AN INVESTIGATION OF CERTAIN COMMERCIAL OFFSET PROCESSES AND OF THEIR ADAPTABILITY TO PUBLIC SCHOOL ART CURRICULA

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B.S. (New York State College for Teachers at Buffalo, 1955)

A THESIS

Submitted in partial satisfaction of the requirements for the degree of

MASTER OF ARTS

AT THE

SACRAMENTO STATE COLLEGE

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Date June 2, 1958
ACKNOWLEDGMENTS

Without the advice and assistance of the following organizations, this thesis would not have been possible.

The Sacramento Office of the California Ink Company was very helpful in supplying information about manufacturers and costs of plates and solutions. Equally generous was the Addressograph-Multigraph Corporation of Sacramento in providing assistance, metal plates, and price lists.
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CHAPTER I
I. THE PROBLEM

The positive values of printmaking in public school education are generally recognized by educators. Block printing (linoleum or wood) and serigraphy (silk-screen), for example, are usually included in public school printmaking courses because the mediums require inexpensive materials, simple tools, and no press. On the other hand, lithography rarely appears at this educational level because, in common practice, it necessitates complex and expensive equipment and materials. Its use, therefore, is prohibitive except in institutions of higher learning and commercial printing plants.

This investigator is not concerned with justifying the use of lithography in the public school art curriculum. Lithography has been recognized for many years as the printmaking medium which permits a maximum expressiveness, freedom and fidelity to the original quality of the drawing.1

1J. Pennell, The Graphic Arts (Chicago: University of Chicago Press, 1927), p. 278; "Lithography is the art of multiplying originals and not of reproducing them."; and C. Seward, Metal Plate Lithography (New York: The Pencil Points Press, Incorporated, 1931), p. 25: "Drawings may be made with pen brush, crayons, or stomps and any or all of the methods combined at will. We will get in the print exactly what we put on the plate."
However, lithography has such distinct advantages over other printmaking media that with simple and inexpensive techniques it should be a basic means of artistic expression in public schools, as it is a basic means of production in commercial printing. A primary value of lithography is its wide range of expression. The surface of the plate can be worked in the manner of all media: ink, pencil, water color, etc. (Block printing and serigraphy, however, necessitate modifying the original sketch with a resultant loss of spontaneity and expressiveness.) Unfortunately, while a rapid refinement of lithography was being developed in the commercial world in the direction of increasingly inexpensive metal plates, no extensive experiments or comparable research were being carried on to relate known commercial advantages to classroom use.

The purpose, therefore, of this problem shall be to formulate a simple method whereby such materials and procedures can be used in public school printmaking classes by: (1) conducting a series of sixteen experiments in direct process technique, using zinc and aluminum lithographic plates; and (2) identifying, recognizing, and organizing

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2Seward, Ibid.: "Lithography is the most versatile of all the graphic arts. The method and manners of doing a lithography is [sic] limited only by the inventiveness of the artist."
the materials and procedures necessary for a successful technique in the use of these metal plates for artistic expression.

The qualitative differences between stone and metal plate lithography do not need to be considered because, in either case, evaluation should be based on the fidelity of the impression to the original design.

II. HISTORY

The development of metal plate lithography as a commercial process is fairly well documented and its progress has been almost uninterrupted.

From the beginning, it was realized that the use of stone was too cumbersome and too slow a method to satisfy the immediate needs of commercial production. Alois Senefelder (the inventor of lithography) was, himself, aware of these limitations. Less than twenty-five years after stone lithography had been invented, zinc plates had already been tried as a substitute.

3A. Senefelder, *The Invention of Lithography* (New York: The Fuchs and Lang Manufacturing Company, 1911) p. 32: "This fact gave me hopes of discovering a sort of artificial stone paper some day, which might be less costly, less massive, and less fragile; and, as a matter of fact, I succeeded in inventing an artificial stone-paper in 1813."

The early history of metal plates has been briefly traced by Charles Harrap.\textsuperscript{5} The first commercial production work was accomplished, by Bruegnot of Paris, by plates of zinc in 1829.\textsuperscript{6} Zinc was also used for printing scale maps in England in 1855.\textsuperscript{7} By 1870, "it [zinc] was practically almost [sic] as well known as printing from stone."\textsuperscript{8} On the other hand, aluminum "was not actually introduced in the printing trade until Mullaly and Bullock's patent of September eighth, 1891."\textsuperscript{9}

It should not be assumed that progress with metal plate lithography proceeded smoothly. Initial explorations with metals were often unpredictable. As Warren Browne points out, "Ponderous slabs of zinc were used, generally half-an-inch thick, and fully impregnated with impurities of other metals and dross."\textsuperscript{10} The weight and impurities led to difficulties which hindered progress many years.

T. R. Johnston introduced the rotary press in 1895,\textsuperscript{11}

\begin{itemize}
\item \textsuperscript{5}Ibid., pp. ix-xvi. \textsuperscript{6}Ibid., p. x.
\item \textsuperscript{7}Ibid. \textsuperscript{8}Ibid., p. xi. \textsuperscript{9}Ibid
\item \textsuperscript{10}W.C. Browne, Metal Plate Printing (New York: The National Lithographer, 1910) p. 10.
\item \textsuperscript{11}Harrap, op cit., pp. xiv-xv.
\end{itemize}
however, and offset lithography followed in 1904.\textsuperscript{12} By 1910, metal plates were preferred, and only the introduction of photographic techniques remained to be perfected. As the chemistry of lithography became better understood, metal plates and etching solutions were perfected to the point where only careful and clean habits were required for successfully producing a limited edition.

