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Creative use of metals in art education

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CREATIVE USE OF METALS IN ART EDUCATION

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by

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CHAPTER I

THE PROBLEM AND DEFINITIONS OF TERMS USED

In the past artists and sculptors have worked with metals as sculptural media. Their projects were created for the purpose of recording and communicating a significant activity. There are others who have introduced metals into art education, but it seems that many relationships beneficial to this way of working have been overlooked.

I. THE PROBLEM

Statement of the problem. This study is to show how metal sculpture can be used in art education.

Importance of the study. Creative teaching has often been stressed as one of the most important aims of art education. There are many adequate techniques designed to aid in the teaching of this goal. In this study metal, as a sculptural medium, is projected in an attempt to encourage others in its use for creative work.

II. DEFINITIONS OF TERMS USED

Due to a lack of understanding on the part of administrators, principals, and guidance counselors concerning art education, this subject seems to be

misrepresented in the curriculum. For example, a counselor sent a student to the art teacher with a note saying that this individual had very high art ability and interest. The gifted student certainly should not be overlooked but neither should any student. This selective thinking on the part of the counselor is trite, unprogressive, and unfair because art is for all instead of the talented few. It is innate for everyone to explore and experiment. For the children, the art class is an amazing, thrilling, and eventful session where emphasis is placed on the activity, the product being of secondary importance. For the adolescent, art work becomes an outlet. The keyed-up student may release his energies in painting or sculpture. If the art program is to be carried on successfully, the philosophy underlying it should be brought out. John F. Rios[1] has defined art by procedures:

> (a) Art is a procedure. It develops within the individual, through his emotional and intellectual life, the power to organize in that satisfying and unified manner which achieves beauty.
>
> (b) Art is an educational procedure. It interprets the necessities and luxuries of everyday living in terms of social and economic values.

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[1]John F. Rios, "Art is a Procedure," School Arts, 52:303-305, May, 1953.

(c) Art is a communicative procedure. Crafts have been instruments for recording or transmitting ideas, facts, feelings, and plain history to our civilization.

(d) Art is a creative procedure. Students realize, arrange, and organize their ideas in visual form.

(e) Art is an experimental procedure. It gives not only a natural approach to academic subjects, but also a more confident basis for tackling the difficulties of social relationships. It gives one the opportunities to move and express himself.

(f) Art is a psychological procedure. It serves as a means of understanding human behavior and the development of personality.

(g) Art is an integrating procedure. It is the inheritance of all. It equips millions with at least an introductory appreciation of the contributions that art can make to happiness.

(h) Art is a cultural procedure. It illuminates human character, action, and ideals.[2]

In order to support these definitions, viewpoints held by various authorities in this field and the investigator's own observations will be discussed. References will be made to metal sculpture samples that were completed under the investigator's supervision.

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[2]<u>Ibid</u>., pp. 303-304.

CHAPTER II

REVIEW OF THE LITERATURE

Numerous writings have been concerned with the phases of teaching art through various media, but only superficial information has been written evaluating the techniques concerned with the experimental method in the study of metal sculpture. The main cause of this state of affairs is that the art rooms are not properly equipped or designed for this purpose. Through docendo discimus (we learn by teaching), this study of metal sculpture was further exploited by coordinating a unit with the shop program. As John Dewey sums it up,

> The answers cannot be found unless we are willing to find the germs and roots in matters of experience that we do not currently regard aesthetic; having discovered these seeds, we may follow the course of their growth into the highest forms of finished and refined art.[1]

Art education today is emphasizing creative expression. Viktor Lowenfeld in his Creative and Mental Growth[2] puts great emphasis on the need for creative expression through

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[1]John Dewey, Art as Experience (New York: Minton, Balsh and Company, 1934), p. 12.

[2]Viktor Lowenfeld, Creative and Mental Growth (New York: The Macmillan Company, 1952), 408 pp.

the understanding of the mental and emotional development of children. As creative expression is self-identification with the expressed, it is also that with the medium by which it is expressed. For these reasons, a thorough study of metal and its processes as a sculptural medium will be made. In regard to artistic development, Read[3] has developed schematic stages similar to those of Lowenfeld,[4] Helga Eng,[5] and Florence Goodenough.[6] Their studies will be beneficial in that their ideas will apply to this research into three-dimensional expression. The Commission on Secondary School Curriculum,[7] for which Thayer and others are responsible, has also set up a method of teaching art. D'Amico[8] has written a practical philosophy of creative

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[3]Herbert Read, Education Through Art (New York: Pantheon Books, 1945), 320 pp.

[4]Lowenfeld, loc. cit.

[5]Helga Eng, The Psychology of Children's Drawings (London: Kenga, French, Trubne and Company, 1931), 127 pp.

[6]Florence Goodenough, Measurement of Intelligence by Drawings (Chicago: World Book Company, 1926), 177 pp.

[7]V. T. Thayer and others, Commission on Secondary School Curriculum, The Visual Arts in General Education (New York and London: D. Appleton-Century Company, Inc., 1940), 166 pp.

[8]Victor D'Amico, Creative Teaching in Art (Pennsylvania: International Textbook Company, 1946), 261 pp.

teaching. There are many in the teaching profession who have made contributions by illustrating various techniques and methods.

Some of the foremost architects and artists have stressed the need for art education to be directed into proper channels. Even Frank Lloyd Wright[9] and Eliel Saarinen[10] have ventured into the subject of art education objectives. They stress the need for developing the potential creative talents of our people through exploration in the arts. Moholy Nagy[11] emphasizes the stirring of interest for developing creative energies, and Gyorgy Kepes[12] states that a child is not satisfied with accidental views; he wants to explain the various possible visual aspects of the object he wishes to represent. The child gains awareness through experimentation with tools, processes, media, and such accidentals as may occur soon become the basis for controlled direction and understanding use.

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[9]Frank L. Wright, The Future of Architecture (New York: Horizon Press, 1953), p. 18.

[10]Eliel Saarinen, Search for Form (New York: Reinhold Publishing Company, 1948), p. 342.

[11]Lazlo Moholy Nagy, The New Vision and Abstract of an Artist (New York: Wittenborn, Schutz, Inc., 1947), p. 17.

[12]Gyorgy Kepes, Language of Vision (Chicago: Poole Bros., Inc., 1944), 228 pp.

CHAPTER III

METALS AND ALLOYS

In the foregoing pages, some principles underlying today's art education have been presented. The education of primitive man proceeded through actual experience to the mastery of his tools. But not until the elements (tools, media, and processes) with which man works are grasped, can there be truth in any art. Therefore, to have honesty in the use of materials in this study, an investigation has been made of the metals and alloys. "It was the Buddha who noticed that the spoon may lie in the soup for a thousand years and never know the flavor of the soup."[1]

Potentialities of metals. Metals have certain characteristics which can be utilized through various techniques. The three-dimensional possibilities in this material are those properties which lend themselves to visual expression such as shaping, molding, texturing, coloring, and soldering. The way to discover material potentialities is to experiment with the materials. Many significant facts which cannot be told about sheet metal

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[1] Frank L. Wright, Genius and Mobocracy (New York: Duell Sloan and Pearce, 1949), p. 6.

such as copper, aluminum, and lead, can be learned by bending, hammering, and joining the metal.

Metals are divided into two classes: (1) Ferrous, metals made from iron; and (2) nonferrous, such as copper and aluminum, or alloys derived from them.[2] Ferrous metals are usually thought of as steel and cast iron. Ordinary steel is a comparatively soft metal which may be bent without breaking readily. It is very light gray in color--almost white when seen in cross section. If it is struck on the edge with a hammer it will dent; it will not chip. Medium and low-carbon steels are the most commonly used metals. The projects presented in this study are made mainly from this medium. Steel melts at approximately 2600° F. Cast iron is a hard, brittle metal usually gray in color. It will chip when struck near the edge with a hammer. It melts at about 2300° F.

Copper and its alloys are nonferrous metals. Two important qualities of copper are: (1) high electrical conductivity; and (2) resistance to corrosion. It is a pliable, rather soft metal and can be easily formed. It melts at about 1950° F. Two important alloys of copper are

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[2]Herbert P. Rigsby and Chris Harold Groneman, Elementary and Applied Welding (Milwaukee: The Bruce Publishing Company, 1948), pp. 12-14.

brass and bronze. Both have a high tensile strength and are used extensively in cast and rolled forms. Copper and its alloys melt at 1626° to 1922° F.

Aluminum is a strong, light metal and is almost white in color. It is highly resistant to the ordinary attacks of corrosion and has a melting point of 1150° F.[3] Aluminum differs from other metals in its hot shortness. This means that the metal does not have sufficient strength to support its own weight at or near the melting temperature. It gives no warning before melting since it does not change color. The welding zone of aluminum should always be supported.[4]

Figure 1, "Fighting the Atoms," is an example of what may happen by using two metals in art that differ in chemical and physical properties. The sphere (head-like form) is thin copper which has a lower melting point than the ferrous metal combined in the project. In the process of welding, the copper melted before the ferrous metal as evidenced by the hole in the copper. The use of a brazing rod would have been more successful because of its low heat at point of fusion. The brazing rod is made of bronze and melts at a relatively low temperature; it is used when

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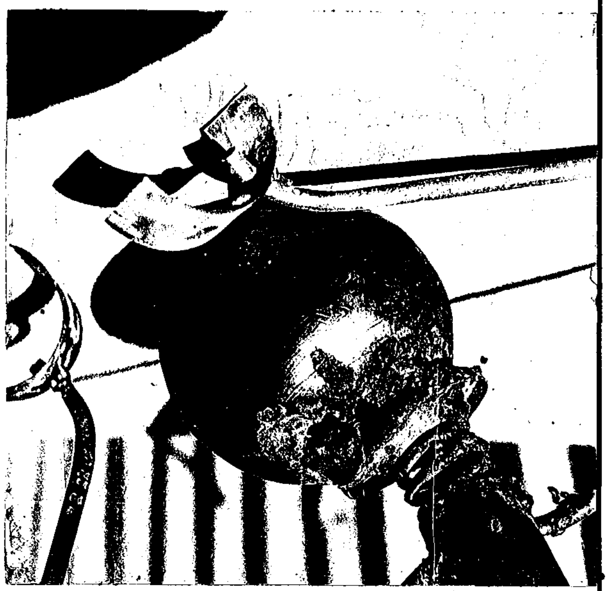
[3] *Ibid.*, p. 14.

[4] *Ibid.*, p. 41.



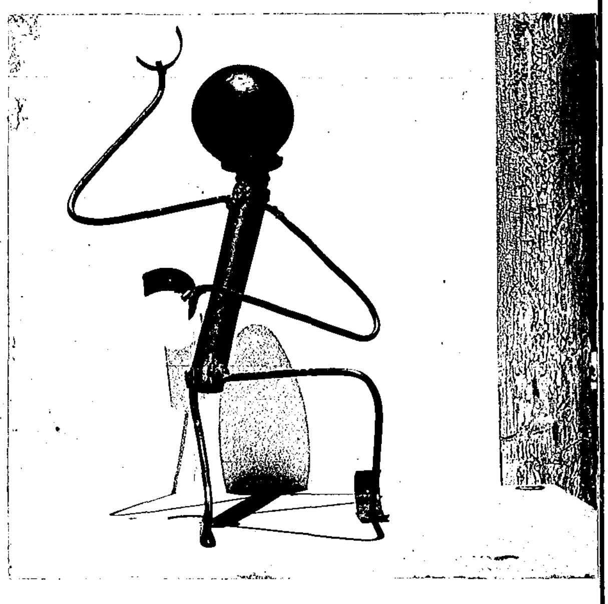


FIGURE 1

FIGHTING THE ATOMS (METAL SCULPTURE)

metals are to be welded without raising their temperatures to the melting point. It is also used to join the higher temperature metals such as cast iron, steel, and dissimilar metals. In bronze welding cast iron and steel, it is only necessary to raise the temperature of the base metal to a cherry red heat. This bronze welding technique is similar to that used in other welding operations. A slightly oxidized flame is best for this purpose (Figure 2).[5]

Some metal alloys melt at very low temperatures, making it possible to build up a form with the soldering iron. One of these is Wood's metal which is sold commercially as Cerrobend.[6] This remarkable metal, an alloy of bismuth, lead, tin, and cadmium, melts at 158° F. Only 38 per cent of the temperature is necessary to melt its lowest component, tin. It has a tensile strength of 5990 pounds per square inch and a Brinell hardness of 9.2 which is two times greater than lead. Modalloy, another of these alloys, and a low fusing metal, is available in sheet-form. The technique that is recommended for its use is to crumple up the sheets and compress them around an armature. The final surface is worked over with a heated tool to fuse the metal.

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[5]Ibid.

[6]Jules Struppeck, The Creation of Sculpture (New York: Henry Holt and Company, 1952), p. 66.

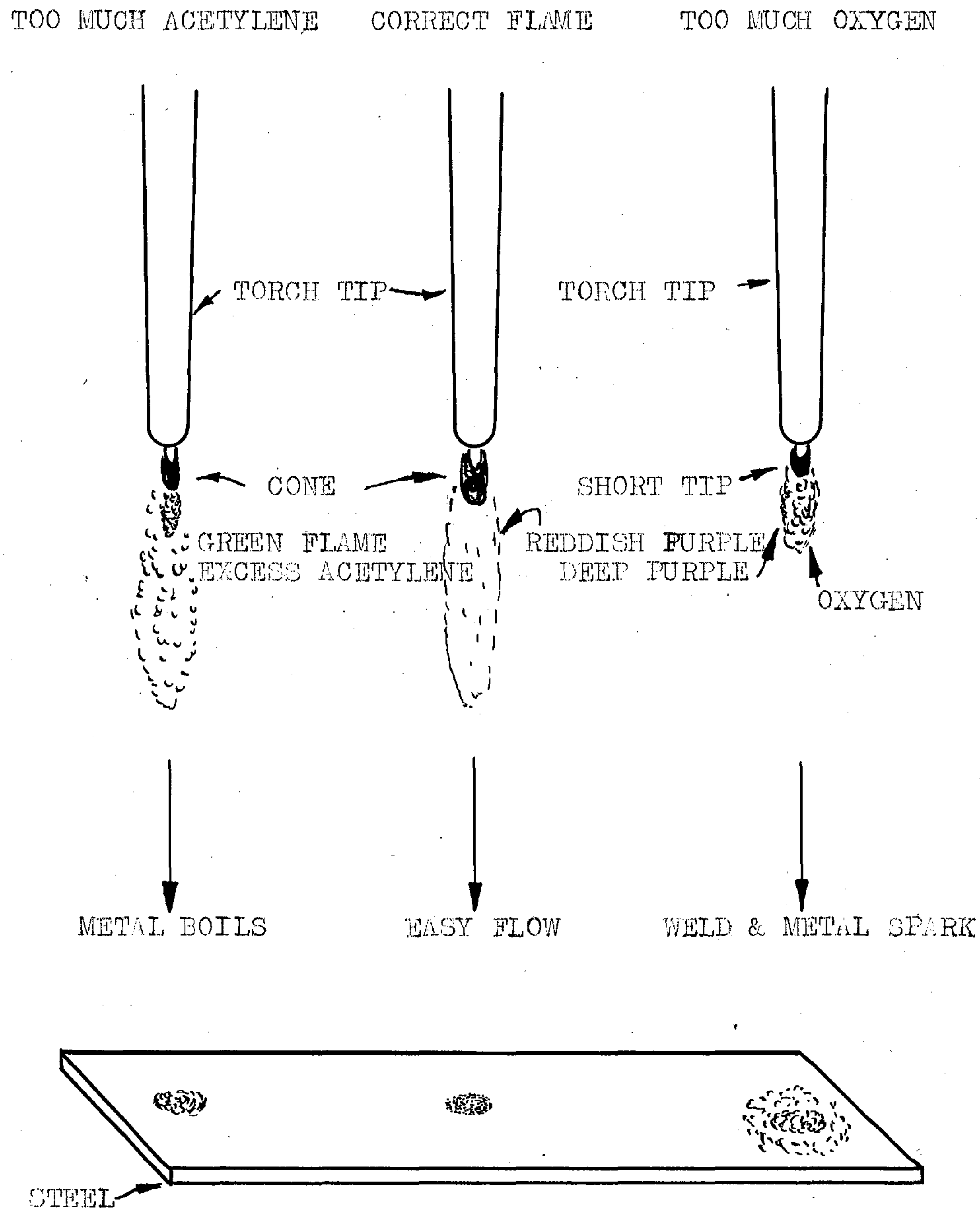

FIGURE 2

FLAME ADJUSTMENT

Sculp-metal[7] is a new wonder metal marketed through art stores and craft supply houses. It models like clay and hardens into metal, and its exceptional characteristics are versatility, convenience, and economy. Since it is a direct medium, it lends itself to fresh, vital, and vigorous expression. It does not chip, crack, expand, or shrink and will stand temperature up to 450° F.

Although Calder[8] has experimented with different media, his characteristic material is metal. He has always avoided modeling in favor of direct handling, cutting, shaping with a hammer, or assembling piece by piece. Such an approach has fostered a simplicity of form and clarity of contour in his work. His use of new materials links him with the Russian Constructivists of the early 1920 period. The Constructivists explored materials as related to their use in artistic expression, but some, if not most, of the materials had been in use industrially for a long time prior to the Constructivist use. The humorous animals and figures that Calder has formed out of wire, wood, and leather would be valuable projects for any age group. They have certain qualities that predominate, such as unfamiliar

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7Jules A. Petrenos, "New Wonder Metal," Design, 54:9, October, 1952.

8James Johnson Sweeney, Alexander Calder (New York: Simon and Schuster, 1951), pp. 8-70.

rhythms and provocative surprise. These features could be embodied in a more aesthetic expression--provided that they were held in proper balance with form and material.

Calder has stated in an interview:

> I feel an artist should go about his work simply with great respect for his materials. . . . Sculptors of all places and climates have used what came ready to hand. They did not search for exotic and precious materials. It was the knowledge and invention which gave value to the result of their labors. . . . In my own work, when I began using wire as a medium, I was working in a medium I had known since a child. For I used to gather up the ends of copper wire discarded when a cable had been spliced and with these and some beads would make jewelry for my sister's dolls. . .[9]

When building up an elementary curriculum, it may be wise to refrain from comparing exercises of self-expression with the work of genius. The student should gain experience through his own experiments, form his own judgment, and develop his own abilities before he studies the historically great. Moholy Nagy[10] says that fear and self-consciousness are serious psychological hindrances. The students are often distressed that their work cannot be worth-while. Yet, they may react against any feeling of inferiority and free themselves for their own individual attempts.

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[9] Ibid., p. 70.

[10] Lazlo Moholy Nagy, Vision in Motion (Chicago: Paul Thiebold, 1948), p. 26.

In the exploration of metals and alloys, it may be necessary to purchase these materials in sheets. Some of the three-dimensional works are assembled in planes to build up a design in space division; a similar type of work can be constructed by welding sheet metals into sculptural forms. Sheet metal is any metal such as iron, steel, copper, aluminum, and tin plate that has been rolled into thin sheets.[11] Tin in its pure form is seldom used. Tin plate, commonly referred to as tin, is actually steel or iron sheets with a coating of tin. It can be secured in various thicknesses; I. C. and I. X. are the thicknesses that are commonly used. I. X. is the thicker of the two.

