and articles appearing in PHOTOGRAMMETRIC ENGINEERING and other scientific and technical organs. However, this type of education does not carry over in the way which the literature on photogrammetry does. I believe that educators must realize this when they go out beating the bush for teachers in the subject.

In closing I will briefly discuss photogrammetry and allied surveys as they relate to state licensing and state registration of civil engineers. State registration of civil engineers was first required in this country to provide protection against fraudulent and unreliable maps. Thus, it was recognized that surveying and mapping was embraced by the civil engineering profession. Land surveying was also recognized in some states as being a part of the practice engaged in by civil engineers. Now the big debate is whether photogrammetric mapping is or is not a function of civil engineering. In the United States, this method of mapping was not developed by universities in their engineering colleges except in a few cases. It was developed practically in spite of the colleges' failure to do anything with photogrammetry. And to this day, the situation has not changed substantially.

Admittedly, the situation is improving; nevertheless, graduating civil engineers on the whole cannot lay claim to photogrammetric mapping as a part of their profession by virtue of their education alone.

The practicing of photogrammetric mapping by non-registered persons or corporations is being argued in the courts in one Western state. A bill at this moment is before the same state's legislature to exclude photogrammetric mapping and all necessary surveys incident to the mapping, from the civil engineer and land surveyor code.

If photogrammetry is to be a function of civil engineering, then it should be a part of every civil engineering curriculum.

PHOTOGRAMMETRIC TRAINING FOR THE TECHNICAL FORESTER*

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THE magnitude of the importance of photogrammetric training to the professional forester is a fact so well substantiated and documented that any attempt here to provide further verification would be purely repetitious. That forestry schools are, in general, cognizant of this fact is borne out by a recent survey to which 25 of the 26 accredited United States forestry schools responded. This survey revealed that all of these 25 schools will incorporate photogrammetric training in their respective curricula this coming academic year. In fact, they are already doing so. The mere presence of such training in a professional forestry curriculum, however, is not enough in itself. What is really pertinent is whether or not this training is geared to the actual needs, now and in the future.

What may we reasonably define as our educational requirements in photogrammetry for the future? If assumed that our needs will continue to increase, it seems logical to believe that our training will have to be expanded beyond a concentration on forest inventory applications, to which most of us presently confine ourselves, and to enter to an increasing extent into photogrammetric applications in the fields of silviculture, forest management, forest influences,

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timber harvest, recreation, protection, range and wildlife management.

We cannot teach techniques which do not exist, however, and the answer to this deficiency lies in a research program which is considerably expanded and intensified beyond what we now have.

The phenomenal advances in forest photogrammetry which we have witnessed over the past two decades have been largely the results of the efforts of a comparatively few men. Since research men are the result of training, and the products of their research form the basis for expanded and improved training, we appear to be faced with somewhat of a "chicken or the egg" proposition in the search for a definition of our future training requirements.

For a possible solution let us, therefore, examine the situation at the practical field level.

Canadian and United States foresters deal with vast expanses of land in comparison to their European colleagues and, as a result, there is always a shortage of the time, the money and the manpower necessary to bring much of this land to a reasonable level of productivity.

The real need in photogrammetric education in the future lies in the necessity for finding, and passing on to the practicing forester more and improved applications of photogrammetry which will enable him to do an increasingly more effective job of management.

Among those applications of photogrammetry needing further consideration and exploratory work are soil and site analysis, forest inventory, management plan preparation, planning silvicultural practices, road location, planning timber harvest operations, land evaluation, presuppression and fire control planning, and disease and insect damage detection.

The use of aerial photogrammetry in forest inventory, for example, has greatly reduced time and costs and increased the accuracy of this operation, thus serving to release more effort in the direction of cultural practices.

Our educational programs must, insofar as possible, concern themselves with three categories of students: 1. The four-year professional graduate. 2. The graduate student and the undergraduate who specializes—that is in photogrammetric interpretation. 3. The technical forester in the field who either has had no previous photogrammetry training, or has had some training but desires further instruction in new techniques.

