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This facility planning guide was developed by a commercial firm for use by school personnel in planning and equiping industrial education shops. It is based on an analysis of reports made by the company's 150 field representatives and information furnished by school administrators and architects. Five fundamental planning concepts and a cycle of human influences serve to organize the contents. Briefly, these are (1) community goals, (2) educational specifications, (3) course outlines, (4) physical considerations, and (5) equipment specifications and (1) instructor recommendations, (2) administrator acceptance, (3) architect interpretation, (4) state department consultation, (5) manufacturer response, (6) school board approval, and (7) student inducement. The contents include: (1) List of Considerations, (2) Layout Development, (3) Sample Plans, (4) Equipment Specification, (5) Purchasing Principles and Costs, (6) Scale Outline of Equipment, (7) Bolt Hole Dimensions, and (8) A Source Checklist. (EM)

SCHOOL SHOP DEVELOPMENT:

Research and Planning

$2.00

Rockwell
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FOREWORD

Rockwell Manufacturing Company has given serious thought to the overall problems of school shop and laboratory planning. They realize that the combined thinking of school men who daily face this difficulty is the most valid source for up-to-date planning information. These men are constantly confronted with an ever increasing student body, both school age and adult, plus facilities that are being increasingly overtaxed to meet today's modern educational needs. Based on this analysis, Rockwell has prepared this publication as a contribution in helping to solve these problems.

First, the reports of more than 150 Rockwell field representatives were carefully studied and, in many cases, additional information requested. Second, many school men throughout the United States, from the teaching to the School Administrator level, were contacted. This book includes the thinking of these people, plus the combined opinions of various architects specifically involved in school planning and development.

Every concept presented in this guide is not appilcable to each situation; however, we have attempted to summarize the best thinking of those individuals concerned with modern day school laboratory and shop development.

CONTENTS

OVERALL PLANNING INFORMATION

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Those individuals presently concerned with the proper education of both students and adults are confronted with the most tremendous growth and support that education has ever seen. There are many reasons for this, including the rapid advancement of modern technology, the heavy increase in population, new state requirements concerning Industrial Education (Industrial Arts and Vocational Industrial Education) in the secondary school, the consolidation of school districts and the tremendous Federal programs which are designed to help both general and industrial education at every level. Because these development are radically different, there is really no past history or accumulation of statistics which can adequately predict the future, or provide the proper guidance, that will insure well planned, modern and meaningful industrial education for tomorrow.

In general, we might say there are two basic approaches to industrial education planning or shop planning. One would be traditional and the other, more modern, attempting to incorporate to the best of the planner's ability the needs of the foreseeable future. Tradition might indicate that the planner would review past history and past actual plans, duplicating these plans for use in his present educational system. A more modern approach would be to thoroughly research the needs of the community and write the Industrial Arts or Vocational Industrial Education specifications to match these needs. It would follow then that the physical shop plan or laboratory layout and the equipment would be planned, specified and purchased to put the educational needs and desires into effect.

Layout development and planning is a very personal thing from either a teacher or community standpoint. Inside the bracket of "meeting the educational specifications," there is much room for differences of opinion with no real right or wrong being involved. No two architects or educators would plan a shop or laboratory in exactly the same manner, even though they were given the same initial information. Regardless, there is a list of general premises which they would all adhere to, and by the same token a list of common errors which none would make. There are always many local or area requirements, also various limitations which might greatly change the physical configuration. These might have to do with the community's needs, the space involved, the money available, and even personal opinion. It is obvious that an effective program can result only from a coordinated, well planned effort.

Many schools do not achieve their desired objectives because of a primary deficiency... not knowing the sequence of steps to follow when planning a new facility.

Instructor—Recommendations
Curricula, preference, today's concept of the specific objectives.

School Administrator—Acceptance
Coordinates overall curriculum objectives coinciding with today's educational thinking, regional and industrial needs prevailing.

Architect—Interpretation
Layout to be incorporated into overall building plan and readily translated into brick and mortar. Coordinates with State Department of Education.

State Department—Consultation
State fund reimbursement, architectural, legal and educational requirements.

