A PHOTOGRAMMETRIC MAPPING TECHNOLOGY PROGRAM

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ABSTRACT

A major concern of many mapping organizations is the hiring of qualified photogrammetric technicians who could function in the work place with a minimum of training as stereoplotter operators. For small organizations, such as those found in developing countries, the need to employ technicians familiar with all the phases of mapping is also important. The Center for Photogrammetric Training at Ferris State College offers this very specialized training within the Photogrammetric Mapping Technology Program. During the course of study, the student is at least introduced to the various aspects in mapping thereby allowing that individual to function intelligently within the work environment. Through cooperation with other departments, an individualized training program can be arranged with courses in computer science, surveying, mathematics, and printing.

BACKGROUND

The need for training photogrammetric technicians, primarily stereoplotter operators, should be of prime concern to the photogrammetric community in light of changing technology. With the advent of new instruments and techniques for data collection, the question that will arise is can the present class of plotter operators, generally trained in-house, adapt? For those in education, the development of educational tools to facilitate the change and perform the retraining is the next big challenge within the profession.

There is a serious lack of qualified technicians within the mapping community worldwide. Brandenberger [1976] presents data to show that there are only 281 institutions worldwide at the technologist and/or technician level and only one within the category of the auxiliary personnel level. When compared to previous surveys, the number of institutions is shrinking and if that trend has continued, then one can infer that the situation is not better today. Brandenberger [1980] presents manpower figures for photogrammetry. The present breakdown is shown as

15,000 professional (university level or equivalent)
75,000 middle-level personnel (technologist, technician or equivalent)
60,000 auxiliary personnel (photographers, lower level plotter operators, etc.)

This corresponds to a manpower ratio U:T:A = 1:5:4. He also states that the profession can accommodate personnel (for educational planning) at about 5% of the active manpower rate. At this pace, there is a need for 3750 technicians/technologist and 3000 auxiliary personnel every year.

In a survey by Rick and Swartz [1979], the need for trained photogrammetric technicians was also identified. From that study, and with the information of a worldwide need for stereoplotter operators, the Photogrammetric Mapping Technology (PMT) Program was initiated within the Center for Photogrammetric Training at Ferris State College. It's goals were, and remain, the training of stereoplotter operators for the private and public mapping community. It is felt that graduates should be technically proficient with photogrammetric procedures and equipment and cognizant of the other tasks involved in the mapping process, i.e., surveying, drafting etc.

Historically, the training of plotter operators has been done in-house. This leads to some serious problems [Burtch, 1982a, 1982b]. These deficiencies are:

a) The training becomes, by necessity, job related.
b) As the job function changes, retraining becomes necessary.
c) At each stage of the training/retraining process, at least two individuals and the necessary photogrammetric equipment are removed from the production environment.
d) Individuals are not knowledgable of ancilliary personnel involved in the mapping tasks and unable to communicate effectively with these individuals.

The most efficient method of alleviating these problems and preparing individuals to handle problem oriented tasks is by offering the broadest educational background possible. While these individuals would not be proficient from a productivity point of view, that time period is greatly reduced. Most students leave confident of their abilities but still unsure of what lies ahead in a production environment.

The program of study was developed based on the Rick and Swartz study. Central to the training is the laboratory oriented, plotting courses in which over three hundred hours are put into stereoplotting and map production. Over the short history of the curriculum, some changes have occured and more are contemplated for the future. Input is received from an advisory committee, comprising private and public sector practitioners and instrument manufacturers, and from graduates in the profession. These groups provide valuable information as to weaknesses and strengths of the program along with an idea of where the profession is heading technologically. While future trends are necessary it is equally important to prepare

the student for the tasks that await them in the near term.

PMT CURRICULUM

Appendix A gives the course of study presently in place. Under the quarter hours column, the numbers in parenthesis indicate the number of lectures plus the number of laboratory hours during one week. From this outline, one can see the heavy dependence upon hands-on lab training. It is this type of training that differentiates technicians from pre-professional (B.S.)/professional (graduate) studies. Appendix B provides course descriptions for each of the photogrammetry courses offered. It should be pointed out that those individuals desiring additional education can elect to enter the Applied-Mathematics or S rveying programs on the Ferris campus. Once in these programs, additional courses in analytical photogrammetry, data adjustments, and mathematical cartography are available. In addition, there are a number of "ladder" type programs that also lead towards a bachelor degree which students may elect to pursue.

