

A STUDY OF THE STATUS OF PHOTOGRAMMETRY IN THE ENGINEERING SCHOOLS OF THE UNITED STATES AND CANADA*

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PHOTOGRAMMETRY is definitely being assimilated in the engineering curricula of the colleges in the United States and Canada. The stimulation of two world wars and a better understanding of general mapping needs have made photogrammetry an accepted tool. Colleges have followed rather than initiated developments for the most part, and probably will continue to do so, but certainly more interest is being shown in giving some coverage to the subject.

In order to determine the present status of photogrammetry in the colleges, one-page questionnaires were sent to 145 institutions. The questionnaire, and the first follow-up, were addressed to the professors in charge of surveying, and resulted in answers from all but eleven schools. The third request went to Department Heads and reduced the number of "holds outs" to two. A fourth questionnaire was then directed to the Deans. Fortunately these brought replies and avoided bothering the Presidents of the two prominent universities. Returns from one hundred per cent of the schools contacted are thus available for analysis although many replies were incomplete. Catalogue searching filled some of the gaps.

Quotations from 36 questionnaires are included as Appendix A in the report to supplement the tabulated material. Despite somewhat divergent viewpoints, the majority of teachers who appended remarks feel that inclusion of some work in photogrammetry is desirable. Names of individuals and schools are omitted and the quotations merely numbered to avoid possible embarrassment of anyone.

Results of the questionnaire are itemized in Table I. The summary shows that of the total of 145 schools, 16 or 11% have a required separate course in photogrammetry; 41 or 28% offer an elective course; the average number of credits for either type of course is 2.6; 75 or approximately 52% give photogrammetry as a separate section of another course; and 24 schools or roughly 17% are contemplating adding a course or giving some coverage in the future. Thus only 22 colleges (including two not giving four year degrees in Civil Engineering) or 15% do not offer or plan to give any work in the subject.

At least one lecture in photogrammetry is given by 93 of the 145 schools; 76 have laboratory periods; and 27 schedule visits to mapping agencies. Twenty-nine schools give the same or a similar course to geologists, geographers, foresters etc.

A supplementary question determined the average number of required surveying credits in the present curricula of 131 colleges to be 11.0. This value checks closely with the average of 11.3 credits found in the study of Summer Surveying Schools and Camps in the United States and Canada made in 1947 for Committee 8 by the author.

Fifty-one institutions offer elective courses in surveying, the average being 4.7 credits per school. It is evident that more Civil Engineering Departments can improve their lists of electives by adding surveying courses to compete with options in structures and hydraulics.

* This paper was read at the Photogrammetry Seminar, Denver, Colo., August 7, 1950.