Stock sizes for the sheet metal vary with the material. Galvanized iron and copper are sold in sheets 24" and 30" wide by 72", 84" and 96" long. Tin plate is sold in sheets 20" x 28". Brass is sold in sheets 12" wide.

The thickness of sheet metal is usually stated as a gauge number; wire is also measured by gauge. Ten gauge is thicker than 30 gauge. Some sheets are described by weight. Copper is often referred to in this manner; 10 oz. copper means copper weighing 10 oz. per square foot.

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[11]C. C. Ashcroft and J. A. G. Easton, General Shop Work (Toronto: The Macmillan Company of Canada Limited, at St. Martin's House, 1940), p. 71.

(Thin metal up to 18 gauge copper and 20 gauge brass and iron can be cut with tin snips).

Two gauges are in common use: The U. S. (United States) Standard gauge is used for ferrous (iron) sheets and wire; the B. & S. (Brown and Sharpe) for nonferrous metals (copper, brass, aluminum). The U. S. Standard gauge has wider slots than the B. & S. gauge for every gauge number (Table I).[12]

For convenience in finding the thickness of sheets a measuring tool called the wire gauge is used. It has a number of slots exactly the thickness of a particular gauge. Table I gives the gauge number and thickness in decimals of an inch.

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[12] *Ibid.*

TABLE I

THICKNESS FOR GAUGES IN DECIMALS OF AN INCH

Gauge No.	U. S. Standard Thickness Decimals of an Inch	Brown & Sharpe Thickness Decimals of an Inch
10	.141	.102
12	.109	.081
14	.078	.064
16	.062	.051
18	.050	.040
20	.037	.032
22	.031	.025
24	.025	.020
26	.019	.016
28	.016	.013
30	.012	.010

CHAPTER IV

TOOLS AND EQUIPMENT FOR METAL SCULPTURE

One of the greatest needs in art education is to develop in the student the desire to experiment with tools and materials in order to discover their possibilities and limitations. This necessary period of experimentation must take place before the student constructs his finished project so that the results of the experiments can be put to better use. (A similar thought existed back in 1919, when the Bauhaus was founded by Walter Gropius,[1] in the belief that experimentation was more valuable than production at first.) During the experimental stage the student should acquire a thorough understanding of tools. Accidentals may be interesting, but in order to seek honest, genuine work, the tool (such as the electric welder) should be part of the project. Struppeck[2] says that sculpture is a fusion of three elements: idea (subject matter), form (three-dimensional design), and technical means (materials and techniques). These elements are so interrelated, the

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[1] Walter Gropius, "The Gropius Symposium," Arts and Architecture, 27:31, May, 1952.

[2] Jules Struppeck, The Creation of Sculpture (New York: Henry Holt and Company, 1952), p. 5.

one dependent upon the other, that their true value exists only when the three are seen as a unit.

Since the value of tools and equipment cannot be underestimated, an investigation has been made of the acetylene welder, electric welder, and the soldering iron; these are the main tools considered in this research.

The oxyacetylene welder. The oxyacetylene (acetylene or gas) welder was formerly the oxyhydrogen blowpipe which was devised by the American chemist, Robert Hare,[3] more than one hundred years ago. The only difference was that hydrogen was burned in place of acetylene. The oxyhydrogen blowpipe flame was able to melt platinum at 1755° F. The acetylene torch today is used primarily for cutting and welding. The technique has advantages of construction and modeling--shapes can be cut from metal sheets, brazed, or welded together and modeled over by fusing bits of metal to the form. The process is also practicable for welding very thin or light sections where there is no great danger of warping. It is also generally advisable for the welding of smaller sections of bronze, brass, aluminum, and cast iron, and for overlaying steel with many of the hard-surface

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[3]William McPherson, William Edward Henderson, and George Winegar Fowler, Chemistry at Work (Boston: Ginn and Company, 1942), p. 110.

alloys. Steel can be cut fairly easily by the oxyacetylene process. Table II and Table III, page 22, give sufficient data for regulating the gas pressures for various thicknesses of metals.[4] Fluxes are used in welding all metals with the exception of steel. (In welding steel, protection from oxygen is provided by the flame envelope which excludes the air.)[5] By forming a film about the molten metal, the flux prevents oxygen from entering the weld and thus filters out impurities. The following equipment and tools are adequate:

1 cylinder of oxygen, 110 or 220 cu. ft. capacity.
1 cylinder of acetylene, 100 or 220 cu. ft. capacity.
Note: Oxygen and acetylene cylinders are loaned, without charge, usually for a period of 30 days.
1 oxygen regulator.
25 ft. oxygen hose, 1/4 in. with connections.
25 ft. acetylene hose, 1/4 in. with connections.
1 torch handle.
6 welding tips with mixing chamber, jet sizes 0.040, 0.0465, 0.055, 0.0635, 0.076, and 0.098. The last size is useful for heating purposes.
1 cutting torch.
2 cutting tips, sizes 1 and 2.
1 pair of welding goggles.
1 spark lighter.
1 wrench for connecting hoses, regulators, and acetylene cylinder valve.[6]

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[4]Herbert P. Rigsby and Chris Harold Groneman, Elementary and Applied Welding (Milwaukee: The Bruce Publishing Company, 1948), p. 19.

[5]The Oxy-Acetylene Handbook (New York: Linde Air Products Company, 1951), p. 166.

[6]Rigsby and Groneman, op. cit., pp. 3-5.

TABLE II

DATA FOR OXYACETYLENE WELDING

Jet, or Tip Orifice, Size	Thickness of Metal, in inches	Approx. Pressure at Regulators in Lbs. Per Sq. In.		Cleaning Drill Size	Approx. Cu. Ft. of Gas Used Per Hour	
		Oxy.	Acet.		Oxy.	Acet.
0.040	1/16 to 1/8	2	2	60	5.0	5.0
0.0465		3	3	56	7.0	7.0
0.055	1/8 to 3/16	3	3	54	9.0	9.0
0.0635	3/16 to 1/4	4	4	52	12.0	12.0
0.076	1/4 to 3/8	5	5	48	21.0	21.0
0.090	1/2 to 5/8	7	7	40	36.0	36.0

TABLE III

DATA FOR OXYACETYLENE CUTTING

Metal Thickness, in Inches	Size No. of Cutting Tip	Oxygen Pressure, in Lbs. per Sq. In.	Acetylene Pressure, in Lbs. per Sq. In.	Hand Cutting Speed, in In. per Min.
3/8	1	30	3	14.5-16.5
1/2	1	40	3	12.0-14.5
3/4	2	40	3	12.0-14.5
1	2	50	3	8.5-11.5
1 1/2	3	50	3	6.0- 7.5
2	4	50	3	5.5- 7.0

This total welding and cutting outfit with the accessories will cost approximately $90.00. The welding outfit alone will be about $65.00.

The electric welder. The development of the electric arc or electric welding, as it is called, has taken place within the last fifty years, the patent for the "Carbon Arc Process" having been granted to H. V. Benardos in 1887. Two years later, the patent for the metallic electrode process was granted to a Mr. Coffin. Three years earlier, in 1886, basic patents on the "Thomson Resistance Welding Process" were applied for by Professor Elihu Thomson.[7] In the immediate succeeding years little practical use was made of these processes and their development was very slow. However, within the last two decades, the application of electric arc welding process has been remarkable. This process is generally more economical than the oxyacetylene process. It is used for welding metals such as copper, aluminum, nickel alloys, and tungsten, as well as more commonly used metals. About its only limitation is the difficulty of using it for welding very small steel parts. It is a fascinating tool for obtaining texture and modeled qualities. Two types of rods are used: bare rod and coated,

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[7]Robert A. Harcourt, Electric Arc Welding (Stanford University Press, 1936), p. 111.

or shielded, rod.[8] The bare rod was in common use until recently; the shielded rod has proved far superior to it. Bare rod allows nitrogen and oxygen to enter the weld to form nitrides and oxides, which harmfully decrease the strength of the welded metal. The coating on the coated rod provides a gaseous shield which surrounds the joint while the weld is being made. The rod produces a slag which covers the weld metal and prevents oxidation. Table IV and Table V, page 27,[9] list the common oxyacetylene and arc welding rods according to type, size, current range, arc volts, metal thickness, and use. The following equipment and accessories are recommended:

1 electric driven d. c. arc welder or one a. c. transformer.
Note: either machine should have a rated capacity of 150 amps and 25 to 40 volts or more, and should operate from a 220 volt power line. An arc welder with a rating less than these specifications is not suitable for general use.
2 25 ft. lengths of size No. 1 welding cable with necessary lugs.
1 250 amp electrode holder.
1 clamp or plate for ground cable.
1 head shield for welder, grade A, shade No. 9 lens.
1 hand shield for teacher, grade A, shade No. 9 lens.
(A No. 9 lens will effectively filter all harmful rays.)
10 feet of three-wire, rubber insulated, connector cable with plugs and receptacles for welding machine.[10]

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[8]Rigsby and Groneman, _op. cit._, p. 8.

[9]_Ibid._, pp. 10-11.

[10]_Ibid._, pp. 5-9.

TABLE IV

OXYACETYLENE WELDING RODS

Type of Rod	Size, in inches	Kind of Flame	Metal Thickness	Use
Mild Steel	1/16	Neutral	1/16-3/32	General purpose
General purpose	3/32		3/32-1/8	All positions
All positions	1/8		1/8 up	For pipe, structural
	5/32		1/8 up	steel, steel plates,
	3/16		1/4 up	etc.
	1/4		1/4 up	
High-Test Steel	1/8	Neutral	1/8 up	Used where high-quality
A nickel-alloy rod	3/16		3/16 up	welds are desired
All positions	1/4		1/4 up	Produces gas-tight welds
				For welding nickel and
				nickel alloys
Cast Iron	1/8	Neutral	1/8 up	For welding cast iron
Cast-iron rod	3/16		1/4 up	Flux must be used
Produces soft,	1/4		1/4 up	
machinable welds	3/8		3/8 up	
Bronze	1/16	Neutral	1/16-1/8	For brazing steel, cast-
	1/8		1/8 up	iron, brass, and bronze
	3/16		1/4 up	
	1/4		1/4 up	
	5/16		3/8 up	
	3/8		3/8 up	

TABLE IV (continued)

Type of Rod	Size, in inches	Kind of Clame	Metal Thickness	Use
Low-Fuming Bronze	1/8 3/16 1/4 5/16	Neutral	1/8 up 1/4 up 1/4 up 5/16 up	An excellent grade of bronze used on steel, copper, and cast iron
Aluminum Coated	1/16 1/8 3/16 1/4	Slightly acetylene	1/16-1/8 1/8 up 1/4 up 1/4 up	For welding sheets of common aluminum-alloy compositions
Aluminum Bare	1/16	Slightly acetylene	1/16-1/8 1/8 up 1/4 up 1/4 up	For welding aluminum sheets of common aluminum-alloy compositions Flux must be used
Phos-Copper Alloy of copper and phosphorus	1/16 1/8 3/16	Slightly acetylene	1/16 up 1/8 up 1/4 up	Used for copper joints Self-fluxing when used on copper joints
Composite Hard	1/8 5/32 3/16 1/4	Slightly acetylene		For hard-surfacing cutting and wearing edges such as drilling bits Plow shares, etc.

TABLE V

ARC-WELDING RODS

Type of Rod	Size, in Inches	Current Range	Arc Volts	Metal Thickness	Use
Mild Steel	1/8	70-125	25	3/32-3/16	General purpose with
Reverse polarity	5/32	90-160	27	1/8 up	d. c. current
d. c. only	3/16	125-240	28	3/16 up	Best for vertical and
Shielded arc	7/32	150-275	28	1/4 up	overhead use
All positions	1/4	160-325	30	1/4 up	5/32 best for general use
Mild Steel	1/16	20-60	18	1/32-1/8	General purpose with
Straight polarity	3/32	25-85	20	1/16-1/8	d.c. or a.c. current
a.c. or d.c.	1/8	70-125	24	1/8-3/16	Recommended for
All positions	5/32	90-170	26	1/8 up	thin metal where
	3/16	120-225	28	3/16 up	joint fit is poor
	1/4	175-350	30	1/4 up	
Mild Steel	1/8	70-125	25	1/8-3/16	Fillet welds with a.c.
Straight polarity	5/32	80-160	27	1/8 up	or d.c. current
a.c. or d.c.	3/16	130-250	28	3/16 up	Flat position only
Flat position only	1/4	225-375	30	1/4 up	Produces smooth head with low splatter and slag loss
High-Tensile Steel	1/8	75-130	25	1/8-3/16	General purpose with
Reverse polarity	5/32	90-175	27	1/8 up	d.c. current only
d.c. only	3/16	140-225	28	3/16 up	For welding high-tensile
Shielded arc	7/32	160-270	28	1/4 up	steels under 30%
All positions	1/4	190-325	30	1/4 up	carbon, and low-carbon nickle steels

TABLE V (continued)

Type of Rod	Size, in Inches	Current Range	Arc Volts	Metal Thickness	Use
High-Tensile Steel	3/16	180-230	30	1/4 up	Flat position with a.c.
Deep groove joints	1/4	300-360	35	1/4 up	or d.c. current
Reverse polarity					For welding high-ten-
d.c. or a.c.					sile steels such as
Flat position only					pressure vessels
Light-Gauge Steel	3/32	45-60	20	Sheet gauge	General purpose with
Straight polarity		35-50	20	16	d.c. or a.c. current
a.c. or d.c.		50-45	18	18	All positions where
All positions		30-40	18	20	joint fit is poor
				22	Very thin metal
Mild Steel	3/32	25-65	18	3/32-3/16	General purpose a.c.
Shielded arc	1/8	43-185	22	1/8 up	or d.c. current
a.c. or d.c.	5/32	75-190	24	3/16 up	All positions
All positions	3/16	100-240	26	3/16 up	Especially adapted
	1/4	170-385	30	1/4 up	to transformer-type
					welds
Stainless Steel	1/16	10-40	16	1/16-3/32	For welding 18-8
Shielded arc	5/64	20-55	16	1/16-1/8	stainless steel in
a.c. or d.c.	3/32	30-70	18	3/32-3/16	all positions
Reverse polarity	1/8	50-100	22	1/8 up	a.c. or d.c.
All positions	5/32	75-130	24	1/8 up	Reverse polarity
	3/16	95-165	26	3/16 up	
	1/4	150-225	28	1/4 up	

TABLE V (continued)

Type of Rod	Size, in Inches	Current Range	Arc Volts	Metal Thickness	Use
Cast iron Reverse polarity All positions Shielded arc Works better with d.c.	1/8	80-100	22	1/8 up	Cast iron Works better with d.c. Beads are run intermittently so work will not become heated
Aluminum Reverse polarity d.c. only Flat welding only Heavy coated	1/8 5/32 3/16 1/4	45-125 60-170 85-235 125-360	20 22 24 28	1/8 up 1/8 up 3/16 up 1/4 up	Can be used with electric or oxyacetylene torches A 5% silicon rod produces strongest weld d.c. only when used with arc
Bronze Reverse polarity d.c. only Heavy coated Flat position only	1/8 5/32 3/16	50-125 70-170 90-220	20 24 27	1/8 up 1/8 up 3/16 up	For welding bronze, brass, and copper
Hard Surfacing Shielded arc Reverse polarity d.c. only Flat position	1/8 5/32 3/16 1/4	70-110 100-150 150-225 225-350	22 24 28 30	1/8 up 1/8 up 3/16 up 1/4 up	For hard-surfacing worn parts Produces best welds when welded in flat position Moderate resistance to shock and abrasion

TABLE V (continued)

Type of Rod	Size, in Inches	Current Range	Arc Volts	Metal Thickness	Use
Tool Surfacing	3/32	30-65	18	3/32-1/8	For hard-surfacing
Shielded arc	1/8	65-100	22	1/8 up	cutting edges where
Reverse polarity	5/32	90-160	24	1/8 up	shock is encountered
d.c. only	3/16	125-200	28	3/16 up	Flat position
					produces best weld

Following is a list of some arc welders sold on the market:[11]

Westinghouse Arc Welder, approximate cost, $260.00 295-Amp. 230-volt AC Model. UL approved; meets NEMA specifications. For heavy-duty garage repair work, construction use or light industrial jobs. Welds metal from 1/16 in. to heavy plate; cuts up to 1/2 in. jobs.

Uses electrodes up to 1/4 in. 30 heats from 20 to 295 amps. 20% duty cycle. Use on 220-240-volt, single-phase, 60-cycle AC. Maximum line draw 65 amps.; open circuit volts 65; arc volts 30; power factor corrected to 60%. Maximum power used 9.0 kilowatts. De-ion circuit breaker protects welder from overloads. Steel case 34 3/8 x 21 7/8 x 19 1/8 in. on 10-in. steel sheels. Includes: 16-ft. 3-conductor primary cable, 3-prong plug and receptacle; two 16 ft. welding cables; electrode holder; helmet; brush; weight 320 lbs.

Westinghouse 180-AMP Arc Welder approximate cost, $185.00 180-Amp. 230-Volt AC Model. UL approved. Welds 20 gauge sheet metal to heavy plate; cuts up to 5/16-in. plate. For garage work, light construction use, etc. 20 heats ranging from 20 to 180 amps. Uses electrodes up to 3/16 in. 20% duty cycle. Use on 220-240 volt, single-phase, 60 cycle AC. Meets REA and NEMA specifications. Maximum line draw 33 amps.; open circuit volts 65; arc volts 25; power factor corrected to 75%. Maximum power used 5.3 kilowatts. Built-in de-ion circuit breaker protects welder from steel case 25 x 17 1/2 x 12 1/2 in. on steel wheels. Includes: 8-ft. 3-conductor primary cable, plug, receptacle; two 12-ft. welding cables; same accessories as above; weight 190 lbs.

POWR-KRAFT AC WELDER, Approximate cost $50.00. UL approved portable 50-amp. welder for work in home or shop, weld 1/32 to 1/8 in. steel, cut up to 3/32-in. sheet metal. Use with arc torch to braze galvanized sheet metal, and to sweat solder. Operates on 110-120 volts AC with 20 to 30 amp. fuse. No maintenance or

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[11] <u>Spring and Summer</u>, <u>Montgomery Ward</u> (Oakland: /n.n./, 1955), pp. 768-69.

adjustments needed. 4 heats ranging from 35 to 50 amps. Gives complete sheet metal range. Class "B" spun glass insulation prevents overheating and insures operator safety. Handy on-off switch, handle. Power factor corrected to 72%--reduces installation and power costs. 20% duty cycle. Includes: 6 ft. rubber cord; 9 ft. electrode cable and insulated holder; ground cable, clamp; helmet with protective lens; cover lens; 1 lb. of 5/64 in. electrodes; 1 lb. of 3/32 in. brazing rods; 5 carbons; jar of easy to strike poweder. Size overall: 9 1/4 x 8 1/4 x 9 1/4 in. Plugs into any 110-120 volt receptacle. With 3 prong plug, and adapter for use with standard outlets. Weight 48 lbs.

