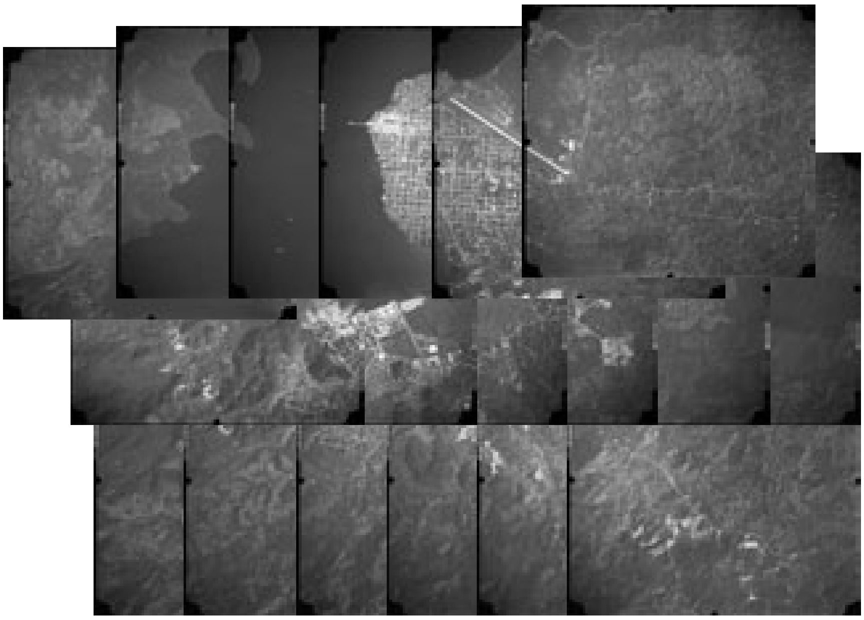


Figure 2.4-5 "Puerto Barrios", the OJT sample area

The Puerto Barrios area was the most suitable as a sample because it is covered by only 6 orthophoto maps and is separate from other areas, so that the ground control points were set out specifically for this area.

The technology transfer schedule is shown in Table 2.4-2. As there were many applicants wishing to participate, the program was implemented by dividing the minimum program necessary for acquisition of the technology (8 days) into 3 cycles. The technology transfer was conducted in accordance with the manual prepared in advance by the Study Team. After each step of the orthophoto mapping process had been demonstrated, the counterparts were asked to perform the same operation.

The participants were mainly staff members of the "Photogrammetry Division", together with several participants from the "Cartography Division" (Table 2.4-3). The skills level of participants from the "Photogrammetry Division" ranged from those with a high level of knowledge and experience in photogrammetry, to those with little experience.

Table 2.4-2 Content of technology transfer

	Description
Day 1	General explanation of digital photogrammetry and explanation of this part of the technology transfer. 1) Differences between Digital Photogrammetry and past methods, and work flow 2) Functions of the Digital Photogrammetry Workstation 3) Features and resolution of Digital Orthophoto 4) Equipment supplied in this study 5) Work flow for the preparation of the 1:10,000-scale orthophoto maps of Guatemala implemented in this study OJT [Preparation] 1) Scanning of aerial photos 2) How to use the scanner and Photoshop
Day 2	OJT [From preparation to extraction of tie points] 1) Parameter assignment as preparation for the use of VirtuoZo 2) Importing image data 3) Preparation of image list 4) Interior orientation 5) Strip offset assignment 6) Automatic extraction of tie points
Day 3	OJT [Aerial triangulation] 1) Rough adjustment computation using PATB 2) Input of control points 3) Adjustment computation by the Bundle method, using PATB 4) Accuracy control table
Day 4	OJT [Image matching and preparation of ortho images] 1) Image matching 2) Preparation for image matching 3) Compilation of results of image matching 4) Preparation of DEM 5) Preparation of ortho images 6) Mosaic
Day 5	OJT [Feature collecting (plotting)] 1) Feature collecting (plotting) using IGS 2) Input of planimetric features and contour lines
Day 6	OJT [MicroStationJ] 1) Basic operation of MicroStationJ
Day 7	OJT [Plotout] 1) Data Export 2) Plot-out using Descartes
Day 8	Q&A

Table 2.4-3 Participants in technology transfer program

	Participants
1st cycle	Luis Fidel Ajanel Mynor Mendizabal Mario E. Maldonado P.
2nd cycle	Elmer R. Estrada P. Jose G. Lopez C. Mario Orellana Regina Menendez
3rd cycle	Erick V. Moino Otto E. Fuentes Sergio A. Valenzuela T. Lesbia Carolina Herrera

3) Content of technology transfer

Day 1: Outline

First, an explanation was given of the basic knowledge necessary for handling the digital photogrammetry system provided by JICA for this Study.

The counterparts already had knowledge on photogrammetry, so this was omitted. An explanation was given in terms of a comparison of digital photogrammetry technology with conventional analogue photogrammetry techniques.

In particular, emphasis was placed on the lecture on stereo-matching technology and image data.

In addition, an introduction was given to both the hardware and software for the system provided in this study, and the work flow for the preparation of orthophoto maps and 1:50,000-scale national base maps carried out

Photo 2.4-7 Lecture on digital plotter (technology transfer)

in this study was explained.

On the second half of the day, after a brief description of the OJT to be undertaken, aerial photos were scanned using the procured scanner. Then, a lecture was given on adjusting the image quality of the image data obtained using “Photoshop”, and the work flow was demonstrated.

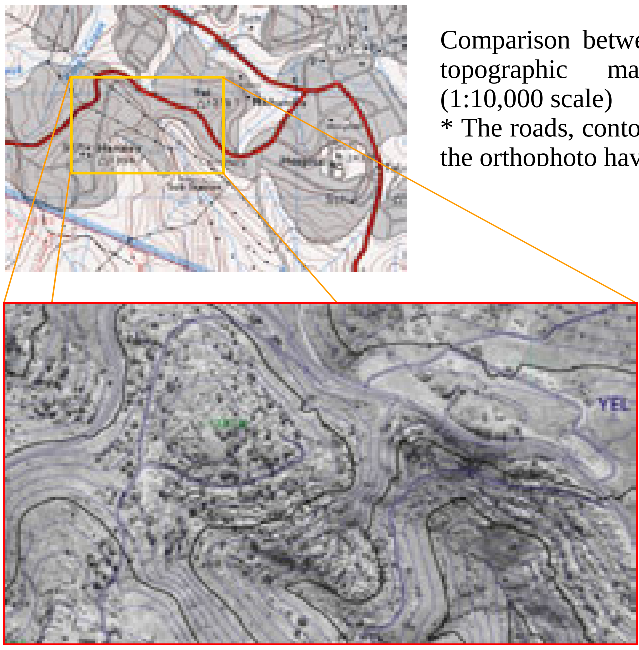
Day 2: Outline

On the 2nd day, OJT commenced using the digital photogrammetry systems “VirtuoZo” and “VirtuoZoAAT”.

First, the setting of various parameters and preparations necessary to start work was carried out. Next the parameters for camera calibration, ground control point data, DEM intervals and the resolution of orthophoto data were set before the conversion processing of the image data was implemented. For the next step followed a lecture and practical training on the process from automatic interior orientation to extraction of tie points (relative orientation). Although the most advanced digital photogrammetry system was used, the process itself is not greatly different from photogrammetry using conventional analogue equipment, so that the practical training could go forward smoothly.

Photo 2.4-8 Practical training in digital plotting using a stereoscope

Day 3: Details



Comparison between line map (1:50,000 topographic map) and orthophoto (1:10,000 scale)
* The roads, contours, annotations, etc. on the orthophoto have been plotted.

Figure 2.4-6 Difference between line map and orthophoto map

Aerial triangulation using "VirtuoZoAAT" and "PATB" was carried out.

First, those of the tie points extracted on Day 2 that had large errors were deleted using "PATB", after which the control point data was input using "VirtuoZoAAT". After the adjusting computation method using "PATB" was explained, the processing was actually carried out. The results obtained from the processing were verified and the control points with large residuals were remeasured and the process was practised until the residuals were within the allowable range. Finally, using the accuracy control table actually used in the Study, an explanation was given on how to prepare the table and how to implement accuracy control.