TABLE I

Name of School	Photogrammetry					Hours			Total Number of Students per Year	Prerequisites	Open to Juniors—3, Sophs.—2, Seniors—4, Graduates—5	Same or Similar Course Given to Others. Foresters—F., Geologists—G., Geograph—Gp.	Total Required Surveying Credits Including Photo-grammetry	Total Elective Surveying Credits Including Photo-grammetry
	Re-quired Se-pa-rate Course	Elec-tive Course	Semes-ter Credits	Separate Section of Other Course	Num-ber of Hours Allotted	Contem-pled for (Date)	Lec-ture, Rec-itation	Labora-tory						
Alabama Poly.	F.	x		x	25							F.	20	
Univ. Alabama		x	3	x	½ cr.		2	3	20	9 cr. S.			9	6
Univ. Alaska				x	16		4	12	7	Pl. S.			6	3
Univ. Arizona		xx	2	x	10	50	4T.	6T.		All S.			3, 4, 5	5
Univ. Arkansas				x	3-5		3-5		50	El. S.			3, 4, 5	
Univ. California		x	2				2		6-9	3 or G.			3	
Univ. So. Calif.				x	5		5		85	El. S.		F., Gp.	2, 3, 4	2
Calif. Inst. Tech.												G.	7	2
Univ. Santa Clara													5½	2
Stanford Univ.				x	4		2	2	40				4	2
Univ. Colorado		x	3				26	33	6	Topog.		G.	8	3
Colo. Sch. Mines				x			15	35	4	Pl. S.			3, 4, 5	8
Univ. Denver													10-25	8
Col. A. & M.													7½	
Yale Univ.				Inc.			8		35	Pl. S.			12	
Univ. Conn.		P.		x	21	R.	8	13	60-70	El. S.			6	
Univ. Delaware		x	3				2	3					6	
Catholic Univ.				x	15		15		1	Geo., S.			12	3
George Wash. Univ.						x							14	
Howard Univ.				x	20-24		10-12	12-14		El. Ad. S.			7**	3**
Univ. Florida		x	3		3T.		2	3	14-20	Ad. S.		Elect.	14½	
Ga. Inst. Tech.				Inc.					20				6	3
Univ. of Hawaii		x	3			1950	→ 3		100				8**	
Univ. of Idaho				x	9	1952	1	3	15	Pl. R.			14	3
Illinois Tech.						x			30	El. S.		Ag. F., G.	9	2
Northwestern Univ.						x							8	
Univ. Illinois		x	3				15	30	10-12	P. T.			8	6
Bradley Univ.													10	
Rose Poly. Inst.				x	15		15	3	20	El., Calc.			9	
Univ. Notre Dame						x							11	
Purdue Univ.		x	2				1	3	30	Camp.		Qual.	11	2
Tri-State College													13½	
Valparaiso Univ.													7	
Iowa State College		x	2	x	16		4	12	1 vis.	El. S., T.			4	4
Univ. of Iowa				x	15-20		5	10		El.			2	
Kansas State Col.		x	4				2	6		S. I, II			3, 4, 5	
Kansas Univ.				x	2		8	48		Alg. Tr.			4, 5	
Univ. Louisville				x	21		6	15		Pl. S.		G.	3	Δ
Univ. Kentucky				x	15		15	Fd.		All S.			14	
Tulane Univ.				x	4†				100	El. S.			15	
La. State Univ.		x	3	x	Men.		2	3		Adv. S.			2	3
La. Poly. Inst.													13	
La. S. W. Inst.													12**	
So. La. Inst.				x	8		8		20	2 Sem. S.			12	
Univ. of Maine					S. Lect.							F., 2 cr.	12**	
Univ. Maryland		x	3	x	5		2	3	9	Ad. S.			11	3
John Hopkins Univ.					Exp.								6**	
Univ. of Mass.				x	6		4	2	12			F.	12	
Harvard Univ.		x	6				2	6		Tr., Sc. M.		Gp. Exp.		

TABLE I—Continued

Name of School	Photogrammetry				Hours				Total Number of Students per Year	Prerequisites	Open to Juniors—3, Sophs.—2, Seniors—4, Graduates—5	Same or Similar Course Given to Others. Foresters—F., Geologists—G., Geograph—Gp.	Total Required Surveying Credits Including Photo-grammetry	Total Elective Surveying Credits Including Photo-grammetry
	Re-quired Se-pa-rate Course	Elec-tive Course	Sem-es-ter Credits	Se-pa-rate Section of Other Course	Num-ber of Hours Allotted	Con-tem-plated for (Date)	Lec-ture. Rec-itation	Labora-tory						
Northeastern Univ.				x	12		6	6		70			15	
Worcester Poly.	x	2					1	3		19	Pl., Top		22	
Mass. Inst. Tech.		x	3	x	30		30	30		60	Pl., Top	2	18	12
Univ. Detroit													11	
Mich. Coll. M. & M.	x	2, 4					36	48		120	R. S., Dg.	3, 4, 5	15.1	
Univ. Michigan		x	2	x	20		15	15/4h		40	7 hr. S.	3, 4, 5	11	12
Mich. State Coll.				x	6	x	6		x	80	Top. S.	3, 4, 5	20	6
Wayne Univ.				x	3		2	3		14-16	R. Top.	3, 4, 5	7	3
Univ. Minnesota	x	2					20	30		12	All S.	4, 5	19½	3½
Univ. Mississippi													18**	
Univ. Missouri				x	1 cr.†		12	8		30		3, 4, 5	11	
Mo. School Mines	x		2				1	3		25	Pl. S.	3, 4	9	2
Washington Univ.	x		1				1	2			El. S.		10	
Montana State Col.				x	10	x	6	2	Fm. 2	40-50	9 cr. El.	3, 4	16	
Mont. Sch. Mines				x	4									
Univ. Nebraska				x	½ cr.			3	12	20			11	3
Univ. Nevada				x		x	Same						12**	
U. New Hampshire													14	
Dartmouth Coll.						x							10	
Newark Coll. Engr.		x	3				45	45			El. Adv.	4, 5	8	3
Rutgers Univ.				x	6-8		6-8			20-30			13	
Princeton Univ.				x	3								11	
Stevens Tech.														
N. Mex. Sch. Mines				x	2 cr.		1	3		8-15			S4 FG. 3	Δ
Univ. New Mexico													10	
Clarkson Tech.	Gr.				3 cr.		2	3		3	El. Top.	Grad.	8	
Cooper Union	x		2				1	2		22			17	
Cornell Univ.		x	3	x	11		32	40	1 day	15	Pl., Top.	3, 4, 5	13	33
Columbia Univ.													6**	
Coll. City N. Y.				x	25		10	15		160	EL., 1 Camp.	3	16	
New York Univ.		Gr.		x	8-10		15	45				4, 5	12	
Manhattan Coll.				x	1 cr.		4	11	Cont.	70-90	El. S.	2	10	
Brooklyn Poly.				x	34		10	20	4	80	EL., R. S.	3	14	
Rensselaer Poly.				x	2½ cr.		24	36		110	El. S.	2	16	
Union Coll.				x	1	x	1						11	
Syracuse Univ.	x	x	3				2	3	4 days	125. 20	6 wk. Camp.	2, 3	11	9
U. S. Mil. Academy				x	32		8	24		600		2	2	
N. Carolina State		x	3				2	2		90	Sen.	4	14	
Duke Univ.													11*	
Univ. N. Dakota				Geol.				x				2	6	4
N. Dakota Ag. Sch.													9½	
Univ. of Akron				x	7		3	4		8-10		3	9	
Case Inst. Tech.				x	56		16	40		35	R. S., Camp.	2	14	
Univ. of Cincinnati				x	32		11	21		40	Soph. S.	3	12 est.	
Univ. of Dayton				x	3								13	
Ohio Northern Univ.				x									13½	
Ohio State Univ.				x	½ cr.		1/wk.	3/wk.	3	50-7	Pl. S.	3, 4	18	8½
Ohio Univ.				x			2	2			R., T.	3	10	5
Univ. of Toledo		x	3	x									9	2
Oklahoma A. & M.							6-8			90		2, 3, 4	9	3