Manufacturer—Response
Sensitive to plan requirements and assures availability of necessary equipment to fulfill intention of plan.

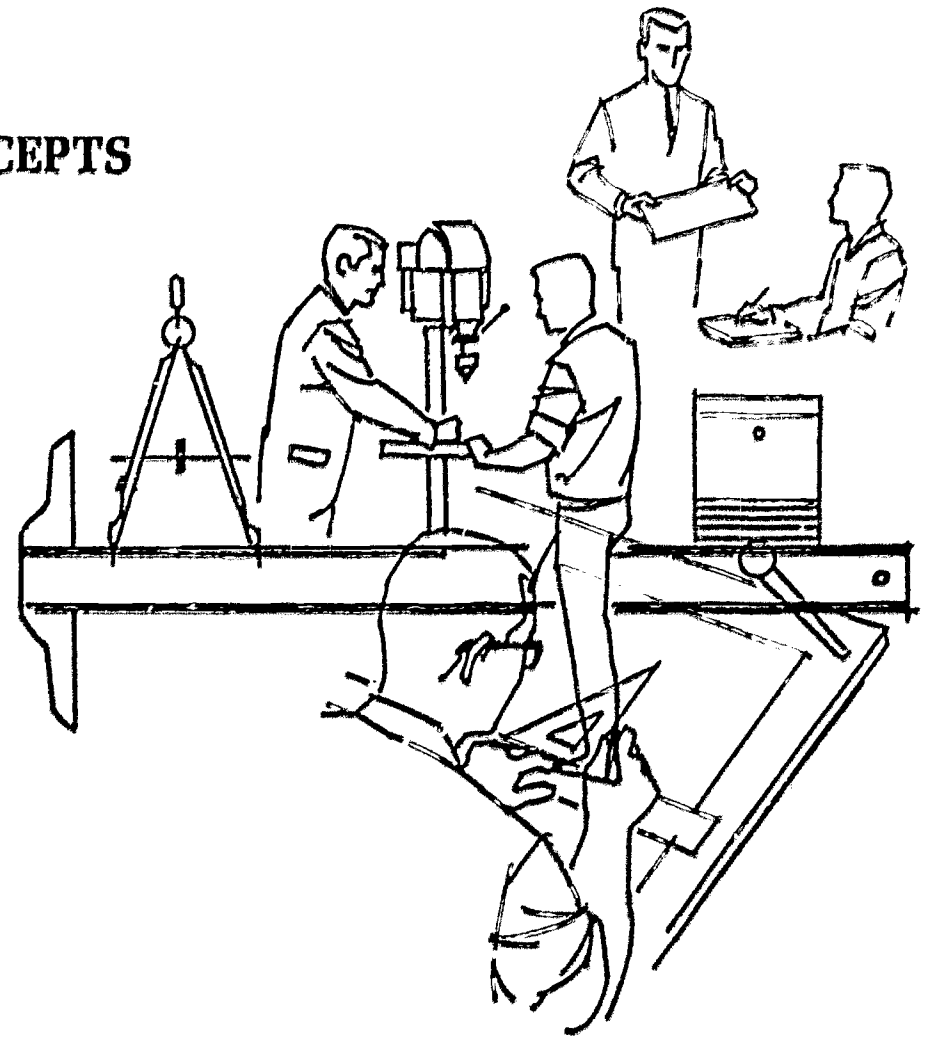
School Board—Approval
Integrates with overall school objectives, community needs prevailing. Provide fiscal direction.

Student—Inducement
Plan must encourage him to extend himself to fulfill the shop's purpose.

EVOLUTIONAL STEPS AND "HUMAN" INFLUENCES ON SHOP PLANNING

As a result of this cooperation by the planners, many views are generated which helps determine how and if objectives can be met.

FIVE FUNDAMENTAL PLANNING CONCEPTS



1. The plan should be one that can be readily correlated with today's educational thinking and meet the community's industrial and educational needs.

2. The physical arrangement and the equipment, as indicated by the curriculum, must be one readily integrated with the overall educational goals established for the total school.

3. The layout should be designed in accordance with a modern concept of Industrial Arts and Vocational Industrial Education. A modern planning approach concerned with basics such as safety and flow of material and personnel is essential.