The core of the PMT program involves photogrammetry training. It begins by introducing the student to the aerial camera, optics, vertical/tilted photographs, -arallax, and flight planning. Laboratory assignments deal with working on paper prints to determine, from the geometry, some basic calculations. The utilization of stereoscopes are used in making basic parallax determinations. This leads quite naturally into orientation of the stereoplotter. To facilitate this training, optical plotters, Kelsh and Multiplex, are used because of the simplicity in design and ease in which their operation aids in explaining the mechanics of the creation of the model. This is followed by lectures detailing orientation of the stereoplotter, plotter design and construction, and an introduction to photo interpretation and orthophotography.

The second year of the photogrammetry training is primarily project oriented. Several projects have been performed, such as the production of a five color topographic map of the town of Big Rapids, another five color topographic map of the campus, an orthophoto map of the town, two close-range architectural studies, and others. While more indepth lecture topics dealing with photogrammetry are covered in a formal atmosphere, part of the time is spent in the practical problems encountered in the student project and it is not uncommon that the class will reconvene in the laboratory to discuss aspects of instrumentation or technique that will aid in the solution of problems incurred within the student project. Laboratory time is arranged so that the student:plotter ratio for a particular lab is 1:1. This tends to maximize the training process.

The philosophy of the instructors within the Center for Photogrammetric Training is that each student should receive a well rounded education in the mapping sciences. Therefore, from the listing of the PMT curriculum, one can see the heavy reliance on the other tasks, specifically, surveying, drafting, and photography. It is felt that graduates can, if required, at least funtion in these other tasks during slack periods. This is especially important for small proprietorships where the need for individuals with a multifaceted background is necessary so that better utilization of staff can keep the production costs down. In addition, this varied background is also important in order to effectively communicate to support staff. The operator becomes appreciative of the various units involved in map production and is aware of difficulties that may develop.

By far, the largest of the support categories is within surveying. The courses here are designed to introduce the student to basic surveying tasks and techniques in measuring distances and angles and the determination of height. This basic knowledge is then broadened to include control surveying procedures and techniques coupled with the mathematical background to perform the basic and intermediate calculations that may be required in control work.

Drafting is also a very important area within the present curriculum. With the courses in graphics, topographical drafting and through the special photogrammetry project, the student is introduced to the various methods in which drafting is performed, i.e., ink, pencil, and scribe. While these skills will be diminishing in the future, many smaller firms still require competent draftsmen to prepare the final manuscript for the client. Realizing that drafting skills may not be necessary in the future due to the emergence of low cost and accurate computer-assisted cartographic plotters and the increasing importance of the creation of data banks in lieu of map manuscripts, the Center has a Calcomp 1136 drum plotter and is in the preparation stage of drafting a grant proposal to install an interactive graphics work station to the School of Technology's Computervision CAD-CAM system. As these tools become the norm for private practitioners, more reliance will be placed in student training in this area.

The remaining courses within the program provide a general mix of subjects that are designed to let the student grow as an individual. This is one of the main advantages of having an Associate Degree program instead of a comprehensive training program in mapping within a shorter time frame. Thus, it is not only important to provide the technical background that allows the individual to perform the require mapping tasks in production, it is equally necessary to help the student understand their role in society. The student leaves with a

marketable skill and an awareness of personal development which will lead to a satifying, rewarding, and purposeful life.

EQUIPMENT

Equipment to train individuals in photogrammetry is important. While one may feel that it is nice to have all of the different kinds of plotters and other equipment found in the work place, the need is not present since the basic skills can be easily transferred to comparable equipment. The program is lucky to be able to draw on the many resources within the college and by cooperation, ancillary equipment is often available for student use. Central to this is the large surveying laboratory which contains numerous surveying instruments for most phases of field surveying. Likewise, access is also available of the photographic facilities and film processing unit within the Graphics Arts Department and an excellent series of computer laboratories that offer instruction and use of the college IBM mainframe computer, Computervision CAD-CAM computer system, and a number of different micro computer facilities. The photogrammetry laboratory is also well equipped. The present inventory covers in part:

- 5 mirror stereoscopes
- 20 pocket stereoscopes
- 2 Wild A-7 Autographs
- 2 Wild A-8 Autographs
- 1 Wild AG-1 Aviograph
- 1 Wild PUG 2 point transfer instrument
- 3 Zeiss C-8 Stereoplanigraphs
- 1 Gigas-Zeiss GZ-1 Orthoprojector
- 4 Kelsh plotters (1 anaglyphic, 2 PPV, 1 SIA)
- 1 Multiplex plotter (4 projector)
- 2 Mann monocomparators
- 1 Coordinatograph
- 1 Wild P-30 close range camera
- 2 Fairchild aerial cameras
- 1 Calcomp 1136 drum plotter

STUDENT PLACEMENT

To date, we have had four graduating classes with a class range from 6 to 18 students. There has been no problem in placing students who are looking for a photogrammetric position. A small portion of our graduates have continued schooling and are entering the job market in areas where photogrammetry is not the primary function of the company, such as engineering firms. Still another small portion have decided to pursue work outside of the surveying and mapping field. Our students are well received in industry and our success in the training program is best exemplified by the number of firms who have come back to hire additional graduates.

FUTURE OUTLOOKS

The main thrust of the PMT program is to train competent stereoplotter operators. The role of the Center for Photogrammetric Training is to do this efficiently and quickly. One area of interest to us is the ability of the plotter operator to discern small changes in height for contouring and profiling operations. To facilitate this task, a cooperative venture with the College of Optometry at Ferris is developing a "contour trainer" [Burtch and Rick, 1983]. This trainer consists of a fiber optic light source and a receiver that will "read" the contour line of a map that corresponds to the contour line within the stereomodel. This device is placed in the drawing fixture on the plotting table. Once the model is oriented, a finished map manuscript is placed on the plotting table and properly oriented to the model. Once completed, the operator will begin by following the perceived contour with the floating mark in the instrument. If the operator faithfully follows this contour, the "contour trainer" indicates acceptable performance by remaining silent but if the operator wanders off the contour line, the trainer signals unacceptable performance by emitting an audible tone. It is felt that this approach will reinforce the psychological aspect of vision and provide positive reinforcement for successful completion of the visual task of contouring.

Preliminary examination of this method of training indicates that the selection of an appropriate map is very important due to the fact that all maps, by virtue of their reduction in scale, are generalized to some degree. To solve this problem, tests are being completed now using a stereopair produced on a writing microdensitometer from a digital terrain model data base. Both the stereopair and the corresponding topographic map form a very accurate set of graphic data on which training can be conducted without any opportunity for human error in contour location.

Another area of training is also being looked at. One can understand the large investment that a mapping organization may be forced to bear by sending employees to school for two years. Therefore, we have identified that a 12-month program would be also an attractive option. While it would retain much of the same flavor of the current program, it would exploit the use of accelerated instruction to prepare the student in the summer in order to be able to enter the second year of the program. In addition, there exists a certain degree of flexibility within the program so as to allow the student the opportunity to obtain training in other areas such as mathematics, computers, or printing, depending on the student's and mapping organization's needs.

The future will also find changing courses within the

curriculum so as to provide additional training at the technician level in computer-assisted drafting and remote sensing. Both of these areas are contingent upon the successful acquisition of equipment and approval of the college. With the help of the advisory board and industry, the education of photogrammetrist at the Center will prepare the student for the myriad of tasks that the future indicates.

CONCLUSION

The need to train stereoplotter operators is important to the photogrammetry industry. The Photogrammetric Mapping Technology Program within the Center for Photogrammetric Training offers such a curriculum that has been successful in providing competent technicians cognizant of the whole mapping process.