TABLE II

PHOTOGRAMMETRIC EQUIPMENT ON HAND AT THE ENGINEERING SCHOOLS WITH ESTIMATED VALUE
Needed Equipment Indicated by Asterisk

Univ. Alabama	Stereoscopes, stereocomparagraph, photos. \$340. *Lazy Daisy Triangulator, Misc. \$500.
Univ. Alaska	Equipment loaned by local unit of ROTC.
Univ. Arizona	Pocket stereoscopes, stereocomparagraph, sketchmaster, photos. *Mechanical templates for radial plot, photos.
Univ. California	50 pocket stereoscopes, 2 mirror stereoscopes, 7 contour finders, Lazy Daisy triangulator, planimetric plotter, rectoplanigraph. \$3,735.
Univ. South. Calif.	3 table, 2 pocket stereoscopes, contour finder, photos. \$500.
Stanford Univ.	1 table, 16 pocket stereoscopes. \$95.
Univ. Colorado	20 table stereoscopes, 2 stereocomparagraphs, sketchmaster, slotted template set, aerial camera and mount.
Colorado Sch. Mines	Kelch plotter, multiplex, misc. small equipment. \$9,000.
Yale Univ.	Stereoscopes. \$50.
Univ. Connecticut	4 reflecting stereoscopes, 2 stereocomparagraphs and drafting machines, scales, photos, misc. \$1,100. *4 vertical sketchmasters, mechanical triangulator, 4 reflecting stereoscopes, 4 parallax bars, misc. supplies. \$1,500.
Catholic Univ.	2 photo interpreters, sketchmaster. \$100.
Howard Univ.	4 pocket, one magnifying stereoscopes, stereocomparator, drafting machine, photos, misc. *Stereocomparator and plotting machine, 2 sets of apparatus for taking photos simulating aerial photos, 3 sketchmasters.
Univ. Florida	1 mirror, 12 pocket stereoscopes, comparagraph, parallax bar. \$500 *Contour finder, 3 sketchmaster. \$622.
Univ. Hawaii	Stereoscopes, radial plotter, misc. drafting equipment. \$1,000.
Univ. Idaho	Contour finder, 6 stereoscopes. \$1,000.
Univ. Illinois.	20 stereoscopes, 2 stereocomparagraphs, 12 parallax bars, 2 contour finders, 3 sketchmasters, metal template kit. \$2,500.
Rose Polytechnic.	Stereocomparators, stereocomparagraph.
Purdue Univ.	Lazy Daisy mechanical template, 50 lens stereoscopes, magnifying stereo., 10 vertical sketchmasters, 3 stereocomparagraphs, materials for radial plots using hand templates. \$4,500.
Iowa State Coll.	Stereoscopes of various types, plotting equipment, etc. \$5,000. *Multiplex.
Univ. of Iowa.	30 hand, 3 large stereoscopes, 3 comparators, "Explorer's Kit," 3 drafting machines, rectoblique plotter, Fairchild plotter, etc. \$2,000. *Minimum multiplex setup. \$10,000.
Kansas State.	2 large mirror, 12 pocket stereoscopes, 3 stereocomparagraphs, rectoblique plotter, 4 vertical sketchmasters, Lazy Daisy triangulator, 2 Paulin System altimeters, several hundred AAA photos. \$3,500.
Univ. Kansas	Lens and mirror stereoscopes, stereocomparagraphs, rectoblique plotter, rectoplanigraph, template cutter, etc., sketchmasters, parallax bar. \$4,000.
Univ. Louisville	4 stereoscopes, stereocomparagraph, template cutter. \$500.
Univ. Kentucky	Contour finder. \$250.
Tulane Univ.	Some equipment. U. S. Engineer equipment available for demonstration.
Louisiana State	5 pocket stereoscopes, 2 contour finders, 2 sketchmasters, mechanical triangulator, stereocomparagraph. \$1,486.
Univ. Maryland	Lens and mirror stereoscopes, stereocomparagraph, contour finder, vertical sketchmasters, 8 photo interpreters. \$1,500. *Photo-theodolite, K.E.K. plotter, camera equipment.
Johns Hopkins U.	Equipment for complete course.,
Univ. Mass.	Stereo pairs.
Northeastern Univ.	30 stereoscopes, 2 mechanical triangulator kits, 3 contour finders, vertical sketchmaster, oblique sketchmaster, rectoblique plotter board, misc. \$2,200.
Worcester Polytech.	Several small stereoscopes, stereocomparagraph, vertical sketchmaster.
M.I.T.	Set Mechanical templates for 100 photos, slotted template cutter, radial planimetric plotter, multiscope, 5 vert sketchmasters, comparator, 17