100-AMP. "SELFWELDER" Approximate cost $102.00. Powr-kraft 115 or 230 volt Arc Welder. 100 Amp. welder designed for both "Selfweld" process and conventional welding. Selfweld process, developed by Lincoln Electric Co., simplifies arc welding. Special "match-head" electrode is placed on workpiece, starting switch pressed, arc forms automatically. Adjustable leg on holder keeps rod at correct angle. Welds anything from 20 ga. sheet metal to heavy plate. Six taps at 10 amp. intervals--range of 50 to 100 amps. 20% duty cycle. Maximum open circuit 70 volts. For 110-120 or 220-240 volt single phase 60 cycle AC. Use 40 amp. fuse for 110-120 v. or 20 amp. for 220-240 v. Uses rods to 1/8-in. diam. NEMA, UL approved. Size 12 x 9 x 14 in. with 3 ft. electrode cable holder; 7-ft. ground cable, clamp, hand shield; 3 lbs.[12]

<u>The soldering iron</u>. The soldering iron is the most convenient and cheapest method of joining metals. It plugs into any 110-120 volt wall plug. The cost ranges from $1.50 to $13.00, and the more expensive trigger type irons will heat up instantly.

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[12] *Ibid.*, p. 769.

In the process of soft soldering,[13] a 50-50 solder (50 tin and 50 lead) in 1/8 inch wire forms, melting at 401° F., is recommended. A commercial soldering paste, sold under the name of "Lotan," is recommended for iron-work. The flux, recommended for all-round utility, is an ammonium chloride preparation commonly sold as "soldering salts." Soldering paste and zinc chloride may be used on copper, brass, and tin, tallow on lead, and hydrochloric acid on zinc. The function of the flux is to keep the metals clean. Metals are soldered by means of alloys of lower melting point. The soldering metals fuse with the adjoining molecules in the metals soldered if their entrance is unobstructed. Heat sources may be used from a Bunsen burner, alcohol lamp, or a gas torch.

Gold, platinum, and silver solders are expensive but may be recommended for certain types of work where stronger joints may be needed. Wildberg Brothers, a smelting and refining company, have set up tables for gold, platinum, and silver solders (Tables VI, VII, page 35, and VIII, page 36).[14]

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[13] A. F. Bick, Artistic Metalwork (Milwaukee: The Bruce Publishing Company, 1940), pp. 72-73.

[14] Wildberg Brothers, Precious Metals (San Francisco: [n.n.], 1955), pp. 6, 10, and 11.

TABLE VI

GOLD SOLDERS *

Quality	Color	Approximate Melting Point	Recommended for Use With:
# 8	Yellow	1210°F.	8 Kt. Yellow Gold
#10	Yellow	1225°F.	10 Kt. Yellow Gold
#10	White	1250°F.	10 Kt. White Gold
#10	Green	1300°F.	10 Kt. Green Gold
#10 Hard	Yellow	1235°F.	10 Kt. Yellow Gold (new work)
#12	Yellow	1250°F.	12 Kt. Yellow Gold
#14	Yellow	1280°F.	14 Kt. Yellow Gold
#14	White	1290°F.	14 Kt. White Gold
#14	Green	1320°F.	14 Kt. Green Gold
#14	Red	1330°F.	14 Kt. Red and Pink Gold
#14 Hard	Yellow	1350°F.	14 Kt. Yellow Gold (new work)
#18	White	1500°F.	18 Kt. Yellow Gold
#18	White	1550°F.	18 Kt. White Gold
#18 Welding	White	1600°F.	18 Kt. White Gold Welding
#20			18 Kt. White Gold

*Wildberg Brothers, Precious Metals (San Francisco: /n.n./, 1955), p. 6.

TABLE VII

PLATINUM SOLDERS*

Grade	Type	Approximate Melting Point
#1100	Soft	1633°F.
#1200	Medium	1782°F.
#1300	Medium Hard	1831°F.
#1400	Hard	2080°F.
#1500	Extra Hard	2227°F.
#1600	Special Welding	2376°F.
#0	Welding Extra Hard	2975°F.
#1	Welding Hard	2925°F.
#2	Welding Medium Hard	2900°F.
#3	Welding Medium	2875°F.

Supplied in one dwt. pieces or bulk strips. Bulk strips in quantities of one ounce are sold at a price that makes a substantial saving.

*Wildberg Brothers, Precious Metals (San Francisco: [n.n.], 1956), p. 10.

TABLE VIII

SILVER SOLDERS*

Use	Grade	Form	Approximate Melting Point	Color
Herd first Soldering	#1	Sheet and Form	1425 deg. F.	Silver White
Silver Jewelry	#3	Sheet and Form	1375 deg. F.	Silver White
Silver, Copper, Monel, Nickel	#4	Filings	1325 deg. F.	Silver White
Second Soldering	#5	Sheet and Wire	1340 deg. F.	Yellow White
Low Fusing Second Soldering	#14	Sheet, Wire Filings	1150 deg. F.	Dull White

*Wildberg Brothers, Precious Metals (San Francisco: /n.n./, 1955), p. 11.

Other methods. There are other methods of welding which are infrequently used. They are the thermit process, electric resistance welding, and forge welding. Forge welding is not a fusion process because pressure as well as heat is used.

Forging and hot forming.[15] Many school shops have a forge which consists of a hearth, tuyere (fire pot), hand blower, and hood. The fuel is coal. Hot forging has a twofold purpose: One is shaping of metal, and the other is the development of texture (modeling). Texture is often used on commercial iron to overcome its raw and cold appearance.

Since iron resists the effort to change its form, it can be brought up to a bright red heat (about 1800° F.) and made plastic under a hammer. This gives it malleability so that it can be pounded or bent into sculptural forms.

Forging is an ancient method used for sculpture or modeling, and shops are using this process for metalwork. The student projects are everything from door knockers to medieval brackets for lights or plants. A pattern or blue print with all the dimensions is often furnished.

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[15] Bick, *op. cit.*, pp. 50-51.

Knowledge of the tools and the understanding of pattern reading are necessary in preparing one for a trade, but it should be pointed out that a student needs to be given opportunity to embody his own design in the projects he makes. F. L. Wright says, in part,

> . . . but outside mechanical genius for mere contrivance, we are not good workmen, nor, beyond adventitious or propitious respect for property, are we good citizens as we should be, nor are we artists at all. We are one and all, consciously or unconsciously, mastered by our fascinating automatic implements, using them as substitutes for tools.[16]

Annealing (softening).[17] When steel is forged the heating and forging process disturbs the structure of the metal, which may result in the metal cracking or breaking. The structure of the metal may be restored by annealing. The annealing process for steel is to heat it to a dull red and cover it with hydrated lime for an overnight period.

Copper and brass are also annealed so that they may be formed or beaten. Gas flame or forge fire should heat the metal until it is a faint red; then the metal should be

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[16]Frank Lloyd Wright, The Future of Architecture (New York: Horizon Press, 1953), p. 73.

[17]C. C. Ashcroft and J. A. G. Easton, General Shop Work (Toronto: The Macmillan Company of Canada Limited, at St. Martin's House, 1940), p. 126.

plunged into a pickling solution. This pickle acts as a cleansing agent to loosen the scale or oxide on the metal, which then should be removed by buffing or rubbing with steel wool. The pickle consists of a gallon of clean water and a tablespoon of sulphuric acid; the pickle must be kept in a non-metallic container.[18]

Safety practices.[19] Before a student begins to work with the different methods, he should realize the necessity of developing habits of safety and care in the use of tools. Adolescents are apt to be careless, and this carelessness may result in permanent injury to the worker, to someone else, or damage to the equipment.

The following procedures and safety rules are concerned particularly with the use of oxyacetylene equipment. Arc welding equipment does not involve as many problems.

Procedure for setting up an oxyacetylene unit.

1. Remove the valve caps from the oxygen and acetylene cylinders. These caps prevent damage to the valves.

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[18] *Ibid.*, p. 93.

[19] Rigsby and Groneman, *op. cit.*, p. 15.

2. Open the valves slightly, then close them quickly. This blows away any foreign matter which may have collected in the regulator seat of the cylinder valve.

3. Attach the oxygen and acetylene regulators to the valves on their respective cylinders as well as the outgoing pressure to the hose lines. The oxygen regulator has a male adapter with a female nut which has a right-hand thread; the acetylene regulator has a male adapter with a female nut which has a left-hand thread. This prevents interchanging the regulators.

4. Test the regulator fastening for possible leaks by applying soap suds around the joints. If any gas is escaping it may be necessary to remove the regulator and to re-examine the seat for possible foreign matter.

5. Attach the oxygen hose, which is always green, to the oxygen regulator. Note that the nut on the oxygen hose has a right-hand thread.

6. Attach the acetylene hose, which is always red, to the acetylene regulator. Note that this attachment has a left-hand thread.

7. Test both hose connections for any possible leaks. The connections should be made secure by tightening with a wrench.

8. Fasten the torch handle to both hoses. The proper connections for the respective hoses may be identified on the torch handle by (1) color (green for oxygen and red for acetylene); (2) the name of the gas, acetylene and oxygen, which is stamped on the handle; or (3) the type of threads, right-hand for oxygen and left-hand for acetylene. The connections must be made secure by tightening with a wrench. Do not use pliers for this assembly because the working surface of the nut may be injured.

9. Connect the mixing head and tip to the torch handle. Tighten this connection by hand because it is often necessary to change the mixing heads and tips for different jobs. These connections have ground joints which, if properly tightened, will not leak.[20]

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[20] *Ibid.*, pp. 17-19.

Procedure for regulating the gas pressure.

1. Completely loosen the adjusting screw on the oxygen regulator.

2. Open the oxygen valve slowly until it is completely open. If the regulator and valve are opened in this order, leaking of the valve packing will be prevented. With a normal room temperature of 70° F., the high-pressure gauge of the regulator will register approximately 2100 lb.

3. Tighten the adjusting screw on the regulator until the desired working pressure is registered on the low-pressure gaguge. Secure the proper working pressure desired from Table II, page 21.

4. Loosen the adjusting screw on the acetylene regulator.

5. Open the acetylene cylinder valve about 3/4 of a turn. If the cylinder is full, the high-pressure gauge of the regulator will register about 260 lb. p. s. i.

6. Tighten the adjusting screw on the regulator until the desired working pressure is obtained. Refer to Table II for the correct pressure. The pressure should never be allowed to go above 15 lb. p.s.i.; it will be observed that most acetylene low-pressure gauges have a danger mark at this point.[21]

Procedure for lighting and adjusting the torch.

1. Open the acetylene vavle on the torch 1/4 of a turn and ignite the gas at the tip of the torch, preferably using a spark lighter. For tip sizes refer to Table II, page 21.

2. Adjust the acetylene valve until the flame burns clean and strong and gives off a minimum amount of smoke. Usually the correct adjustment for the acetylene valve is the point just before the flame begins

[21] *Ibid.*, pp. 19-20.

to leave the tip; the flame should not separate from the tip.

3. Open the oxygen valve on the torch slowly. As the amount of oxygen is increased, the flame will become shorter and will turn a bluish color. Continue to open the oxygen valve until the last trace of green, unburned acetylene disappears from the blue cone at the end of the tip. Figure 2, page 12, illustrates correct flame adjustment. It also shows what occurs when excessive acetylene or oxygen is present and the effect of various flames on the weld.[22]

<u>Procedure for shutting off the torch.</u>

1. Close the acetylene valve on the torch to extinguish the flame. This clears the torch and tip of combustible gases.

2. Turn off the oxygen valve on the torch.

3. Shut off both cylinder valves.

4. Release the pressure in the hose by allowing gas to escape through the torch.

5. Loosen the regulator adjusting screws.

6. If desired, the torch and tip may be disassembled.[23]

<u>Procedure for oxyacetylene welding with the use of welding rod.</u>

1. Light the torch and adjust for a neutral flame as explained in procedure for lighting and adjusting the torch. Refer to Table II, page 21, for proper gauge pressures.

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[22] *Ibid.*, pp. 21-22.

[23] *Ibid.*, p. 22.

2. Hold the flame practically stationary at the point where the weld is to begin until the metal is brought to a melting point, or when the metal beneath the tip becomes thoroughly fluid.

3. Place the welding rod in the center of the molten pool.

4. Proceed to weld the seam or joint describing semi-circles with the torch around the rod (Figure 3). Move the rod back and forth to distribute the metal evenly. It should be noted that the base metal must always be kept molten. In case of an excessive amount of metal, remove the welding rod.

If the rod is kept in the center of the molten material during the welding process, little effort will be required to manipulate it. But if the rod is moved to the edge of the pool, it will stick in the soldifying metal.

Fusion will be very poor if the rod, on the other hand, does not touch the work. Thus the metal is allowed to drop on the work, exposing it to atmospheric contamination.[24]

<u>Procedure for cutting metal by the oxyacetylene process</u>.

1. Light the torch and adjust for a neutral flame as explained in Figure 2, page 12.

2. Hold the torch with the point about 1/16 in. from the work and preheat the metal at the point where the cutting is to begin.

3. Open the high-pressure oxygen valve all the way. The cut will begin instantly.

4. Move the torch at a uniform rate of speed along the cutting line. Thin materials naturally are cut more rapidly than heavy materials--the cutting speed of

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[24] *Ibid.*, pp. 27-28.

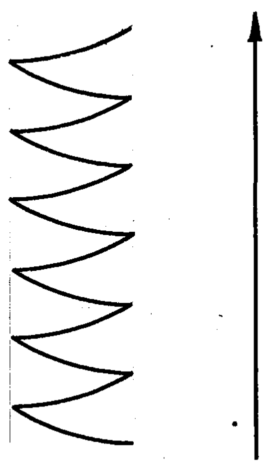

FIGURE 3

WEAVING PATH OF THE TORCH

travel can be determined by practice on metals of different thicknesses. If the torch is moved too slowly, the edges of the metal will be overheated, and an excessive amount of slag will accumulate. Often this slag and metal will fuse.

The angle at which the tip is held in relation to the work depends upon the thickness of the material: for cutting thin metal 1/8 in. thick, the tip should be inclined 20° to the horizontal and pointed in the direction of travel. For thicker material, the tip is inclined towards the perpendicular; it is held at right angles to the work for cutting material 1/2 in. or more in thickness (see Figure 4).[25]

Checklist for examination of primary and secondary connections to an arc-welding machine.

1. See that the leads from the primary circuit of the welding machine are securely fastened both on the terminals and on the male plug.

2. Have the electrician check to see that the main circuit in the building is not overloaded.

3. Be sure that the proper size fuse is used in connection with the machine as required by the manufacturer's specifications.

4. The welding unit should be tested by the teacher or welder in the presence of the electrician to make sure that the secondary circuit of the machine has been properly connected and that the machine functions properly.

5. After the teacher and electrician have checked the unit with the manufacturer's specifications, this material should be posted or fastened in a readily accessible location.[26]

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[25] Ibid., pp. 30-31.

[26] Ibid., pp. 33-34.

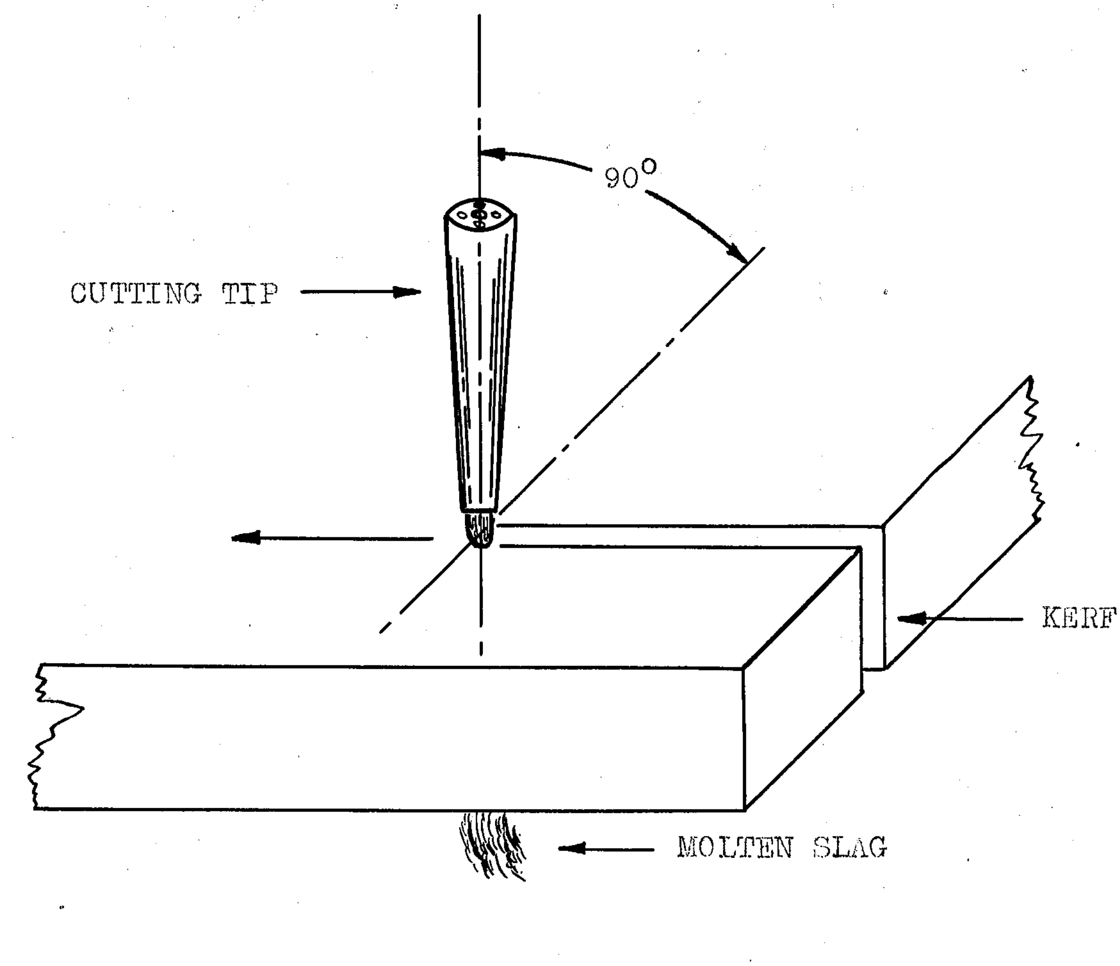

FIGURE 4

ANGLE OF CUTTING TORCH FOR CUTTING HEAVY STOCK

<u>Procedure for arc welding on flat metal.</u>

1. Select the electrode. A 3/32 in. electrode is most suitable for practice work. For specific jobs, consult Table V, pages 27-30, for rod sizes.

2. Place the uncovered, or bare, end of the electrode in the electrode holder. See that the connection is secure.

3. Turn on the switch.

4. Poise the electrode directly above the point where the weld is to start; it should be perpendicular to the work.

5. Pull the face shield down over the eyes.

6. Make contact between the electrode and the work. To make contact, or "strike an arc," use a slightly circular, scratching movement. As soon as contact is made and the current begins to flow, raise the electrode from the plate, or work, a distance equal to the diameter of the electrode (or 5/32 in. for this practice). This distance is called the arc length, and for sound welds, it is essential that the proper arc length be maintained.

The operator can easily determine the correct arc length by observing the characteristics of the arc. If the arc is too long, as the metal melts from the end of the electrode it will form small drops and pass through the arc stream in this manner. Excessive splatter and poor fusion result. This condition is corrected by shortening the length of the arc.