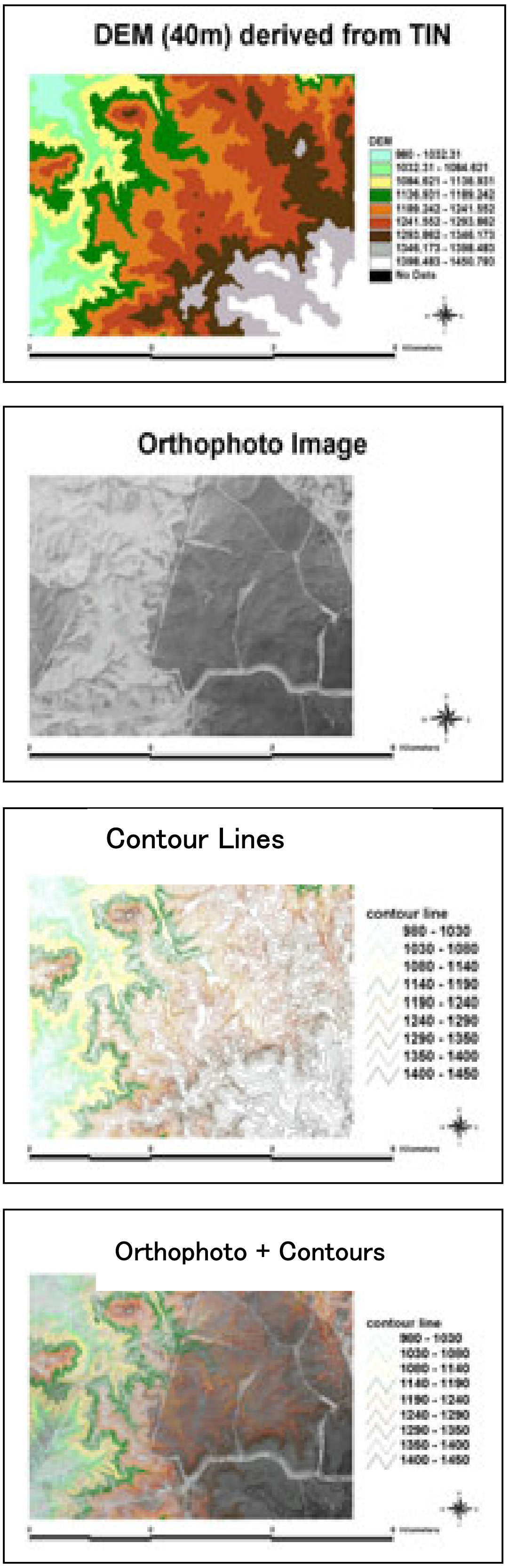


Figure 2.4-7 Orthophoto creation process

Day 4: Details

Continuing the Day 3 work, practical training was given in image matching and orthophoto image creation, using the sample data.

First, epipolar images were created and the automatic stereo matching of these images was carried out. For those parts (shadows, mountainous areas and water surfaces) of the resulting DEMs that were not properly matched, an explanation was given of how to edit the DEM in order to obtain more appropriate values. Then, an orthophoto and DEM was created for each model using automatic processing, and practical training was given in mosaicking these to create an overall orthophoto and DEM as the finished product.

Day 5: Details

Digital plotting work was practiced, using the epipolar images created on Day 4. Then, an explanation was given on "IGS", the plotting application integrated into "VirtuoZo" as a plotting tool, and practical training in topographic data acquisition was undertaken.

In topographic data acquisition, the explanation focused on the data acquisition standards unique to digital mapping, such as layer assignment for each item, data types (lines, symbols, curves, etc.) and node matching (processing of line ends). The simple editing functions of "IGS" were also explained.

Day 6: Details

An orthophoto map is the ortho image output with an overlay of vector data such as contour lines, roads and rivers. At this point, practical training was given in the "MicroStationJ" functions for editing these vector data.

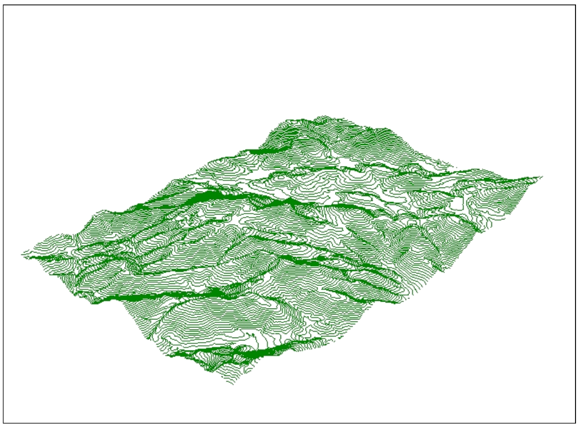


Figure 2.4-8 Solid terrain image using DEM

Because of the special characteristic of the orthophotos in this case, in that they were being used as the background for hazard maps, there were fewer vector data items than for general orthophotos, so that the compilation was easy if the basic functions were mastered.

Actual training began with the start-up of "MicroStationJ", followed by the updating, movement, copying and deletion of various elements. These operations were explained and practised.

Day 7: Details

The orthophoto images and vector data created on the course so far were overlaid and output via the plotter provided as one part of the study equipment.

Since the vector files acquired using "IGS" were in a special format that could not be converted directly into a DGN file, which is the "MicroStationJ" format, it was converted into the "MicroStationJ" format

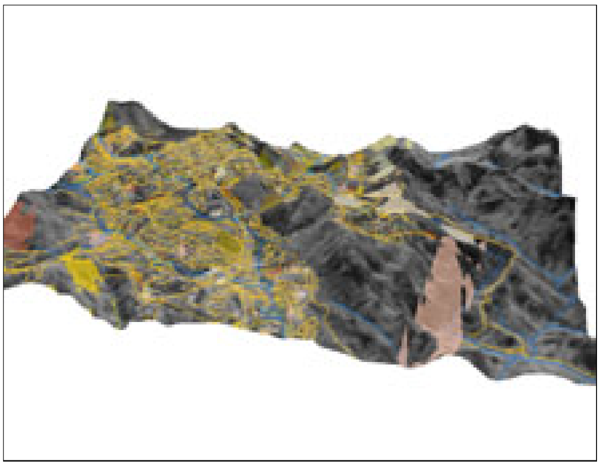


Figure 2.4-9 The solid model above +orthophoto + line data

via the universal DXF format. The orthophotos created using "VirtuoZo" were converted into the Tiff format, which is a "World format". Both were then overlaid on "MicroStationJ" for checking, then output.

Day 8: Details

On the final day, there was a Q & A session to deal with the problems that had arisen so far in practical training, giving each participant a deeper understanding.

4) Counterparts' understanding of the technologies transferred

a) Knowledge of digital photogrammetry

The digital photogrammetry system was a new piece of equipment brought in as part of the study equipment, but since the basic theory of digital plotting is not that much different from analogue methods, those experienced in photogrammetry seemed to have no problem understanding it.

Concepts that are unique to digital photogrammetry, such as "epipolar images", might be less easy to understand, but repetition of the actual work in the future will deepen the counterparts' understanding of them.

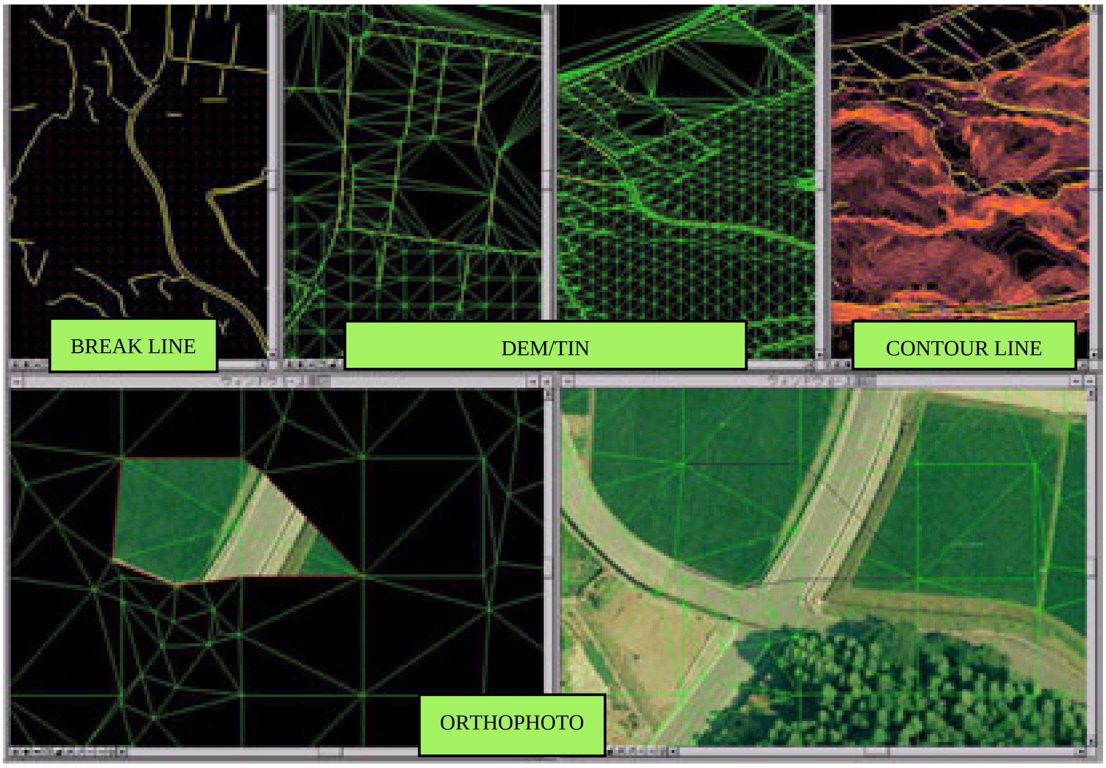


Figure 2.4-10 Various stages of the orthophoto preparation process

b) Aerial triangulation using the digital photogrammetry system

The counterparts seemed to have little experience in wide-area aerial triangulation. However, they were able to gain a better understanding of it from an explanation of the full process of the work as they practised on a sampling of a relatively small area.