TABLE II—Continued

	lens stereoscopes, 3 mirror stereoscopes, 3 parallax bars, contour finder, 2 stereocomparagraphs, misc. equip. \$3,500.
	*K.E.K. plotter. \$1,200.
Mich. Coll. M & T	Equi-angulators, binocular mirror stereoscopes, point indicators, photos, Lazy Daisy triangulators, sketchmaster, contour finder, stereocomparator. \$18,000.
Univ. Michigan	18 small stereoscopes, 6 large stereoscopes, template cutter, Lazy Daisy kit, contour finder, 2 sketchmasters. \$1,000.
Michigan State	Lazy Daisy, height finders and stereoscopes, vert and oblique sketch masters, contour finders. \$1,000.
	*More of same.
Wayne Univ.	3 contour finders, 12 lens stereoscopes, several cameras, vert sketchmaster radial line mechanical templates. \$1,000.
	*3 mirror stereoscopes, parallax bar, stereocomparagraph, also a photogrammetric lab by 1951. Equip. \$2,000. Lab. \$3,000.
Univ. Minnesota	Vert sketch master, lazy daisy triang., photos, 16 stereos. \$1,000.
Univ. Missouri	Viewing equipment, etc. \$1,500.* Small additions for using, not for preparing, maps.
Mo. Sch. Mines	40 refract. Stereoscopes, 2 mirror type stereoscope comps., 2 contour finders. Access to U.S.G.S. equipment.
	*More Stereoscope Comps, contour finders.
Washington Univ.	25 pocket stereoscopes, mirror stereoscopes, contour finder, 2 vertical sketch masters, 36 point transfer. \$2,300.
Montana State	Stereo-comparagraph, vert sketchmaster, 12 pocket stereoscopes, 1 mirror stereoscope, parallax bar \$630.50.
Univ. Nebraska	Stereo-comparagraph
Newark Coll.	Access to Aerial Surveys Co. equipmt.
Rutgers Univ.	Stereocomparagraph \$300.
Princeton Univ.	8 Home-made viewers, 2 contour plotters.
N.M. Sch. Mines	Table stereoscope, 3 pocket stereoscopes, maps \$250.
	*10 pocket stereoscopes. \$100.
Clarkson Coll.	Stereocomparagraph, 2 contour finders, 2 mirror stereoscopes, 12 pocket stereoscopes, mechanical triangulators, 3 draft machines, misc. draft equipmt. \$1,500.
Cooper Union	6 stereoscopes, 4 stereocomparators, etc. \$7,000.
	*More of same. \$1,500.
Cornell Univ.	Stereoscopes, template slotter, Lazy daisy, 2 stereocomparators, vert sketchmaster, radial planimetric plotter, mosaic supplies, extensive photo library, dark room \$1,300.
	*Viewing tables, etc. \$1,000.
Coll. City N.Y.	Stereocomparagraph, 2 contour finders, sketchmaster, 4 mirror stereoscopes, magnifying stereoscope. \$1,100.
Manhattan Coll.	2 stereocomparators, stereocomparagraph, 2 sketchmaster, 6 stereoscopes. \$1,000.
	*Mechanical triangulators, etc., to complete line. \$600.
Brooklyn Poly.	12 stereoscopes, 2 stereocomparagraphs, 2 contour finders, 2 rectoplani-graphs, 5 parallax bars, mechanical triangulator, 3 sketchmasters (oblique), 2 vert. sketchmasters. \$5,500.
Rensselaer Poly.	24 stereoscopes, 25 reading glasses, steel scales, point identifiers and styluses, 3 stereocomparagraphs, parallax bar, contour finder, ratio projector, 4 aerial cameras for display, terrestrial camera for taking photos for lab. probs., 3 sketchmasters, rectoblique plotter for trimetregon templates, several sets of photos complete with control, lab. equipped with 20 work spaces each having its own light table (cost \$3,000). \$13,000.
Union College	5 stereoscopes.
Syracuse Univ.	Multiplex (3 projectors), Auxiliary multiplex (3 project.), multiplex aero-projector (3 project with reduction printer). KEK plotter, 2 stereocomparagraphs, 7 contour finders, Saltzman overhead projector, 5"×7" comparator, Zeiss terrestrial camera subtense bar, photo theodolite, 4 calculating machines, 3 sets mechanical triangulators, darkroom equipment. \$35,000+.