7. Move the electrode slowly and evenly to deposit the metal along the line of weld. If the rate of travel is too fast, sufficient metal will not be deposited; if it is too slow, the build-up will be excessive, and the weld will be rough and uneven. A 14-in. electrode will produce from 8 to 10 in. of single-bead weld.

When welding a joint follow the above procedure; however, oscillate the electrode from side to side across the joint to insure perfect fusion of adjoining edges (see Figure 3, page 44).

> Whenever it is necessary, because of the thickness of the material and the depth of the groove to make more than one pass or layer or complete the weld, slag should be thoroughly cleaned with a chipping hammer and a wire brush before the succeeding passes, or layers, are made.[27]

It is important that the tools, media, and processes fit the age levels and particular abilities of the students. No task should be given that is beyond student comprehension or ability. The adolescent will often demand resisting materials (like metal) because they challenge his intelligence and consume his abundant energy.

Students of the same chronological age may differ widely in artistic development. An adolescent of fifteen may have the creative age of a child of six. (The photographs of student projects used in this research are age groupings from thirteen to eighteen years and may illustrate this meaning of creative age.) Some have the creative impulse so inhibited through neglect or adverse training that they may not respond to any media. Since so wide a range of media is necessary for continuing the motivation of adolescents and since the use of metal as shown throughout this study is relatively new, it is felt that one more approach is now available to the harried teacher of arts and crafts.

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[27] *Ibid.*, pp. 35-38

CHAPTER V

TECHNIQUES AND RESULTS OF HIGH SCHOOL STUDENTS' PROJECTS

With regard to use of techniques, Goethe remarked,

> In the limitation the master reveals himself. The most economical use of technique and their application will be the best. The most definite use of them will be the most direct, outspoken, and forceful.[1]

In developing a unit of study, the aim was to experiment first with copper or soft iron wire because, whenever anyone picks up a piece of wire, it is usually bent by him in many directions in a non-objective way, which is similar to the results gained when a person doodles with a pencil on paper. The possibilities of wire are often discovered in this way, and the training may eventually be directed toward sensory experiences, enrichment of emotional values, and the development of thought. This experience also allows the individual to explore creatively, or imaginatively, while perfecting his object--in opposition to the traditional process of stereotyped and stilted mechanical blueprint-following of plans set up by others. Figure 5 is an outcome of twisting and bending copper wire. The student has intimated that he wrestled

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[1] Viktor Lowenfeld, Creative and Mental Growth (New York: The Macmillan Company, 1952), p. 291.

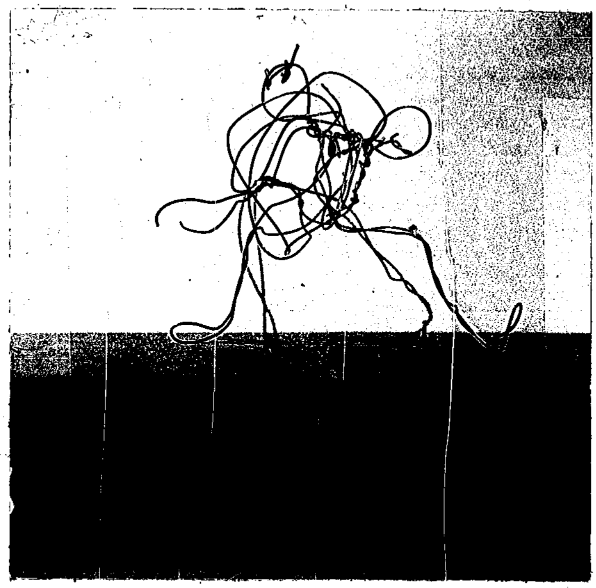

FIGURE 5

THE WRESTLERS (COPPER WIRE SCULPTURE)

with the wire and ended with "The Wrestlers." Jane Gehring[2] has taught design by combining wire and cast shadows. Figure 6 is a photograph of a shadow of Figure 7 ("Wire Form"), page 53, in which a pattern is displayed with a sense of design that is as interesting as the object that was casting the shadow.

Wire has its uses in contour drawings.

In contour drawing, form is carefully studied. Contour differs from outline; an outline is thought of as a diagram or silhouette, flat and two dimensional. Contour has a three dimensional quality; that is, it indicates the thickness as well as the length and width of the form it surrounds. Wire may serve as an aid because it helps the student visualize the quality of the third dimension. The eye moves slowly along the outline or edge of the object while the hand holding the pencil draws the observed outline. During this process, the eye does not watch the pencil as it moves but attempts to keep in co-ordination as the object is being studied. The value of this is that the experience of touch is combined with sight; also, hand and eye coordination is developed. Proportions will take care of themselves

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[2]Jane Gehring, "Dynamic Design from Wire and Shadows," School Arts, 50:125, December, 1950.

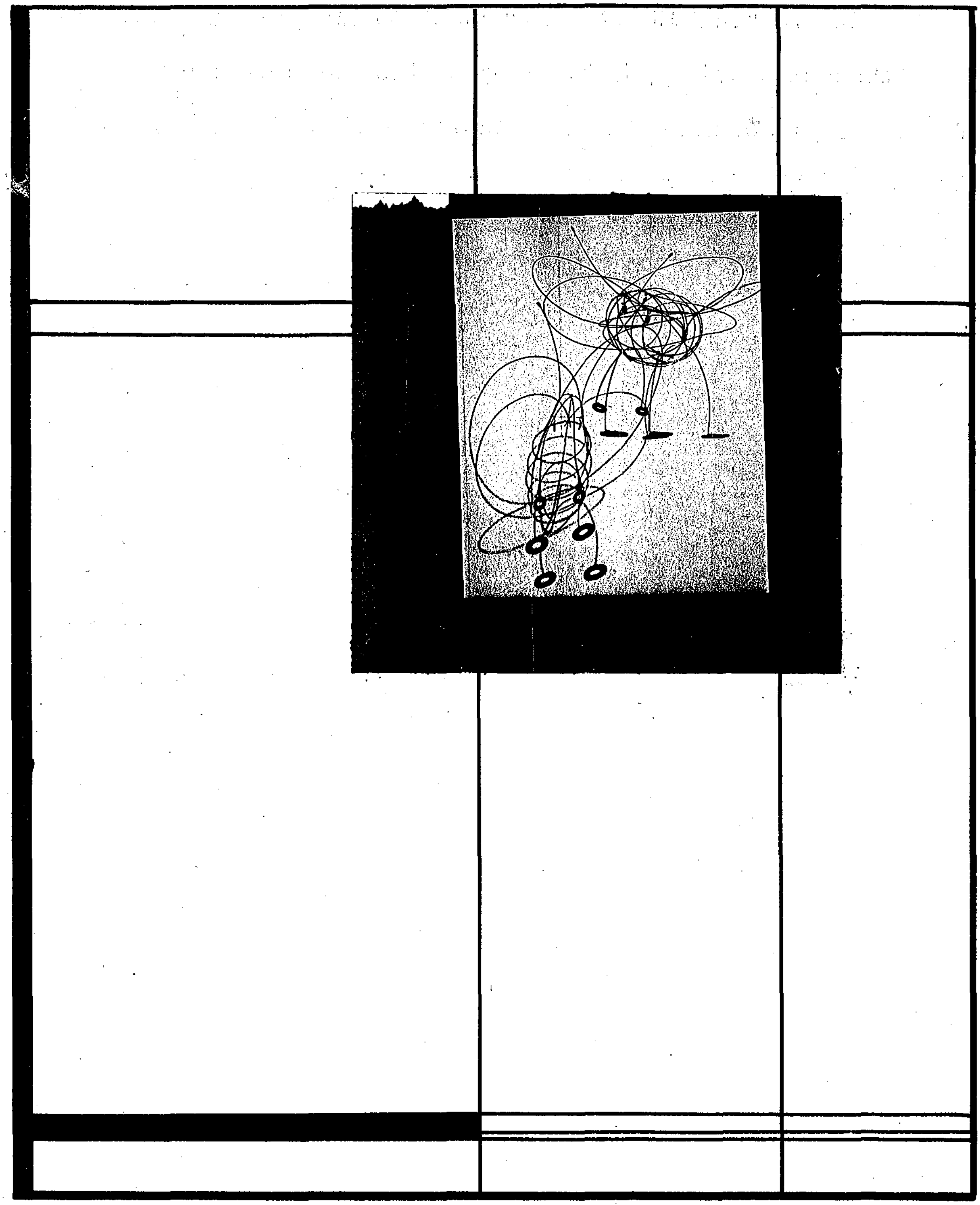

FIGURE 6

SHADOW STUDY OF "WIRE FORM"

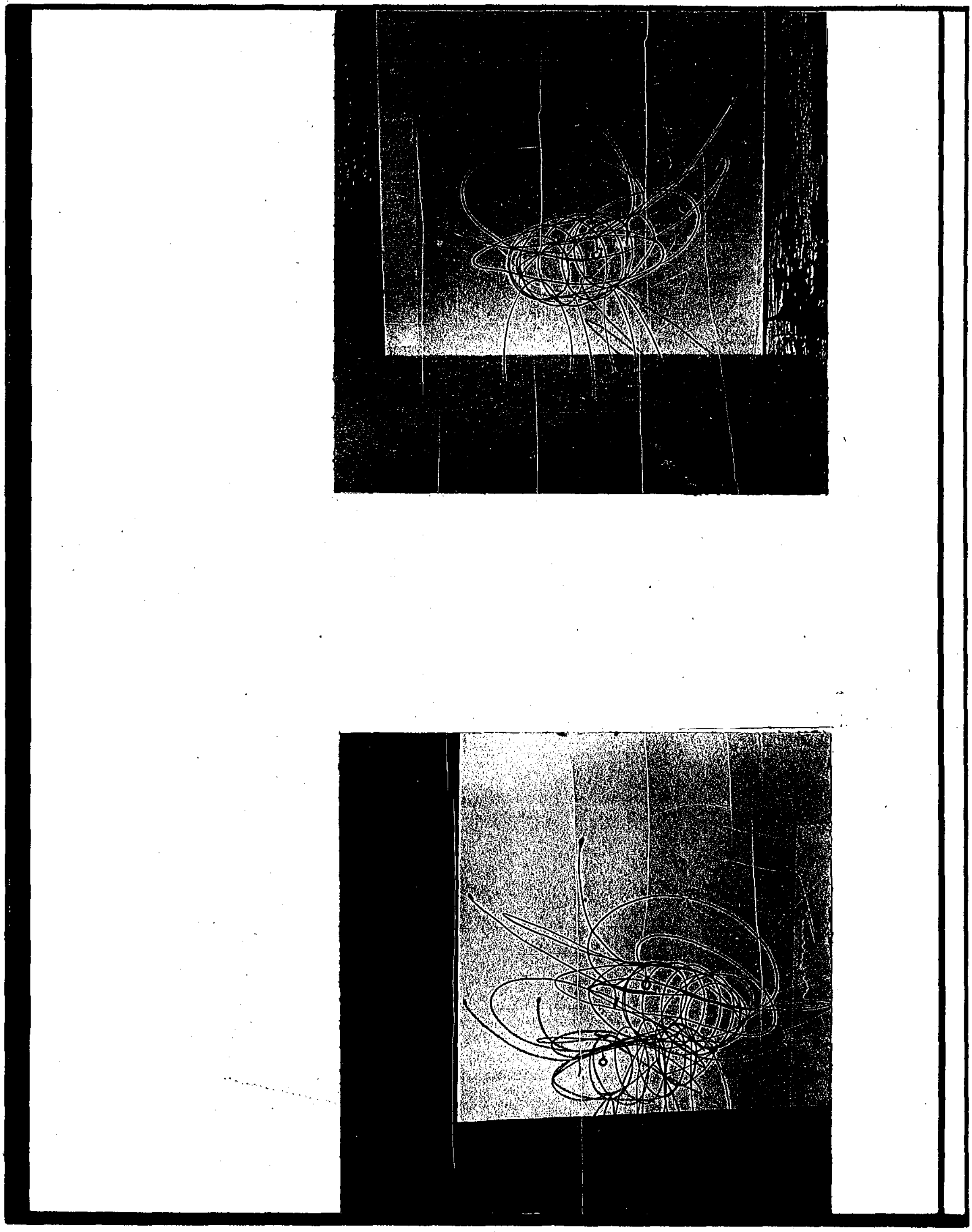

FIGURE 7

WIRE FORM (STEEL WIRE)

in time and a clear, strong line is achieved rather than an unsure, scratchy line. Kimon Nicolaides[3] illustrates a contour drawing with two apples in Figure 8. Figure 9, page 56, does not illustrate contour drawings because the line follows the eye and not the sense of touch. Figure 10, page 57 ("The Honker") and Figure 11, page 58 ("Discus Thrower") are suggestive of a contour drawing taken from the three dimensional wire project. Calder's wire sculpture called "The Hostess" (Figure 12, page 59),[4] might be described as a line drawing in three dimensions, for here the line actually carves and defines space.

In Figure 13, page 60 ("Action") and Figure 14, page 61 ("The Runner") the copper wire figures may be related to a gesture drawing. Gesture drawings are made in accordance with what the object is doing and not with what it looks like nor what it is. In this type of drawing, the artist feels the movement of the whole form in his body and is closely related to the actual experience. Figure 15, page 62, illustrates a gesture drawing.[5] The copper wire,

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[3]Kimon Nicolaides, The Natural Way to Draw (Boston: Houghton, Mifflin Company, 1941), p. 13.

[4]Ray Faulkner, Edwin Ziegfeld, and Gerald Hill, Art Today (New York: Henry Holt and Company, 1949), p. 188.

[5]Nicolaides, op. cit., p. 16.