While rapid progress in the use of metal plates was being made in industry, no simplified procedure of printing with metal plates was available until recently. Unfortunately too, publications describing metal plate lithography are rare. Perhaps the first book of real value was \textit{The Grammar of Lithography}, published in 1886.\textsuperscript{13} It was followed by \textit{Metal Plate Printing}\textsuperscript{14} in 1910, \textit{Metalography}\textsuperscript{15} in 1912, \textit{The Art of Lithography}\textsuperscript{16} in 1914, and

\begin{itemize}
  \item \textsuperscript{13}W. D. Richmond, \textit{The Grammar of Lithography} (London: Wyman and Sons, 1886).
  \item \textsuperscript{14}Browne, \textit{op. cit.}
  \item \textsuperscript{15}Harrap, \textit{op. cit.}
  \item \textsuperscript{16}H. Rhodes, \textit{The Art of Lithography} (London: Scott, Greenwood and Son, 1914).
\end{itemize}
more recently, *Metal Plate Lithography* in 1931. Of all these volumes, only the last one dealt with metal plate lithography as a fine arts medium.

Since then, Mr. Horace Heilman's article "Lithography Simplified" has been the only publication in this area.

III. IMPORTANCE OF THE PROBLEM

Metal lithography remains unknown to art teachers. Available publications perform little service in dispelling notions that the technique of metal plate lithography is complex and difficult. Most published material has been written by accomplished artists or commercial technicians, and consequently they are esoteric, to say the least. At best, the attention to endless detail prevents their wide usage and discourages the inclusion of lithography in public school printmaking programs.

Specifically, a simple and practical technique for producing lithographs from metal plates is urgent. Since this investigator has already indicated that such possi-

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17 Seward, *op. cit.*

ilities are obviously inherent in present-day commercial usage, the attainment of this objective is a realistic and readily available one. In addition, a simple, practical technique will extend printmaking activities, open up a more flexible medium of printmaking, increase the basic knowledge of modern printing procedures, and, in general, promote a more realistic attitude toward lithography.

Aside from Mr. Heilman's article,\textsuperscript{19} there are no other publications in this area. Mr. Heilman has already proposed a procedure for using metal plates at the college level of education.\textsuperscript{20} There is, however, no information about the technique in relation to public school situations. Although presses are used, the ease, economy, simplicity, and quality of commercial printing clearly indicates that the same advantages await fine and student artists as soon as conversion research can be carried out. Toward this urgent objective this paper contributes, it is hoped, the basic scientific research on the use of metal plates in public school art programs -- i.e., without offset presses -- by providing information about the: (1) comparative qualities of both zinc and aluminum plates; (2) efficiency

\textsuperscript{19}Ibid. \textsuperscript{20}Ibid.
of various etching solutions on these two metal products; (3) possibilities of both crayon and tusche drawings on these plates; (4) effectiveness of hand burnished and press prints; (5) methods of regraining used plates; (6) supplies, sources and approximate costs; and lastly, (7) use of these techniques in primary and secondary art education.

IV. DEFINITIONS OF TERMS USED

Common lithographic terms will not be defined unless their meanings are essential to the investigation. These definitions are offered with a hope of standardizing technical vocabulary and increasing precise communication.

Burnish. A process whereby an impression is obtained from the plate through hand pressure and any appropriate tool. (See Fig. 4, page 40.)

Counteretch. Any solution used to clean grease and dirt from a metal plate before the drawing is executed. The process is known as "counteretching".

Direct-process. A system by which an impression is obtained through direct contact with the metal plate, i.e., the printing is done by laying the paper on the plate.
Etch. Any acid solution that is applied to the plate after the drawing has been executed to accentuate the affinities between the greasy drawing medium and the oil-based ink, and between the open areas and water (fount).

Fount. Any solution that is used to keep a plate damp throughout the printing sequence.

Grain. The irregular surface quality of a plate. The process of creating a surface texture is known as "graining". Grains on lithographic plates vary widely, depending on the manufacturer and the purpose of the plate.

Re-grain. Any process that is used to produce a grain on a plate that has lost its original grain.

Roll-up. Applying ink to the image on a plate by rolling an ink-charged brayer across its surface.

Sensitizer. Some manufacturers use "sensitizer" instead of "etch". In this paper the term "sensitizer" will be used only for references.

Stock. The paper used to receive the impression.

Undermine. The tendency of the "etch" to erode the metal beneath the small dots of crayon on a plate.
V. PROCEDURE

The traditionally prescribed procedure for preparing metal plates before printing is extensive and time consuming. Furthermore, it is impractical in public school situations, and so it seemed convenient to adopt a modified procedure of Horace Heilman's.21

(1) Counteretch: All plates were placed grained surface up in a glass tray containing enough counteretch solution22 to cover the plate at least one-half an inch. Each plate was scrubbed lightly with a stiff brush, -- a bronze-bristled pot brush is excellent -- and kept in the counteretch for three minutes. It was then removed and washed in running water.

(2) Acid Stop: While still damp, the plates were sprinkled with a small amount (about one teaspoonful) of bicarbonate of soda. This was worked over the surface of the plate with a clean cotton wad for a few seconds and the plate again washed in running water, blotted, and fanned dry.

(3) Drawing: The areas to receive the drawings were

21Heilman, op. cit., et passim.

22Counteretch solution prepared with one-fourth ounce Acetic acid to one quart water.
indicated directly on the plate with a common pencil, and the crayon or tusche was then applied.

(4) Etching: Although the solution varied for each experiment, in every case the etch was applied to the counteretched surface of the plate with a soft brush. The etch was washed from the plate with a water-dampened sponge and the plate left quite damp.

(5) Dampening Paper: The paper stock was cut to size, and each sheet wiped on one side with a water-dampened sponge.

(6) Inking the Slab: A small daub of ink was put on the palette (glass, metal, plastic, or smooth-coated board) and rolled out to a thin even film with a gelatine brayer.

(7) Dampening: The plates were dampened with an "elephant ear" sponge using a commercial fount solution.