In an ordinary wide-area aerial triangulation, more conditions must be added than in the sample area used for practical training. The adjustment computation software "PATB" also has many other functions apart from those for which training was given. It is judged that as they handle many actual tasks the counterparts will acquire a wide range of applied technology through trial and error.

c) Creation of DEM, creation of orthophotos and mosaicking

"VirtuoZo" can perform automatically the processes of creating DEM or orthophotos and mosaicking, which are relatively simple operations. Thus, the operating technology was understood and mastered with no problems. However, while the DEM and orthophoto image were checked on the screen after computation, the computation process to that point may have been difficult to understand intuitively.

d) Digital plotting

The study equipment was equipped with the same kind of interface as conventional plotting equipment, such as a hand wheel (X,Y), Z-board and foot pedal, rather than a 3D mouse. This meant that the engineers experienced in operating a plotter had no trouble with the operation of the equipment. Although the touch of the foot pedal and the timing of data point entry were

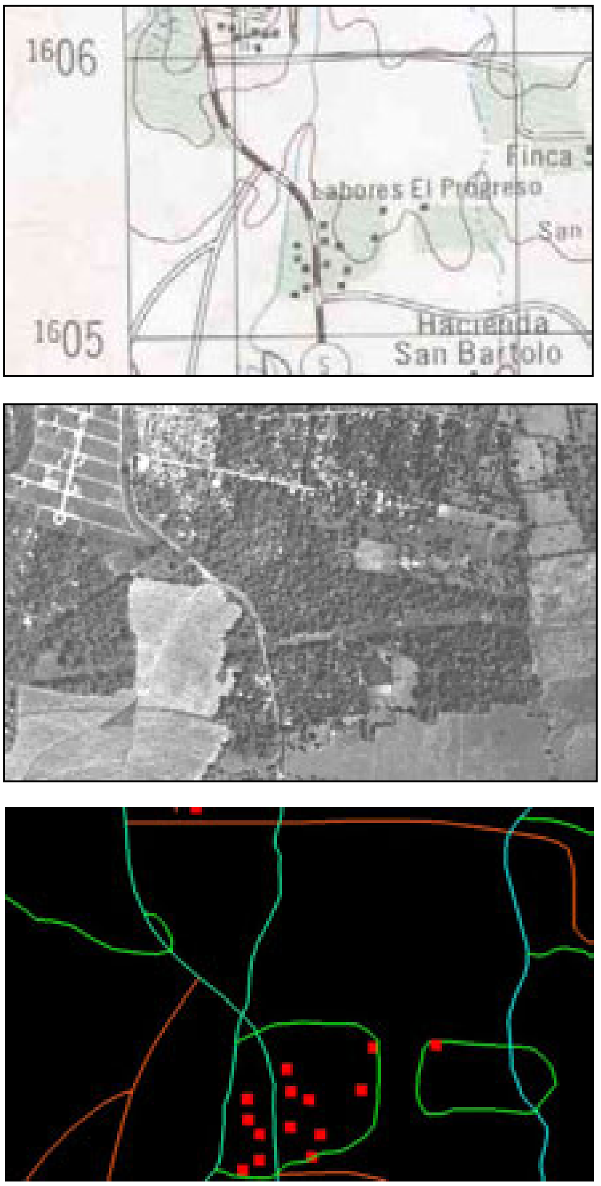


Figure 2.4-11 Relationship between existing map, orthophoto and existing data

perceived to be a little different from conventional plotters, it is thought there will be no problem once they are familiar with the equipment. They could readily understand the effective use of the input support functions, such as right-angle correction and node matching.

e) Compilation using MicroStationJ

The counterpart agency possesses “AutoCAD”, a CAD software application with functions similar to those of “MicroStationJ” and has made effective use of it in digitization. In this study, the counterparts underwent practical training in the basic operation of “MicroStationJ”. They were not familiar with the operational differences between this and “AutoCAD”, but they had no trouble understanding the basic functions. They were also able to master the operation of a simple compilation task using the orthophoto map data, which in this study was limited to the data acquisition items.

f) Conclusion

By and large, the acquisition of technology relating to the creation of orthophoto maps, which was the aim of the present technology transfer program, was achieved. Content included knowledge of digital photogrammetry, aerial triangulation, DEM creation, orthophoto creation,, digital plotting and simple digital compilation using the digital photogrammetry system.

Generally speaking, there was a tendency for those engineers with a long experience in plotting to be unaccustomed to operating a PC, while conversely the young engineers who were proficient in PC operation had less experience in plotting. However,

Figure 2.4-12 Existing data + ortho, existing data + new line data, compiled line data + ortho

this situation is the same in any country, not only Guatemala. It is essential to merge both types of engineers.

"VirtuoZo" is a digital photogrammetry system that is highly valued for its accuracy and speed in automatic matching. On the down side, a disadvantage is that images and vector data are acquired in a unique format, which must always be converted when the data is transferred to any other system.

(2) Transfer of technology for topographic mapping and orthophoto creation (part 1)

1) Introduction

The technology transfer in the third field survey on the methods for creating 1:10,000 scale orthophoto maps was implemented. In the fourth field survey, the technology transfer was aimed at acquiring the techniques for correction of secular changes to the 1:50,000 scale national base maps. The digital plotter that had rapidly been spread worldwide in recent years was capable of creating not only the digital orthophoto maps but also plotting line maps. It was also particularly suitable for plotting of modifications of secular changes in this Project. This technology transfer was carried out considering the effective use of the study equipment provided by JICA.

The techniques and knowledge to be acquired in this technology transfer covered the single-model orientation method, digital compilation, the method of creating map symbols and the vectorizing of map sheets. In these processes, the digital photogrammetry system "VirtuoZo", the data compilation CAD software "MicroStationJ" and the add-on software "MicroStationDescartes" for display and output of image data were used.

2) Outline of technology transfer

The technology transfer was carried out in accordance with the flowchart of correction work for the 1:50,000 scale national base maps (Figure 2.4-13). The products from the actual correction work for the national base maps were used as samples for this technology transfer program.

The technology transfer was scheduled as shown in Table 2.4-4, and it was provided in 3 cycles, each cycle taking the minimum necessary period of nine days for gaining the mastery of the technology. The first six days were allotted for the explanation and exercises in the use of the technology. In the remaining three days, the counterparts, on their initiative, reviewed and practiced the technology acquired in the first six days for mastering the technology.

There were many techniques that overlapped with those transferred in the third field survey, but these were not omitted, and were reviewed through lectures and exercises in order to deepen the counterparts' understanding.

The participants were mainly the staff members of "Photogrammetry Division" and one member of "Cartography Division". The list of participants is shown in Table 2.4-5.