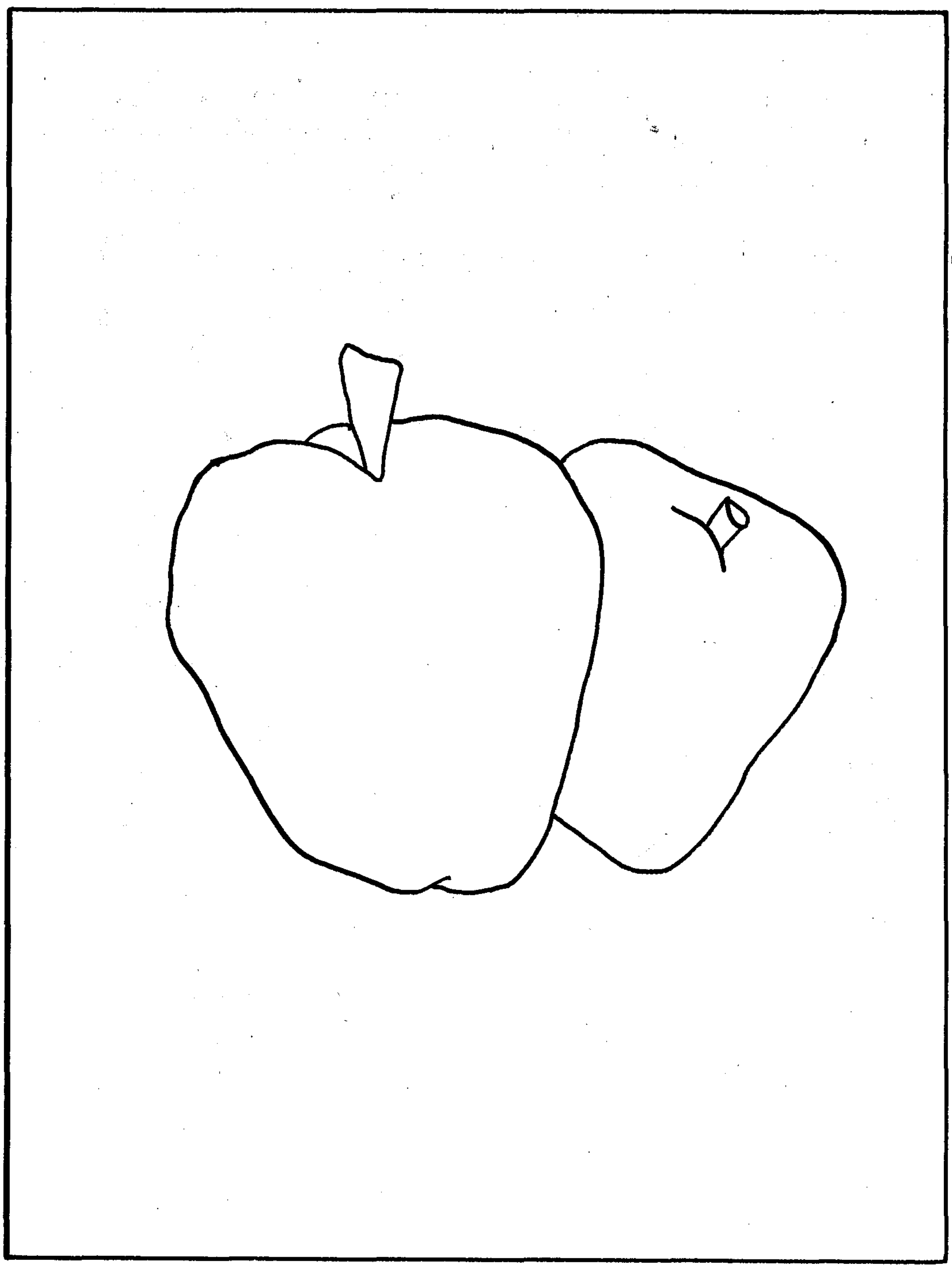

FIGURE 8

NICOLAIDES CONTOUR DRAWING

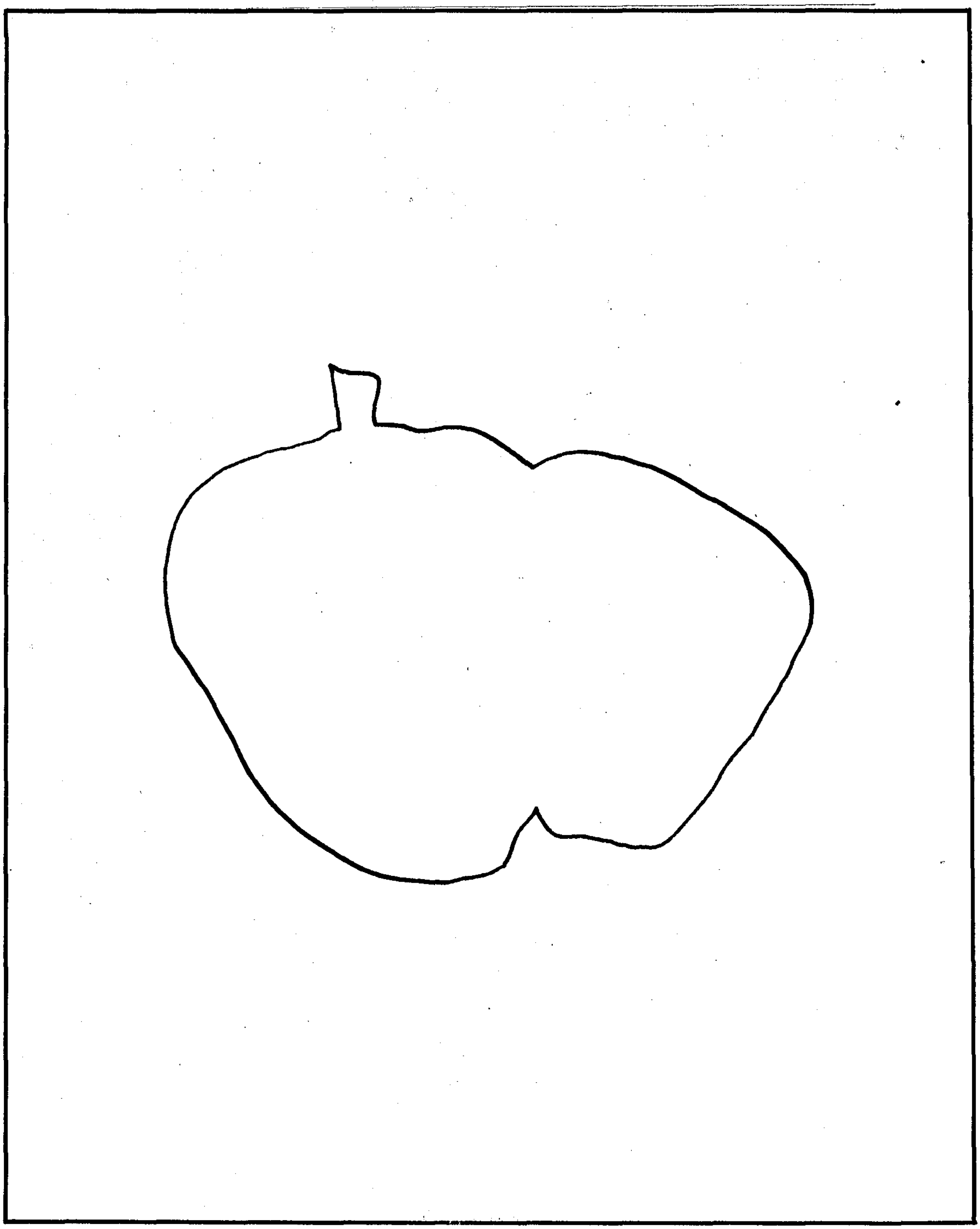

FIGURE 9

NICOLAIDES DRAWING

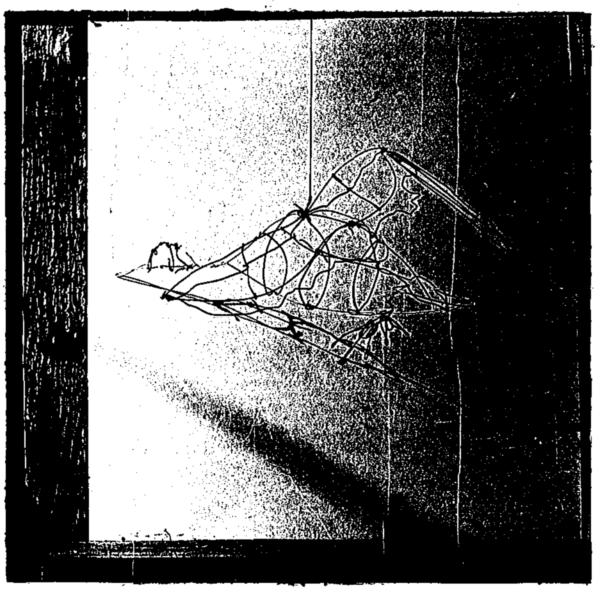

FIGURE 10

THE HONKER (IRON WIRE)

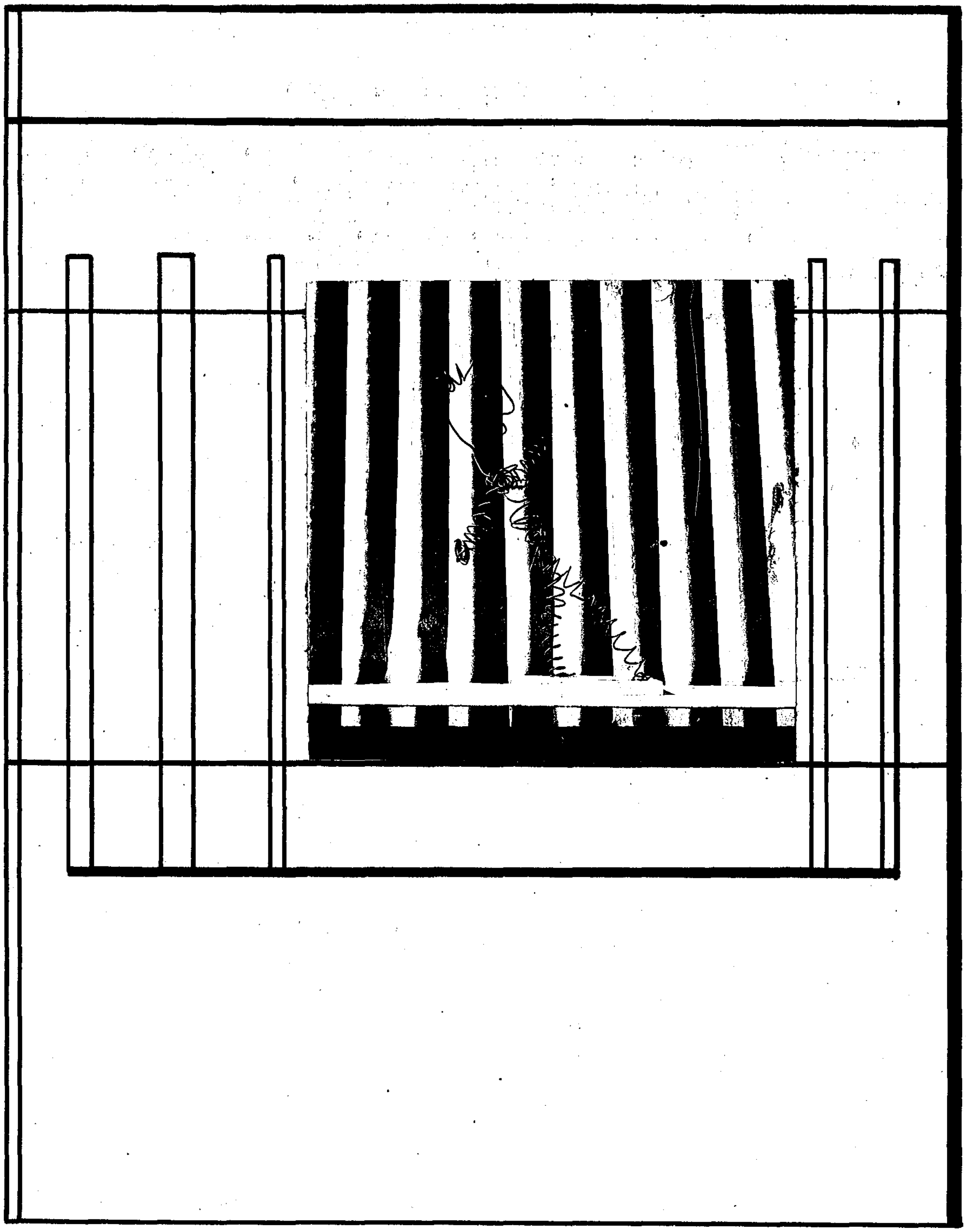

FIGURE 11

DISCUS THROWER (IRON WIRE)

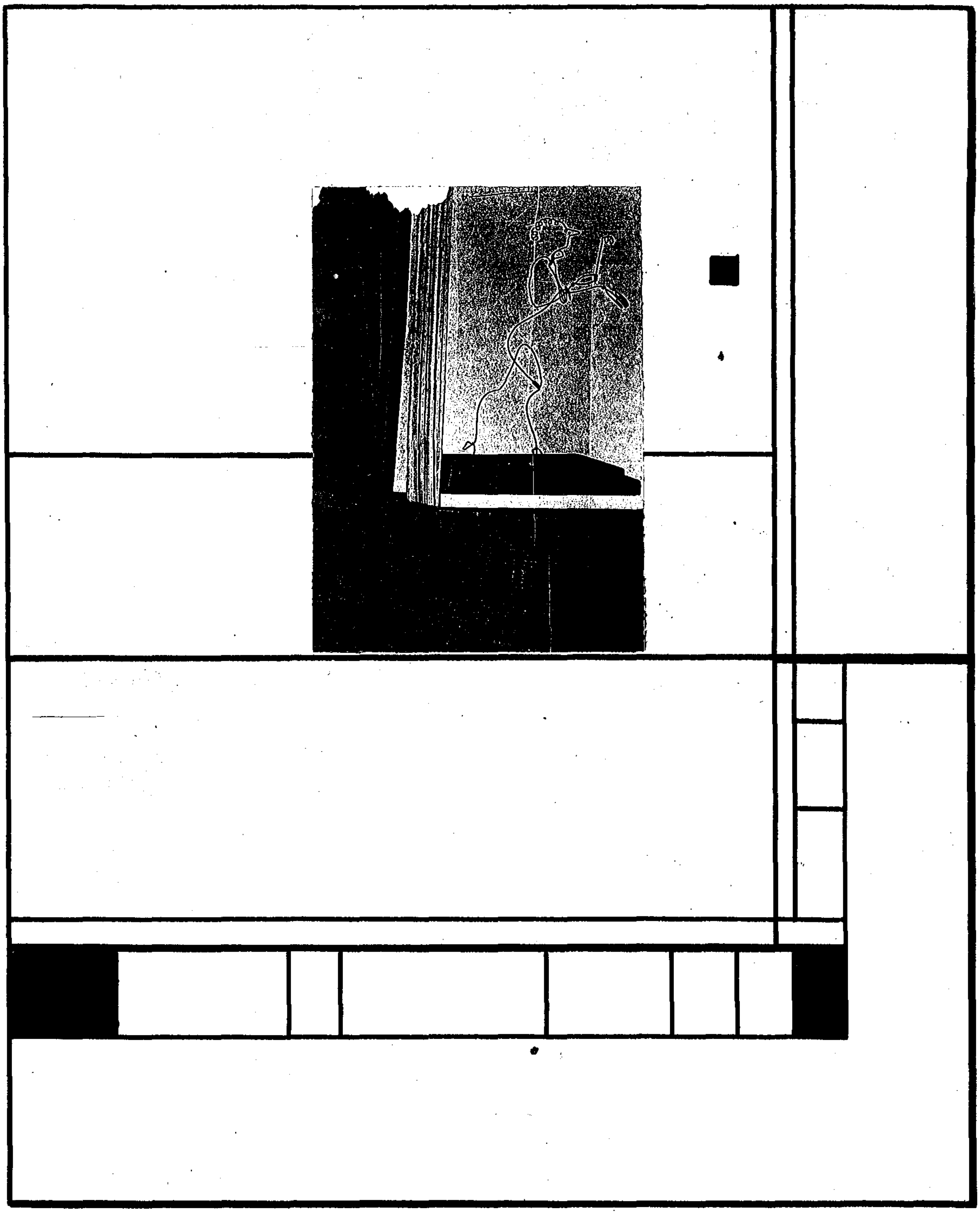

FIGURE 12

CALDER'S WIRE SCULPTURE (THE HOSTESS)

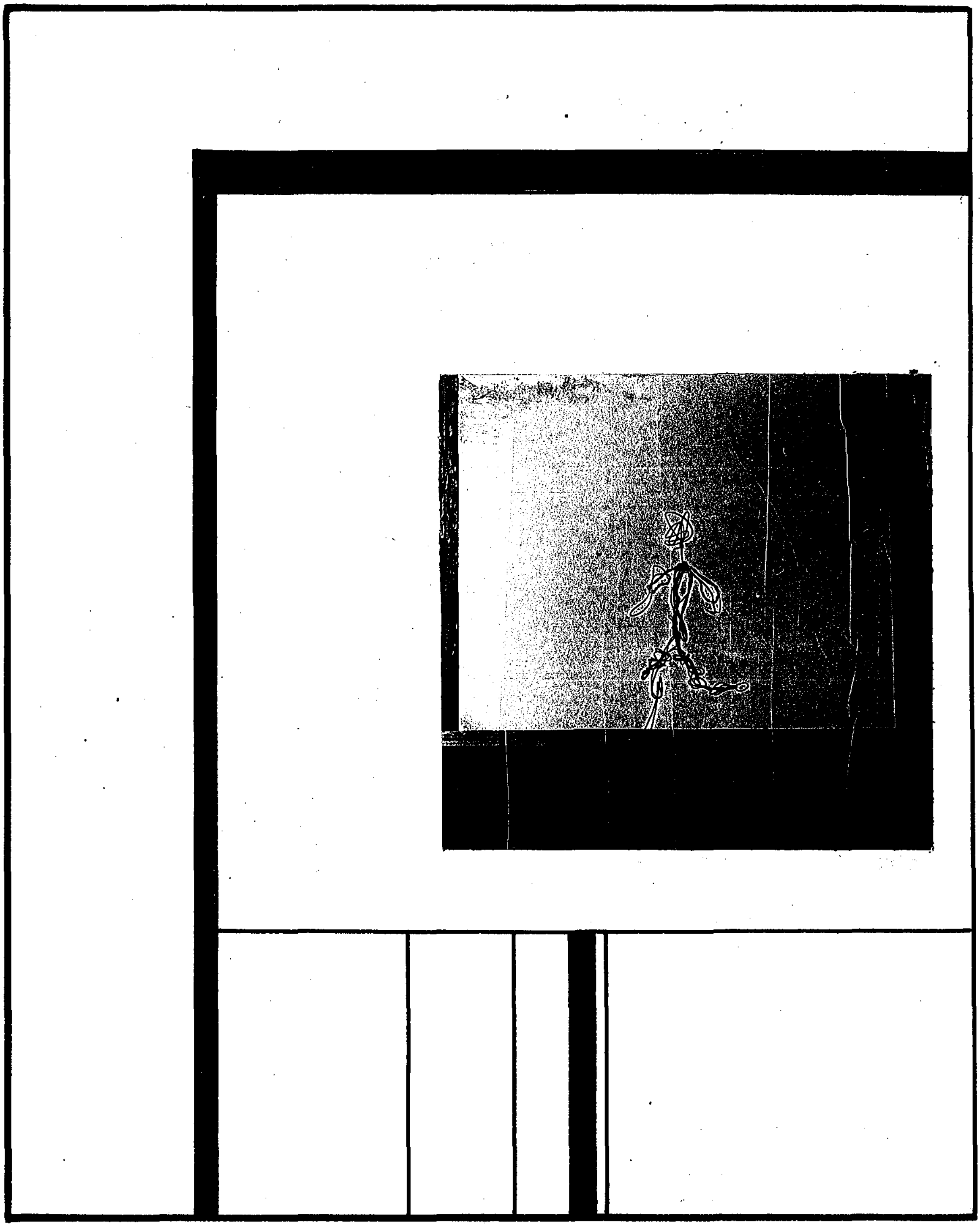

FIGURE 13

ACTION (COPPER WIRE)

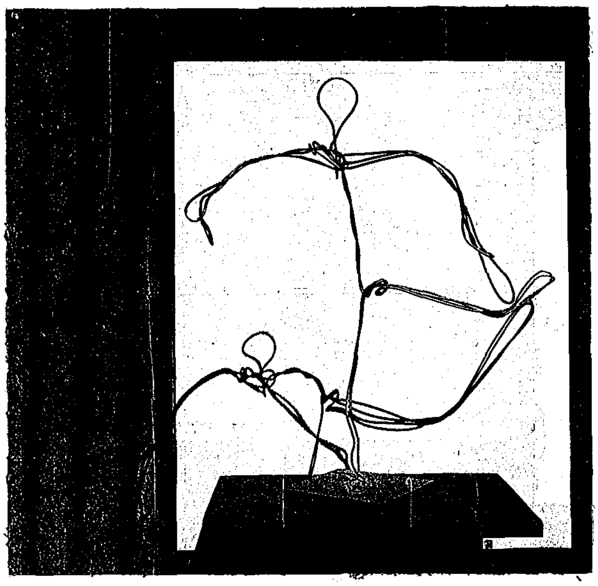

FIGURE 14

THE RUNNER (IRON WIRE)

FIGURE 15

NICOLAIDES GESTURE DRAWING

being soft and pliable, can be worked into any shape and form, giving the student the freedom of working with this unique physical characteristic of the material. The results of these creative projects and their design values are important and should not be separated from the individual and his psychological needs. For Gehring's type of projects, the only tools necessary are a pair of pliers and a soldering iron. This simplifies the use of copper wire as a material for problem-solving in the classroom.

In a sequence of problems, heavier wire might come next. In Figure 16 ("Wire Wonder") the plier was the only tool used and the material was baling wire scraps. Figure 17, page 65 ("The Ostrich") has a welding rod for its legs and silver solder to hold the legs and body together. An acetylene torch was used to melt the silver solder (hard solder). Other joints have been joined with soft lead solder. This is an example in which soft solder was not strong enough for some of the joints required and a combination of solders became necessary. The basic structure is obviously brought out with a sense of design that is interesting and humorous.

Since the wire was purchased at an army surplus store for schools, the very small cost has provided the students opportunity to engage in a meaningful, enjoyable,

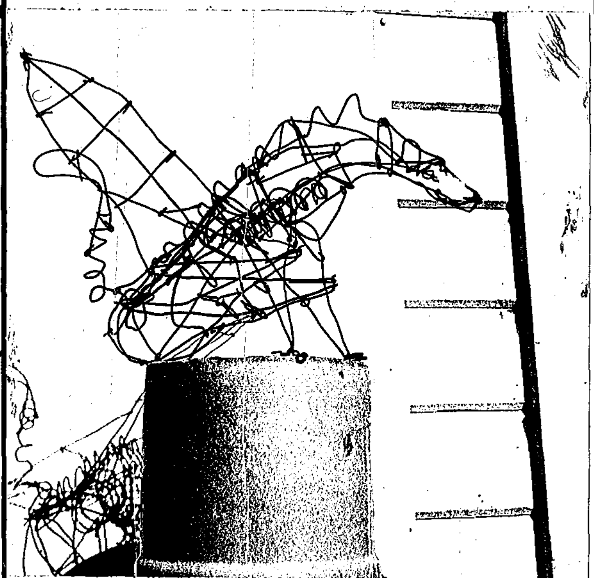

FIGURE 16

WIRE WONDER (BALING WIRE)

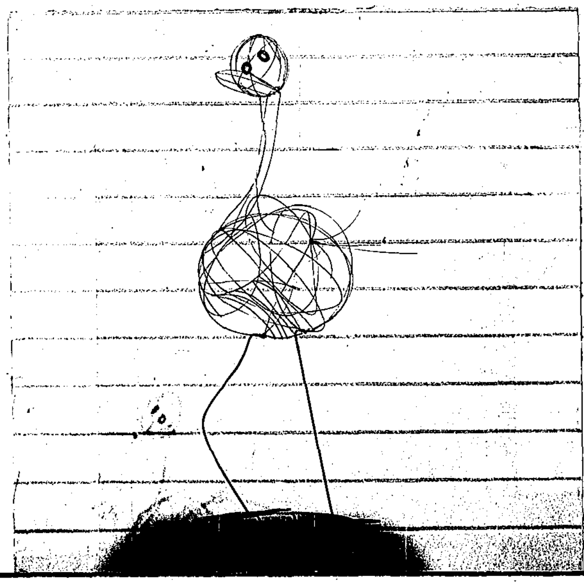

FIGURE 17

THE OSTRICH (STEEL WIRE AND IRON ROD)

creative, and informative experience. Mildred Whittaker[6] has experimented in the classroom with wire wall plaques for decorations. She has used coat hangers and although the designs are two dimensional, the work is backed by the understanding of the medium--its possibilities, limitations, and further applied uses.