(8) Roll-up: The plate was "rolled-up" by passing the gelatine brayer over the dampened surface of the plate.

(9) Printing: Each "rolled-up" plate was placed

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23Pencils that may contain grease should be avoided. Sanguine or charcoal are recommended.

face up on a blotter, the dampened side of the stock laid on the plate, another blotter laid over the top of the paper, and the impression was made using a proofing press or by hand burnishing and a smooth, round tool.

(10) Edition: After the impression was carefully removed, the plate was immediately re-dampened with the sponge and fount solution, rolled-up again, and impressions made until the desired edition was complete.

It may be important to recall that this experimenter has confined this investigation to plates of zinc and aluminum. The undeniable popularity of these two metals in the commercial printing and their universal availability, dictated their selection. Since the purity of all such metal plates is high, chemical reactions remain constant, and most of the variations that occur between plates of

25Specifications for "Press", see Table III, page 74.

26Any smooth, hard tool will suffice, e.g., a spoon or round drawer pull.

27See page 2. Plates were manufactured by the Addressograph-Multigraph Corporation.

28Seward, op. cit., p. 7: "Many materials may be used, but zinc and aluminum are the most practical and at the same time most trustworthy where a number of impressions are desired."

29In addition to these two metals, other surfaces that are frequently used are magnesium, paper, and plastics.
various manufacturers are those of surface grain and thickness.

All impressions were made on dampened paper. Only two inks were used: Braden Sutphin block printing ink, and Cal-Ink lithographic ink.

Drawing on the plates was done with William Korn's lithographic crayon Nos. 2 and 4 -- applied in cross-hatching and built-up tones, and Korn's liquid tusche -- applied in a varying manner with pen and brush.

None of the plates in this thesis were printed on a lithographic press. Printing was accomplished by hand burnishing or proofing press. Roll-up was done with a six-inch gelatine brayer.

30White Seaplane offset paper, 120 pound, Zellerbach Paper Company, 534 Battery Street, San Francisco, California.

31Braden Sutphin printers' oil black, No. 24225, Braden Sutphin Ink Company, 3800 Chester Avenue, Cleveland, Ohio.

32Cal-Ink lithographic black, California Ink Company, 2908 Capitol Avenue, Sacramento, California.

33Although both zinc and aluminum plates were from the same manufacturer, the aluminum plates were thinner and had a finer grain than the zinc.


35Specifications of "Brayer", see Table III, page 73.
CHAPTER II
I. EXPERIMENTATIONS

Except for the control variations, sixteen experiments were conducted in the manner described on pages 10-12. A brief description precedes each experiment to call attention to the control variations. The sixteen experiments were conducted on aluminum and zinc, making eight experiments on aluminum and eight on zinc. Throughout the experiments, the prefix "A" indicates an aluminum plate and the prefix "Z", a zinc plate.

Drawing media were investigated alternately. Odd numbers indicate those plates on which crayon was used. Examples are "A-1" and "Z-3". The even numbered plates will be those on which tusche was used. Examples are "A-2" and "Z-4".

Four kinds of etches were used on both types of metals and drawing media to make up the sixteen experiments. Nitric acid was used as an etch in the first series, phosphoric acid in the second, and Uni-clean etch\textsuperscript{36} in the third. For the fourth block of experiments (experiments 13-16), etches that are considered effective only on that specific metal, i.e., aluminum or zinc, were used.

\textsuperscript{36}Uni-clean etch, Harold M. Pitman Company, North Bergen, New Jersey.
**EXPERIMENT 1**

A-1: Aluminum plate, nitric acid etch, crayon.

Nitric acid is commonly used as an etch. For this experiment an etch consisting of one ounce lithographic gum and ten (10) drops of nitric acid (70% CMP) was used.

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<th>Procedure</th>
<th>Observations</th>
<th>Evaluation</th>
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<td>(1) Counteretch</td>
<td>Procedure: As described on page 10.</td>
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<tr>
<td>(2) Acid Stop</td>
<td>Procedure: As described on page 10.</td>
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<tr>
<td>(3) Drawing</td>
<td>Procedure: Crayons in built-up tones, cross-hatchings and stippling were applied.</td>
<td>Observations: The crayons went on smoothly and provided a wide range of grey tones.</td>
<td>Evaluation: The plate is an excellent surface for crayon.</td>
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<td>(4) Etching</td>
<td>Procedure: As described on page 11, with nitric acid solution for two minutes.</td>
<td>Observations: No bubbling was apparent; image remained undamaged by the etch.</td>
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<td>(6) Inking Slab</td>
<td>Procedure: As described on page 11.</td>
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<tr>
<td>(7) Dampening</td>
<td>Procedure: As described on page 11.</td>
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<tr>
<td>(8) Roll-up</td>
<td>Procedure: As described on page 11, using Braden Sutphin Ink.</td>
<td>Observations: Scumming was encountered. The ink bled into the clear plate areas.</td>
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</tbody>
</table>
EXPERIMENT 1 (continued)

(9) Printing

Procedure: As described on page 11-12. The first twenty impressions were made by proofing press; impression twenty-one, by hand burnishing.

Observations: All impressions were satisfactory. See Plate 1, page 48. The first six impressions deteriorated slightly, but quality remained constant thereafter. A circled area on Plate 1, page 48, shows where thick dots of No. 2 crayon were smeared by the pressure of the press. Hand burnishing produced impressions as satisfactory as the proofing press. Cf. Plate 3, page 50 and Plate 2, page 49.

Evaluation: Satisfactory impressions are easily obtained.

(10) Edition

Procedure: As described on page 12.

Observations: An edition of twenty impressions was made and only a slight thickening of the ink occurred. Cf. Plate 3, page 50 and Plate 2, page 49.
EXPERIMENT 2

A-2: Aluminum plate, nitric acid etch, tusche.