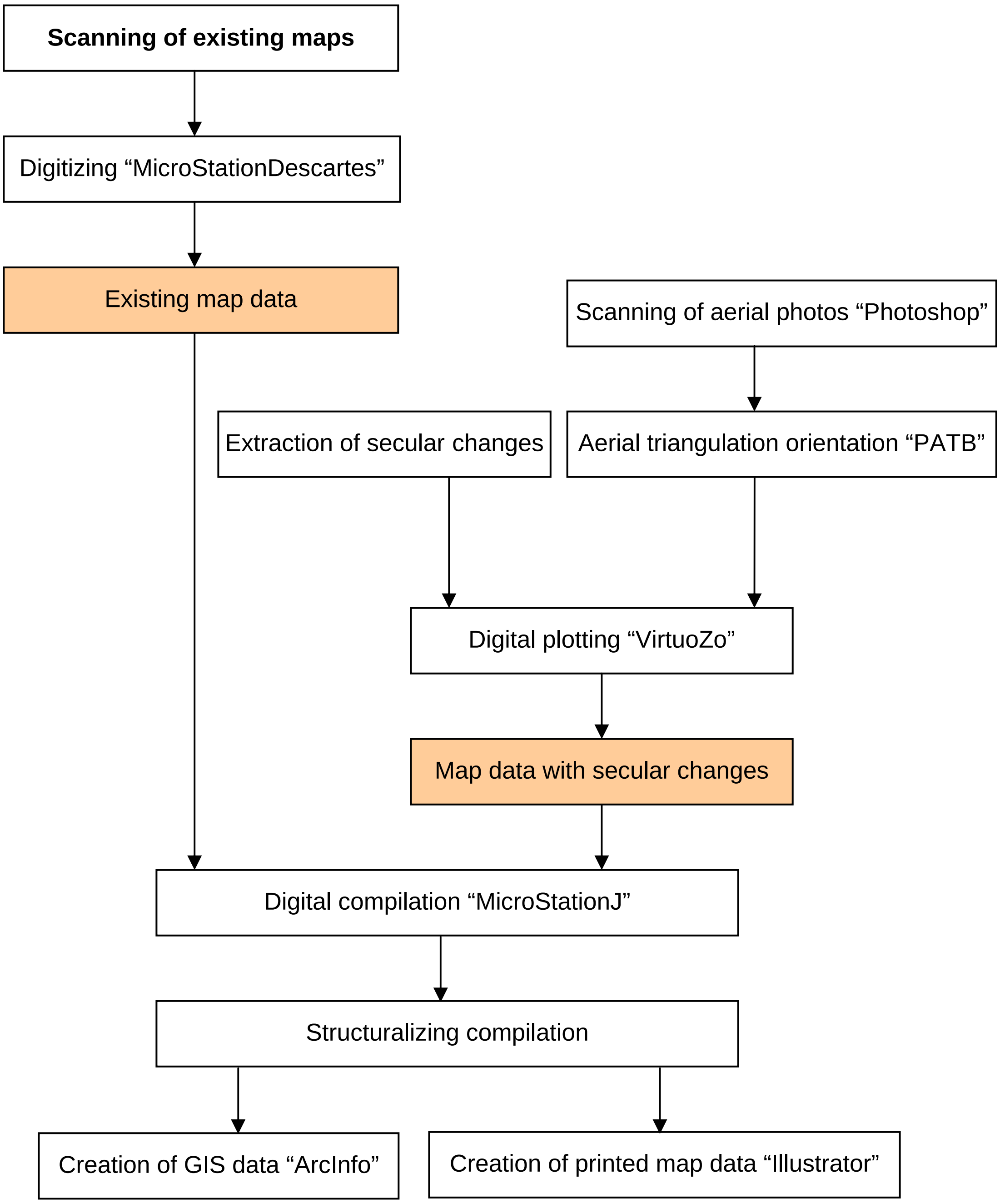


Figure 2.4-13 Flow of correction of secular changes to national base map

Table 2.4-4 Details of technology transfer

Schedule	Outline
1st day	**Orientation of a single model** The method of orienting a relatively small area as one model without executing aerial triangulation was explained using “VirtuoZo”.
2nd day	**Orientation of a single model for the case that the product of aerial triangulation was available** The orientation method for the case that aerial triangulation had been conducted was explained. In this case, the products in the work of producing the 1:50,000 scale national base maps were used. “VirtuoZo” was used.
3rd day	**Operation of “MicroStationJ”** The basic operation procedure of “MicroStationJ” that was acquired in the previous technology transfer was reviewed. Then, the operations necessary for using “MicroStationJ” in the practical work were explained.
4th day	**Symbols and special lines** The “cells” that were symbols on “MicroStationJ” were created and the method of registering the “cells” in the “Cell Library” and the method of arranging the “cells” were explained. For handling special lines (such as broken lines) on “MicroStationJ”, the method of creating and using special lines by the use of “Patterning” and the method of creating and using special lines by the use of “CustomLine” were explained.
5th day	**Digitizing existing maps** The method of digitizing the existing map sheets on “MicroStationJ” was explained. The practical operations of “MicroStationDescartes” such as Geo reference to raster data and vectorizing of lines, symbols and texts were explained.
6th day	**Secular change corrections to 1:50,000-scale national base maps, establishment of map symbols (data acquisition standard), and digital compilation** The method of correcting secular changes in the 1:50,000 scale national base maps was explained. The data acquisition standard and points of caution in producing map sheets from digital data were also explained. The method of compiling the data acquired in digital plotting was also explained.
7th – 9th days	**Exercises** The counterparts did repeated exercises on the processes of digital plotting, digitizing and digital compilation on their initiative and based on the results of past exercises.

Table 2.4-5 Participants in technology transfer

Course	Participants
1st cycle	Erick. V. Monio Otto E. Fuentes Jose G. Lopez C. Regina Menendez
2nd cycle	Mario E. Maldonado P. Luis Fidel Ajanel Cesar Lopez
3rd cycle	Sergio A. Valenzuela Elmer R. Estrada P. Mynor Mendizabal

3) Details of technology transfer

Preparation

The operational check on the study equipment installed in the previous field survey was made before starting the technology transfer. It was confirmed that almost all the equipment was able to operate normally, but the cable extended from the encoder around the handle of the digital plotter was disconnected. (See Figure 2.4-14). The wire disconnection probably appeared to be caused by an accident in which a participant's foot was caught by the cable when rotating the Z-disk in plotting, thereby having applied a large load to the connection with the encoder. The repair of the equipment was requested of a precision equipment supplier in the City of Guatemala and was completed two days later, so that the equipment was rehabilitated. It was foreseen that such similar accident might occur in the future and the order for a spare encoder was placed with the supplier of the digital plotter in Tokyo. The spare encoder was provided to IGN. (See Figure 2.4-15)

Based on this experience, the cable from the encoder fitted at the present digital plotter was fixed so that no direct load would be applied to the connecting part with the encoder if the cable catches any person's foot. (See Figure 2.4-16). It is common that this connecting part is designed to be flexibly detachable plug type in other digital plotters. Thus, it was pointed out to the plotter manufacturer that this equipment should be improved at this part.

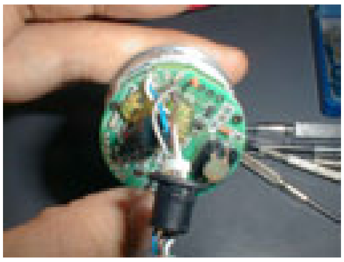


Figure 2.4-14 Broken encode


Figure 2.4-15 Spare encoder


Figure 2.4-16 Fixed cable

1st day

First, the outline of the technology transfer was explained before starting it. The flowchart of secular change correction to the national base maps (Figure 2.4-13) was presented to explain the flow of the secular change correction work. This flowchart was also used in the technology transfer as needed on and after the 2nd day in order to ensure that the counterparts securely grasp the significance of each technique to be acquired in the entire flow of work.

During the latter part of the first day, the technique for orienting a single model for a relatively small area was explained and practiced. In the secular change corrections, the aerial triangulation was not conducted, but each single model was oriented (studied separately) in most cases. As it was expected that the counterparts would have more opportunities of plotting small areas, much time was allotted for the exercise for them to gain the complete mastery of the technology.

In the work of correcting the national base maps, the plotting samples prepared in Japan were used for the exercise because the control points were not installed in Guatemala. (See Figure 2.4-17)

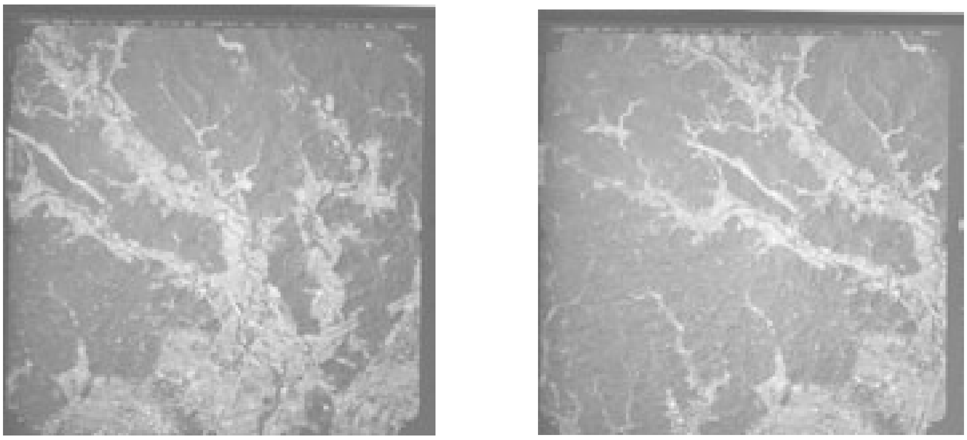


Figure 2.4-17 Aerial photos of sample areas

2nd day

The orientation method was explained and practiced using the product of PATB that was the typical adjustment computation software for aerial triangulation and that was introduced as one item of the study equipment. (See Figure 2.4-18)

Figure 2.4-18 Index map for 1:50,000-scale national base map

As described in the Progress Report 2, the Study Team implemented the aerial triangulation of the entire study area using the digital plotting system because there were many features with secular changes that were found in the second field survey though JICA Work Instruction Manual specifies: “Plotting shall be carried out by map sheet orientation.” The technology transfer in the fourth field survey was conducted using the products of PATB at that time (Figure 2.4-19). The greater part of the techniques was overlapped with that on the 1st day, which was also practiced for review.