To carry these experiments farther, Anna Pauk and Margaret Mitzit[7] have used crepe paper, construction paper, cloth, and yarn with wire sculpture. The project was introduced in the third grade. The possibility of correlating art with nature study is mentioned in this work. (In order to stay within the limits of our study, the examples used in this research will be mainly concerned with metal in order to minimize the distracting elements.)

Some of the more interesting work has been carried on at University High School, State University of Iowa. Frank Wachowiak and Doris Yordy[8] have developed problems using scrap metal. They have discovered these projects to

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[6]Mildred Whittaker, "Coat Hangers and High School Art," School Arts, 54:32-33, December, 1954.

[7]Anna E. Pauk and Margaret S. Mitzit, "Making Wire Birds," School Arts, 54:35-37, June, 1955.

[8]Frank Wachowiak and Doris Yordy, "Scrap Metal Sculpture," School Arts, 51:184-85, February, 1952.

be challenging and rewarding. Everyone in class achieved a new respect for materials and a realization that beauty can be found in ordinary things. Again, the limitations observable in their work were typical of the restricted sizes of the finished projects. The tool used was a soldering iron which has rather low heating capacity. If a welding outfit had been available, the creative aspects of the problem assigned would have been multiplied. Close-up photos have been taken to show the two methods. Figure 18 is a soldered joint. Solder could also be used to build up form but would be relatively expensive if used in this manner. Figure 19, page 69, and Figure 20, page 70, illustrate what welding and cutting will do. Note the characteristics of texture, form, and design.

Metal sculpture, if it is going to have its best three dimensional impact, should convey a largeness of spirit. It has a useful function in relation to architecture. Carroll Barnes[9] designed a wall of sculptural metal forms for the Jedediah Elementary School, Sacramento, California. This work, being related to architecture, illustrates the need for larger scale as well as three-dimensional form. At the University Elementary School,

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[9]Carroll Barnes, "Sculpture Can Be Used," School Arts, 53:9-12, April, 1954.

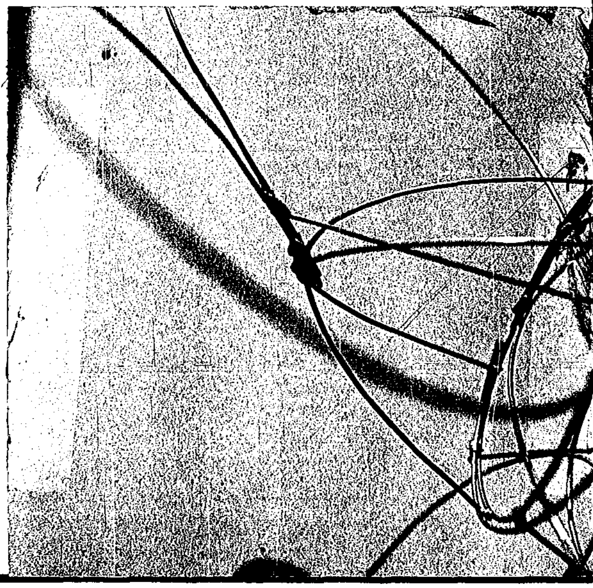

FIGURE 18

SOLDERED JOINT

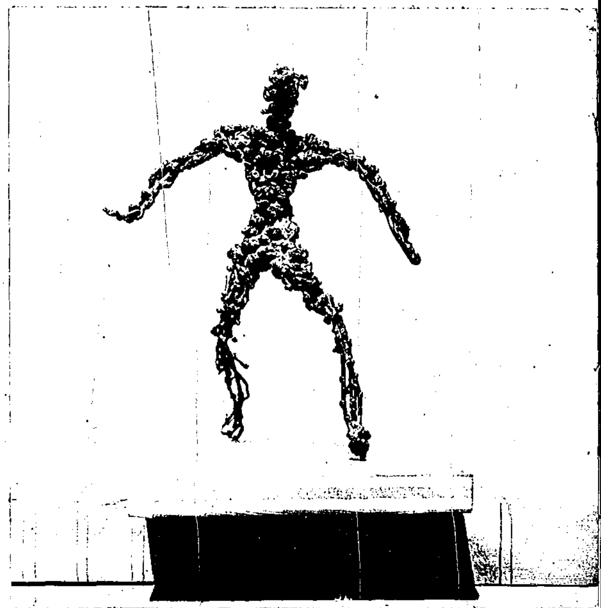

FIGURE 19

AFTER THE A BOMB

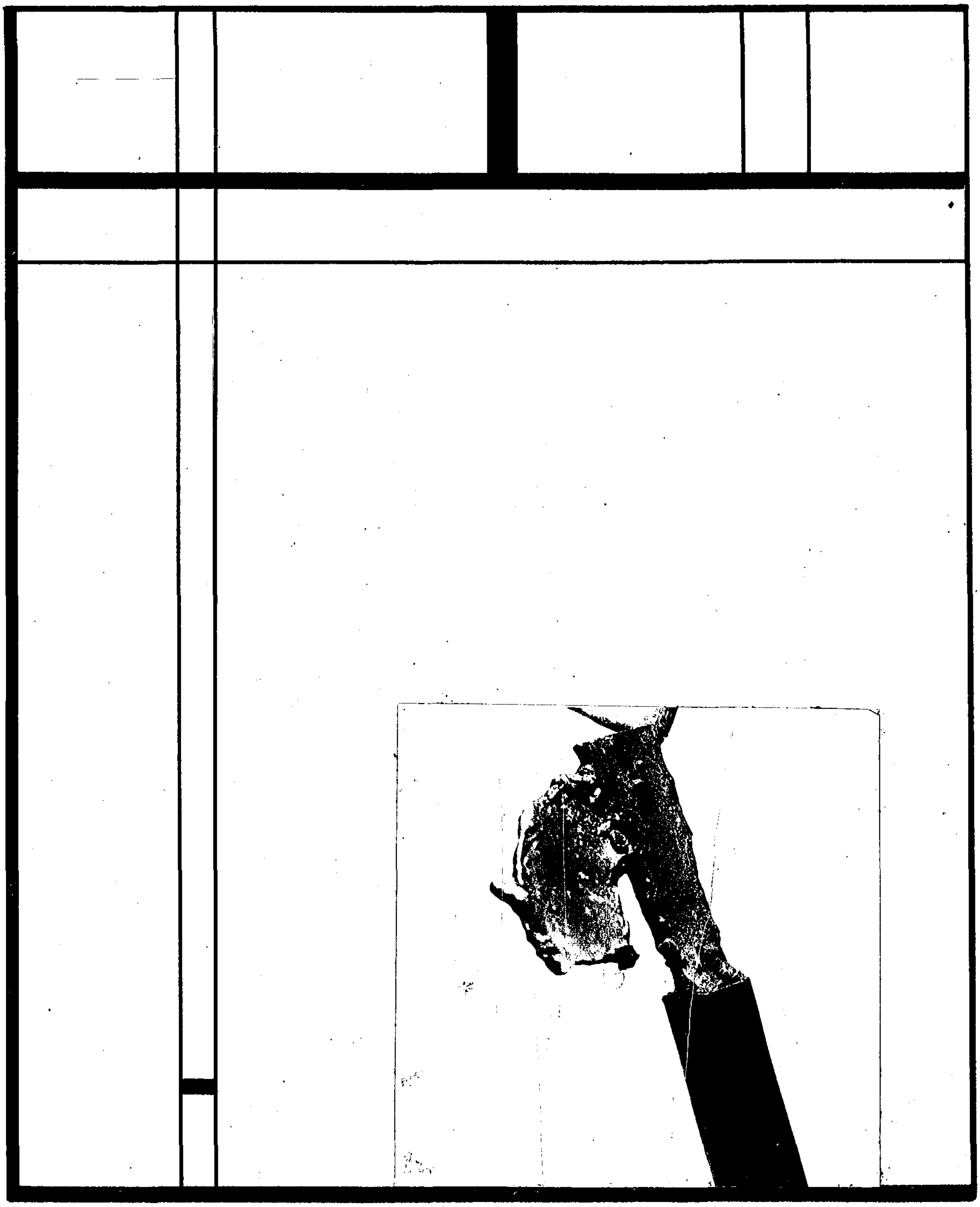

FIGURE 20

HEAD FROM PAUL REVERE'S LAST RIDE

U. C. L. A., Bernard Rosenthal's[10] bronze sculptures, "Animal Group" and "Fish Fountain," have been recently installed. The use of wrought metal as his medium is quite apparent. It is illuminating to find that the sculptors are collaborating with the architects. What is more important is that the projects are being introduced in elementary school buildings where the children will be more susceptible to this type of work and will grow up with it.

Figure 21 illustrates a project using scrap iron. The intention was to present a three-dimensional work with emphasis on line and form. This work could be used as a stabile or mobile in relation to architecture and landscape. (The mobile in Figure 22, page 73, is suspended and moves with air currents. It is a moving sculpture, and its effectiveness is determined by constantly changing spatial relationships. The stabile in Figure 21, also a sculpture, is mounted on a rod and is always stationary.) Schnier[11] emphasizes the fact that American architecture has been a potent factor in the development of American

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[10] Bernard Rosenthal, "Recent Bronze Sculptures," Arts and Architecture, 67:20-21, April, 1950.

[11] Jacques Schnier, Sculpture in Modern America (Berkeley: University of California Press, 1948), p. 13.

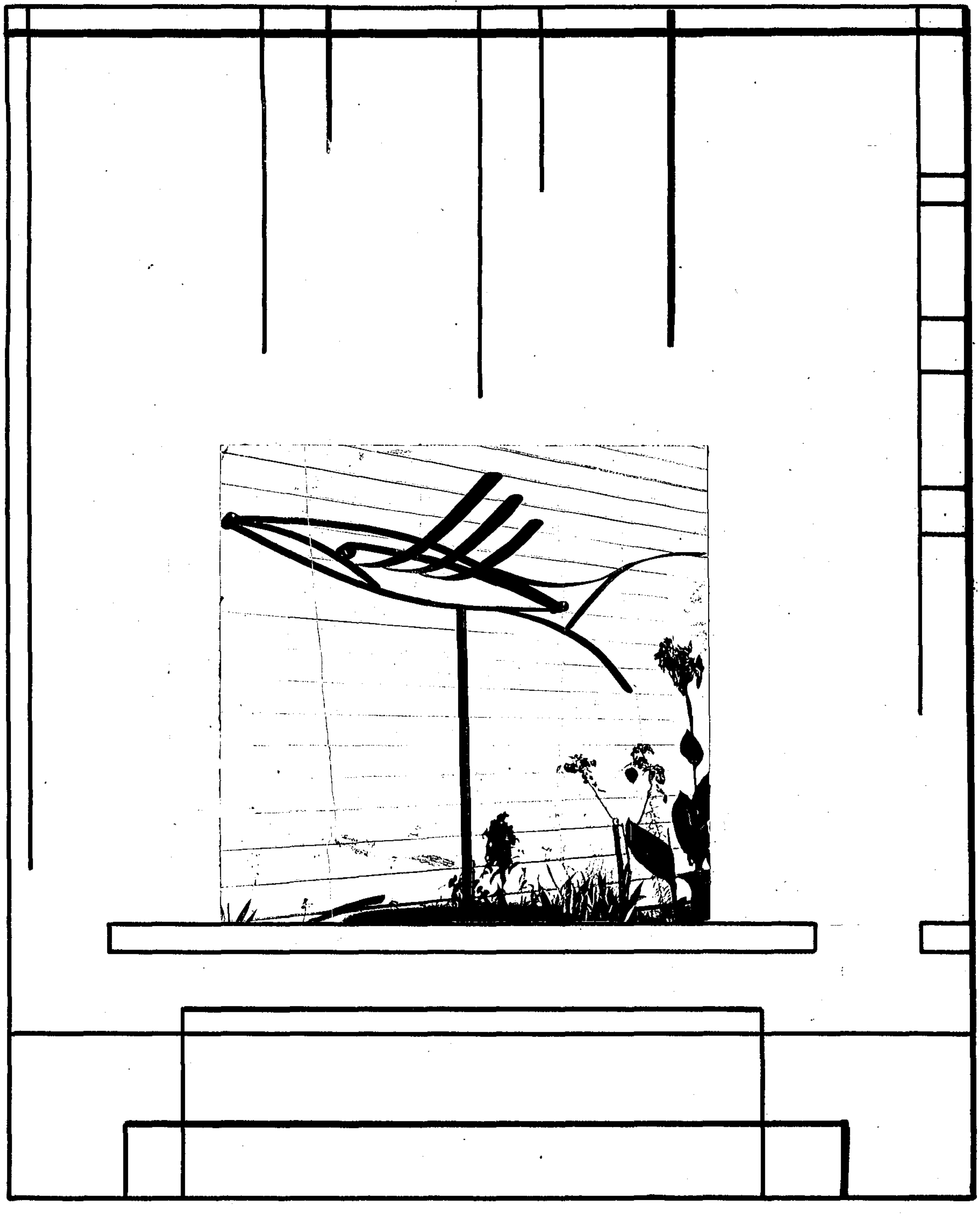

FIGURE 21

SPRINGS (STABILE)

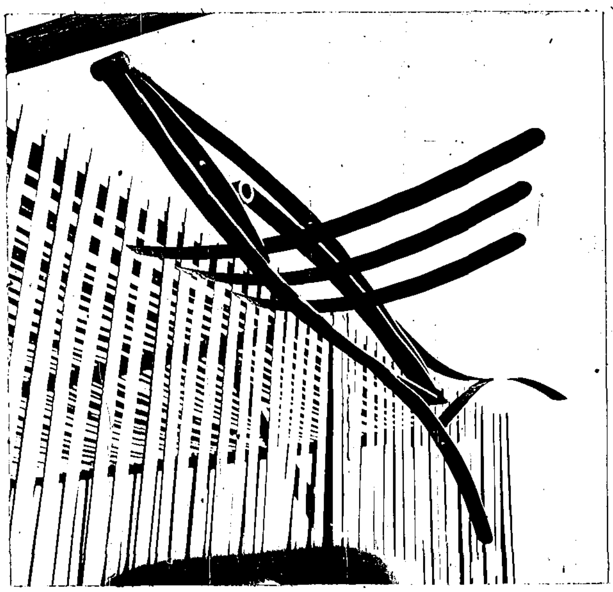

FIGURE 22

SPRINGS (MOBILE)

sculpture. The field of architectural sculpture has provided artists the widest opportunity for the application of their talents. Some contemporary buildings are being designed with sculptural enrichment as a part of the original plan.

Figure 23 ("Paul Revere's Last Ride") was at first a mass of welded iron on which the students were learning to weld. This freedom of working, being uncontrolled regarding form, resulted in a conglomeration of shapes. After evaluating this welded mass of iron for possible suggestions of imagery, areas were cut out (the analytical process) with the acetylene cutting torch. Then, to bring suggested form into clearer definition, pieces were added on (the synthetic process) with the electric welder. These procedures have educational merit and the results are exciting because they combine the rational with the imaginative approach to problem solving.

This project was entered in the Scholastic Art Exhibition in San Francisco where it received a certificate of merit. The award proved beneficial to the student's attitude because of his feelings of inferiority caused by poor grades in other classes. As a result of the recognition this individual also tried to achieve status by doing extra work during class and spent his study hall hours in

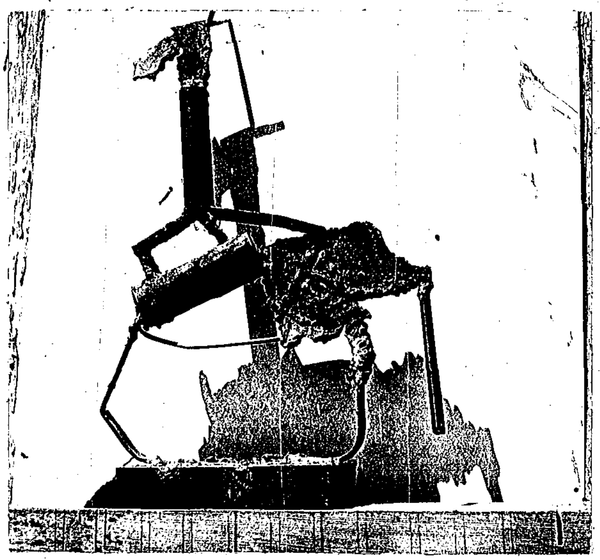

FIGURE 23

PAUL REVERE'S LAST RIDE (SCRAP IRON)

the art room. Admiration from classmates, feeling of success, and encouragement from teachers mean much to this type of student. The Commission on Secondary School Curriculum[12] states that the aim of art education in the secondary school is to further the growth of individuals in rich enjoyment and effectiveness and to encourage them to create a society where such living is possible for all.

In Figure 24 ("Wire Mobile") wire is used as the dynamic line for design. Since the joints are not fixed with solder or weld, the line movement of wire can be easily shifted to different positions. This type of project can be managed by anyone and still incorporate some views from Calder:

> Disparity in form, color, size, weight, motion is what makes a composition, and if this is allowed, then the number of elements can be very few. . . . Symmetry and order do not make a composition. It is the apparent accident to regularity which the artist actually controls by which he makes or mars a work.[13]

Cutting shapes out of tin cans for mobiles would be a type of metalcraft applicable to any grade level. Lightness in gauge and malleability of metal facilitates handling.

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[12]V. T. Thayer and others, Commission on Secondary School Curriculum, _Visual Arts in General Education_ (New York and London: D. Appleton Century Company, Inc., 1949), p. 166.

[13]James Johnson Sweeney, _Alexander Calder_ (New York: Simon and Schuster, 1951), p. 70.