A nitric acid etch identical to that of Experiment 1 was used for this experiment.

(1) Counteretch
Procedure: As described on page 10.

(2) Acid Stop
Procedure: As described on page 10.

(3) Drawing
Procedure: Varying textures with a pen and tusche were applied.
Observations: The plate accepted tusche readily.
Evaluation: The plate is an excellent surface for pen and tusche.

(4) Etching
Procedure: As described on page 11, with nitric acid solution for two minutes.
Observations: No bubbling was apparent, image remained undamaged by the etch.

(5) Dampening Paper
Procedure: As described on page 11.

(6) Inking Slab
Procedure: As described on page 11.

(7) Dampening
Procedure: As described on page 11.

(8) Roll-up
Procedure: As described on page 11, with Braden Sutphin Ink.
Observations: Scumming was encountered.\footnote{Since scumming was again encountered as in Experiment 1, the Braden Sutphin ink was assumed to be responsible. Lithographic ink was successfully used in all subsequent experiments.} The ink bled into the
EXPERIMENT 2 (continued)

clear plate areas.

Evaluation: Braden Sutphin Ink is not suitable.

(9) Printing

Procedure: As described on page 11-12. First twenty impressions were made by proofing press; impression twenty-one, by hand burnishing.

Observations: All impressions were satisfactory. See Plate 4, page 51. No deterioration was evident. Hand burnishing produced impressions as satisfactory as the proofing press. Cf. Plate 6, page 53 and Plate 5, page 52.

Evaluation: Satisfactory impressions are easily obtained.

(10) Edition

Procedure: As described on page 12.

Observations: An edition of twenty impressions was made and only a slight thickening of the ink occurred. Cf. Plate 5, page 52 and Plate 4, page 51.

38In all following experiments, none of the plates with tusche images showed any sign of deterioration from printing.
EXPERIMENT 3

Z-1: Zinc plate, nitric acid etch, crayon.

A nitric acid etch identical to that of Experiment 1 was used for this experiment.

(1) Counteretch  
Procedure: As described on page 10.

(2) Acid Stop  
Procedure: As described on page 10.

(3) Drawing  
Procedure: Crayons in built-up tones, cross-hatchings and stippling were applied.

Observations: The crayons went on the plate satisfactorily but had a tendency to slip and stick. A wide range of grey tones was possible.

Evaluation: The plate is a suitable surface for crayon.

(4) Etching  
Procedure: As described on page 11, with nitric acid solution for two minutes.

Observations: Bubbling was noticed. Images eroded entirely from the plate.

Evaluation: This etch is not suitable.

Experiment not continued.
EXPERIMENT 4

Z-2: Zinc plate, nitric acid etch, tusche.

A nitric acid etch identical to that of Experiment 1 was used for this experiment.

(1) Counteretch  Procedure: As described on page 10.
(2) Acid Stop     Procedure: As described on page 10.
(3) Drawing      Procedure: Varying textures with a pen and tusche were applied.
                 Observations: The plate accepted tusche readily.
                 Evaluation: The plate is an excellent surface for pen and tusche.
(4) Etching      Procedure: As described on page 11, with nitric acid solution for two minutes.
                 Observations: Bubbling was noticed; the images eroded entirely from the plate.
                 Evaluation: This etch is not suitable.

Experiment not continued.
EXPERIMENT 5

A-3: Aluminum plate, phosphoric acid etch, crayon.

An etch suggested by Harrap\textsuperscript{39} was mixed for this experiment. Following his proportions, one ounce lithographic gum was combined with ten (10) drops of phosphoric acid (85\% CMP).

(1) Counteretch Procedure: As described on page 10.
(2) Acid Stop Procedure: As described on page 10.
(3) Drawing Procedure: As described for Experiment 1, page 15.
(4) Etching Procedure: As described on page 11, with phosphoric acid solution for two minutes.

Observations: No bubbling apparent; the image was undamaged by the etch.

(6) Inking Slab Procedure: As described on page 11.
(7) Dampening Procedure: As described on page 11.
(8) Roll-up Procedure: As described on page 11, with lithographic ink.

Observations: No scumming apparent.

Evaluation: Lithographic ink is suitable.

\textsuperscript{39}Harrap, \textit{op. cit.}, p. 89.
EXPERIMENT 5 (continued)

(9) Printing

Procedure: As described on page 11-12. All twenty impressions were made by proofing press.40

Observations: All impressions were excellent. See Plate 7, page 54. Almost no deterioration took place.

Evaluation: Excellent impressions are easily obtained.

(10) Edition

Procedure: As described on page 12.

Observations: An edition of twenty impressions was made with complete fidelity of image to the plate. Thickening of the ink was only slight. Cf. Plate 8, page 55 and Plate 7, page 54.

40Since Experiments 1 and 2 proved the success of hand burnished impressions, hand burnishing will no longer be compared.
A-4: Aluminum plate, phosphoric acid etch, tusche.

A phosphoric acid etch identical to that of Experiment 5 was used for this experiment.

(1) Counteretch  Procedure: As described on page 10.
(2) Acid Stop    Procedure: As described on page 10.
(3) Drawing      Procedure: As described for Experiment 2, page 17, with brush and tusche added.
(4) Etching      Procedure: As described on page 11, with phosphoric acid solution for two minutes.

Observations: No bubbling was apparent; image was undamaged by the etch.

(6) Inking Slab     Procedure: As described on page 11.
(7) Dampening      Procedure: As described on page 11.
(8) Roll-up        Procedure: As described on page 11, with lithographic ink.
(9) Printing       Procedure: As described on page 11-12. All twenty impressions were made by proofing press.

Observations: All impressions were satisfactory. See Plate 9, page 56.

Evaluation: Suitable impressions were easily obtained.