A part of this process clearly involved some bugs in VirtuoZo. As it was important that the counterparts understood this problem, the countermeasure against it and the processing method were also lectured to them.

Figure 2.4-19 Dialog for entry of PATB products

This problem was that "the parallax would remain after orientation if p (3.141592) is not subtracted from the value in the exterior orientation element file."

This means that the orientation element should be entered for each photo image by manual computation. Therefore, it is necessary to integrate a simple processing program into the software in considering the higher work efficiency in the independent practical works by IGN in the future.

425833.01116	1718941.29110	8946.64422
-0.016022	-0.044786	3.173133

Figure 2.4-20 Results of exterior orientation elements

3rd day

The first part of the day was to be allotted to the review of the operation method of MicroStationJ that was transferred in the third field survey. The latter part was planned for the explanation and practice of the detailed operation method necessary for the practical work. However, the review of the previous transfer took more time than expected and the planned program for the latter part was shifted to the 6th day.

The study equipment was set up on the condition that the process after plotting would be performed on MicroStationJ. As a high level of knowledge on MicroStationJ was required to produce the planned map sheets, it was decided to use the latter part of the 3rd day to do repeated exercises on the basic operation procedure.

4th day

The technique for creating symbols and special lines to be prepared using MicroStationJ before producing the products was explained and the exercise for creating some simple symbols and special lines was done. (See Figure 2.4-21)

5th day

The method of vectorizing the map sheets using Descartes that is the add-on software to MicroStationJ and is capable of handling the image data was explained and exercised. (See Figure 2.4-22). This technology transfer covered a wide range: from the cautions for scanning to the positional relation of the vector data with the images and the manual and semi-automatic vectorizing methods. The blue plate (related to water areas such as rivers) and sepia plate (related to contour lines and their values) from the scanning data of the existing topographic maps that was acquired in the work of correcting the national base maps were used as sample data.

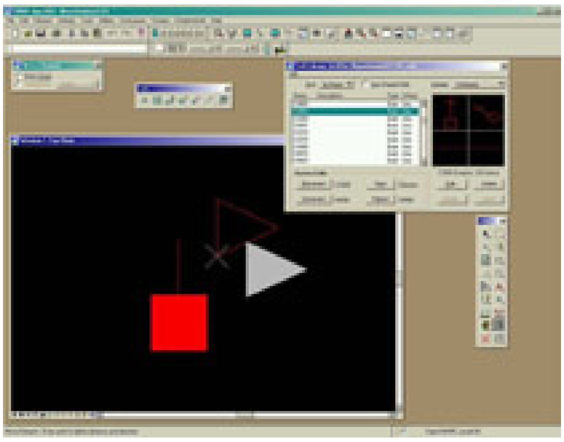


Figure 2.4-21 Creation of symbols

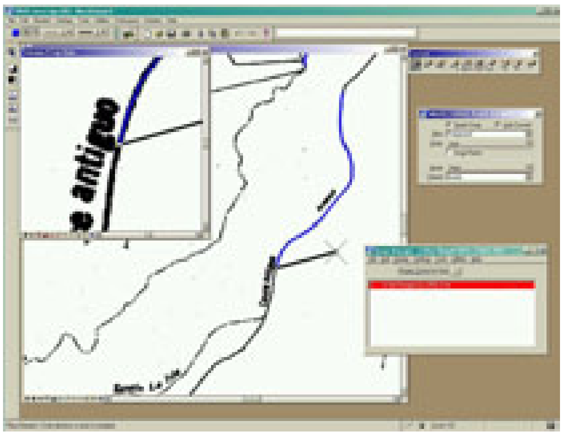


Figure 2.4-22 Digitizing

6th day

The operation of MicroStationJ for applications that was planned for the 3rd day was explained. Special importance was placed on the items such as the plot-out method and the 3-dimensional concept, which were difficult to understand by only referring to the manual attached to the software. How to use the mastered operation procedure for the actual compilation work was also exercised using the products from the work of correcting the national base maps. How to define the matters to be specified before producing the map sheets including the symbol structuralizing method was also explained.

7th to 9th days

During 3 days of exercises, the review was made focusing on the operation of VirtuoZo, which, compared with MicroStationJ, was difficult to learn without an instructor.

A series of operations for the single model orientation that was practiced on the 1st and 2nd days was repeated until the counterparts could master completely on their own. In this exercise, no instruction was given from the Study Team, but only minimum advice was given, when required.

4) Counterparts' understanding of technologies transferred

a) Knowledge on secular change correction technique

This technique was changed from the analog to the digital method, but the process of extracting and plotting the features with secular changes was basically the same, so that the counterparts dealing with the practical work of photogrammetry could understand the technique by minimum explanation. Therefore, stress was placed on the explanation of the effectiveness of aerial triangulation and the importance of data matching at the time of secular change correction because the counterparts were deemed to be unfamiliar with them.

b) Single-model orienting method

It was expected that the counterparts could fully understand two techniques for the use of the products of aerial triangulation and for the use of ground control points.

In the previous third field survey, the technology transfer was made on a wide range of area, so that much time was used for image conversions and the products were made up several days after the lecture. Compared with this case, the time taken for one process was relatively short in the fourth field survey, so that the exercise of a series of processes from preparation to making up products could be carried out one day after the lecture. It made them understand the workflow easily.

c) Compilation on MicroStationJ

In the previous technology transfer, the basic operation of MicroStationJ was already explained, so that the technology transfer this time would be intended for applications. When the technology transfer was started, however, the counterparts appeared to show some perplexity in operating MicroStationJ. Therefore, the explanation of its basic operation was explained again in the same way as in the previous time. After that, the explanation on applications was made, but there was great difficulty in understanding those application techniques because a certain level of knowledge and experience was required.

The great difficulty in understanding was caused the

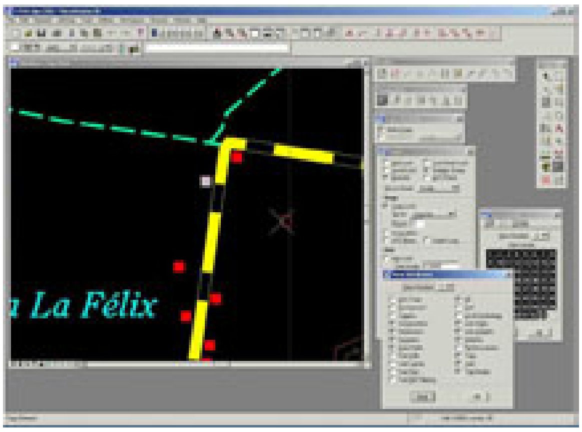


Figure 2.4-23 Digital compilation work

counterparts having no opportunity of operating MicroStationJ in their practical work after the previous technology transfer. The counterparts preferred the AutoCAD with the similar functionality and they showed excellent capability of operating it. Probably, they would prefer to use AutoCAD application software for their practical work. (Figure 2.4-22)

However, the counterparts are required to master as soon as possible the operations of the vectorizing functions of Descartes as will be described later, the data cleaning function of MicroStationGeographics that is planned for the next technology transfer, and MicroStationJ, that is excellent as mapping CAD, because they were going to use the digital plotter with these functions.

d) Method of creating symbols and special lines

The process of creating map symbols is a designing work rather than mapping work because the sizes of map symbols are specified as numerical values. The counterparts fully understood the process of creating symbols, but they were required to have knowledge and experience other than for topographic mapping in order to create figures as specified by the design diagrams (specifications).

The technique to create complicated special lines (called Custom Lines) on MicroStationJ is troublesome and difficult to understand. The counterparts could not fully understand it from one cycle of explanation, but the trial and errors are necessary for them to master the technology and they should get familiar with this software by creating making more opportunities for using it.

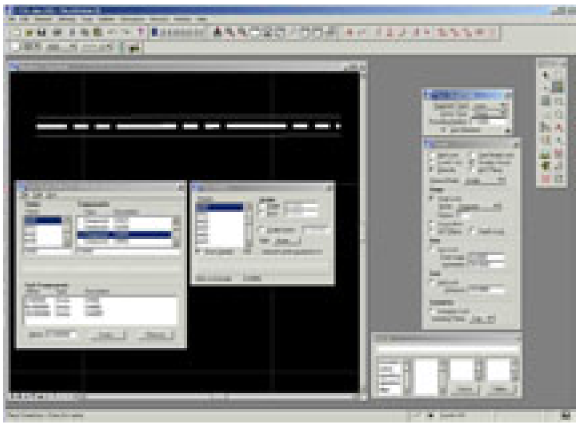


Figure 2.4-24 Creation of Custom Line

e) Vectorizing on Descartes

The counterparts had experienced the process of scanning and digitally vectorizing map sheets to create the vector data. The operation for digitizing the data on Descartes was so simple that the counterparts could acquire the techniques smoothly.

f) Conclusions

The technology transfer had so many participants that one cycle was forced to be shortened to a period of nine days.