TABLE II—Continued

U.S. Mil. Acad.	600 pocket stereoscopes, 375 mirror stereoscopes, multiplex with 6 wide angle projectors. \$11,000.
N.C. State	7 vert. sketchmasters, stereocomparagraph, 2 contour finders, set mechanical slotted templates, 2 hooded glass top tables with delineascopes, 4 draft. mach. and other draft. equipmt.
Univ. N. Dakota	Contemplated equipmt. cost, \$700.
Univ. Akron	3 stereoscopes
Case Inst. Tech.	Saltzman ratio projector, stereocomparagraph, 3 contour finders, vert. sketchmaster, 30 stereoscopes, Fairchild camera 6" lens, field film processing unit, about 500 photos, 200 slides, slotted templates, incidental supplies. \$4,000.
Univ. Cincinnati	*Additional stereocomparagraphs. \$1,000. 15 stereoscopes, parallax bar, 50 photo interpretometers. War Surplus was source.
Ohio State Univ.	3 mirror stereoscopes, 4 lens stereoscopes, 2 stereocomparagraphs, 8 contour finders.
Ohio Univ.	45 pocket stereoscopes, 8 mirror stereoscopes, contour finder, 3 stereocomparagraphs, vert sketch master, oblique sketchmast., radial intersector set, 2 intervalometers, bomb spotting camera, camera, hand camera.
Oregon State	*Multiplex. 3 stereoscopes, 2 stereocomparagraphs (from surplus).
Bucknell Univ.	*Slotted template cutter, radial plotter, multiplex (portable.) 12 pocket stereoscopes, 2 sketchmasters, modified Lazy Daisy, slotted template cutter, 12 mirror stereoscopes, parallax bar, pantagraph 2 draft. mach. \$500 plus that from surplus.
Lafayette Coll.	*2 height finders, Kail radial projection plotter \$300. 12 pocket, 3 mirror stereoscopes, 2 contour finders, 2 mechanical triang., stereocomparagraph, oblique sketchmaster, 2 vert. sketchmast., rect-oblique plotter. \$2,600.
Lehigh Univ.	Sketchmaster, stereoscopes, stereocomparagraph, contour finder. \$1,500.
Penna State	Sketchmasters, metal templates, rectoblique plotter, stereoscopes, negatives, darkroom, slot cutter \$2,800. *Rectifier. \$800.
Swarthmore Coll.	Stereoscopes, contour finder. \$700.
Clemson Coll.	Several aerial cameras, misc. dark room equipmt., 4 stereocomparagraphs, sketchmaster, 3 mirror stereoscopes, 20 pocket stereoscopes, mechanical triang. set. \$4,000.
Citadel	Pocket and mirror stereoscopes, parallax bar, Lazy daisy, radial plotter, stereocomparagraphs, rectoplanagraph, 500 photos. \$2,100.
Univ. S. Carolina	Cameras, large stereoscopes, 18 pocket stereoscopes, many maps and photos. \$1,500. *Stereocomparators, etc. \$2,000 over five years.
S. Dakota State	Abrams contour finder.
Univ. Tennessee	Lens and mirror stereoscopes, parallax measuring bar, contour finder.
Texas A. and M.	One mirror, 18 pocket stereoscopes, stereocomparator, rectoplanagraph, contour finder, mechanical triang., oblique sketchmaster \$1,500.
Univ. Texas	15 stereoscopes, 2 contour finders, mechanical triang., 2 vert sketchmasters, draft equipment, local photos, \$2,000.
Southern Methodist U.	Contour finder, camera, etc. \$1,500.
Univ. Utah	4 pocket stereoscopes, 2 mirror stereoscopes. \$400. Equipment available on loan. *Stereocomparator, set slotted templates. \$600.
Utah State Ag.	25 magnifying stereoscopes, 4 stereocomparagraphs, K.E.K. plotter, radial line plotter. \$2,350.
Univ. Vermont	Stereoscopes, photos. *Stereocomparagraph \$450.
Va. Poly.	Slotted template cutter, contour finder, 8 mirror and 15 pocket stereoscopes, 2 height finders, vertical sketchmaster, computers, \$3,000.
Univ. Virginia	12 pocket stereoscopes, 3 sketchmasters, stereocomparagraph (Surplus)
V.M.I.	20 pocket stereoscopes, 20 stereocomparagraphs, 20 Lazy daisy sets, 20 drafting kits and arms, 20 sketchmasters, 1 rectoblique plotter, 10 contour finders, mirror stereo, 100 vert photos.

