded methods for using vector objects in algebraic and logical combinations;
- <u>TIN applications:</u> additional applications of the **TIN** object (volume computations, improved contouring, viewshed analysis, ...);
- <u>legends:</u> improved legend generation in Map and Poster Layout;
- <u>raster analysis:</u> a suite of operations for analyzing raster morphology;
- <u>font management:</u> the direct use of any TrueType font in any language (no conversion to outline (***.OF**) format);
- <u>object editor:</u> a new integrated **TNT** interactive editor for vector, **CAD**, **TIN**, text, and database objects; and others.

Windows NT 3.5

All MicroImages products for use with Microsoft Windows **NT 3.5** (**MSNT3.5**) are available for **V4.90 TNT** products. You may also now install any **TNT** product for use with **MSNT3.5**, whether or not you have a network card. Enclosed are 5 additional pages to

add to the last *Detailed Installation and Optimization Manual* distributed to all clients with the release of **V4.80.** These pages provide the special installation instructions needed for setting up Microsoft Windows **NT 3.1** (**MSNT3.1**) or Microsoft Windows **NT 3.5** (**MSNT3.5**) to run the **TNT** products when you do not have any network card installed. If you are currently using Microsoft Windows **V3.11**, alias Windows for Workgroups (**MSW3.11**), MicroImages has found no particular reason to move to **MSNT3.1** or **3.5** unless you want access to the expanded network features it provides. Remember, even when using the older **MSW3.1** or the recommended **MSW3.11**, your **TNT** products are already full 32-bit implementations due to the unique way MicroImages prepares its software. Thus, you will achieve no particular process or interface performance increases by moving to **MSNT3.1 or MSNT3.5**.

Those who attempted to run **V4.80** of the **TNT** products with **MSNT3.5** had difficulty which was related to checking the gray hardware authorization key for the parallel port (not with blue or red "universal" serial key). It turned out that the hardware key manufacturer had to upgrade the key support library specifically for **MSNT3.5**. This originally was not detected in the tests of **V4.80** for **MSNT3.5** as MicroImages uses the universal serial hardware protection key on almost all its computers. In mid-December the revised library functions became available to MicroImages from the manufacturer to allow correct operation of this gray key with **V4.90**.

MI/X (MicroImages' X Server)

X Server for **MSNT**. The **X** Server (**MI/X**) developed by MicroImages for your use with the **TNT** products for **MSNT3.1** and **MSNT3.5** has been modified so that it no longer checks the hardware authorization key. Similar, commercial versions of **X** Servers for **MSNT** retail for about $600. While MicroImages retains its copyright and ownership rights for MI/X, licensed users of the **TNT** products may use as many copies of this **MI/X** server as required for the operation of these TNTmips products. The significance of this is that you may now use as many **NT** based machines as you wish to function as **X** terminals to operate a **TNT** product on a remote machine (a "compute server") which has a key attached and is thus authorized and able to operate your **TNT** product(s). It is pointed out to those that are network wise, that this would even allow **TNT** products to be operated worldwide via Internet using any hardware or **MSNT** equipped computer as an **X** terminal. More information on this remote information topic will be provided in future MicroImages MEMOs.

MI/X for **MSNT3.1** and **MSNT3.5** now provides the 24-bit color mode for display boards which have a server which support this full color display mode.

X Server for **MSW3.11**. The **X** Server (**MI/X**) provided for your use with **MSW3.11** is also similarly modified. However, at present this has little utility as this version of the MicroImages **X** Server does not support remote network operation as a remote **X** terminal (only local X operations). This feature may be added at a future date for those using **MSW3.11** if required. However, the **MI/X** server for Microsoft Windows 95 (**MSW95**) will follow the design of the **MSNT** version, and when available will support both local operation and remote **X** terminal emulation. In fact, the reason MicroImages has not retroactively added remote **X** terminal operation for **MSW3.11** is that it will be easily provided via **MSW95**. So much for believing Microsoft's' many promises for the release of **MSW95**!

Windows 95

Start thinking of this Microsoft product as becoming readily available to you in 1996. It has officially been delayed for public release until August from its original release date in 1993! Does it still make sense to call it Windows 95? This just shows how using gimmicky names like Windows 95 can get you into embarrassing situations.

MicroImages is an official software developer for Microsoft, but has not yet even received a first beta version of this product (only a selected few are so anointed). Needless to say, MicroImages expects to be able to easily and quickly recompile all the **TNT** products, including the **X** Server, and release all **TNT** products immediately for this platform.

ULTRIX

MicroImages would like to discontinue the distribution of the **TNT** products for **DEC** workstations using the old **ULTRIX** operating systems. **ULTRIX** has been replaced by **OSF/1.** If you are planning on using **V5.00** of any **TNT** product with **ULTRIX**, please contact MicroImages immediately on this matter so that arrangements can be made to continue its availability. If no one responds, MicroImages will not issue the **V5.00 TNT** products for **ULTRIX**, and will no longer offer it for sale.

TNTmips™ 4.9

If you have subscribed to **TNTmips 4.9**, please proceed to install it from the **V4.90 TNT** product **CD**s following the instructions provided by the **INSTALL** process on either disk or in the *Detailed Installation and Optimization Manual* . If you did not order **TNTmips 4.9** and wish to do so now, please contact MicroImages by **FAX** or phone to arrange to purchase your quarterly upgrade to **V4.90**. MicroImages will immediately supply you with an authorization code by **FAX**. Entering this code when running the installation process will allow you to complete the installation and immediately start to use **TNTmips 4.9** and the other **TNT** products.

If you do not have an annual subscription to **TNTmips**, you can purchase **V4.90** under the elective upgrade plan at the cost in the table below. Please remember that new features have been added to **TNTmips** with each quarter. Thus, the more quarters you are behind **V4.90**, the higher your upgrade will cost, up to a limit. Upgrades from all previous versions of **MIPS** and **TNTmips 4.4** or earlier are the same, fixed cost shown below. As usual, there is no special additional charge for the upgrade of the peripheral support features which you may have added to your basic system.