The accomplishment of such a program could reasonably be expected to produce the following results:

1. The production of professional men with the bachelor's degree who on a continually improving scale have a good versatile basic training in photogrammetry and its applications so as to be receptive to new ideas, to be able to implement them, and to effect local modifications. And that is important.

2. The training of advanced students who have specialized in the applications of photogrammetry in one or more fields and who can contribute further through continuing work in the field, with research agencies, or in education.

3. The return of professional field men to refresher training in short courses given by the forestry school, and in which they receive initial training and/or indoctrination in new techniques.

If the foregoing estimation of educational needs is valid, how well are we prepared at the present time to fulfill our obligations? Actually, the changing trend in photogrammetric education evidenced over the past fifteen years in 25 accredited forestry schools is most heartening. During the academic year 1946–1947, 12 of the 25 schools provided training, and of those 12 eight schools required it for graduation and two provided graduate training.

During the academic year 1955–1956, all schools will provide training, of which twenty will require it for graduation, seven will provide additional undergraduate work, ten will provide graduate training, and five will include on their suggested elective list courses in such departments as civil engineering, geology and geography. Approximately one-half of the schools will offer short courses.

To incorporate such a program, wholly or in part, necessarily requires certain adjustments in the traditional professional forestry curriculum. From the standpoint of such adjustments it must be said that it is usually a great deal easier to proffer suggestions than it is to implement them in actual practice. The average four-year professional forestry curriculum is already bulging at the seams, and one cannot reasonably insert a series of photogrammetry courses in lieu of other basic work. After all, our ultimate objective is to produce professional foresters trained in photogrammetric applications instead of producing professional photogrammetrists trained in forestry applications.

As Spurr pointed out in 1947, conditions vary greatly between different schools but, in general, the most logical and painless solution seems to be to provide an elementary photogrammetry course and to follow this up by integration of specialized applications of photogrammetry into such courses as silviculture, management, protection, et cetera.

Specialized electives can then be provided, in addition, which would permit advanced undergraduates and graduates to either specialize further or do original research. Such a solution would not impose undue strain upon an already crowded core of courses required for graduation.

Such integration has certain other advantages in that it brings the photogrammetry instructor in constant contact with the other forestry fields of specialization and makes for a better mutual understanding of the problems in those respective fields. Certainly, some such arrangement is of paramount importance if the photogrammetry instructor intends to guide graduate students doing a variety of research in photogrammetry applications! This process of integration, where possible and feasible, should also pass beyond the limits of the forestry school itself. Certain of our problems are peculiar to forestry alone and are subject to eventual solution within our own borders.

However, we have already entered certain aspects where the forester can no longer stand alone, and we shall need to lean more and more upon the work being done by photogrammetrists in other professions. Work in site analysis, for example, brings us directly to the doors of the geologist and the soil scientist. Where opportunities for such cooperation exist, every encouragement should be given to students to take such course work in other departments as may be applicable. Such an arrangement should also serve to bring photogrammetry instructors out of the confines of their individual niches, and create an amicable atmosphere favorable to an interchange of ideas and the coordination of research activities fruitful to both.

To set up an ambitious educational program such as this without consideration being given to the actual mechanics of the teaching processes would be a very grave error, indeed. It is problematical as to whether a photogrammetric educational program on a grandiose scale, delivered to the student by way of poor instructional methods, is any better than a very modest program efficiently taught. No four-year curriculum graduate will ever be a polished professional at the time of graduation; the proof of any professional education pudding will be determined under the baptism of fire of practical forestry field conditions.

The REAL challenge to the educator is: To how high a peak of efficiency, both in skills and reasoning powers, can a man be brought by the time his

coursework has been completed, and how can we help him to attain it? The idea, of course, is to provide field administrators with men who are able to adapt themselves and to accept responsibility in the shortest possible time.

Our current forest photogrammetry teaching techniques for the most part leave a great deal to be desired. This is not intended as an indictment of photogrammetry instructors either individually or as a group; the fact simply remains that we have been in existence as an educational body for such a very short time that the intricacies of our teaching problems are only now becoming apparent.

It is frustrating, to say the least, to receive a group of students about whom you know very little at the beginning of the semester and, after giving the best in the way of teaching of which you are currently capable, to release them at the end of the semester still knowing very little about their individual potentialities as photo interpreters or for that matter without much idea of what they have learned.