TABLE II—Continued

Wash. State	*5 sketchmasters, 1 multiplex.
U. Washington	Viewer, height finder, contour finder. \$500. 40 stereoscopes various designs, contour finder, parallax bar, height finder, sketchmaster, 40 parallax wedges. \$1,300.
West Va. U.	*Kelsh Plotter, other items. \$4,500. 2 aerial cameras, 2 contact printers, 2 height finders, stereocomparagraph, 6 folding, 2 portable and 5 table stereoscopes, 2 vert. sketchmasters, radial planimetric plotter. \$10,000.
Univ. Wisconsin	*Lazy Daisy, contour finder, rectoplanagraph, stereoscopic plotter. 2 stereocomparators, 3 vert sketchmasters, 18 stereoscopes, mirror stereoscope with parallax bar, set metal templates to handle approx. 100 photos, photos, draft. equipmt. \$1,600.
Univ. Wyoming	*Photo lab. precision type plotter such as multiplex. 3 cameras, 10 stereoscopes, sketchmaster \$3,000. *Small stereoscope projector, enlarger, home made stereoscope plotter during next 3 years \$3,000.
Univ. N. Brunswick	30 pocket, 6 mirror stereoscopes, 4 parallax bars, equipmt. for template work, 3 transfer devices.
Univ. Alberta	Pocket stereoscopes, mapping stereoscopes, vert. sketchmaster, photos \$1,000.
Univ. Manitoba	Stereoscope.
Univ. British Columbia	6 stereoscopes, 2 parallax bars, rectifier. \$1,500.

Table II lists the photogrammetric equipment available at the 145 schools. Additional equipment was undoubtedly lost by incomplete answers. Ninety-one schools or 63% report equipment on hand or accessible. Twenty-eight contemplate obtaining more.

Stereoscopes are the most common piece of equipment, 81 colleges having them. Only 2 schools have a multiplex although 6 hope to obtain one.

The cost of photogrammetric equipment is a critical factor for most school budgets. War surplus equipment has been acquired by many colleges, some in used condition, making its value difficult to estimate. The minimum value of equipment on hand varies from nothing for some institutions to a high of \$35,900+ at Syracuse University, \$18,000 worth at Michigan College of Mining and Technology, \$13,000 at Rensselaer, \$10,000 at West Virginia, etc.

It is hoped that the information obtained from this study will be of value to engineering teachers and administrators in analyzing their surveying programs. Now that military preparedness again calls for numerous qualified photogrammetrists, perhaps the colleges are ready to train some of them.

APPENDIX A

(1) "Photogrammetry included experimentally this year for the first time."

(2) "We give two lectures on photogrammetry in Advanced Surveying. Are of the opinion that photogrammetry is a specialized course which can be handled best at graduate level."

(3) "Photogrammetry and Route Surveys are now included in one course under the title of Advanced Surveying. Elements of photogrammetry as they apply to vertical photographs, are covered. We plan to add a surveying course which will cover more advanced photogrammetry and high order surveys. This course will probably be an elective and the present elementary work in photogrammetry will be retained: thus all students will be required to take some work in photogrammetry and those who are interested will have an opportunity to go further in this field."