(10) Edition     Procedure: As described on page 12.

Observations: An edition of twenty impressions was made. Thickening of ink was only slight. Cf. Plate 10, page 57 and Plate 9, page 56.
EXPERIMENT 7

Z-3: Zinc plate, phosphoric acid etch, crayon.

A phosphoric acid etch identical to that of Experiment 5 was used for this experiment.

(1) Counteretch  Procedure: As described on page 10.
(2) Acid Stop     Procedure: As described on page 10.
(3) Drawing       Procedure: As described for Experiment 1, page 15.
(4) Etching       Procedure: As described on page 11, with phosphoric acid solution for two minutes.

Observations: A slight foaming was apparent; image was damaged on the plate.

(6) Inking Slab    Procedure: As described on page 11.
(7) Dampening     Procedure: As described on page 11.
(8) Roll-up       Procedure: As described on page 11, with lithographic ink.
(9) Printing      Procedure: As described on page 11-12. All twenty impressions were made by proofing press.

Observations: All impressions were unsatisfactory. See Plate 11, page 58.

Evaluation: Impressions were not satisfactory.

(10) Edition      Procedure: As described on page 12.

Observations: An edition of twenty impressions was made and only slight thickening of ink occurred. Cf. Plate 12, page 59 and Plate 11, page 58.
EXPERIMENT 8

Z-4: Zinc plate, phosphoric acid etch, tusche.

A phosphoric acid etch identical to that of Experiment 5 was used for this experiment.

(1) Counteretch
Procedure: As described on page 10.

(2) Acid Stop
Procedure: As described on page 10.

(3) Drawing
Procedure: As described for Experiment 2, page 17, with brush and tusche added.

(4) Etching
Procedure: As described on page 10, with phosphoric acid solution for two minutes.
Observations: A slight foaming was apparent; image was slightly damaged on the plate.

(5) Dampening Paper
Procedure: As described on page 11.

(6) Inking Slab
Procedure: As described on page 11.

(7) Dampening
Procedure: As described on page 11.

(8) Roll-up
Procedure: As described on page 11, with lithographic ink.

(9) Printing
Procedure: As described on page 11-12. All twenty impressions were made by proofing press.
Observations: All impressions were satisfactory. See Plate 13, page 60.

Evaluation: Satisfactory impressions were easily obtained.

(10) Edition
Procedure: As described on page 12.
Observations: An edition of twenty impressions was made with only slight thickening of the ink occurring. Cf. Plate 14, page 61 and Plate 13, page 60.
EXPERIMENT 9

A-5: Aluminum plate, Uni-clean etch, crayon.

For this experiment one ounce Uni-clean etch was combined with two ounces of lithographic gum.

(1) Counteretch  Procedure: As described on page 10.
(2) Acid Stop  Procedure: As described on page 10.
(3) Drawing  Procedure: As described for Experiment 1, page 15.
(4) Etching  Procedure: As described on page 11, with Uni-clean etch solution for two minutes.

Observations: No bubbling was apparent; image was undamaged by the etch.

(6) Inking Slab  Procedure: As described on page 11.
(7) Dampening  Procedure: As described on page 11.
(8) Roll-up  Procedure: As described on page 11, with lithographic ink.
(9) Printing  Procedure: As described on page 11-12. All twenty impressions were made by proofing press.

Observations: All impressions were satisfactory. See Plate 15, page 62. Deterioration was only slight. Cf. Plate 16, page 63 and Plate 15, page 62.

Evaluation: Satisfactory impressions were easily obtained.

(10) Edition  Procedure: As described on page 12.


41 See Footnote No. 36, page 14.
A-6: Aluminum plate, Uni-clean etch, tusche.

The Uni-clean etch solution for Experiment 9 was used for this experiment.

(1) Counteretch: Procedure: As described on page 10.
(2) Acid Stop: Procedure: As described on page 10.
(3) Drawing: Procedure: As described for Experiment 2, page 17, with brush and tusche added.
(4) Etching: Procedure: As described on page 11, with Uni-clean etch solution for two minutes.

Observations: No bubbling was apparent; image was undamaged by the etch.

(6) Inking Slab: Procedure: As described on page 11.
(7) Dampening: Procedure: As described on page 11.
(8) Roll-up: Procedure: As described on page 11, with lithographic ink.
(9) Printing: Procedure: As described on page 11-12. All twenty impressions were made by proofing press.

Observations: All impressions were satisfactory. See Plate 17, page 64.

Evaluation: Satisfactory impressions were easily obtained.


Observations: An edition of twenty impressions was made with only slight thickening of the ink occurring. Cf. Plate 18, page 65 and Plate 17, page 64.
Z-5: Zinc Plate, Uni-clean etch, crayon.

The Uni-clean etch solution referred to in Experiment 9 was also used for this experiment.

(1) Counteretch  
Procedure: As described on page 10.

(2) Acid Stop  
Procedure: As described on page 10.

(3) Drawing  
Procedure: As described for Experiment 1, page 15.

(4) Etching  
Procedure: As described on page 11, with Uni-clean etch solution for two minutes.

Observations: No bubbling was apparent, image was undamaged by the etch.

(5) Dampening Paper  
Procedure: As described on page 11.

(6) Inking Slab  
Procedure: As described on page 11.

(7) Dampening  
Procedure: As described on page 11.

(8) Roll-up  
Procedure: As described on page 11, with lithographic ink.

(9) Printing  
Procedure: As described on page 11-12. All twenty impressions were made by proofing press.

Observations: All impressions were satisfactory. See Plate 19, page 66. Deterioration of image was slight. Cf. Plate 20, page 67 and Plate 19, page 66.

Evaluation: Satisfactory impressions were easily obtained.

(10) Edition  
Procedure: As described on page 12.