4. The physical arrangement and design should be such that an architect can readily incorporate it in an overall building plan and interpret it in terms of brick and mortar.

5. The plan must be one that will encourage both the instructor and the student to extend themselves in fulfilling the purpose for which the laboratory or shop was designed.

Educational Specifications are, without a doubt, the most important part of school planning. Without them, the entire educational system would expand or develop with no "Constitution and Bylaws" to fall back on. By the time this situation comes to light, it is often too costly or impossible to correct.

This is most noticeable where "Capital equipment" is involved. Brick and steel in the building itself are rather permanent in nature and should be designed to match the needs and desires set down in the Educational Specifications. Many academic departments can change their methods of teaching or update their programs rather easily at a later date with only a change of text books and teaching plans. Industrial Education, regardless of the type, falls into the "difficult to change" class due to the capital equipment and costs involved. This makes intelligent planning vital the first year and for possible expansion or changes in the years to come. Once the "tools" and equipment are purchased, put in place and in operation, the die is pretty well cast for the immediate and often long term future. Various mechanical considerations such as air, water and electrical outlets, dust collection, ventilation, lighting, storage, flow of materials and safety are now either a reality or are non-existent.

Specific locations of equipment in the shop or laboratory are often considered the major or only job in "shop planning." Actually, this is not true. Possibly, the placement of equipment is the most easily solved problem, if the educational objectives were properly planned and stated in the beginning. The following is a sample outline of what should be known or done for good planning:

1. Desires and goals of the community in relation to education. This could concern the specific school district, the area, the state, or even our country.

2. Educational Specifications for the school in question for all departments — academic and also extra-curricular.

3. Course outlines for the various areas of the Industrial Education Department. This should include the goals and the specifics of what is to be taught and how it is to be taught.

4. Physical plans for the building, indicating the area for Industrial Education and the "unchangeable" mechanical or architectural considerations.

5. Equipment specifications based on the over-

all educational desires of the community and the school district.

6. Physical "shop planning" or layout of laboratory equipment, including all electrical and mechanical considerations, etc., to insure the best and safest teaching conditions.

Too often, the general approach to this question is almost in complete reverse. This forces the instructor to design his course outline to match the equipment and layout. It also forces the department head to match his entire educational program to existing mechanical errors, inadequate equipment, poor physical arrangement or, even more important, the wrong size, type or kind of equipment.

Aside from the overall considerations, many pieces of detailed information should be known or assumed before the actual physical planning begins, for instance:

A. General information concerning the type of community, the type of industry in the area, the interests of the population and how these can be coordinated with the educational specifications of both the school and industrial education department. What percent of the graduates go to college and what percent will be looking for jobs? Is the industrial education course of study, project or technically oriented? It is taken for granted that the specific type of school would be known. Present class size and any future increase in class size is, of course, necessary information.

B. An important consideration is the amount of money available for the industrial education department. It would be a waste of professional talent and time to design a shop or laboratory which the budget would not support.

C. The personal opinions of the school administrators whether they be school board members, the superintendent of schools, the director of industrial education or the teachers involved are very important and have a direct bearing on the details in planning a shop.

D. The major physical information should be obtained from the architect, if the plans are not already underway, or should be suggested to the architect in the first place, if at all possible. It is necessary to know or assume all of the details of the floor plans, the position of doors, the type and height of windows, which doors open into the hallway and which outside, the specific measurements of the entire area including inside and outside walls, possible electric distribution and type, location and type of lighting, possible water or air outlets, and elevation plans, if possible, to indicate ceiling height, etc.

Regardless of other considerations, it is absolutely necessary that the community's desires, the education specifications and the amount of money available be known before any physical planning begins.

After the assembly of the detailed information, it is now possible to begin an intelligent job of the physical planning or layout.

Normal order of progression from concept to reality:

1. Community Needs
2. Educational Objectives of the Total School or School System
3. Industrial Education Objectives
4. Layout Development and Building
5. Equipment Specifications
6. Purchasing and Installing
7. Teaching

LIST OF
CONSIDERATIONS

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SAFETY:

Safety should be given first consideration in shop and laboratory planning. It is strongly desirable that all portions of the area be clearly visible to the instructor. Therefore, interior room partitions should be half glass.