(4) "Have been trying to get a course inaugurated and probably will before long."

(5) "We feel that the student should be acquainted with these tools, have a knowledge of the advantages of using aerial photogrammetry in topographic work and be able to use simple stereoscopes and stereocomparators. Due to lack of time in the undergraduate curricula, the course is not designed to produce expert photogrammetric

technicians. We feel, however, that the student will have sufficient background to develop under proper guidance."

(6) "Not considered necessary for 'Run of Mine' C. E. student."

(7) "One unit of graduate credit has been given regularly each semester for the last two years."

(8) "Seek only to show the limitations and usages of aerial photography."

(9) "Course is in development stage, in operation 3 semesters to date. I have, perhaps, attacked photogrammetry from an unusual angle due to my long period of service in the U.S.C.&G.S. In carrying the course along with Higher Surveying (principally Geodesy) I have made use of my contacts in the U.S.C.&G.S. in getting a number of stations of 1st and 2nd order triangulation on, and in the immediate vicinity of, the _____ reservation.

"This forms the basis for a strong radial plot. Following that, we use a low-level flight for intimate detail, with contouring as much as time allows. Each semester I select a different localized area for the detail, and I hope as time goes on to have a genuine planimetric map which will 'stand up.'

"Our scope, you will note, is limited, since we do not have, close by, those major offices using the expensive equipment. Nevertheless our idea is to ground the students in the idea of adequate *control*, and to give them a share in a definite project. Their interest seems to be heightened thereby."

(10) "In addition to the photogrammetry which is taught as a part of Advanced Surveying, we include the use of air-photo identification of soils and rock in our course in Soil Mechanics (required). This instruction amounts to about 35 to 40 hours (effort) of air photo identification."

(11) "There is no qualified photogrammetry instructor and there has been no inquiry or demand other than interpretation."

(12) "We have a total 6 credit hours of courses in the field of aerial mapping." (School of Mines).

(13) "We cover the basic principles of photogrammetry in our course in Advanced Surveying. About two lectures in the course in Highway Engineering are devoted to the utilization of photogrammetric methods in highway location."

(14) "No course offered at present. Have been thinking of value and outline to teach all engineers. Aerial photographs used at present for work in geology and topography." (School of Mines).

(15) "We have no equipment for teaching photogrammetry."

(16) "Course in photogrammetry given to graduate students only."

(17) "Cornell is, I believe, unique in giving advanced engineering work in surveying, mapping, and photogrammetry leading to both an M.S. and a Ph.D. degree. Also unique in having set up the so-called Cornell Center for Integrated Aerial Photographic Studies to include not only surveying and mapping but also Forestry, Agronomy, Geology, City and Regional Planning, Water Resources, Highway Planning, etc.

"Courses here in Geology and Agricultural Engineering make use of aerial photos including photo interpretation, radial line plots, and planimetric details."

(18) "We are revising our C. E. curriculum but doubt if we will find space for undergraduate course (separate) in photogrammetry."

(19) "Elementary Photogrammetry as taught is part of a 180-hour Military Topography course, which includes surveying, elementary and advanced map reading, study of air photos (vertical and oblique), and the use of the stereoscope and other photogrammetric equipment, terrain appreciation and evaluation, and military sketching—all directly pointed toward the needs of the Military. The mission of the course is quoted as follows: 'To teach cadets to read skillfully maps and air photos of domestic and foreign areas and to give them familiarity with the standard topographic and photogrammetric equipment and processes employed in the production of U. S. Military maps, charts and sketches. This course is believed to be unique, hence the expanded remarks.'"

(20) "Photogrammetry is required at present but will be an elective beginning Fall Term 1950."

(21) "We do not offer a separate course in Photogrammetry but intend to squeeze some into our advanced surveying this year and perhaps offer a separate course later.

We do not have a well qualified person to teach such a course at this time."

(22) "Photogrammetric surveying is not of sufficient general importance to undergraduate students to warrant its emphasis. I doubt that over 1% of our graduates will ever have occasion to use it."

(23) "At present photogrammetry is just a few days assignment in the Advanced course. It probably never will develop into a separate course, although I intend to stress it a bit more and hope to get some equipment to aid in instruction and demonstration."

(24) "A short lecture in Plane Surveying to barely acquaint the student with such a science; one or more lectures in Route Engineering and Highway Engineering on work being done by such states as Ohio and Michigan in the Highway Departments, in the use of Photogrammetry for Highway design and location; use by transmission lines, etc."

(25) "The advantages and disadvantages and some principles are discussed in the lectures."