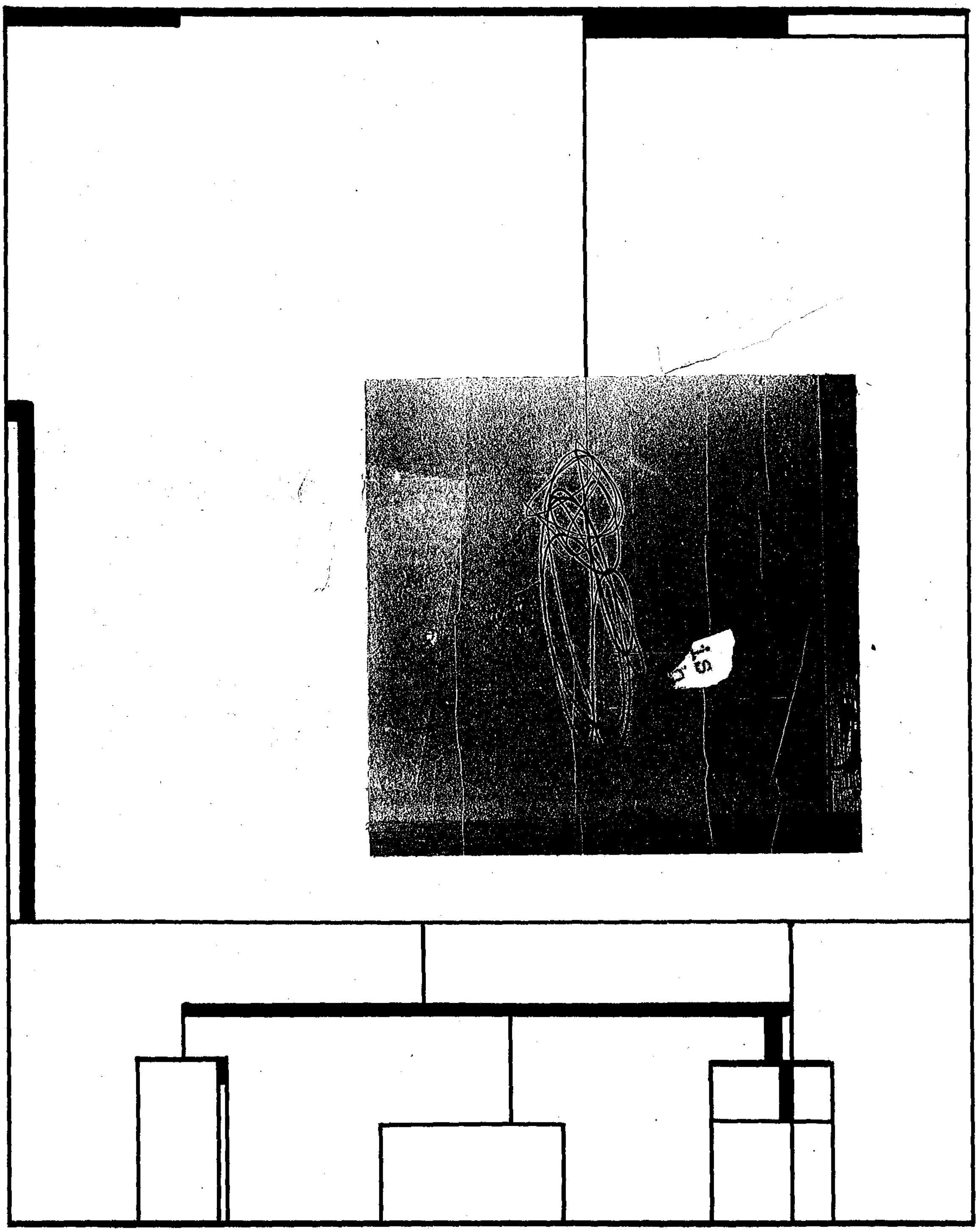

FIGURE 24

WIRE MOBILE (STEEL WIRE)

Many a veteran of World War II will remember how the commonplace tin can became a housekeeping necessity during combat days and how, later, during the spare moments of occupation-trooping and the long waits in repple deppels (replacement depots where troops awaited shipment home or new assignments) a bit of scrap metal or plastic form from a wrecked airplane was converted into some form of jewelry.[14]

In a classroom situation, Morton[15] writes on third-dimensional experiments with mobiles which offer invigorating creative experiences for the lower grades and become the nucleus of increased research toward design development for the upper levels. For the sake of increasing interest, the designer can project his interpretations infinitely beyond the realm of realism.

Mobiles can have utilitarian values. Some restaurants are placing menus on these moving objects in space. Eye-catching signs are being constructed with mobiles to aid in advertising. The need for this work is even greater

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[14] Eugenia C. Nowlin, "Crafts in the United States Army," School Arts, 51:75, November, 1951.

[15] Esther de Lemos Morton, "Nature Creates Mobiles," School Arts, 51:326-27, June, 1952.

when we know that man could view and appreciate the forms and colors about him. Ritchie states that however revolutionary our new experiences of space and time may be, we tend to sacrifice many visual experiences that are only possible at a leisurely pedestrian pace.[16]

In looking through the student work, it will be seen that in an attempt to find themselves the students' expression ran from realism to abstraction. Familiarity with materials shows that form and style are influenced by the limitations of the material used and the fullest expression can only be achieved by observing these limitations.

Psychologically, everyone responds differently to each material, and two-dimensional art work had not appealed to the student whose work appears in Figure 7, page 53. The wire medium was presented because it required a minimum of technical skill and allowed a maximum concentration on form. The results proved fascinating to the teacher as well as to the student. Students look forward to this type of work because it gives them a chance to explore some new materials and to use strange new tools.

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[16]Andrew Carnduff Ritchie, Sculpture of the Twentieth Century (New York: Simon and Schuster, 1953), p. 9.

They enjoy the physical stimulus of working with the material that intrigues as well as disciplines them. Viktor Lowenfeld has illustrated the stages of development of the child according to age groupings.[17] He states that the period of adolescence (thirteen to seventeen years age group) is an important period of decision in human development. The child's creative experiences are mainly connected with such subjective experiences as bodily feelings, muscle sensations, and touch impressions. Lowenfeld classifies individuals and their response-reactions to experience in two divisions. He calls the person who constantly responds to outside stimuli the <u>visual</u> type. Those others who focus all experience on the self, referring to the subjective feelings, muscle sensations, or kinesthetic experiences, he classifies as the <u>haptic</u> type.

If a case study was made of the student who did the work called "Wire Form" (Figure 7, page 53), without doubt it would be found that he was on the verge of neurosis. The cause for this may be due to the adolescent's unused energy and subconscious frustrations. The doing of this wire sculpture, seen as a means of expression, remedied his

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[17]Lowenfeld, <u>op</u>. <u>cit</u>., pp. 71-230.

aggressive impulses to a certain extent. It served as therapy, and some confidence in his creative power was restored. Being the haptic type, he has also benefited from the following experience. During the soldering process, he required assistance by others to hold the wire in its place. Working together with others and helping each other is very important. Classmates also become critical on how joints should be soldered and how more interesting forms could be developed. Fellow students became more respectful toward this problem-student's abilities, and the sense of belonging to the group lessened the arrogance and incorrigibility of this individual. His interest was so aroused that he brought his own tools and solder. This feeling of responsibility further helped him respect his tools and materials. He had never enjoyed himself or the work until this wire project was introduced. Perhaps there may have been some degree of maladjustment originating from the home. This student may have lacked sympathy, kindness, and attention from his parents, but his accomplishments in this type of work seem to have compensated his unbalanced life. Many teen-agers do not have the ideal home situation, and Luella Cole lists a desirable home for adolescent boys and girls as follows:

(1) it allows its children to grow up;
(2) it does not pass on its own maladjustments;
(3) it is willing to modify externals;
(4) it provides a haven of security at all times of stress;
(5) it keeps a harmonious balance among its members;
(6) it serves as a model;
(7) it is a stimulating and interesting place;
(8) it contains a complete family circle;[18]

The school is challenged with these problem-home situations and creative work has a distinct place in the curriculum.

The teacher must be aware of individual differences. Discipline based upon fear in a classroom situation is often useless to haptic types. Fear has an inhibiting effect for creative work, and adolescents need outlets for their emotional interest and for self-expression.

Herbert Read states that art is a profoundly significant factor in any psychological approach to the problems of human society.[19] The theories of Freud have not met with universal acceptance, but, though they may require drastic criticism and may still have to be amplified in many directions, there are no longer any serious grounds for questioning their relevance. (Freud's theory concludes that the purely formal or aesthetic elements in a

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[18] Luella Cole, Psychology of Adolescence (New York: Rinehart and Company, Inc., 1950), p. 30.

[19] Herbert Read, Art and Society (New York: Pantheon Books Inc., 1945), pp. 82-92.

work of art constitute a sort of pleasure-premium or preliminary seduction which, once it operates on our sensibilities, permits the liberation of a secondary and superior kind of enjoyment springing from much deeper psychic levels. "I believe," he says, "that the aesthetic pleasure produced in us by the creative artist has a preliminary character, and that the real enjoyment of a work of art is due to the ease it gives to certain psychic tensions.")

The results of Figure 10, page 57, Figure 25 ("Thin Man"), and Figure 26 ("The Bull"), page 85, are projects of the haptic type. The tactile sensations of the wire and the freedom of expression appealed to this very energetic and fun-loving student. This mania for working with this medium had become such a part of the person that any suggestion of a drawing assignment brought protest. This student was well adjusted although nick-named "Tank" for his fatness. (The investigator, in frequent visits to his home, observed that he was treated in a normal and healthful manner in this well-to-do family. His physical appearance was probably compensated for by this ideal home environment.) Sorenson concludes that factors in a personal adjustment are mental ability, physical traits and

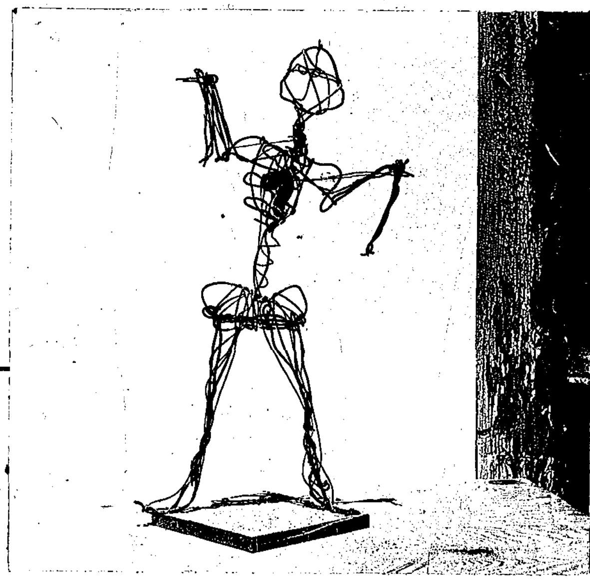

FIGURE 25

THIN MAN (BALING WIRE)

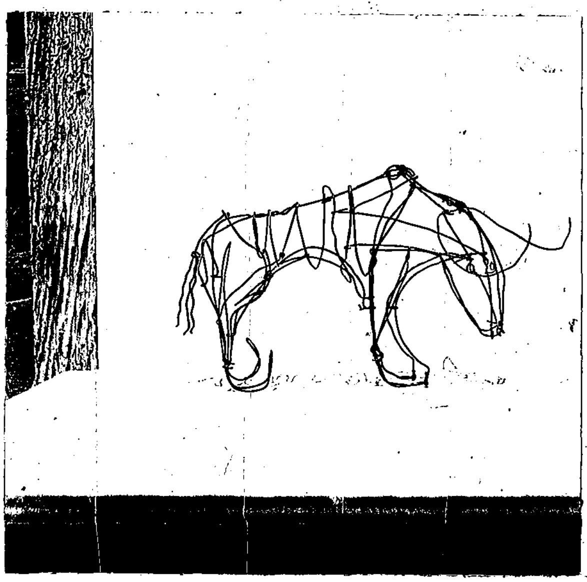

FIGURE 26

THE BULL (BALING WIRE)

handicaps, and the social and economic status of the child.[20]

An experiment was attempted with a girl student. A very springy wire was presented with which to do a non-objective problem, or an abstraction of a human figure, a bird, or an animal. The springiness of the material was a discouragement and a more pliable wire had to be introduced. Since she was so much the visual type, as evidenced by her work in two dimensions, this extreme experiment for the haptic types was questionable. In this case it proved to be detrimental because the girl developed an ill-feeling toward any wire. Thayer and others have stated that adolescence is the period of greatest change during the young person's school years. Flux, ambivalence, instability enter into all aspects of his life--physical, intellectual, and emotional. Indeed, the most fixed characteristics of the period are its lack of fixity, its fluidity, and the insecurity resulting.[21]

Figure 27 ("The Texan") is an adolescent's approach in translating a rider and horse into wire. It is an example of the spontaneous art effort of children. The

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[20]Herbert Sorenson, Psychology in Education (New York: McGraw-Hill Book Company, Inc., 1948), p. 145.

[21]Thayer and others, op. cit., p. 22.

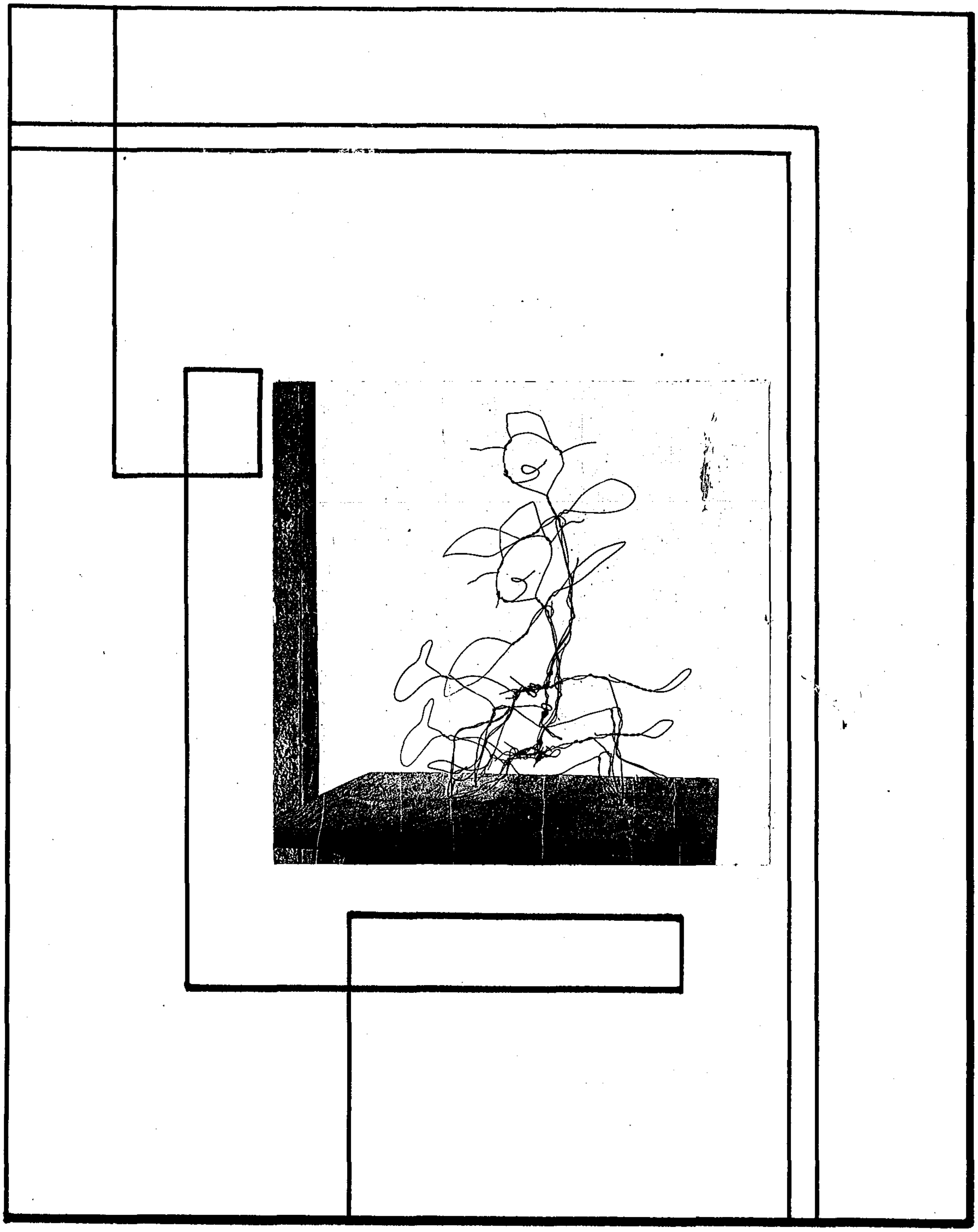

FIGURE 27

THE TEXAN (COPPER WIRE)

approach is directed toward simplification, generalization, and abstraction. Much pleasure was derived from this work, for the soft copper wire conformed with the student's desire for expression and the project was automatically constructed by imagination.

According to Schnier, this type of work is not always art.[22] Children and savages usually begin and end with mere random scrawlings or disorganized jumbles of blurred shapes. It is a long way from these to the sophisticated, well-integrated organizations of modern sculpture. It would be illusory to hope that merely recapturing the naivete and freedom of childhood, or that of the savage state, could produce work as excellent in quality as that of recognized contemporary sculptors, but there is an essential continuity between the spontaneous art of a native artist or gifted child and that of a modern, nonrealistic sculptor. By contrast both the native and the nonrealistic sculptor are working along similar lines: the selection of significant visible qualities, their recombination into a generalized nonrealistic (though not necessarily nonrepresentational) form, and the generation of the aesthetic pleasure that accompanies

[22]Schnier, op. cit., p. 47.

such a process.[23]

Lowenfeld gives his interpretation of a work of art:

> It is a product of human spirit, thinking, and emotions, and can be only understood when the driving forces which lead to its creation are understood. These driving forces are of essential significance and everything else is only a by-product. If these driving forces are lacking, not even the most developed skills can ever replace them. That is why the works of the Primitives can be great works of art, while most skillfully executed works are not necessarily works of art if they lack of the driving forces, the inner spirit that determines the greatness of an art work. They are like beautiful wrappers around nothing.[24]

In Figure 28 ("Acrobats"), the forms are simple in their construction. The stick figures are almost representative of the hieroglyphic art of the primitives. Although some adolescents are bothered by this childish interpretation, the creator of "Acrobats" enjoyed the work. (From ages eleven to fourteen is a stage of development in which the child becomes disillusioned and discouraged because his efforts to reproduce objects are now laborious and slow.)[25] By the stiffness of the wire, the student recognized the fact that to get the maximum out of this medium, the project would have to be kept simple. Henry

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[23] Ibid.

[24] Lowenfeld, op. cit., p. 256.

[25] Herbert Read, Education Through Art (New York: Pantheon Books, 1945), 320 pp.