Where a hazard exists around machines, the machines should be so placed that students are not in the line of danger. Added protection is given by enclosing these machines in a safety zone painted on the floor.

Wide aisles of travel should be provided between benches, machines, and in areas in front of tool panels and storage lockers. Special safe space should be allotted to areas where molten metal, welding, heat treating, etc. are handled.

Aisles of travel may be designated by painted lines similar to those used in industry. These aisles should be a minimum of 3 to 4 feet in width.

Non-skid surfaces such as Ferrox or sand on shellac should be applied to the floor at machines to minimize danger of slipping. Moisture absorbing material should be regularly stocked for use on oily or wet areas.

Open floor space maintained at entrances and exits prevents congestion.

The word "safety" regarding machinery should actually go far beyond the general concept of providing guards over belts and pulleys and the conventional hood over revolving blades. It should begin with the original design of the machine whether it be a stationary or portable unit. Safety, through proper design, should include not only the normal mechanical and electrical aspects but also take into consideration the inexperience and "investigating" nature of student operators.

Tools and supplies should be located as near to work areas as practical to reduce travel and interference.

Placement of machines with regard to sequence or association of operations is necessary particularly with the circular saw and jointer; spinning lathe and buffing machine; forge and anvil; cut-off saw and lumber rack; power hack saw and metal storage rack.

Machines should be placed to allow for ease of cleaning around the base. Cabinets should fit flush to walls or be trimmed to fit flush for the same reason.

Bases for cabinets and benches should provide toe space for comfort and safety of the worker.

Work stations, tool panels and equipment should be grouped so that related activities can be carried on with a minimum of travel.

Windows should be approximately 54 inches from the floor. This allows tools or tool panels to be placed against the wall and eliminates visual distraction or glare.

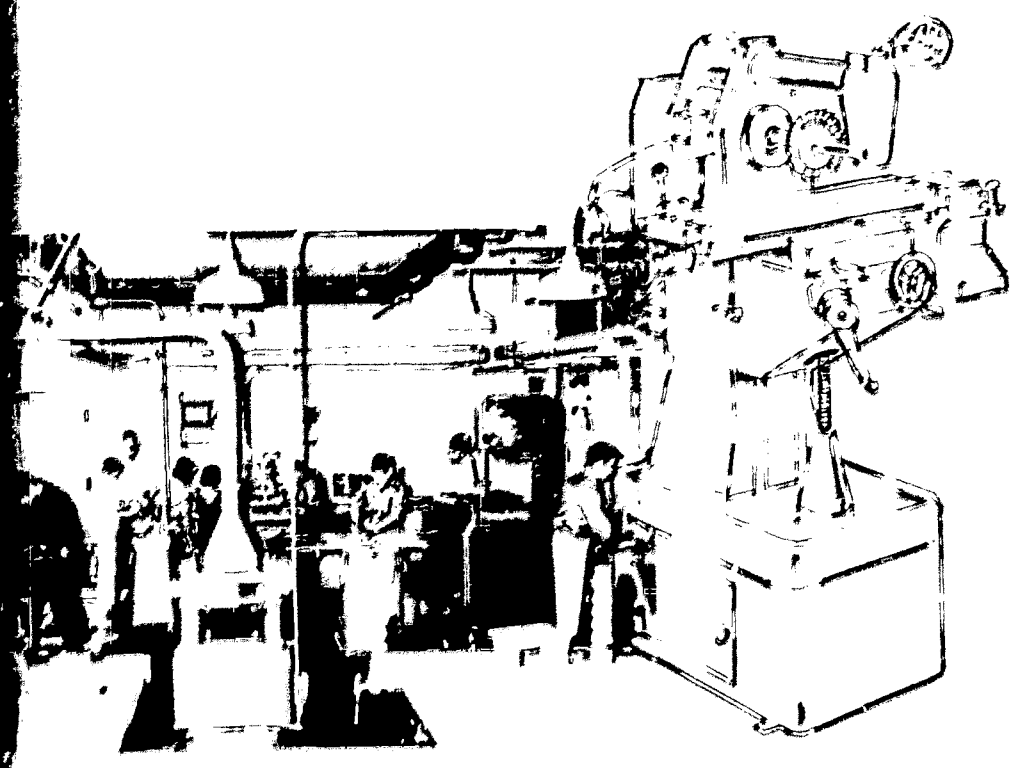
Fire alarm boxes usually found in halls and not classrooms, should be included in the shop areas, particularly in the hot metal and electrical areas.