Only one unit of digital plotter was used for the technology transfer on digital plotting, so that every participant could not operate that one unit of plotter. Based on the reflected points in the previous lecture, however, the latter part of the period of the lecture was used for exercises to ensure that the participants could operate the equipment repeatedly. As a result, they could master the technique for secular change correction.

The participants were grouped in such good balance that the long-experienced and the less experienced were mixed in each group and that the experienced could often furnish technical consultation to the less experienced during the technology transfer exercises. This chance given the participants was one of the positive effects of the technology transfer.

It was also impressive that the counterpart side had a strong determination to make use of the furnished training for their actual work. The Study Team received many questions after lecture hours and responded to as many as possible in order to help enhance the participants' understanding.

As so many staff members participated in the technology transfer, it was surely effective that the knowledge on digital photogrammetry spread widely among IGN and other related agencies. However, it is also necessary that the participants would pursue the practical

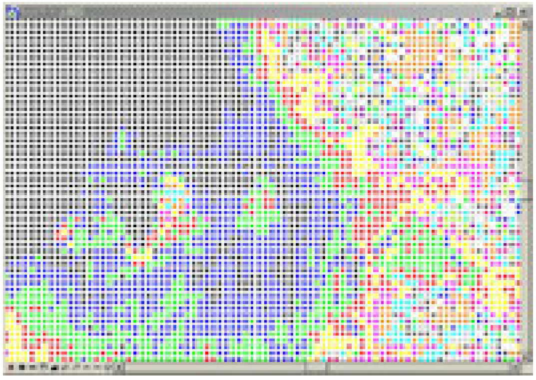


Figure 2.4-25 DEM

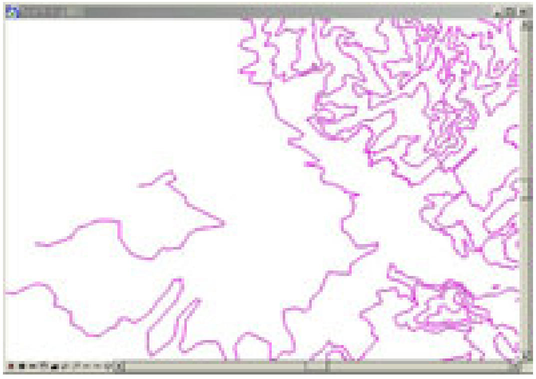


Figure 2.4-26 Contour

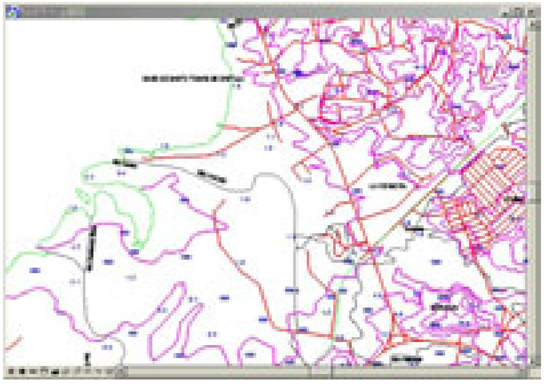


Figure 2.4-27 Vector data

Figure 2.4-28 Mosaic-processed orthophoto

work in their individual fields to become experts and to complement one another in their functions.

In the work of correcting the secular changes to the 1:50,000-scale national base maps, it was difficult to keep a uniform accuracy for all the areas in map orientation for each single model and it was foreseen that the work efficiency would be lower from the comprehensive viewpoint. Thus, the aerial triangulation was implemented by dividing each area into 2 blocks. The results of aerial triangulation and the scanned aerial photo images were provided to IGN.

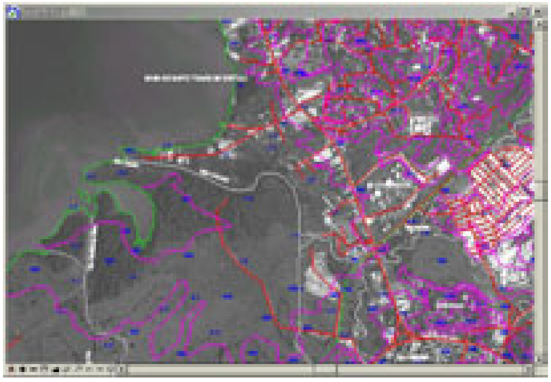


Figure 2.4-29 Integration of orthophoto with vector data

It was highly valuable that the effective use of these materials and data served to acquire the orthophotos, DEMs and topographic map data on arbitrary areas through simple work. The participants could get familiar with the operation techniques on the 2nd day and for the latter days of exercise. It is expected that various types of data provided and the technology furnished in the technology transfer will have useful effects on the future work of the counterparts.

(3) Transfer of technology of topographic mapping/orthophoto production (part 2)

1) Introduction

The lecture for the 1/10,000-scale orthophoto production method was carried out in the first technology transfer and the lecture for the method of secular change correction method for the 1/50,000-scale national basic maps was provided in the second technology transfer. In this project, the aerial triangulation for multiple models was carried out and all the processes up to orthophoto production were reviewed and exercised. The lecture for these processes was finished in the first lecture, but the technology was not fixed among the counterparts because they had little opportunity of using this technology in their actual activities. Therefore, the practical trainings on the technology were repeated at the second lecture aiming at fixing the most important technology in digital photogrammetry.

In addition, the technology in the method of utilizing the vector data and raster data in the products by the use of MicroStationGeographics and TNT-mips was also transferred to the counterparts.

The software used in the second technology transfer included the digital photogrammetric system "VirtuoZo", the data compilation CAD "MicroStationJ", the add-on software "MicroStationGeographics" having the GIS-based functions for "MicroStationJ", the GIS "TNT-mips" and the graphic software "Photoshop".

2) Outline of technology transfer

The schedule of technology transfer is shown in Table 2.4-6. Orthophoto production was carried out for 3 days, and the operation of MicroStationGeographics and TNT-mips was exercised for the remaining 2 days. All 8 staff members except the managers of Photogrammetry Division participated in the lecture (Table 2.4-7). Of the participants, one member joined the lecture for the first time, another member attended only the second lecture and others participated in all the technology transfer including the first one.

Table 2.4-6 Technology transfer schedule and items

Schedule	Lecture Item
1st day	Orthophoto map production (1) "VirtuoZo" was used in parameter setting, internal orientation and relative orientation.
2nd day	Orthophoto map production (2) "PATB" and "VirtuoZo" were used in entry of ground control points and aerial triangulation (adjustment calculation).
3rd day	Orthophoto map production (3) "VirtuoZo" was used in creation of epipolar images, stereomatching, creation, evaluation and editing of DEMs, orthophoto production and mosaicking.
4th day	Operation of "TNT-mips" (1) "TNT-mips" and "Photoshop" were used in the basic operation of "TNT-mips" and orthophoto mosaicking.
5th day	Operation of "TNT-mips" (2) and operation of "MicroStationJ" "TNT-mips", "Photoshop" and "MicroStationGerographics" were used in orthophoto mosaicking and vector data cleaning.

Table 2.4-7 Participants in technology transfer

Course	Participant
1st lecture	Otto E. Fuentes Jose G. Lopez C. Mynor Mendizabal
2nd lecture	Sergio A. Valenzuela Elmer R. Estrada P Luis Fidel Ajanel
3rd lecture	Juan Carlos Cesar Lopez

3) Content of technology transfer

Preparation

Before beginning the technology transfer, the PC that had been used so far was replaced with new one (Photo 2.4-9). Various applications were installed in the PC, to which peripheral equipment was connected, so that the environment at the time of equipment introduction before the PC was broken down was restored.

Photo 2.4-9 Replacing PC

The software “VirtuoZo” installed in this project was upgraded from the originally used version (Ver3.1 → Ver3.3). The new version is not largely different from the older one, but supported the license management by dongle.

1st to 3rd day

Before the technology transfer was begun, its outline including those of the first and second technology transfer was explained. The processes up to orthophoto production that were lectured in the first lecture were repeatedly explained and practically trained.