REFERENCES

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APPENDIX A

PHOTOGRAMMETRIC MAPPING TECHNOLOGY NAME: _____

Hours Required for Graduation: 91

CIV 110	Introduction to Civil Technology	3	(3 + 0)
EGR 121	Elementary Graphics	3	(2 + 4)
MTH 121	Intermediate Algebra	4	
ENG 111	English 1	3	
ELECTIVE	Humanities _____	3	
PMT 111	Introduction to Photogrammetry	4	(3 + 3)
MTH 124	Numerical Trigonometry	4	
ENG 112	English 2	3	
EGR 123	Engineering Graphics	3	(2 + 4)
PMT 112	Stereo Photogrammetry	4	(3 + 3)
SUR 130	Fundamentals of Surveying	5	(3 + 8)
PHO 101	Fundamentals of Photography	6	(3 + 7)
PMT 211	Stereo Compilation 1	6	(3 + 9)
SUR 221	Surveying Calculations	4	(3 + 2)
SUR 230	Control Surveying	5	(3 + 8)
PMT 212	Stereo Compilation 2	6	(3 + 9)
PMT 215	Cartographic Principles and Designs	4	(4 + 0)
SUR 261	Topographical Drafting	3	(1 + 6)
ENG 211	Technical & Occupational Writing	3	
PMT 213	Stereo Compilation 3	6	(3 + 9)
PMT 214	Photogrammetric Calculations	3	(3 + 0)
ELECTIVE	Technical Elective _____	3	
ELECTIVE	Behavioral Science _____	3	

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APPENDIX B

PHOTOGRAMMETRIC MAPPING TECHNOLOGY

Course Description

PMT 111 INTRODUCTION TO PHOTOGRAMMETRY 4

Introduction to photogrammetric mapping includes history of photogrammetry, interior geometry of the camera, photographic results, film processing, optics, lens distortion, and the geometry of the vertical and tilted photographic image. Radial line plotting will be used to illustrate relief displacement about the nadir. Flight planning, cost analysis and various camera platforms will be introduced.

PMT 112 STEREO PHOTOGRAMMETRY 4

Geometric construction and the mathematical analogue of the stereo model are presented together with human perception of the stereo model. Relative orientation of contact printed aerial photography, observation of the resulting model using lens and mirror stereoscopes, and basic parallactic measurements using monoscopic and stereoscopic methods will be presented. Mechanical and optical analogue restitution equipment, interior orientation, relative orientation and absolute orientation will be covered. Students will operate restitution equipment.

PMT 211 STEREO COMPILATION I 6

Course will develop practical skills in compiling map information (planimetric and topographic) from a stereo pair of aerial photographs. Particular emphasis is placed upon student proficiency in performing relative and absolute orientation. The operating characteristics of several mechanical stereoplotter parts are taught. A mapping project is begun and students plot control information on the plotter manuscript, perform model orientation and compile terrain data.

PMT 212 STEREO COMPILATION II 6

This course is a continuation of Stereocompilation I. Compilation of a project manuscript is continued and planimetric and topographic detail is plotted and scribed onto scribe coat film. The student will develop proficiency in plotting and will develop scribing skills necessary for good cartographic craftsmanship. State plane coordinate calculations and the availability of government control information is explained together with coordinate transformation and other calculations. Introduction to the programmable desk-top calculator. PREREQUISITE: PMT 211.

PMT 213 STEREO COMPILATION III 6

A continuation of Stereocompilation I & II, designed to develop stereocompilation skills and acquaint students with mathematical techniques used in photogrammetry. The mapping project begun in Stereocompilation I will be completed. Class time will be used to permit students to investigate more advanced numerical processes and some fundamental stereoplotter tests and calibration procedures to determine instrument integrity. Laboratory topics will be coordinated with PMT 214, Photogrammetric Calculations, which must be taken concurrently. PREREQUISITE: PMT 212.

PMT 214 PHOTOGRAMMETRIC CALCULATIONS 3

Use of digitizing equipment for relative and absolute orientation, volume and area studies, perspective center determination, mechanical and semi-analytical triangulation is included. Instrument calibration such as focal length determination, optical alignment, machine coordinate indexing is covered. Small calculator programs will be developed to illustrate the assignments. Must be taken concurrently with Stereo Compilation III.

PMT 215 CARTOGRAPHIC PRINCIPLES & DESIGN 4

This course introduces the student to the principles of cartography, covering in part the processing of information into a graphical form, generalization, symbolization, and computer-assisted cartography. The student will also learn map design, representation of relief, and the representation of physical and artificial features that form the graphical basis of cartography.

PMT 300 PRINCIPLES OF REMOTE SENSING (PROPOSED COURSE) 4

This is an introductory course covering in part sensor systems, interpretation of aerial photographs for geologic and stratigraphic structures, Landsat imagery, Thermal infrared imagery, and radar imagery. Also introduced is digital image processing and land use and land cover classification and mapping. PREREQUISITES: Junior status or permission of the instructor.