Sprinkler systems, if installed in boiler rooms or elsewhere in the school, should be "extended" to include the shop or laboratory areas. This would not only add to the safety factor, but also could lower insurance rates.

Alternate personnel exits should be provided to afford maximum escape possibilities in case of emergency. Enclosed areas within the shop, such as storage rooms, spray booths, etc. should be similarly equipped whenever possible.

FLOOR:

Although concrete today is the most used floor material, it is possibly the most unsatisfactory. In general, concrete should be used only in the "hot metal" area or other similar areas where a fireproof floor is absolutely necessary. Concrete floors, unless properly treated, may cause



both a safety and health hazard. Even when sealed or painted to eliminate the dust problem, they are still hard and, in addition, slippery. The actual floor material used should depend on the activity involved for that specific area. Wood flooring is generally recommended. Probably the most expensive flooring and the best is either end grain wood block or a "parkay type." With this type of floor, it is much easier to replace a damaged section than with a normal hardwood floor. Maple is generally recommended over oak because of its ability to resist splitting. Tile floors have recently become popular due to the ease of replacing individual tiles, and because of their low initial cost. Some caution should be exercised in specifying the exact type of tile due to solvents and other inherent damaging effects when used in a shop or laboratory.

WALLS-CEILINGS:

The ceiling height should be at least twelve feet. Although cost is a definite factor, acoustical material or treatment is highly recommended for the ceiling. In addition, it is often possible to also use acoustical plaster on the walls, down to approximately five feet of the floor.

The lower wall areas should be tile, ceramic block or other easily cleaned durable material. Certain epoxie paints are also excellent when used on normal construction block.

The color chosen for these areas, whether original material or paint, should be semi-gloss so as to create a safer, more pleasant atmosphere.

DUST COLLECTION:

It should be decided in the initial planning stage both from a health and physical point of view whether dust collection is desired. In initial planning, the duct work can be more easily run under the floor rather than overhead. This creates a less cluttered appearance in the shop but also, within reason, dictates the final positioning of the machines and makes difficult any future changes due to the outlets being in one specific spot. In this light, overhead duct work is more flexible. It should also be decided whether every machine is to be attached to this system or only those which create dust rather than chips, i.e., the Belt Sander, the Disc Sander and other Abrasive tools. It is often possible to obtain individual dust collectors for machines of this type rather than install a complete system. A full dust collection system is, of course, the most desirable but also the most expensive.