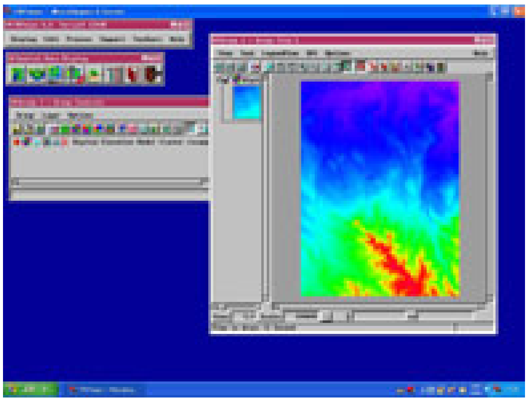


Figure 2.4-30 Practical training in use of sample data

4th day

The GIS software “TNT-mips” was explained. The interface with “TNT-mips” is under the strong influence of UNIX, but different from Windows. The RVC file to be used with this software has a unique structure that can store various types of data called objects in the single data file. Therefore, the trainees began with the step in which they got familiar with the operation in displaying and checking the tutorial sample data prepared for the lecture. (Figure 2.4-30.)

The lectures and practical trainings intended for the practical work were made in the second half-day hours. First, the basic method of setting GTM to “TNT-mips” was explained and exercised. This operating process is not so complicated so that the trainees could fully

Figure 2.4-31 GTM setting

understand it. (Figure 2.4-31.)

Subsequently, the method of mosaicking orthophoto images was explained and exercised. The orthophotos that the Study Team had prepared were in the scale of 1/10,000. In considering the future use of it, the scale was too large, so that the number of map sheets might be so high and difficult to handle. Thus, it was necessary to mosaic (combine) some orthophotos to form a single orthophoto image. In this case, it was a problem that the neatline of this orthophoto was defined by latitude and longitude, deforming the neatline on a plane. However, the image data has a structure in which the data pixels are arranged in a rectangle of m x n, but not arranged diagonally. In the orthophoto images prepared by the Study Team, the data stuck or lost out of the neatline of a printed map was cleared by arranging white pixels. (Figure 2.4-32)

In simply mosaicking orthophoto images, the white pixel zone may hide the pixels representing a topographic map part, causing a white blank part between the neatlines. (Figure 2.4-33)

The mosaicking process using “TNT-mips” (Figure 2.4-35) solves this problem (Figure 2.4-34.). In mosaicking in practice, the white pixels were processed as Null, so that the white

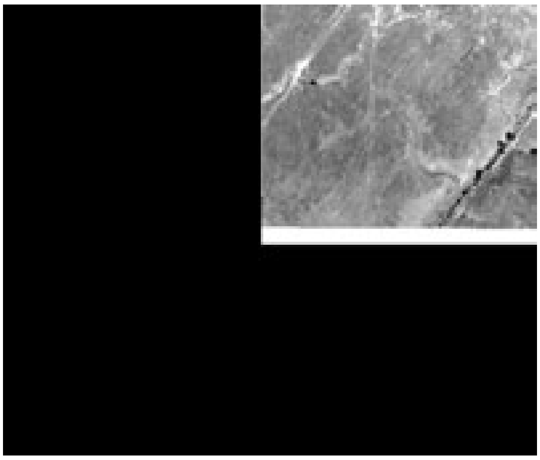


Figure 2.4-32 Pixels along a neatline

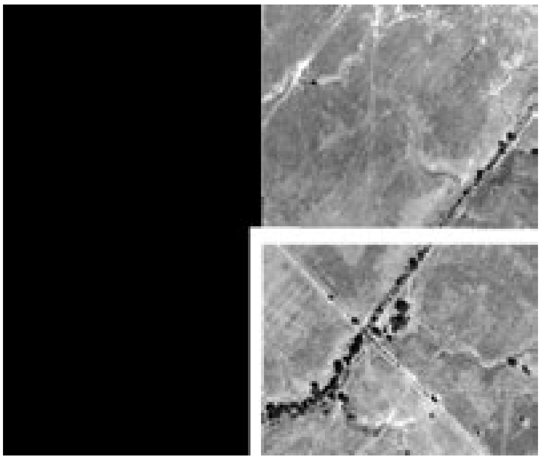


Figure 2.4-33 Mosaicked orthophoto image

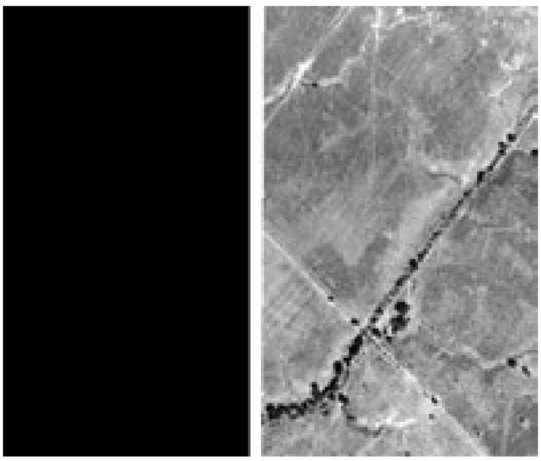


Figure 2.4-34 Ortho-image with white zone cleared

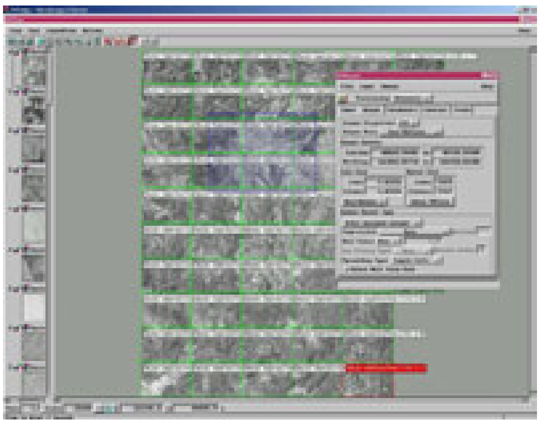


Figure 2.4-35 Mosaicking process using “TNT-mips”

pixels were transparent, disturbing the topographic map data. This processing method was also explained and practically trained.

5th day

The mosaicking process exercised in the second half-day hours on the 4th day consisted of many steps and it is a technology that will be required often in the future. It is necessary for the trainees to acquire the technology, so that the exercise of the mosaicking process was repeated in the first half-day hours on the 5th day.

In the second half-day hours on that day, "MicroStationGeographics" was explained. For effective use in GIS of the map data files that was created through plotting and compilation, the map data files had to be set to the condition to ensure the phase structure to be configured. For this, it was necessary to eliminate the problems such as dangle, gaps, duplicate or infinitesimal segments (Figure 2.4-36). The method of solving these problems by the use of "MicroStationGeographics" was explained (Figure 2.4-37).

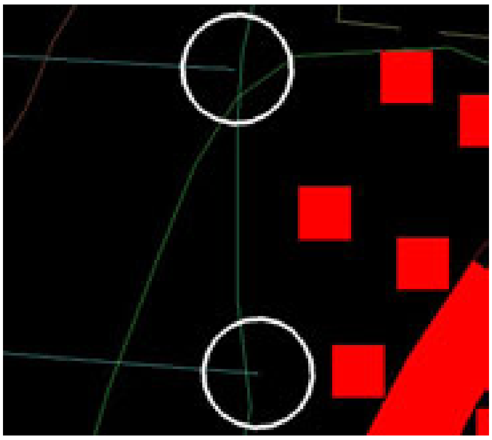


Figure 2.4-36 Dangle and gaps

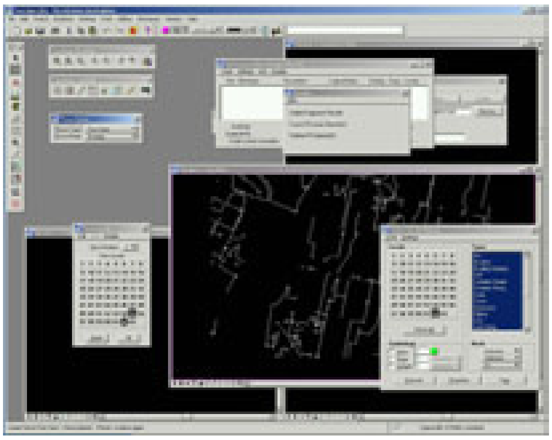


Figure 2.4-37 "MicroStationGeographics" screen

4) Counterparts' understanding of the technologies transferred

a) Orthophoto map production technology

This technology was explained and exercised in the 1st technology transfer, so that the counterparts could fully understand the operation and processes without any large questions. However, it is necessary for them to deepen the knowledge including the peripheral technologies because any and all situations are foreseen in their future practical works.

b) TNT-mips operation

"TNT-mips" has a number of functions all of which it would be difficult for the counterparts to understand and not necessary for them to understand . They could master the basic operation in the repeated practical trainings of reference to sample data and mosaicking. The "TNT-mips" manual was relatively well prepared, so that the counterparts would be able to master other functions by referring to the manual as necessary.

c) "MicroStationGeographics" operation

"MicroStationGeographics" is the add-on software for "MicroStationJ". It is natural that the operation method of "MicroStationJ" applies accordingly to that of the add-on software. This technology was exercised in the 1st and 2nd technology transfer courses, but the counterparts had little opportunity of practice using the technology, so that their operation skill was still unstable. Thus, they understood only the functions of "MicroStationGeographics", but could not acquire the technical capability to meet their practical works. In particular, on "MicroStationGeographics", the function of cleaning data is used. In the future use of map data as GIS, this technology will be required. Thus, the counterparts will be able to operate this software checking the on-line help if necessary.