(26) "Consideration is now being given to the creation of a 5 year course in Civil Engineering in addition to the existing 4 year one. Such a course would probably offer, in the Senior Year, at least three semester credits of photogrammetry."

(27) "We wish to introduce photogrammetry in our elementary surveying course, to have about 16 total hours in our advanced surveying course and to have an additional 2-credit course for advanced students and graduate students."

(28) "The only time devoted to this subject amounts to one hour of discussions and the showing of the U.S.G.S. film, 'Topographic Mapping by Photogrammetric Methods.' It is contemplated that it will be included as a part of surveying with another credit added to surveying, to provide for its inclusion."

(29) "Beginning with the 1950-51 school year, Photogrammetry will be required for students majoring in General, C.E. and Highway Engineering, but will be considered as a technical elective for others."

(30) "Contact prints and enlargements are obtained from the Western Division Photogrammetric Lab. of the AAA. At present, we are using their facilities to obtain slotted templates and rectified photographs."

"The work done in the course involves plotting horizontal and vertical ground control, obtained during the summer surveying camp; marking of prints and making of templates; orientation of photos; and sketching of planimetric detail and 100 ft. contours for an area of approximately 6 sq. miles to a scale of 1/12,000.

"The area covered each year is a new portion of the ——— National Guard Camp. The completed portions of the map are being used by the ——— National Guard for tactical purposes during their annual encampment and by the C. E. Dept. as a check on and base for a plane table survey to the same scale, but with 25 ft. contours made during the summer surveying camp each year.

"It is believed that by having the students cover the area first by ground methods and then by photogrammetric methods, a reasonable and graphic comparison of the relative costs, time consumption and accuracy of the two methods can be made."

(31) "There is to be a course offered in airphoto interpretation of soils and materials in the Spring, 1951. Elective for graduates, Seniors and Geology students."

(32) "We regard our work in photogrammetry as very much in the development stage. The course is popular and registration is increasing. We were required to provide an additional section to take care of the demand this Spring."

(33) "The whole situation regarding surveying is under consideration. There is far too much time devoted to it for present day needs."

"Photogrammetry is of growing importance in Canada. But it is a comparatively simple subject to teach and should not be given more time than necessary as far as theory is concerned. The practical application is another matter. I feel that this can only be gained by working with those who actually carry on the work in the field.

"It is hoped to put all advanced surveying into a fifth year option for the *very few* who wish to take it. A longer course in Photogrammetry could be included in this fifth year.

"The surveying that the average civil engineer does now is so simple that his course should not be overloaded with advanced geodesy as has been the case in the past. This

was largely due to the large amount of surveying and railroad construction in Canada carried on up to the 1920s."

(34) "Repeated coverage of University land, 5,000 acres, gives opportunity for ground checking any phase of the work. Course has evolved from one called Topographic Surveying given to the 4th year Foresters. It has built up slowly over a 6-7 year period. Emphasis on elements of mapping and interpretation, mainly forest and related.

"The University is in the process of shifting from 4 to 5 years base in Applied Science. Heavy Forestry postwar enrollment forces Engineers out of course temporarily. Plan to resume for Civils in Fall of 1950."

(35) "The photogrammetry option is open only to Civils, and comes in second term of final year. We expect that in any one year we will give EITHER the photogrammetry OR the geodesy and lab. option. We would expect about 10% of the class to elect this option."

(36) "Need for such a course is felt here. A course is being planned but no final choice has been made yet."

Chairman McNair: The next speaker needs no introduction to most of you. Professor Rayner, from the University of Illinois, is famous for his textbooks and for his writings. Many of you, doubtless, have studied surveying out of one of the Davis, Foote and Rayner textbooks or the Rayner texts. You probably also know that Professor Rayner is on the Executive Committee on Surveying and Mapping of the American Society of Civil Engineers.

INSTRUCTION IN PHOTOGRAMMETRY AT THE UNIVERSITY OF ILLINOIS

Professor W. H. Rayner, Civil Engineering Department, University of Illinois

THIS paper describes the courses of instruction in photogrammetry for civil engineers in the University of Illinois. Three courses are given: (1) six two-hour periods in the course in route surveying, required of all civil engineering students; (2) an elective course with three semester hours credit for undergraduate and graduate students; and (3) a graduate course as part of the requirements for the Master's degree in Civil Engineering.

THE REQUIRED COURSE

The six periods required of all civil engineering students are designed to acquaint them with the basic characteristics of vertical aerial photographs. The topics included are: definitions, perspective principles, scale of a photograph, image displacements caused by ground relief, computation of height of lens, true length of a line, the air base, and the radial-line method of establishing map control by the use of plain templates.

The materials used include con-



W. H. RAYNER