Within the **NAFTA** reselling area (Canada, U.S., and Mexico):

Product Code	Price to upgrade from **TNTmips**:					MIPS:
	V4.80	**V4.70**	**V4.6**	**V4.51**	**V4.40**	any version
D30 to **D60** (**CD**s)	$250	450	600	700	750	750
D30 to **D60** (floppies)	$300	560	750	875	940	940
D80	$375	675	900	1050	1125	1125
M50 (replaces **U45**)	$250	450	600	700	750	750
U100	$450	800	1000	1200	1300	
U200	$780	1400	1875	2200	2350	
U300	$1030	1850	2475	2900	3100	

For all other nations:

Product Code	Price to upgrade from **TNTmips**:					**MIPS**:
	V4.80	**V4.70**	**V4.6**	**V4.51**	**V4.40**	any version
D30 to **D60** (**CD**s)	$300	560	750	875	940	940
D30 to **D60** (floppies)	$350	600	800	925	990	990
D80	$425	800	1050	1225	1300	1300
M50 (replaces **U45**)	$300	560	750	875	940	940
U100	$500	850	1050	1250	1350	
U200	$830	1450	1925	2250	2400	
U300	$1080	1900	2525	2950	3150	

M50 is the new product code for the Apple Macintosh **Mac OS 7.x** versions and replaces their older designation as **U45** for the Mac using **A/UX**.

Loading a full installation of **TNTmips 4.9** onto your **PC** hard drive for **MSW3.11** will require 87 megabytes with an additional 14 megabytes for the illustrations. The full install of the **TNTmips 4.9** processes onto your **PC** hard drive for **MSNT-I** (Intel) will require 110 megabytes with an additional 14 megabytes for the illustrations. The full install of the **TNTmips 4.9** processes onto your hard drive for **MSNT-A** (Alpha) will require just more than 124 megabytes with an additional 14 megabytes for the illustrations.

The full installation size, including illustrations, will vary for workstations depending upon the platform type as follows: Data General = 89 mb; Hewlett-Packard = 92 mb; Sun SPARCstation with Solaris 1.x = 82 mb; Sun SPARCstation with Solaris 2.x = 73 mb; **SGI** = 120 mb; **DEC** ULTRIX = 90 mb; **DEC OSF/1** = 90 mb; and **IBM RS**/6000 = 135 mb.

There are no **V4.90 TNT** products on these **CD-ROM**s for the Macintosh using **A/UX**. Since Apple has discontinued providing this version of **UNIX** for new platforms, MicroImages has discontinued development for **A/UX**. Those clients using the **TNT** products for the Macintosh platforms will be provided an automatic resumption of their quarterly upgrades with the new pending release of the **TNT** products for native operation under **Mac OS 7.x**.

TNTsdk™ 4.9 for TNTmips 4.9

No special features were added to **TNTsdk** other than the quarterly improvements in existing functions and the additional functions added to **TNTmips**.

TNTview™ 4.9

All the applicable changes in the display program noted below are similarly available when **TNTview 4.9** is installed.

TNTatlas™ 4.9 (release of San Francisco Sampler)

Purpose. The promotional San Francisco bay area **TNTatlas** sampler **CD-ROM** is enclosed. It should be carefully noted that this is labeled as a *prototype*. With your assistance, MicroImages will modify and improve this HyperIndex® stack and reissue it.

A copy of this San Francisco **TNTatlas** and the accompanying manualette will be shipped along with the **TNT** product brochures to every potential customer who requests information directly from MicroImages. You will also find enclosed with **V4.90** an

additional set of materials which describe the characteristics of the objects in this HyperIndex stack.

All the software modifications needed to allow the creation of licensed versions of the **TNTatlas** software coupled or bonded to your Project Files have been completed. This "bonding kit" was created by MicroImages in order to prepare this San Francisco sampler to demonstrate the concept of keyless, licensed, run-time versions of **TNTatlas** reproduced on a single **CD** for all platforms, but sharing one common set of Project Files.

Installation and Performance. All 11 versions of the **TNTatlas** "playback" or "run-time" software are present on every sampler with the one HyperIndex stack of 580 megabytes made up of 66 Project Files in 10 directories with a total of 313 primary objects. Linked, compressed, tiled **TIFF** files are used for 37 of the largest raster objects. Thus, these large images can be used in other applications which can directly read this **TIFF** file format as well as in the **TNT** products.

This sampler is designed to be taken to any one of the 11 different computer platforms supported and immediately used to view the images and map materials it contains. The **TNTatlas** software will always be loaded at the time of operation directly form the **CD**. Thus less than 100 kilobytes of space will be required for installation and use on any of the 11 different host platforms for the small reference files required to control the display characteristics and user defaults. MicroImages believes that this is a unique accomplishment in the software field and cannot understand why such an approach is not used by many others: 1 standard data structure in the universal **ISO 9660** format accompanied by programs for each platform!

To accomplish this universality a minor premium must be paid as loading the **TNTatlas** software each time from the **CD** will take more time than if was installed on the hard drive and subsequently loaded. However, this slower start up time saves the approximately 11 megabytes of hard drive space required for a specific version of the **TNTatlas**.

Simply install and set up the "run-from-**CD**" version appropriate for the platform you wish to use, follow the instructions on page ii of the manualette enclosed with the **CD**. The install process will transfer the several small reference files to the hard drive taking less than 100 kilobytes of space and then provide you with further set-up instructions. The software and Project Files will be left on, and used from, the **CD**. Should you wish to operate this **TNTatlas** from your hard drive simply copy the appropriate version of the software **CD** to the hard drive and set it up to operate there.

Regardless of where the software is located, the time required to read and display each large object is a function of where you choose to keep the 66 Project Files making up this atlas: on a single speed **CD**, on a quad speed **CD**, or on a fast hard drive (using 600 megabytes). This is your choice and directly controls the speed at which you can move around in the atlas. If you have the hard drive space, you can significantly increase (depending upon the speed of your **CD**) the retrieval speed of this **TNTatlas** by copying all 580 megabytes of Project Files to it.