5) General comments

The acknowledgment of orthophoto production technology and the understanding of the software technology for data applications that were the goals of this technology transfer project were achieved. In comparing the 1st and 2nd lectures, it was expected that the counterparts improved their sharp sense on operation and they were never perplexed how to do in the basic operation of software.

However, to fix the technology among the counterparts, it is necessary to increase their opportunity of operating the equipment repeatedly after the technology transfer. In the case of the digital photogrammetry system, only one set of equipment is available, so that the number of persons who can use the equipment is limited. However, it is desirable that they will operate the equipment as repeatedly as possible.

2.4.4 Building of database/analysis of GIS

Photo 2.4-10 GIS equipment installed at INSIVUMEH

Technology transfer regarding GIS using a new version of software was started during the third work in Guatemala.
Most of the engineers from the IGN Cartography Division and some engineers from the Photogrammetry Division participated in the GIS technology transfer program. The details of the technology transfer will be described later on.

It should be noted here that 7 engineers from INSIVUMEH, a counterpart agency for the creation of hazard maps, participated in the GIS technology transfer. This showed the strong interest in GIS.

(1) Transfer of technology for vectorizing, plotting of modifications and DEM creation

1) Level of technology

Photo 2.4-11 GIS technology transfer

An understanding of and ability to operate the software necessary for this Project is essential, but in practical terms it is difficult to transfer all necessary techniques and skills to all the counterpart staff. The engineers of the IGN Cartography Division were naturally familiar with manual tasks (such as scribing) based on empirical values (such as scribing), but not so many of them seemed to be familiar with computers.

Further, 7 engineers from INSIVUMEH, the counterpart agency in charge of the production of hazard maps, also participated in the GIS technology transfer, and it became apparent that there were huge differences in the levels of computer skills among the participants.

It was predicted that if the lecture were to be conducted in such a way that all the participants could understand, it would in fact be impossible to transfer all the necessary technology in the limited time available.

In order for the participants to master all the techniques required in this project to develop the topographic maps and GIS database, ideally an intensive technology transfer program should be provided for participants who have some familiarity with computers, after which those participants would transfer the acquired technology to other participants.

Photo 2.4-12 Lecture participated by INSIVUMEH

However, after the situation had been explained and discussed with IGN, the Study Team received a strong request from IGN for the technology transfer to target not only those participants familiar with computer operation, but also beginners. The reason given was that if the technology was available to only some of the engineers it might be lost, because of the low stability of the work force in Guatemala.

2) Acquisition of basic technology

Thus it was decided to determine the theme of each field survey and to raise the level of technology gradually, starting from the basics. At the same time, it was decided to use a special time schedule to transfer to those engineers with a high level of skill, the appropriate necessary technology. The theme of each field survey and an outline are given below.

a) Third Field Survey: What is GIS?

- Introduction to GIS: What is GIS? / features of GIS
- Basic MicroStation: What are topographic map data? and how do they differ from GIS?
- Basic ArcInfo: Basic operation of GIS
- Operation of ArcInfo (ArcMap): Applications of GIS

In the third field survey, technology transfer focused on the understanding of what GIS was and what GIS could provide. Another theme was understanding how it differs from the topographic maps and understanding the special features of GIS data.

b) Fourth Field Survey: Conversion and structuralization – Conversion into GIS database

- Architecture of GIS database (ArcInfo Coverage)

- Method of configuring GIS database (ArcInfo Coverage)
- Architectural differences from the national base map database (MicroStation Design File)
- Conversion into Coverage, structuralizing

In the fourth field survey, technology transfer focused on the acquisition of the technology on practical operation and data conversion. It was intended for the engineers to gain a deeper understanding of the characteristic architecture of GIS data by understanding the data configuration of the GIS software used in this Project and having practical experience in how to configure the data. In addition, the difference between the GIS database and the national base map data was clarified to make sure the engineers understood the process of conversion from the skeleton data.

c) Fifth Field Survey (2003): Correction of GIS database and building of network data

- Connecting of GIS databases
- Additions and corrections to GIS database
- Building of network data + insertion of attribute data
- Application and review

For the fifth field survey, it was planned for the counterparts to master the technology to integrate the spatial basic information data that is divided into map sheets and to reconfigure the phase information for the basic topographic features. A lecture on methods of building the network data and adding attribute data was held.

3) Schedule of technology transfer

In the third field survey, technology transfer was carried out to teach the basic concept of GIS, the basic operation of the software (MicroStation) necessary for creating topographic maps, the basic operation of the GIS software (ArcInfo v. 8.0) and practical applications. As there were many participants in this technology transfer, 4 cycles of lectures were carried out with 5 days taken per cycle.

With regard to GIS application, the effective use of GIS for not only hazard maps but also other fields was taken into account, and multiple cases were described for better understanding. On this lecture, stress was placed on giving the participants practical experience in what GIS is, what kind of procedures are required, etc., rather than trying to teach them how to operate it. The general outline of one cycle is given below.

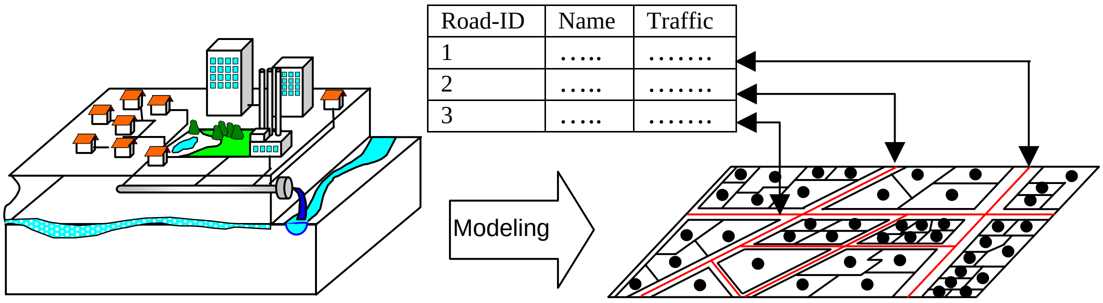
a) Outline

First of all, an explanation was given of the processes used to build the database (national base maps and GIS database) to be developed in this Project, as well as the period for development and the software to be used. This explanation focused on the method of producing the topographic maps (such as the national base maps) that IGN had used so far, and how the technology used in this Project differed from conventional methods. In addition, all the processes were explained and an explanation given of which processes would be undertaken by IGN, so that the participants could better understand the functions of IGN.

b) GIS and the database

Then, an explanation was given of on what GIS is, what fields GIS is being used in so far, and what effective use of GIS would be available in Guatemala. In addition, the data structure unique to GIS and the topological structure that is indispensable to GIS were explained. Then, further explanations were given of what kind of information was added, following what procedure, when the national base maps and the GIS were built.

In this Project, the GIS database is to be developed in addition to the national base maps. These two types of data share much information, yet are very different in nature. Thus, in this Project it is not possible to use, as is, existing methods of constructing either type of data. As described in “Structuralization of GIS database” in this Project the shared information is constructed first and the information necessary for each type of data then added and processed appropriately. For this purpose, it was very important to recognize what the two types of database have in common and what differences.



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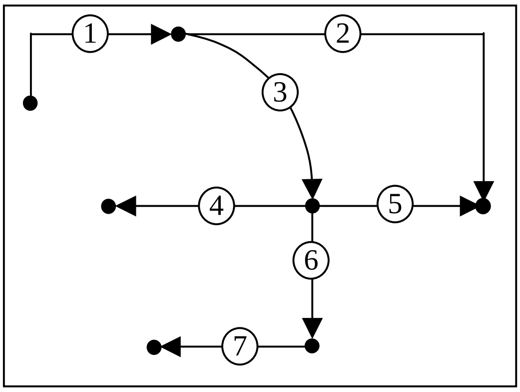
Linear phase structure



LINE.AAT

RECNO	FNODE#	TNODE#	LPOLY#	RPOLY#	LENGTH	LINCOV#	LINCOV-ID
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2	1	4	0	0	101.23	2	2
3	1	3	0	0	58.97	3	5
4	3	5	0	0	62.76	4	4
5	3	4	0	0	49.08	5	3
6	3	6	0	0	45.87	6	6
7	6	7	0	0	33.67	7	7

Figure 2.4-38 Modeling in the real world

Figure 2.4-39 Samples of GIS application

c) The use of editing software

Technology transfer was carried out with regard to the software application MicroStation, used to create national base map data from the skeleton data. Here the