Observations: An edition of twenty impressions was made and only slight thickening of the ink occurred. Cf. Plate 20, page 67, and Plate 19, page 66.
Z-6: Zinc plate, Uni-clean etch, tusche.

The Uni-clean etch solution referred to in Experiment 9 was also used for this experiment.

(1) Counteretch  
Procedure: As described on page 10.

(2) Acid Stop  
Procedure: As described on page 10.

(3) Drawing  
Procedure: As described for Experiment 2, page 17, with brush and tusche added.

(4) Etching  
Procedure: As described on page 11, with Uni-clean etch solution for two minutes.

Observations: No bubbling was apparent, image was undamaged by the etch.

(5) Dampening Paper  
Procedure: As described on page 11.

(6) Inking Slab  
Procedure: As described on page 11.

(7) Dampening  
Procedure: As described on page 11.

(8) Roll-up  
Procedure: As described on page 11, with lithographic ink.

(9) Printing  
Procedure: As described on page 11-12. All twenty impressions were made by proofing press.

Observations: All impressions were satisfactory. See Plate 21, page 68.

Evaluation: Satisfactory impressions were easily obtained.

(10) Edition  
Procedure: As described on page 12.

Observations: An edition of twenty impressions was made and only slight thickening of the ink occurred. Cf. Plate 22, page 69, and Plate 19, page 68.
EXPERIMENT 13

A-7: Aluminum plate, phosphoric acid etch, crayon.

The individual etch prescribed for aluminum by Seward\textsuperscript{42} is so similar to the etch already used in Experiments 5-8 that duplication was needless.

See Experiment 5, page 21-22.

\textsuperscript{42}Seward, \textit{op. cit.}, p. 22.
EXPERIMENT 14

A-8: Aluminum plate, phosphoric acid etch, tusche.

See Experiment 6, page 23.
EXPERIMENT 15

Z-7: Zinc plate, "green etch", crayon.

Most etches for zinc plates contain bichromate of potassium which gives them a green color; hence, they are called "green etches". One and one-half ounces lithographic gum, three-fourths of an ounce saturated solution of bichromate of potassium, and ten (10) drops phosphoric acid (85%) were combined to make the "green etch" used in this experiment.

(1) Counteretch
Procedure: As described on page 10.

(2) Acid Stop
Procedure: As described on page 10.

(3) Drawing
Procedure: As described for Experiment 1, page 15.

(4) Etching
Procedure: As described on page 11, with "green etch" solution for two minutes.

Observations: Bubbling was not evident, but images eroded entirely from the plate.

Evaluation: This etch is not suitable.

Experiment not continued.
EXPERIMENT 16

Z-8: Zinc plate, "green etch", tusche.

The "green etch" referred to in Experiment 15 was also used for this experiment.

(1) Counteretch

Procedure: As described on page 10.

(2) Acid Stop

Procedure: As described on page 10.

(3) Drawing

Procedure: As described for Experiment 2, page 17, with brush and tusche added.

(4) Etching

Procedure: As described on page 11, with "green etch" solution for two minutes.

Observations: Bubbling was not evident, but images eroded entirely from the plate.

Evaluation: This etch is not suitable.

Experiment not continued.
II. CONCLUSIONS

**Plates**

An aluminum plate is better than zinc for lithography because it permits more contrast and reacts more positively to various etches. It is also less expensive than zinc and more readily available.

**Drawing**

Although Korn's crayon No. 2 (soft) may stick and slip somewhat on zinc surface, crayon and tusche work well with aluminum and zinc plates. All drawing techniques were faithfully reproduced in the impressions whenever they withstood the etch.43

Scratching through tusche on the plate, on the other hand, was never successful.44 Whenever parts of a scratched line did print, it soon thickened and was lost. The stippling technique with crayon sometimes gave poor impressions because the dots of crayon were smeared by the press.45 Tusche, in most cases, was a more reliable drawing medium than crayon.

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43Some etches, e.g. Nitric and Phosphoric, were so active that they damaged the images on the plates.

44See Plate 9, page 56.

45See "Observations", item 9, page 16.
Brayer

A gelatine brayer must be used for rolling up.46

Impressions

The first impressions from the plates are the best, since light grey tones quickly disappear. After ten impressions the slight deterioration of grey tones ceases. Hand burnishing produced impressions equal to the quality of those done by the proofing press.

Storage

It is recommended that plates be started and the edition run without interruption. When this is not possible, an un-etched plate may be wrapped in clean paper and stored over night. An etched plate must be rolled up with ink, thinly gummed, and stored in a dry place. A plate stored by this writer for ten days lost some of the quality of the original image. To print with a stored plate, the gum must be washed off, the plate dampened with fount, rolled up, and printed in the previously prescribed manner.

46 A Speedball rubber brayer was tested by this author, but the plate did not take the ink from the roller.
Regraining

Although some investigation of regraining was tried, the time consumed was so great that this step cannot be justified in light of the low cost of the metal plates.

Process

It is hoped the foregoing experiments have demonstrated the ease with which lithography can be adopted to primary and secondary school situations. It is almost as simple as linoleum block printing, less complex than serigraphy, and the necessary equipment and materials are inexpensive and readily available. Because of its similarity to commercial and stone lithography, printing with metal plates can add greatly to a student's understanding of printing and lithography. Most important, of course, is the relatively unhindered expression that is possible with metal plate lithography.

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47Regraining was attempted with (1) carborundum, water and a levigator; (2) carborundum, water and an Indian oil-stone; and finally (3) with steel wool only. Success was achieved with zinc plates but not with aluminum. However, in every trial, the effort was much too time consuming.
CHAPTER III
A RECOMMENDED PROCEDURE FOR THE USE OF METAL PLATE LITHOGRAPHY IN PUBLIC SCHOOLS

The following procedure, using an aluminum plate, has been found satisfactory:

(1) Cut stock. Size of paper should be slightly larger than the plate. Dampen one side with moist sponge.