It is unfortunate, in retrospect, that the new raster pyramiding scheme (see more details below) already developed for use in **V5.00** of the **TNT** products was not available for use on this *prototype* **CD** atlas. MicroImages simply did not want to delay the release of this **TNTatlas** sample product any longer. However, this new, additional raster object storage feature incorporated into the Project File structure for **V5.00** will **<u>drastically</u>** increase the

speed of displaying large rasters at any zoom factor selected. In the meantime, it should be clearly understood that this is a *prototype* version of this atlas produced to help to begin to illustrate the concept of its use and to also to transmit a new set of TNT sample data to all clients.

Linking Project Files. The release of these larger raster, vector, and **CAD** sample Project Files provides **TNTmips** and **TNTview** clients with new and larger sample data with which to experiment. A new feature in **V4.90** is available which allows you to link a Project File to any, and all, of the objects in another Project File. Thus, if you choose, you can leave these large San Francisco objects on the **CD** and link to them from a second Project File created on your hard drive. This new, very small "parent" Project File on your hard drive can then be used by any **TNT** process to read any of these large San Francisco objects directly from the **CD**. Without creating such a parent Project File, you would be unable to alter any of the characteristics of the objects (e.g. color balance, georeferences, contrast tables, and other display parameters) in the **TNTatlas** since they are on the read-only **CD**. The operation of this feature is provided in printed form as the supplemental documentation section entitled: Linking to Objects.

If you use this new Project File linking feature for access to the raster in another Project File, all the unique features of tiling, georeferencing, pyramiding (when available) etc. will be preserved and used. Similarly, links to vector, **CAD**, **TIN**, and database objects are also transparent when you select the new "parent" Project File. MicroImages believes you will also find many other useful applications of linking Project Files to objects in other Project Files.

Currently, during linking you will need to select each individual object (use the multi-object selection procedure). However, a modification will be made for **V5.00** to allow selection of an entire Project File(s) and will automatically select every object in it for linking. When you try linking to 313 individual objects on this *prototype* **CD**, you may understand why adding this new feature is important. Correspondingly, you will also wonder why the total, small parent Project File was not created by MicroImages and placed on the **CD** in the first place, and then transferred to the hard drive as part of the install process. This would have been a complicated approach as this pre-made parent Project File would not know where the **CD** and its Project Files and objects were located on your system (e.g. drive letter or directory location).

Crow Butte. The old, familiar Crow Butte, Nebraska sample data is no longer on the **V4.90 TNT** products **CD**s. It is now located in a separate HyperIndex stack on this same San Francisco **TNTatlas CD**.

Printing. As has been noted previously in the **TNTatlas** promotional materials, if you wish to print any screens displayed in this sample atlas (without using **TNTmips**), MicroImages suggests you use one of the several commercial, very low-cost, window color screen printing software packages such as Pizzaz Plus from Application Techniques, Inc.

TNTdemo™ 4.9

No changes have been made in the **TNTdemo** software or program for this quarter.

On-Line Documentation

An equivalent of 1737 single-spaced printed pages of on-line documentation are included with **V4.90.** This is an increase of 34 pages over that supplied with **V4.80**. Three last minute additional sections were completed for the newest features in **V4.90** after the master disks were created for the reproduction process. These 50 additional pages are included in supplemental, printed form as follows.

> Triangulated Irregular Networks (28 pages)
> Copying to Multiple Objects (5 pages)
> Vector Merge and Transfer of Vector Attributes (17 pages)

Apple Macintosh via System 7.x.

Status. Again the Apple Macintosh versions of the **TNT** products are not being distributed with **V4.90**. MicroImages now has a complete working version of the **TNT** products for 68xxx based Macintoshes (e.g. Quadras) and which also operates on the Power Macs in emulation mode. Only a few errors are showing up in testing. However, it is now clear that a Mac Quadra with a 68040 processor and associated math co-processor functions only about equivalent to an Intel-based 486/25. This performance comparison is already generally accepted in the industry and is the reason behind Apple's switch to the Power PC chip as the 68xxx chip design could no longer be modified to compete with the changes in the Intel chip designs.

Quadra. MicroImages is experiencing an additional performance problem in the way the **Mac OS** multi-finder currently runs independent programs by sharing time equally between the 3 processes: **X** Server, Menu, and an application (e.g. 2D display). This is similar to the way things started out on the **PC** platforms, and eventually MicroImages figured out how to properly share and balance the time of service from the system software and **CPU** for the **X** Server, Menu, and application process. This is the area in which effort is now being expended to increase the performance. However, irrespective of these performance improvement efforts, it is likely that MicroImages will release special **CD**s of the Mac **TNT** versions to those awaiting them just after the Annual Users' Workshop.

Power Mac. Operating the current **TNTmips** processes on the Power Macs in emulation mode provides slower results than operating on a 68040 based Quadra. This might be expected, as this has also been reported in the literature. MicroImages has never seen a software chip emulation which was as fast as the native use of that same chip regardless of the marketing hype surrounding it.

The current problems experienced by all software manufacturers in developing and releasing native software for the Power Mac is made very clear in an article on the status of Microsoft's products for this platform. The quotes below were printed just yesterday in Microsoft to Update Office, Word, and Excel. by Iian Greenberg. 16 January 1995. in Infoworld, page 10.

"Acknowledging widespread use dissatisfaction with software packages it recently released for the Macintosh, Microsoft Corp. announced last week it will ship by March free interim releases of Excel, Word, and Office."

*"Also Word's **slow performance was exacerbated on the Power Macintosh systems because users ran the application under emulation**. However, Word was never optimized for that platform, unlike the native Excel, according to Microsoft."* MicroImages

interprets the word exacerbated to mean slower than operation on a 68xxx based machine just as found with the TNT products!

MicroImages is just completing the compiling of the **TNT** products for the native mode on the Power Mac. At this point it is not yet possible to measure the magnitude of the performance advantages of this native Power **PC** version over the 68xxx version of the **TNT** products.