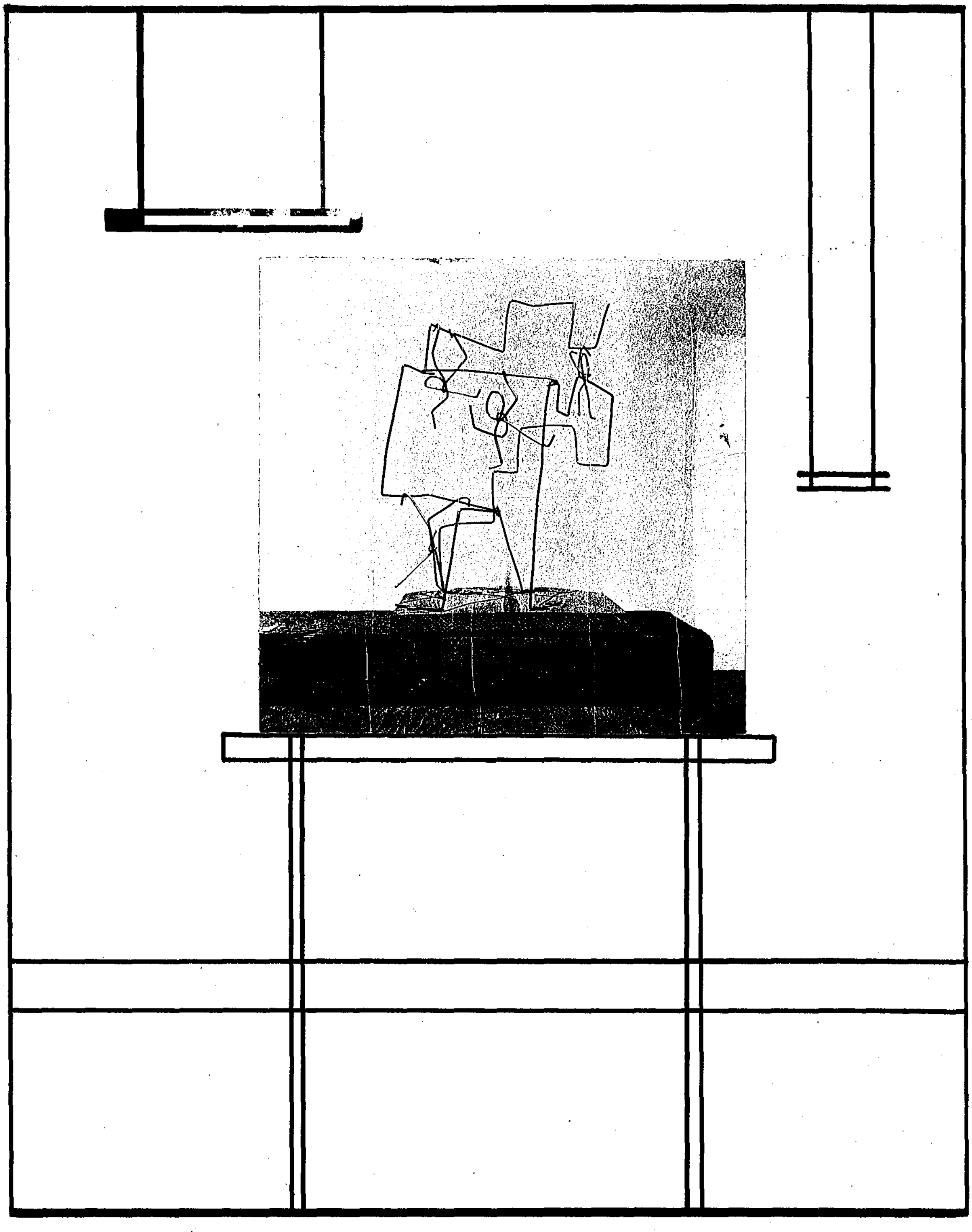

FIGURE 28

ACROBATS (STEEL WIRE)

Grigson, in quoting Henry Moore writes,

> The most striking quality common to all primitive art is its intense vitality. It is something made by people with a direct and immediate response to life.[26]

Sweeney follows up with this statement,

> Sculpture for the primitive people was not an activity of calculation or academicism, but a channel for expressing powerful beliefs, hopes, and fears. All art, he came to feel, has its roots in the primitives . . .[27]

Some of the sculptures of Monroe[28] are assembled with metal rods. They are amusing, inventive, and simple in construction. It is the type of work that would motivate adolescents for it conveys a playful imagination similar to some of Calder's work.

From the teacher's personal experience, it was found among students, other teachers, parents, and community, that some of the foregoing projects and exercises which are not understood are inclined to be ridiculed, but are

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[26] Henry Grigson, _Henry Moore_ (England: Penguin Books Limited, Harmondsworth, Middlesex, 1944), p. 8.

[27] James Johnson Sweeney, _Henry Moore_ (New York: Simon and Schuster, 1946), p. 15.

[28] Keith Monroe, "Sculpture, Furniture," _Arts and Architecture_, 69:16-17, September, 1952.

praised when they are understood. Kainz and Riley[29] suggest that judgment should be reserved about art work that is not understood or things that an artist has created solely for his personal satisfaction until we have a background and understanding with which to accept or to reject them.

The project of Figure 17 ("The Ostrich," page 65) was undertaken by an anti-social or introvert type. Since he needed assistance, working alongside someone else improved his behavior in the group, for now he appreciated his fellows for their cooperative participation in his work. His interest in the work and in the process of creating, is evidence of the pleasure he derived from "The Ostrich." "The soul is made up of opposites," remarked Florence Cane, "one is active, expressive; the other is receptive, dreamy, inward; and each must play its part."[30]

Group stimulus can do much for art education. The body of "The Ostrich" was a mobile at one time. The student was proud of this work but after watching the

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[29]Luise C. Kainz and Olive L. Riley, Exploring Art (New York: Harcourt, Brace and Company, 1947), p. 8.

[30]Florence Cane, "Possibilities of Integration Through Art," Art Education Today (New York: Bureau of Publications of Teachers College, Columbia University, 1937), p. 39.

projects of others, he converted this mobile into a part for the body of the bird.

The first effort in trying the metal sculpture (Figure 23, page 75) was more successful than the second (Figure 29, "Whoa"). The former was received in such a humorous manner by the students that the latter, being influenced by the first one, was worked out on a similar idea but lacks the freedom and freshness of the first. Nevertheless, this type of work has promoted more interest, comment, and criticism among the students than any of the two dimensional work.

Typical questions are, "What is it?" "Is that art?" An inquisitive attitude of this nature should mean more than looking at a portrait painting and saying, "Oh, it looks just like her!" The portrait may have illustrated one's ability in craftsmanship and has a place in art but often lacks the creative aspects.

> "The primary business of art education," as Mursell states, "is to render human beings sensitive to the aesthetic values resident in all the activities of life; to lead them to appreciate and appraise such values when they are present, to demand them when they are absent, and to take initiative in procuring and creating them."[31]

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[31] James L. Mursell, "Some Generalizations Concerning Art Education," Art Education Today (New York: Bureau of Publications of Teachers College, Columbia University, 1937), p. 2.

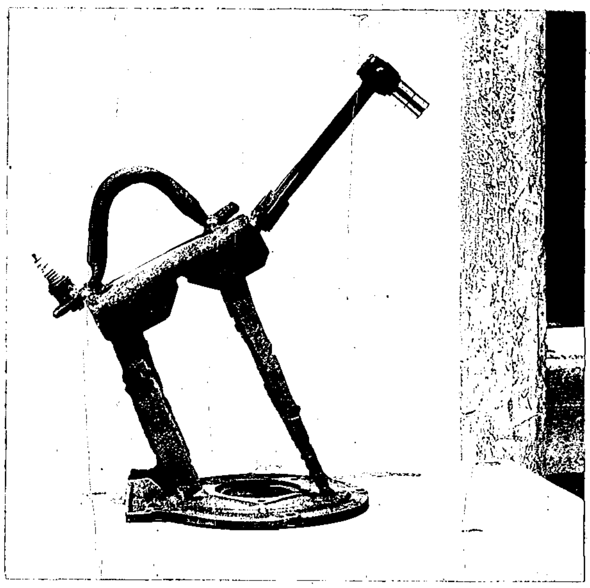

FIGURE 29

WHOA (SCRAP IRON)

One student was so enthusiastic about this wire work that he decided to invest in a trigger type soldering iron for himself. His sample work is Figure 30 ("Contemporary Pest"). This student was inconvenienced by the shortage of soldering irons at the time and had to have someone else solder the joints. This interruption, making a delay necessary, had not appealed to him, so he determined to purchase a soldering iron. The incident illustrates how the energetic adolescent, once he begins, likes to keep working without having to break the trend of his thinking. As these drives develop, the resulting tension has to be released in some kind of reaction. Figure 11, page 58, which he called the "Discus Thrower," represents a desire to relate and interpret a form in his own way.

In reference to these types of outlets with mental hygiene, Zachry[32] comments on the importance of students using art to work out their dilemma in a highly competitive and neurotic society. It must also be broadened to include all individuals and all media of expression.

Imagination has no bounds. In Figure 31, page 97, "Feathered Friend," scraps of metal were organized in such

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[32]Caroline B. Zachry, "The Role of Mental Hygiene in the Arts," Art Education Today (New York: Bureau of Publications of Teachers College, Columbia University, 1937), p. 36.

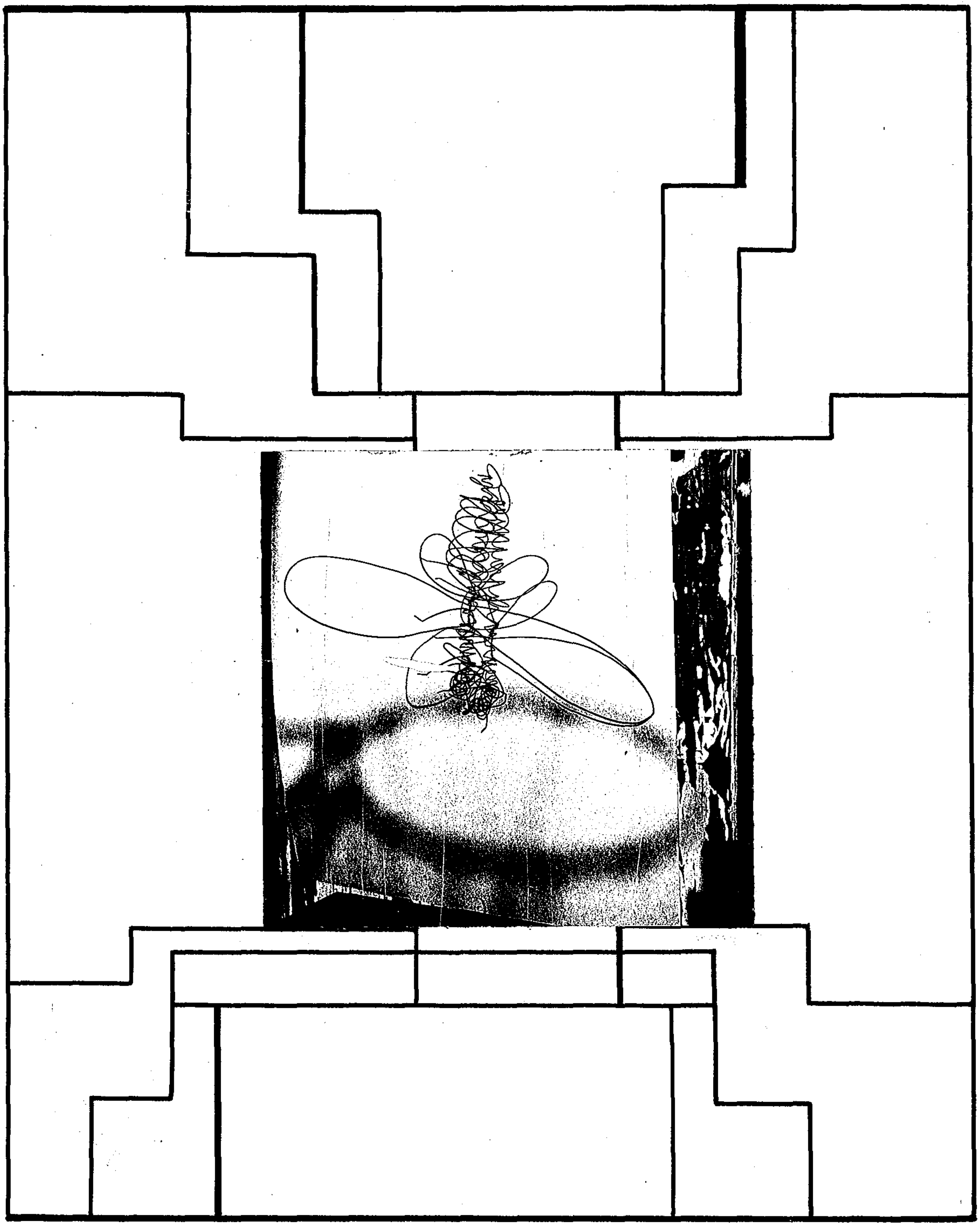

FIGURE 30

CONTEMPORARY PEST '(COPPER WIRE)

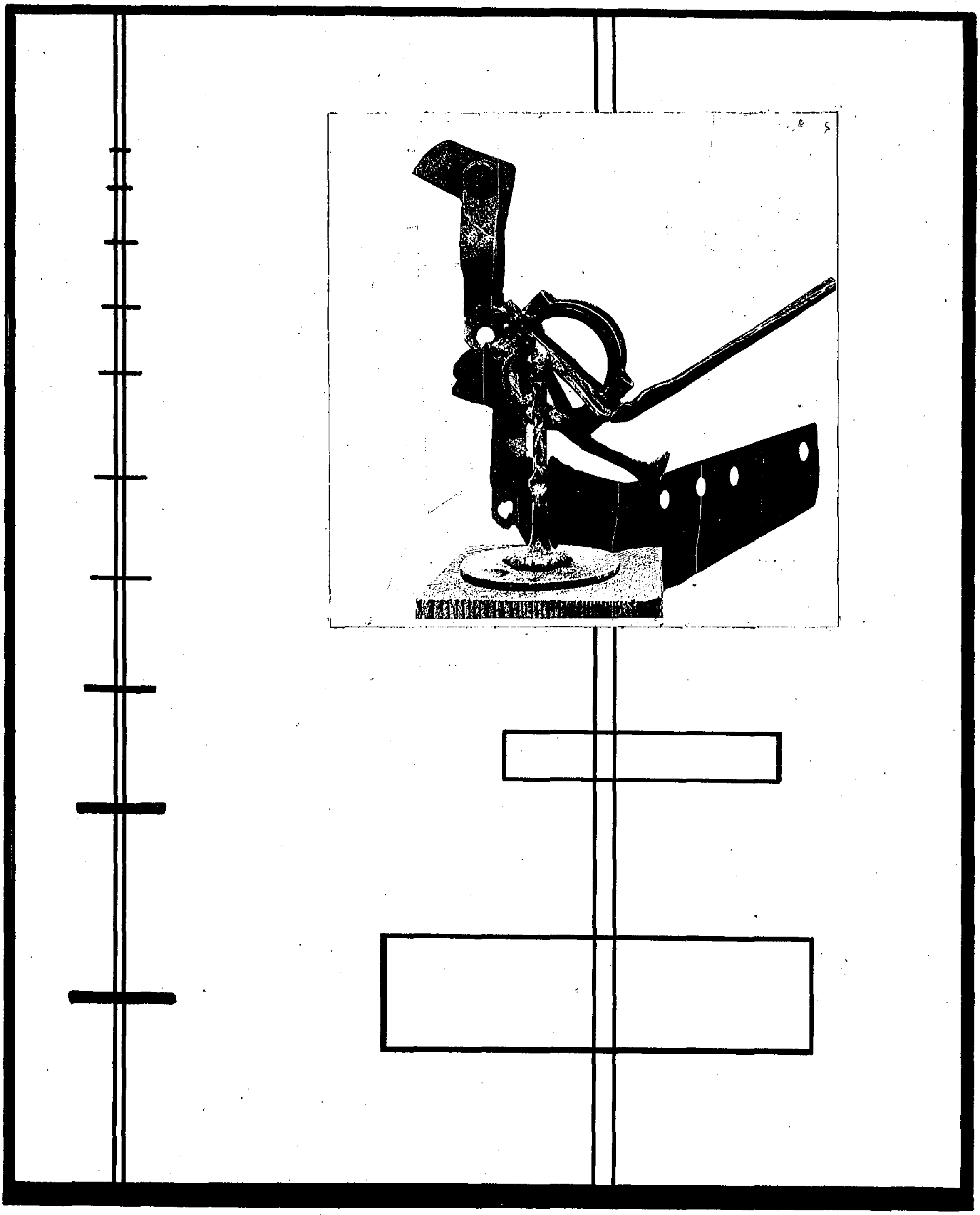

FIGURE 31

FEATHERED FRIEND (SCRAP IRON)

a way that humor became an integral part of the project. Since scrap materials were employed, and the student learned the welding process in this work, the approach appears to be a sound one. Although the tools are modern, the student has not lost sight of the native qualities inherent in his materials. His work is honest and sincere, with interest and motu propri (of one's own impulses). No doubt there are imperfections in the finished product but this aspect should be considered as secondary; the growth of the individual is more important. The development of skill should be considered a part of this experience. Techniques must be introduced for the purpose of arousing free expression.

Malraux has said, "The art of childhood dies with childhood."[33] We can only hope to keep the spirit of childhood alive for our aim is not a sterile society.

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[33]Andre Malraux, The Voices of Silence (New York: Doubleday and Company, Inc., 1953), p. 285.

CHAPTER VI

SUMMARY AND CONCLUSIONS

I. SUMMARY

Creative production is only one phase of the art program. Art education must also make the public aware of its values for life. It is not limited to formal teaching and practices of art in the elementary, secondary, or college levels, which we agree is important, but must be a force for continuation of awareness of and practice in the arts long after formal schooling has ended.

Creative experience requires materials, media, and tools that have to be understood as to their possibilities and limitations and the processes by which they are transformed into art objects. These instruments should fit the individuals, whatever their age group, and be at their command for the expression of ideas.

Creative teaching should be adapted to the changing needs, capacities, and interests of growing individuals, because these individuals progress through schematic stages in their art development.

II. CONCLUSIONS

It may be well to mention that there is a basic knowledge of the subject of mechanics of materials or resistance of materials which may be incorporated in this type of study; also, this elementary knowledge changes with the development of new methods and materials resulting from applications to new needs. We should be looking forward to these particular properties of metal such as light weight aluminum and magnesium for mobiles and sculptures, where strength-weight ratios can be calculated to get the maximum out of the materials.

Although many significant contributions are being made to the field of art education, any original type of study should be added to the list. The world itself is in need of truth, beauty, and goodness. Material values over-shadow the spiritual values as a result of rapid industrialization, mechanization, and specialization. As Frank Lloyd Wright states,

> The artificiality of our mechanized society is helplessly drifting toward a bureaucracy so top-heavy that the bureaucracy of Soviet Russia will seem honest and innocent by comparison.[1]

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[1]Frank Lloyd Wright, Genius and Mobocracy (New York: Duell, Sloan and Pearce, 1949), p. 18.

In order to help design a master plan for art education, materials and methods as well as facilities should be thoroughly studied. To counterbalance the ever-increasing tempo of modern living, art education will have to act as a healthy means of escape and profitable relaxation from the terrific mental, emotional, and physical strain of daily living.

There are obstacles, of course, with which we must deal. For example, from the kindergarten level up, many schools do not have proper facilities, equipment, and working conditions. Administrators and architects should realize that workshops are cheaper to build for art education than permanent, inflexible, overly institutionalized classrooms. The practicability of a multi-purpose workshop is what will serve our educational aims. The older schoolrooms will have to be redesigned to fit the needs of individuals and the objectives of teaching.

Keeping traditional classrooms in an orderly, shining state may be good for school board visits, but productive and creative work is often hamstrung under such disciplined "janitorizing."

In the upper levels (the high school), there is the possibility of coordinating the art program with that of the shops. Some shop teachers will be cooperative and

others may not be so helpful. Utilizing the shops is an ideal solution because there is so much scrap material thrown away. Some of the fortunate students may find access to equipment in machine shops and garages.

With a limited range of materials, tools, and workroom, we cannot expect the best operation of such a program as has been outlined. Many otherwise alert teachers are overlooking this fact and need only become aware of the potentialities inherent in the foregoing suggestions to become even more effective in the work they do with the students under their guidance.

"If we refuse to use our minds, to develop our senses and perceptions, they will gradually atrophy and disappear."[2]

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[2]Andrew Carnduff Ritchie, Sculpture of the Twentieth Century (New York: Simon and Schuster, 1943), p. 7.

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