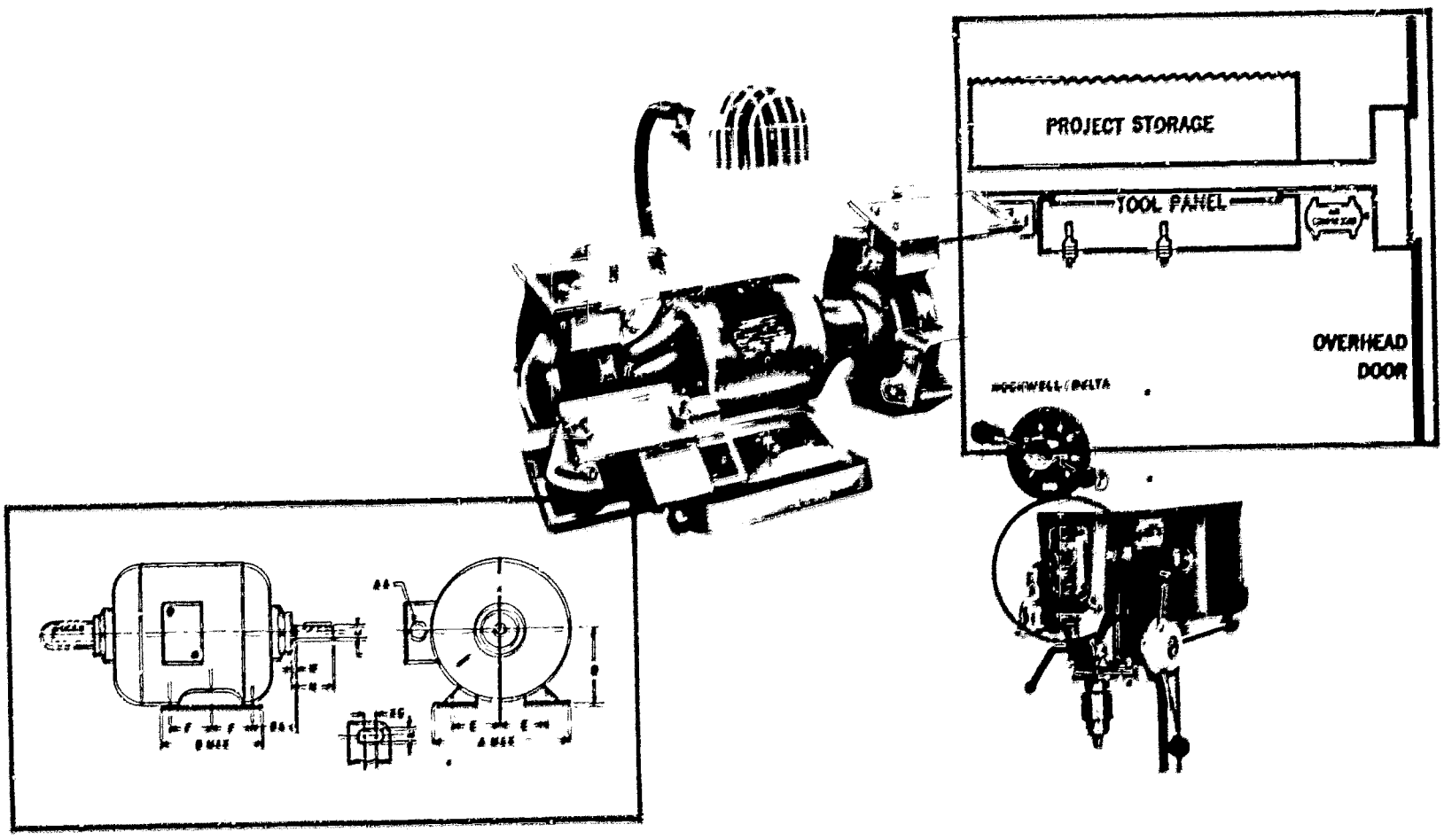
If air conditioning is to be installed, a complete dust control system is recommended due to the problems inherent in pulling undue amounts of dirt into the air conditioning system. The exhaust volumes and transport velocity should be very carefully figured by a competent technician. At least one "floor sweep" duct should be included as a part of the system.

COLOR:

For some time, safety organizations and specific paint manufacturers have recommended various color coding systems, partly for item or area identification and partly for safety. In reference to machinery, there is no actual "standard" color coding system specifying which parts of a machine are to be coded a certain color. This is left up to the interpretation of the individual user or manufacturer. It is obvious that the judicious use of color or various shades of the same color would emphasize certain areas. It is also well known that the use of color for wall and ceiling areas can reduce glare and create safer, more pleasant working conditions. Due to the fact that there is no real standard in this area, most machine color coding is actually done by the user in his own shop to insure that the exact system and same shades of color are used. This decision is based on the person's past experience and personal opinions. Most paint manufacturers are more than happy to submit recommendations concerning their opinion on color.

LIGHTING:

As a rule of thumb, 25 foot candles would be the absolute minimum for any shop and 100 foot candles is highly recommended. In most cases, the use of indirect lighting to avoid glare and evenly diffuse the light is recommended. When needed, individual machines can be individually lighted by lamp attachments or through their own built-in lighting systems. Present day lighting engineers when working with architects, can provide proper lighting which is equal to daylight in almost every respect. They can eliminate many of the problems involved in shop and laboratory planning concerned with the natural light available through restricted window areas which oftentimes varies greatly in candle power.