<u>X</u> Server. The initial releases of the Mac versions of the **TNT** products will be shipped with an **X** Server supplied by another software manufacturer. However, the cost of this **X** Server prohibits its use with the **TNTdemo** product and the run-time version used for publishing your **TNTatlas CD**s. As a result, MicroImages has decided to develop an **X** Server for use with the **Mac OS**. While not a trivial task, this effort will be initiated on or about 1 February.

New TNTmips Features

* Paragraphs or main sections preceded by this symbol "*" introduce significant new processes, or features in existing processes, which are released for the first time in **TNTmips 4.9**.

*** <u>Object Linking.</u>**
A Project File may now be linked to objects in another Project File. This allows objects to be used in all **TNT** processes which reside on permanently recorded media such as a **CD** or a write once optical drive or where you simply do not want to store another copy. The "parent" Project File may contain no objects of its own and merely show many other objects to which it is linked. A Project File may also contain a mixture of local objects (stored within it) and linked objects (stored elsewhere in other Project Files). All **TNT** processes are transparent to the use of linked objects, and no performance is lost when using a linked object.

Additional details on the use of linked Project Files was presented above in connection with the discussion of their use with the San Francisco **TNTatlas**. The operation of this new feature is provided in printed form as the supplemental documentation section entitled: <u>Linking to Objects</u>.

*** <u>TIN Objects.</u>**
A **TIN** (Triangulated Irregular Network) is a topological data structure that represents a continuous **3D** surface as a set of adjacent triangles computed from irregularly spaced **3D** points. The **TIN** data structure also stores topological relationships between adjacent triangles, edges, and nodes.

The triangulation that forms a **TIN** structure satisfies the Delaunay criterion and produces a unique set of triangles with several useful properties: any point within a triangle is closer to its triangle's vertices than to those of another triangle, the number of sliver (long skinny) triangles is minimized as much as possible, each triangle is formed by connection of input sample point with it's two <u>nearest</u> neighbors. **TNTmips** uses tolerance for discarding input points that are too close to each other, which helps maintain TINs with desired spatial density for the resulting triangles. Additional details on the structure and characteristics of a TIN object are contained in the printed supplemental documentation section entitled: <u>Triangulated Irregular Networks</u>.

A **TIN** object contains coordinate and topological information about the nodes, edges, and triangle elements which make it up. You can attach database records or attributes to the node, edge, and triangle elements just as with the point, line, polygon, and node elements in vector and **CAD** objects. In addition, each triangle has an attached characteristics database record with information about perimeter, surface, and projected areas, volume, slope, aspect, and some other useful parameters. These attributes and characteristic databases can be used with queries for displaying and analyzing **TIN** objects in Display **2D** and other processes.

The current method to create a TIN object is to convert points in vector objects into a **TIN** object. The points selected become the vertices of the triangles for the **TIN** object in a process called tessellation. Previous computations of TIN data structures in various software products has been a problem due to the time involved if large numbers of points were used. However, MicroImages has designed an fast and efficient algorithm for this key activity. A new fast TIN computation function was proposed in the paper: <u>Delaunay triangulations in TIN creation: an overview and a linear-time algorithm.</u> by Victor J. D. Tsai. in International Journal of Geographical Information Systems. 1993. 7(6):501-524. This article contains a Table 2 on page 520 shows the results of this new, fast TIN formation procedure (see attached). This table reports that the new method requires 90 seconds to form Delaunay triangles for 10,000 vertices on a 486/66 PC with all input data and results kept in memory. MicroImages is pleased to report that using the algorithm designed for use in the **TNTmips**, this same result on this machine would be between 15 and 20 seconds.   MicroImages also has preliminary indications that its algorithm is several times faster than the tessellation process (**TIN** formation) provided in the current version Arc/Info on each comparable platform supported.

* <u>Voronoi Diagrams.</u>
A new process is available via Interpret / **TIN** / Voronoi Diagram to create a Voronoi polygon structure from a **TIN** object and save it as a vector object. Voronoi polygons are used extensively in a variety of disciplines (e.g. home range in wildlife management). An important application in **GIS** analysis is point pattern analysis. The Voronoi polygons represents a spatial tessellation of continuous space based on the finite input points set that associates all locations in that space with the closest member of the point set. Voronoi polygons are easily constructed from a **TIN** object, as they are directly related to the inherent structure of the **TIN** object.

* <u>TIN to Raster Conversion.</u>
This process converts a **TIN** object into a raster object of the selected data type (8-, 16-, 32-bit, and 64-bit) using linear or quadratic piecewise (each triangle used separately) surface fitting methods. A modified quintic piecewise polynomial surface fit will be added later to provide a smoother surface in the raster object. All methods insure that all triangle vertices occur on the surface computed.

* <u>Contouring a TIN.</u>
This process converts the vertices in a **3D TIN** object to the set of vector lines that represent equal elevation.   The input parameters are similar to those for the raster contouring process. Currently a piecewise linear fit (each triangle is a plane) is provided. A modified quintic piecewise polynomial fit will be added later to generate more curvilinear contour lines.

<u>Project File Maintenance.</u>

The amount of unused space within a Project File is now displayed.

* An **RVC** Project File can now be "packed" to free up space previously captured by objects which were deleted. This feature was available in **DOS MIPS** and now is available in **TNTmips**. The operation of this new feature is provided in printed form as the supplemental documentation section entitled: Removing Unused Space from Project Files.

Display 2D.
The Layer / Edit option has been renamed as Layer / Controls.

There is now an option to allow "differential" X-Y zooming. This will permit each axis of the display to be zoomed independently.

* The new **TIN** object, its database attributes, and other properties can be displayed. The controls are similar to those for displaying a vector object except that there are no "text" elements. Adding the capability to overlay, control, and display this completely new topological object to the display process for all platforms took only a couple of days, illustrating the flexibility of the **TNTmips** code base.

Pin Mapping.
Pin mapping now allows selection of the "internal" table if the pin map is created from a vector database subobject.

Japanese and Chinese characters can now be automatically extracted from the attached database tables and displayed next to the pie, histogram, or other symbolic representations of each pin. A sample color pin map is attached showing multi-line Japanese labels for each pin.