(2) Counteretch. Place plate face up in a glass tray and pour in enough counteretch solution to cover the plate at least one-half an inch. See Fig. 1, below. Scrub the plate lightly with a stiff brush, keeping the plate in the solution for three minutes. Remove plate and wash in running water.

FIGURE 1 COUNTERETCHING

47 See Footnote No. 22, page 10.
(3) Acid Stop. While still damp, sprinkle a teaspoonful of bicarbonate of soda on the plates grained surface. Spread this over the surface with a clean cotton wad for a few seconds. Wash plate in running water, blot, and fan dry.

(4) Drawing. Paint a narrow margin of lithographic gum on the plate to facilitate handling. Draw the image on the plate using crayon or tusche, or both. (Pencil lines may be used as guide lines on the plate.)\(^48\) If tusche is used, allow plate to dry thoroughly, otherwise it may be etched immediately.

(5) Etching. Mix a fresh Phosphoric acid etch using one ounce lithographic gum and ten drops of acid. Apply this to the plate with a soft brush. Work it over the surface for two minutes. See Fig. 2, page 39. Wipe off etch with damp sponge, and leave wet.


(7) Inking Slab. Put a daub of lithographic ink about the size of a quarter on palette\(^49\) and roll out into a thin, even film with a gelatine brayer.

\(^48\)See Footnote No. 23, page 11.

\(^49\)See Procedure, step 6, page 11.
(8) Dampen Plate. Sponge up excess water that was left on the plate and immediately dampen with an "elephant ear" sponge and fount solution.

(9) Roll-up. Ink the plate by passing the gelatine brayer over the dampened surface. See Fig. 3, page 40.

(10) Print Plate. Place the rolled up plate, face up, on a blotter. Put the dampened side of the stock on the plate, and then put another blotter on the stock. Make the impression by hand burnishing, (See Fig. 4, page 40) or by proofing press. See Fig. 5, page 41.

(11) Remove Impression. Remove the impression carefully and put it aside to dry. Continue printing by redampening the plate, rolling up, and following the normal steps.
FIGURE 5

PROOFING PRESS
CHAPTER IV
SUGGESTIONS FOR FUTURE INVESTIGATION

Relevant to the precept that metal plate lithography can be readily and advantageously used in public schools, the following items warrant research.

Papers and Offset Process

Rough surfaced papers have been avoided by direct-process lithographers because the unyielding surface of the metal prevents the image from transferring into the depressions in the paper. Commercial printers solve this problem by using rubber offset rollers whereby the image is first transferred to these rollers and then printed on the paper. The intermediate rubber roller is able to adapt to the hard, smooth metal surface as well as to the irregularities in the stock. If a simple system for offset could be developed, it would enable the use of an infinite variety of paper surfaces for aesthetic purposes.

Whether an offset technique is developed or not, however, there is need for comparative examinations of various papers and their value to metal plate printmaking.

Plates

Plates of other materials than aluminum and zinc should be critically examined. Magnesium, plastics and
paper have been used for plates commercially. An investigation of the comparative abilities and costs of these plates would point out the contribution each could make to public school use.

Etching Solutions

Data concerning etches of all types and strengths, their reactions on all surfaces, and their relative value for metal plate printmaking is needed.

Drawing

The richest field for future investigation lies in the realm of drawing. Experimental drawing techniques such as rubbing, scraping, sanding, drawing on warm plates, litho-tinting (washes in tusche), use of gasoline and other solvents to pull out whites, rolling texture on the dry plate, etc., should be thoroughly investigated. A list of other experimental techniques is given in How to Draw and Print Lithographs. 50