ELECTRICAL:

Although 110/220 volt, single phase current is less expensive to install and more readily available, ½ H.P. and larger motors operate more economically and efficiently on 220 volt, three phase current. Magnetic starters, like manual starters, give the motor overload protection but also have another important function of providing low-voltage, no-voltage and overload protection. After a power failure has been corrected, the machine will not start (even if it was running when the failure occurred) until the operator presses the start button. Magnetic starters are therefore a definite additional safety feature that might well be considered for stationary power tools. All motors should comply with or exceed the motor manufacturing power standards (breakdown torque) as established by the National Electrical Manufacturers Association (NEMA). All portable electric tools should have three-wire conductors with three-prong plugs for proper grounding, or be otherwise indicated as shockproof.

Convenient, grounded wall plugs are a necessity to eliminate the use of extension cords whenever possible. The type of current should be indicated if other than single phase, 115 volt and special receptacles specified. Pull down, self-retracting lines could be specified for "center-of-the-shop" locations.

Besides a central control panel for the laboratory or shop, it is advisable to have panic buttons located in strategic areas which would immediately shut off all power except to the light fixtures. State and local codes often dictate specifically the size of wire which can be used in public buildings or school buildings. It might be well for the instructor to check and make sure that each receptacle is grounded and safe. All tools, both stationary and portable, should be grounded where applicable. The instructor should be able to lock the power panel to avoid unauthorized use and prevent accidents. The amp rating of the electrical distribution panel itself should be carefully figured, considering the equipment to be used and other items which draw power including the light circuits. This should be rated to adequately take care of not only the electrical requirements for today, but also provide for additional current capacity as determined for possible future expansion of facilities.

GAS AND AIR:

Some thought in the initial planning stage should be given to locating the air and gas lines inside the walls rather than having exposed piping. Gas might normally be run only to the soldering bench in the shop or possibly to a forge, but air can be used in almost any area for operating air tools, air powered accessories, or for cleaning purposes. It is highly recommended that this piping be installed in the appropriate places and in the appropriate size of pipe, regardless of whether a compressor is initially purchased or not. This might be comparable to the original installation of phone lines in a home with conveniently located phone jacks.

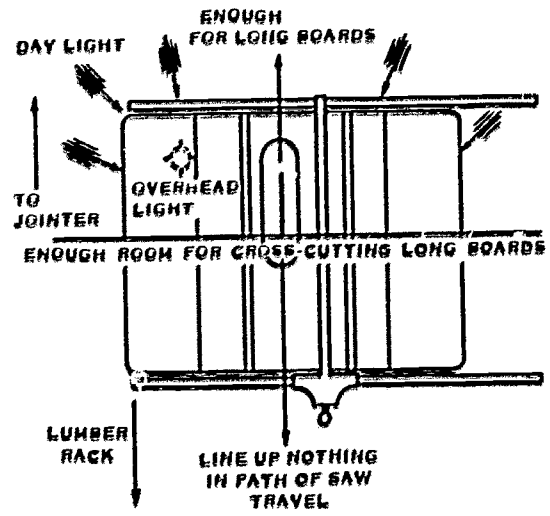
AUDIO VISUAL AIDS:

Adequate space for the use of modern visual aid equipment should be included in any layout. This might be located in a separate area, in the shop or laboratory itself, or in the drawing room. It is also advisable that this area be equipped for actual demonstrations in addition to the audio visual equipment used. Electrical outlets, a projection screen and possibly some internal wiring should be considered, primarily in regard to audio speakers, electronic teaching machines and other more sophisticated audio visual equipment now available.