By now, those clients using pin mapping recognize it as the means of displaying the contents of database objects which may be primary objects or attached to other objects (raster, vector, **CAD**, or **TIN**). While currently only pie, circle, and histogram display forms are available, other

Any symbol which can be designed in the symbol editor can also be used as a pin for displaying database fields or queries which control its selection, color, and size (e.g. stars, circles, trees, etc.). Alternately, two graphical symbols can be selected: the pie diagram and the histogram. Other special graphical types can be added as requested. For example, a "stacked" histogram of vertical boxes with labels at the side has just been requested along with a request to fill the boxes (and the pie and histogram segments) with the bit map pattern symbols designed elsewhere in **TNTmips**.

HyperIndex Stacks.
When making a link, you can now control whether the new image will come up at **1X** or Full View. If you choose to have it at **1X**, you can choose whether you want to come up in the center of the image or at a point centered around the location where it was selected on the parent object.

Selecting Key Fields.
The Select Key Field window has been modified to allow greater ease in data input. This window appears in many vector processes, including buffer zones, copy vector, home range, transfer attributes, and others. The improvements are:

1) multi-line selecting and editing capabilities - previously, you could change only one line at a time, now you can select and change one or many lines at one time, and the lines don't have to be in one contiguous block.

2) The selection remains in effect during the entire run of the process - previously, if you re-entered the select key field window, the previous selections would have been cleared, forcing the user to redo all the work.

Database Editor.
* New fields can now be interactively added to existing internal tables (but not if database is in an external database file). This feature was requested by many users. It is used via "Edit Definition..." in the database editor (AKA Examine Attributes).

* An option was added via "Edit Definition..." to make fields "hidden". The hidden field is still there in the tables but is not shown in the editor.

When creating a table (or by editing the definition of an existing table), you can specify which character encoding is used for the fields in the table. This has been added in connection with supporting the use of other languages and character encoding schemes in the database tables. For example, 2-byte Japanese character fields might occur in a table with a specific encoding scheme (e.g. Shift JIS).

Database Query / SML.
* The database query process now uses the new multilingual text editor and therefore allows characters from other languages to be used in character strings in queries.

The query process now checks to see if you are using a Pentium chip subject to floating point divide errors. If yes, it uses a division routine which avoids it.

Autobounds.
The process now transfers attributes from the raster database (if any) to the vector polygons. Polygon styles are also created if the input raster has a color map.

Editing Rasters.

The text crosshair entry method now supports multilingual text and Unicode fonts.

Import/Export of Rasters.
Raster objects can now be imported from the Arc/Info "Image Integrator" **BIL** (band-interleaved-by-line) and **BIP** (band-interleaved-by-pixel) formats. You may also link to this Arc/Info **BIL** format.

Scanning.
The hardware enhancements on Howtek and Howtek-compatible Sharp scanners are now supported as in **DOS MIPS V3.31**.

Raster Color Conversions.
This process now allows rasters to be skipped for **HIS**, **HBS**, and **RGB** output. For example, you can now specify that only the raster object for the "**I**" component of the **HIS** transformation be created.

Feature Mapping.
This process now creates a raster database table with the categories and features identified stored in records attached to the cell values for the category and feature raster objects. This table contains the feature class which can then be viewed using Examine /

Attributes in Display **2D**. This also allows the class to be transferred to the polygons if the features are vectorized later using Convert / Vector to Raster / Auto-Boundaries.

* Classification.

Purpose.   The multispectral-multitemporal classification process was completely redesigned for **V4.90**. The only practical limits in these revised processes are the amount of memory and the time available. The new processes also standardize the user interface, add more statistical display features, speed up the classifiers, and fix previously reported problems. The on-line documentation describes the operation of all the new features and options in detail.

Speed Enhancements.   For all methods the time to process is now linearly related to the total number of cells in the raster objects.

The processing time for some of the classification methods, notably Maximum Likelihood, will increase with the square of the number of input raster objects. Also if the increased memory required is not available as real memory, and must be satisfied via virtual memory, then a further slow down of as much 10 times could be experienced.

Memory Management Enhancements.   Memory requirements are for all classification methods are independent of the total number of cells processed. However, for most of the methods the required memory (either real or virtual) increases by the square of the number of raster objects. Therefore, doubling the number of rasters will require four times the memory to process.

The amount of memory required is NC * (20 + 8 * NR + 8 * NR * NR) bytes, where NC is the number of classes and NR is the number of raster objects. This memory requirement is doubled for the supervised (trained) classification methods. For example, classifying the 6 raster objects for the Crow Butte Landsat sample quad of 488 by 361 cells into 30 classes would require 30 * (20 +8 * 6 + 8 * 6 * 6) = 10680 bytes of memory. Increasing the number of rasters to 100 increases the memory usage to 2,424,600 bytes of memory.

Capacity Enhancements.   There is now no limit on the number of input raster objects. The maximum number of output classes has been increased to 32,000. As with increasing the number of rasters, choosing a larger number of output classes will increase the time and memory needed to process.   For example, a K-Means classification of 4 raster objects for the Crow Butte Landsat sample quad of 488 by 361 cells and 20 classes required 21 seconds to process on a Pentium 60 MHz. Increasing the number of classes to 40 increased the time required to 34 seconds (all using real memory).

Algorithm Enhancements.   The "Back Propagation" method now allows a non-random initialization of the network. This can often lead to network convergence far sooner than random initialization.

There is a new classification method available: **Minimum Distance to Mean**. This method computes the class means from the training data and simply assigns each output cell to the closest class. At the present time, only Euclidean distance is used. Additional distance measures are planned.

Using a Mask. A mask raster object may now be selected to limit the area to be analyzed, classified, or both. This is especially useful in the fully automatic methods to exclude known areas that will skew the classification results and for which no result is required (e.g. large areas of water).

Statistical Summaries. There is now an option to view the statistics for the training data. The training cell counts, means, and standard deviations are displayed. In addition, the confusion matrix, a matrix showing the distances between class means, and covariance matrices for each class are available. These statistics may be saved to a text file for later use.