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BIBLIOGRAPHY


PLATE 1

A-1: 1st IMPRESSION, BY PROOFING PRESS
PLATE 2

A-1: 20th IMPRESSION, BY PROOFING PRESS
PLATE 3

A-1: 21st IMPRESSION, BY HAND BURNISHING
PLATE 5

A-2: 20th IMPRESSION, BY PROOFING PRESS
PLATE 7

A-3: 1st IMPRESSION, BY PROOFING PRESS
PLATE 8

A-3: 20th IMPRESSION, BY PROOFING PRESS
PLATE 9
A-4: 1st IMPRESSION, BY PROOFING PRESS
PLATE 10

A-4: 20th IMPRESSION, BY PROOFING PRESS
PLATE II

Z-3: 1st IMPRESSION, BY PROOFING PRESS
PLATE 12

2-3: 20th IMPRESSION, BY PROOFING PRESS
PLATE 13

Z-4: 1st IMPRESSION, BY PROOFING PRESS
PLATE 14

Z-4: 20th IMPRESSION, BY PROOFING PRESS
PLATE 15

A-5: 1st IMPRESSION, BY PROOFING PRESS
PLATE 16

A-5: 20th IMPRESSION, BY PROOFING PRESS
PLATE 17

A-6: 1st IMPRESSION, BY PROOFING PRESS
PLATE 18

A-6: 20th IMPRESSION, BY PROOFING PRESS
PLATE 19

Z-5: 1st IMPRESSION, BY PROOFING PRESS
PLATE 20

Z-5: 20th IMPRESSION, BY PROOFING PRESS
PLATE 21

Z-6: 1st IMPRESSION, BY PROOFING PRESS
PLATE 22

Z-6: 20th IMPRESSION, BY PROOFING PRESS
APPENDIX B
### TABLE I

**SOURCES AND COSTS OF ALUMINUM PLATES**

<table>
<thead>
<tr>
<th>Company</th>
<th>Size</th>
<th>Gauge</th>
<th>Price per plate in quantities of:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>Multilith</td>
<td>10 x15(\frac{1}{2})</td>
<td>.006</td>
<td>.23</td>
</tr>
<tr>
<td></td>
<td>11(\frac{1}{2}) x20(\frac{1}{4})</td>
<td>.007</td>
<td>.41</td>
</tr>
<tr>
<td>Davidson</td>
<td>10 x16</td>
<td>.006</td>
<td>.23</td>
</tr>
<tr>
<td></td>
<td>16 x17(\frac{1}{2})</td>
<td>.007</td>
<td>.52</td>
</tr>
<tr>
<td>Webendorfer</td>
<td>15(\frac{1}{2}) x20(\frac{1}{2})</td>
<td>.007</td>
<td>.52</td>
</tr>
<tr>
<td></td>
<td>20 x22(\frac{1}{2})</td>
<td>.009</td>
<td>.68</td>
</tr>
<tr>
<td></td>
<td>27(\frac{1}{2}) x28(\frac{1}{2})</td>
<td>.009</td>
<td>1.15</td>
</tr>
<tr>
<td>Harris</td>
<td>19(\frac{1}{2}) x23</td>
<td>.009</td>
<td>.68</td>
</tr>
<tr>
<td></td>
<td>24(\frac{1}{2}) x30</td>
<td>.009</td>
<td>1.04</td>
</tr>
<tr>
<td></td>
<td>25(\frac{1}{2}) x36</td>
<td>.009</td>
<td>1.15</td>
</tr>
<tr>
<td>Miehle</td>
<td>26(\frac{1}{2}) x31</td>
<td>.009</td>
<td>1.15</td>
</tr>
<tr>
<td>Addressograph-</td>
<td></td>
<td>.</td>
<td></td>
</tr>
<tr>
<td>Multigraph**</td>
<td>10 x15(\frac{1}{2})</td>
<td>.006</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>20(\frac{1}{2}) x15(\frac{1}{2})</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>20(\frac{1}{2}) x20(\frac{1}{4})</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

* These plates are available at local graphic supply houses.

** Complete quotations are not available.
**TABLE II**

COSTS OF ADDRESSOGRAPH-MULTIGRAPH ZINC PLATES*

<table>
<thead>
<tr>
<th>Size</th>
<th>Guage</th>
<th>Price per plate</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 x15(\frac{1}{2})</td>
<td>.006</td>
<td>$ .50</td>
</tr>
<tr>
<td>20(\frac{3}{8}) x15(\frac{1}{2})</td>
<td>.010</td>
<td>2.09</td>
</tr>
<tr>
<td>20(\frac{3}{8}) x20(\frac{1}{4})</td>
<td>.010</td>
<td>2.74</td>
</tr>
</tbody>
</table>

* Due to the growing obsolescence of zinc plates, they were not locally stocked and quotations of other manufacturers were not available.
<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Approximate Cost</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acid, Acetic</td>
<td>8 lb. bottle</td>
<td>$3.00</td>
<td>Lithographic supply house, Drugstore, Chemical supply firm, etc.</td>
</tr>
<tr>
<td>Acid, Nitric</td>
<td>1 lb. bottle</td>
<td>.70</td>
<td>Lithographic supply house, Drugstore, Chemical supply firm, etc.</td>
</tr>
<tr>
<td>Acid, Phosphoric</td>
<td>1 lb. bottle</td>
<td>1.74</td>
<td>Lithographic supply house, Drugstore, Chemical supply firm, etc.</td>
</tr>
<tr>
<td>Asphaltum</td>
<td>1 qt. can</td>
<td>.75</td>
<td>Lithographic supply house.</td>
</tr>
<tr>
<td>Bichromate of Potassium</td>
<td>1 lb. bottle</td>
<td>1.02</td>
<td>Lithographic supply house or chemical supply firm.</td>
</tr>
<tr>
<td>Brayer, gelatine</td>
<td>6 inch width</td>
<td>5.00</td>
<td>Lithographic supply house or Art supply agency.</td>
</tr>
<tr>
<td>Brush, bronze</td>
<td>--</td>
<td>.15</td>
<td>Hardwarestore or Dry goods.</td>
</tr>
<tr>
<td>Crayon, Korn's</td>
<td>1 dozen</td>
<td>3.00</td>
<td>Art store or Lithographic supply house.</td>
</tr>
<tr>
<td>Crystolon</td>
<td>1 lb. can</td>
<td>.86</td>
<td>Lithographic supply house.</td>
</tr>
<tr>
<td>Etch, Uni-Clean</td>
<td>1 gal. bottle</td>
<td>4.30</td>
<td>Lithographic supply house.</td>
</tr>
<tr>
<td>Item</td>
<td>Quantity</td>
<td>Approximate cost</td>
<td>Source</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>--------------</td>
<td>------------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>Fount concentrate, Lith-Kem-Ko</td>
<td>1 qt. bottle</td>
<td>$2.00</td>
<td>Lithographic supply house.</td>
</tr>
<tr>
<td>Gum, lithographic</td>
<td>1 gal. bottle</td>
<td>3.50</td>
<td>Lithographic supply house.</td>
</tr>
<tr>
<td>Ink, black lithographic</td>
<td>1 lb. can</td>
<td>2.40</td>
<td>Lithographic supply house.</td>
</tr>
<tr>
<td>Press, proofing</td>
<td>12&quot; x 18&quot;</td>
<td>90.00</td>
<td>Don Stewart Company, 44 Clay Street</td>
</tr>
<tr>
<td>Sponge, &quot;elephant ear&quot;</td>
<td>1</td>
<td>.75</td>
<td>Ceramic supply store.</td>
</tr>
<tr>
<td>Tusche, Korn's</td>
<td>1 pt. bottle</td>
<td>4.65</td>
<td>Lithographic supply house or Art supply store.</td>
</tr>
</tbody>
</table>