If we intend, through an expanding program of research, to find new and better applications of photogrammetry to forestry, we will also be obliged to seek the quickest and most efficient methods for passing these on to the student and to apply them in practice. This implies that we will have to "plow back" some of our research program into the actual teaching processes.

Some points for consideration are the following:

1. TESTING METHODS

It would help immeasurably if we were able, at the beginning of the training period, to obtain some idea of individual student potentialities. Does he have binocular vision? If not, some dispensation must be made for such a student when the course is required for graduation. If he does, what is his stereoscopic perception? Karl Moessner has done yoeman service in his recently designed test for perception; we need more of this type of device.

How well does the student perceive small differences in lateral dimensions, particularly when only slight variations in tone are involved between the objects and their background? (This is a very common problem in forest photo interpretation.) Does he have the ability to find clues and and to construct a reasonable solution from them? If so, how well does he do it? Can we not devise a test which will give some indication of what kind of a detective he is or can be developed into?

Progress tests, in addition, would be essential in order to permit the instructor to obtain an idea periodically as to what improvement, if any, is being made. If there is a deficiency in the progress of a student, is this organic, pure laziness, or a factor which can be corrected through instructional methods?

2. TRAINING AIDS

In a sense, a stereo pair of aerial photographs represents a portion of the earth's surface over which a number of dismembered jigsaw puzzles have been scattered. To give only verbal instructions and descriptions to the embryo photo interpreter and expect him to find and assemble these bits into their various solutions is completely illogical, particularly so when the interpreter has little or no previous conception of what the eventual solutions should be or could be.

How much better it would be (1) to give him the instructions, (2) to show him a variety of puzzles already assembled, and (3) to get into the picture with him and help in the gathering and the fitting together!

Such an approach is not only feasible but practical through the use of training aids.

a. *Use of three-dimensional models.* Doctor Colwell has pointed out the utility of such an aid in his very stimulating discussion and demonstration yesterday. This permits the student and the instructor to participate jointly.

b. *The use of three dimensional slides.* The novel and startling approach presented here in 1952 by Professor Kenneth Jackson has tremendous possibilities. If refined to the point—perhaps it already is—where it would permit the instructor and the class collectively to simulate conditions viewed through the stereoscope, the teaching of timber typing would be immensely simplified.

c. *The use of photo interpretation keys.* This will implant in the photo interpreter's mind a systematic method of approach and establish a subconscious check-list of clues.

d. *The use of stereograms.* This provides an opportunity for a photo interpreter to view and analyze a large number and variety of situations and solutions in a short time.

e. *Field demonstrations.* These are the ultimate in training. No forest photo interpreter ever reaches even a modest stage of efficiency without considerable cross-checking between photo and ground.

Conclusions

In summary, with energetic and expanding photogrammetry teaching and research programs in our forestry curricula, the efficiency of the field forester can be greatly advanced. To accomplish this, some adjustment is required within the curriculum which can be accomplished only if a sympathetic attitude exists on the part of forestry school administrators. Some still view the application of photogrammetry as being somewhat akin to an iceberg in the desert—very interesting, very novel; but probably shan't be with us long.

Because photogrammetry in forestry involves applications to a variety of specialties, the photogrammetrist's task is a difficult one and requires a great deal of work and the adoption of a scientific realistic attitude of approach. The best fluid in the world for lubricating the mechanism of such research and teaching programs as these, is the periodic sweat raised by the instructor on frequent trips to the field, there to view the situation in the cold, hard light of reality and practicality.

HIGHER EDUCATION IN PHOTOGRAMMETRY*

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BEFORE attempting to prognosticate the future of photogrammetric education, it might be well to briefly review its present situation. Surveying and mapping, and by inheritance, photogrammetry, have traditionally fallen within the domain of the civil engineering departments of colleges and universities, and the small proportion of practitioners in these fields who gained their basic knowledge through formal course work, normally hold degrees in civil engineering.

In the past fifteen years two factors have combined to create great changes in the formerly placid engineering colleges. The first of these is a tremendous increase in technology so that an engineering college graduate today is expected

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