The dendrogram is now available for all classification methods. The dendrogram can now be zoomed and panned. This is useful if the number of classes is so large that the dendrogram lines are too close together.

Spatial Aggregation. A new option is available to view the co-occurrence matrix. This matrix can be used to determine the spatial intermixing of classes. It can be used with an unsupervised classifier which is deliberately set up to produce a large number of classes to help label the classes sought (i.e. aggregating them into the final classes desired). If two classes have a high co-occurrence, this indicates that cells of these classes frequently occur next to each other. This information can be used, along with the dendrogram to determine which classes should be merged into a single coherent meaningful land-cover class.

This concept is described in a paper provided to MicroImages by a client and is entitled: The use of Program mCOCUR to Analyze the Co-occurrence Statistics for Image Classifications with microBRIAN. by Peter Booth and L.B. Jupp. A more complete reference to this paper is unavailable at this time.

Briefly, this reference states that a desirable land-cover classification is one in which the classes are spectrally homogeneous and the elements of the classes are spatially aggregated. Unfortunately, if an unsupervised classification produces classes that are spectrally homogeneous, then the classified image is often very spotty - that is, spatially disaggregated. The incorporation of spatial information into the classification process can assist in aggregating spectral classes into land-cover labels and should also improve the certainty of the classification.

Traditional methods of including spatial data into classification range from supervised classification by a knowledgeable operator, through the inclusion of texture channels into the data set, and the spatial stratification of the raw data. The co-occurrence statistic provides an estimate of spatial autocorrelation in the classified image, which is a spatial intermixing of classes.

The co-occurrence matrix of a classified image is a matrix that tabulates the frequency with which pixels of a given class are adjacent to pixels of every other class. Thus, this co-occurrence matrix C has elements C_{ij} where C_{ij} is the frequency with which pixels of class i have immediate neighboring pixels of class j. The algorithm used does not double count the diagonal elements of the matrix. The results are analyzed by normalizing the matrix, and the randomness of the joins between classes can be tested.

* CAD Object Copying.

An important new process is available to a copy **CAD** object into a new **CAD** object. It allows the extraction and windowing of any **CAD** elements from the existing **CAD** object. Its interface and features are similar to those of the previously available vector copy process. The **CAD** elements to be copied can be selected by database query, attributes, element selection, region selection, and so on. Its operation is described in the on-line manual.

Vector Object Copying.
* This process now supports the selection and copying of elements using attribute selection.

* Transferring Attributes.
This new process allows the user to transfer selected input vector element attributes to selected output vector elements via Prepare / Vector / Transfer Attributes. For example, you may transfer point attributes to polygons that overlap those points, or to the closest line, or to the closest point. Many other possibilities exist. After the process runs, the output vector object will contain a new database with all appropriate vector elements attached to those database records. The operation of this new feature is provided in printed form as the supplemental documentation section entitled: Vector Merge and Transfer of Vector Attributes.

Import/Export of Vectors.
The multi-file selection and processing capability has been added for Intergraph ***.DGN** and **DLG** imports.

A new "polar" vector format has been supported. This format allows simple definition of 3-dimensional shapes using sets of depth, angle, and range values.

* Vector Merge.
This new process allows you to merge two or more vector objects to form one contiguous vector object, all in one operation. This process can be found in Prepare / Vector / Merge. Each input object and attributes are copied to the destination object. Merge will split lines and create new polygons where necessary, attaching database records to the appropriate output vector element.

Fourier Transformations.
Some improvements to the user interface were completed for this process.

Progressive Transformation.
The multi-created / destroyed status dialog was replaced with a continuous status widget. The previous approach of creating multiple status dialogs slowed the performance of this process.

Japanese and Chinese Localization.
All aspects of using Japanese and Chinese within every process have been completed except as noted. Databases and their queries can be performed in these 2-byte languages. Raster editing can use these characters for annotation at any angle. The only known incomplete 2-byte language management in **V4.90** is the display and editing of vector labels in **2D** display, the object editors, and related. However, these processes were also adjusted to properly handle the 2-byte characters just after the initiation of the **V4.90 CD**s and are now available on an individual request basis. The 2-byte keyboard entry methods also vary for each brand of workstation and must be individually accommodated as needed by adjustments to the **TNT** products. Testing must now be undertaken in Japan to determine if localization problems remain and to determine the ease of translation of the user interface into these 2-byte languages.

Thai Localization.
The modifications to the **TNTmips** products to accommodate the Thai language were also completed just after the initiation of the reproduction cycle for the **V4.90 CDs**. Testing

must now be undertaken in Thailand to determine if localization problems remain and to determine the ease of translation of the user interface into these 2-byte languages.

Editing Fonts.

The outline font editor has now been deleted from **TNTmips** as it is no longer worth the effort of maintaining. The **TNT** products use ***.OF** fonts imported from TrueType. Many high quality TrueType font editors are available for **MSW3.11** and **MSNT** to alter and prepare fonts for use in the **TNT** products on any platform. Furthermore, MicroImages plans to eventually eliminate the use of the outline fonts in the **TNT** products. A new TrueType rendering engine is being coded and will eventually allow all **TNT** products on every platform to directly use TrueType fonts available for Mac, Windows, or **UNIX** platforms in any encoding scheme. Direct use of TrueType would eventually further negate the utility of the existing ***.OF** font editor.

Batch Processing.

Process status management features have been added, including error reporting into a log file. If no error occurs, the status information will indicate the time to complete the batch job. The batch job manager can now be stopped from extracting other batch jobs with the "stop" button. The batch job manager window will now also remain open when all batch processes are completed to facilitate viewing the process status logs.

New Image Printers/Plotters Supported

HP Color LaserJet [Model C3099A].

Support for this new color laser printer is now available in **V4.90** under printer levels **P8** for postscript and **P10** for direct support without Postscript. This 8.5 by 11" printer sells for about $7000, operates at 300 dpi and is fast. However, MicroImages has found that this laser printer is not the best choice for color image printing. One sample color print attached illustrating Mt. Fuji with Japanese annotations was prepared on the **HP** color LaserJet ($8000) and is reasonable in apparent quality. However, when compared with prints produced on the **HP** DeskJet 1200C color ink jet ($950 and sample also attached), the LaserJet prints are muddy and lack color contrast range. It does have the advantage of speed printing more duplicate image pages per minute. However, the **HP** Color LaserJet printer does do a good job in "plotting" text and graphics via the **TNTmips** as seen on the attached raster printing of a line map for a small area in Thailand.

Just after the new year the price of the excellent **HP** DeskJet 1200C color ink jet printer (without Postscript) dropped to $950 in the local Best Buy and Office Depot chain stores. All factors considered (print speed, quality, price, and reliability) this is the best 8.5 by 11" color printer available.

New Scanners Supported

The large format grayscale scanner sold by Altek and Vidar (a U.S. equipment manufacturer, not MicroImages Russian Representative) was supported for **TNTmips** just after the **V4.90 CD**s were reproduced. Additional details on this scanner will be provided when the support is released with **V5.00**. However, anyone needing earlier access to the support of this scanner can contact MicroImages for an early release.

Howtek has officially notified us that their Scanmaster III+ scanner has been discontinued due to irreconcilable problems with its manufacturer. A few used models are still available.

Howtek also announced that shortly the product will be replaced by a product with similar purposes and manufactured by them.

Exclusive International Representatives

MicroImages will <u>no longer</u> be directly represented in

       Spain, **Portugal**, and **Taiwan.**

MicroImages has not signed new agreements with the previous Exclusive Representatives to these 3 nations due to their inactivity in communicating with MicroImages and in their lack of understanding of the operation of the **TNT** products. Until such time as new exclusive Representatives are appointed, the purchases of **TNT** products in these countries can be made from MicroImages, any **NAFTA** reseller, or any other International Representative.

All potential and current clients in these 3 nations have been informed of these changes by direct mail. They will, as always, be able to obtain direct product support by FAX, phone, or Internet directly from MicroImages without cost.

NAFTA Reseller and VARs

No new resellers were added this quarter in the U.S., Mexico, or Canada.

Internet Support

A significant portion of MicroImages' clients now have access to Internet. This has enabled them to seek technical support via this route. Of even more significance is that it is also now common for MicroImages to receive sample data sets and provide repaired processes to clients via Internet.

Staff Additions

Kevin Royal has joined MicroImages' technical support team. Kevin completed his bachelor's degree in Agricultural Management at Northwest Missouri State University in 1988. Upon graduation, Kevin was employed as a customer service representative for Farmers National Company, a farm management company located in Omaha, Nebraska. Since 1990 and until recently, Kevin managed a portion of his family's large farm operation in Palmyra, a very small farm town about 20 miles from Lincoln. As part of this activity, Kevin became involved in the use of microcomputer image processing and GIS analysis for farm management. By a circuitous path this has led Kevin to the doorstep of MicroImages. However, you will not be visiting with Kevin for a while yet as he learns the details of the **TNT** products.

Jennifer Larson has joined MicroImages' documentation staff. Jennifer completed her bachelor's degree in Journalism at the University of Nebraska at Lincoln in 1991. Since 1991, Jennifer had been employed as a staff writer for <u>PC Novice Magazine</u> which is published by Peed Publications. In this previous position, Jennifer contributed at least four articles per month to this nationally marketed magazine.

Promo Materials

<u>Small Flier.</u>

Several copies of the new, color envelope-sized accordion flier are enclosed. Please pass these along to your professional associates who may express an interest in your activities with the **TNT** products. If they wish to have a personal copy of the sample San Francisco **TNTatlas**, they can return the attached coupon directly to MicroImages.

Approximately 12,000 of these fliers were mailed out world-wide a couple of days before Christmas. This mailing included those on the MicroImages master address list as well as mining exploration companies and U.S. counties. Additional mailings are planned in February. Over 750 of the attached coupons requesting the sample **CD** and additional information were received in the first 2 weeks of January. This is the largest number of requests for information ever received by MicroImages in any 2 week period.

TNTmips.
You will also find enclosed a new **TNTmips** product brochure. It is quite similar in interior layout and content to the previous brochures. However, there are some minor changes in content reflecting additions to **TNTmips** (e.g. the support of **TIN** objects). The remaining 5 brochures (**TNTview**, **TNTatlas**, **TNTsdk**, **TNTdemo**, and **TNT** prices) are now in various stages of preparation with new color covers and appropriate content upgrades.

Applications Checklist.
A Technical Characteristics Checklist was distributed with **V4.80** and outlined the many innovative technical features incorporated in the **TNT** product suite. A companion item entitled Professional Features Checklist is included with **V4.90**. It can be used to check off the application features of other competitive products against **TNTmips** and the other products. These materials will help you answer the inquiries of others, especially those promoting competitive products. Perhaps you are getting tired of defending your use of **TNTmips** against the characteristics of competing products. It is suggested that you ask those promoting other products to use these checklists to tabulate the characteristics of the system(s) they propose against the **TNT** products and **TNTmips** in particular.

Testimonials

From an experienced Australian client.
"We are also undertaking constancy work for this office and using TNTmips for all the mapping work (in fact, all our maps have a note at the bottom saying the map was produced using TNTmips). We are achieving far more from TNTmips that any other image processing/GIS we have previously used."

From an International Representative.
"This was a very successful 4 days of TNTmips training and response and feedback has been beyond my expectations. The positive aspect of the 4 days was that all of the 8 participants progressed from [having limited knowledge about] *GIS to a stage where they were capable of, and had imported and georeferenced a variety of datasets including TM, MSS, aeromagnetics, gravity, exploration license CAD objects, AGSO (A. Geological Survey Organization) *.E00 vector and dbf database files, in-house fgeochem and others. So, at the end of the 4 days they had built up a GIS of their areas of interest and were actively producing hardcopy of various displays using Paintjet XL and 650C."*

From an International Representative.
"[client name] *seems happier with Version 4.8."*

"I also spoke with [another client name] *who also seemed very happy with 4.8."*

From a new Australian client.
*"I've been using **TNTmips** 12 hours a day for a week now. The more I use it the better I like it! It's a great system."*

From an International Representative.
"Is it still the MicroImages custom for everyone to go to lunch once a week? If so, I would like to pay for lunch to say 'thank you' for all the hard work done this year. Please charge this to my account." [an especially tasty testimonial]

From an experienced U.S. client.
"Got your fix for disp2D (12/2/94) and got a chance to try out the new version of printrvc. Haven't had any complaints about disp2d, so it looks like it is working ok. Was impressed with printrvc. Had a lot of resizing, contrast enhancement, and yes, even rotation. The rotation buttons actually work! The impressive thing was that all through the layout process I didn't hang even once! Dithered my layouts over the networks. Even that didn't hang."

From an Australian Representative.
"May I take this opportunity to wish you and the staff of MicroImages the very best for 1995. The service support provided to [company name] by your team has been superior to anything we might expect in Australia from a GIS software development company - service from [a competitor's name] *is hopeless."*

From a purchaser in Greece of TNTdemo 4.8 (not a current client).
[public question posted on Internet]
"I've heard that a new IDRISI for MS Windows 3.x platform will be out in a couple of months. Are there any other GIS programs available for Windows that are comparable??"
"It would make more sense to me to develop a GIS program utilizing a 32-bit operating system like OS/2 or Windows 95, if it is ever released."
"Comments??"

[public response from **TNTdemo** user]
"Try TNTmips from MicroImages, Lincoln, NE (402)477-9554 CAD, raster GIS, vector GIS, database and programming environment. 30-day full featured demo license available. Win 3.1, NT, UNIX-X platforms. Seeing is believing!"

From an ERDAS user in Fresno, CA.
[public question posted on Internet]
"We are using ERDAS Imagine to load a 3-band, 6000 pixel by 6000 pixel image of Thailand. It took almost 30 minutes on a SPARC 10 running Solaris 1.x. Has anyone experienced such an unacceptable wait?"

[public response posted by MicroImages]
"It is assumed that by "load" you mean to read the 3 bands of the 6000 by 6000 pixel Landsat image from a hard drive and display the sampled image fitting on the screen in color."

*"The current **TNTmips** 4.8 (the Map and Image Processing System) from MicroImages would require approximately slightly more than 6 minutes to display same image from a hard drive on a Pentium based **PC**. It would require perhaps 1/2 that time on a SPARC 10 depending on other activity on the system."*

*"With the advanced image storage methods already implemented in **TNTmips 5.0** which will be shipped in March, the similar display of any 3-band raster of this size or even larger will take less than 15 seconds on the Pentium. This time includes the time to change the rotation angle and resample to any fractional scale."*

*"An even more demanding display test is how long it takes **TNTmips** to display from a 22,000 by 22,000 pixel Russian Priroda monochrome single-band image. With **TNTmips 4.8** displaying a 1:1 (i.e. full resolution) grayscale image would require no longer than 10 seconds. With the new features already added for release in **TNTmips 5.0** the sampled display of the entire image or <u>any subportion</u> including rotation and any fractional zoom factor will always take less than 15 seconds on a Pentium. Of course all of these times would be less when using **TNTmips** on a SPARC 10, a **DEC** Alpha, or some other faster workstation. Should you wish to see these fast displays in person you will find that your University currently has about 15 **TNTmips** systems in operation. Please contact Dr. Jack Paris in the GeoInformation Technology Center for a demonstration to substantiate the times provided."*

"posted by technical support at MicroImages, Inc., 201 N. 8th Street, Lincoln, NE 68508; voice (402)477-9554; FAX (402)477-9559; email info@microimages.com."

Technical References

Selecting a color display board for MSW3.11, MSNT3.1, and UNIX.

<u>True-Color Graphics Accelerators</u>. An in-depth inspection of 35 **PCI** and five Macintosh NuBus cards for ultrafast graphics and deep colors. by Jim Kane, Siva Kumar, and John McDonough. February 1995. in Byte Magazine, 20(1):136-152.

> This article's top rating for use on the **PCI** bus was given to ATI Pro Turbo board (retails $700 with 4 mb **VRAM**) and the Matrox Impression Plus (retails $500 with 4 mb **VRAM**).

TIN references.

<u>Modeling for Sedimentary Surface Basin Simulation.</u> by John C. Tipper. in Computer Modeling of Geological Surfaces and Volumes: pages 93 to 101. 1992. edited by David E. Hamilton and Thomas A. Jones. available from American Associates of Petroleum Geologists, Tulsa, OK. [A good, short summary of the TIN approach]

<u>Mapping Anisotropy in Computer Mapping of Geologic Data.</u> by Gregory Kushnir and Jeffrey M. Yarus. in Computer Modeling of Geological Surfaces and Volumes: pages 75 to 91. 1992. edited by David E. Hamilton and Thomas A. Jones. available from American Associates of Petroleum Geologists, Tulsa, OK.

<u>Computer Modeling of Geological Surfaces and Volumes.</u> 1992. edited by David E. Hamilton and Thomas A. Jones. available from American Associates of Petroleum Geologists, Tulsa, OK. [this whole book is quite well done]

Papers referencing work using MicroImages Products.

<u>Urban Terrain Zone Based **GIS** for **MOUT** (Military Application of a Geographic Information System).</u> by Richard Ellefsen and Jack Liu. 1994. in Proceedings of GIS/LIS '94: Annual Conference and Exposition. pp. 254 to 262. (available from Am. Soc. for Photogrammetry and Remote Sensing, URISA, Am. Assoc. of Geogr., AM/FM Intern., or Am. Cong. on Surv. and Mapping).

<u>Yesterday's spies: making a scene.</u> by Ren Capes. December 1994. in GIS Europe, 3(19):14. (This article contains a high resolution natural color image of the Buckingham Palace

area of London prepared in TNTmips by combining 2 meter Russian (source Piroda) as a panchromatic band with 20 meter 'true-color-corrected' SPOT three-band multispectral scene. Reprints of this article have been ordered and will be sent to you in a future mailing.