PRINCIPLES of MACHINE ARRANGEMENT

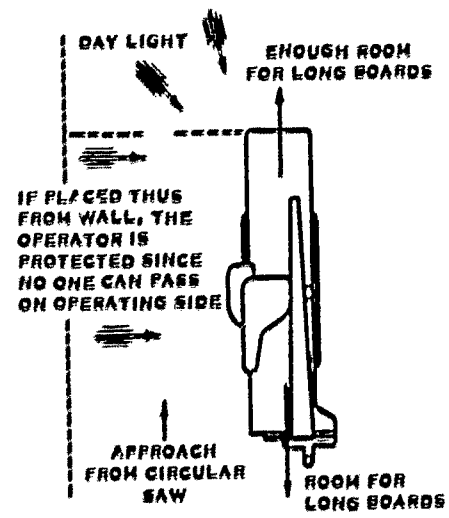
THE CIRCULAR SAW

The circular saw should have natural light coming from the left-hand side and the rear. Artificial light should be from the back of the blade and to the left. Allow enough room for ripping long boards and enough room on each side for cross-cutting. The amount of room necessary will depend upon the type of projects. Generally, projects for the senior high school are larger than those in the elementary and junior high schools and, therefore, more room should be allowed. It is well not to line up another machine or a bench in direct line of the saw travel; a careless student may allow a piece of stock to kick back. Provide a wide aisle to the back or front of the saw to prevent traffic interfering with projecting lumber.



THE JOINTER

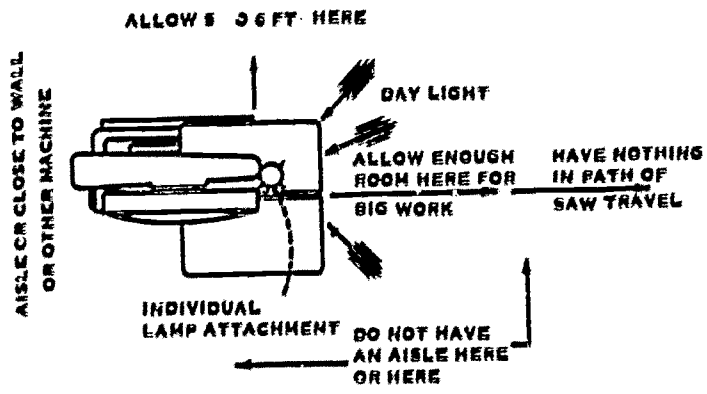
The jointer should be placed to the left and behind or ahead of the circular saw. Jointer operations generally follow work on the saw. Light on the jointer should come from the left and back as shown. Enough room should be allowed in front and back of the jointer for running the size of boards generally used. The widest aisle should be on the left side of the machine so that passing students do not bump into the operator.



THE BAND SAW

The band saw should have its light coming from the right-hand side. Since most modern machines, however, can be equipped with an individual light attachment, this is not absolutely vital.

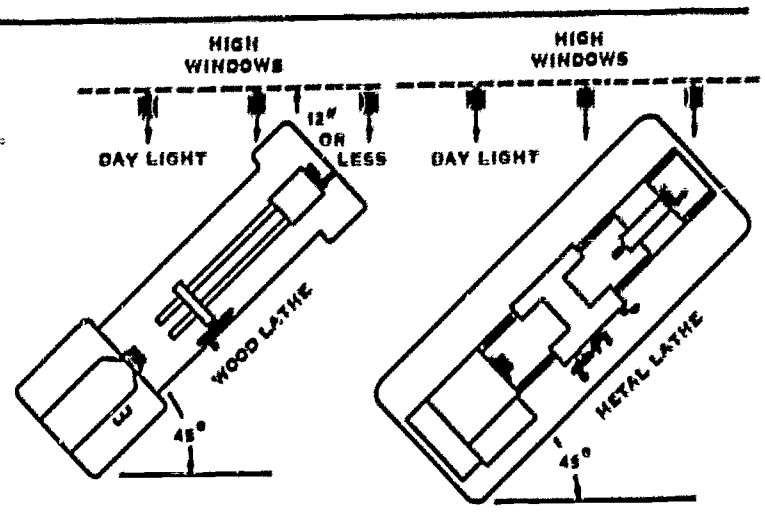
The band saw may be placed so that there is an aisle to the operator's left or to the back of the machine. A wide aisle should be to the right or in front of the machine to eliminate possible interference with the operator. Locate the machine so that the path of saw travel is not in line with other operators or people at their benches.

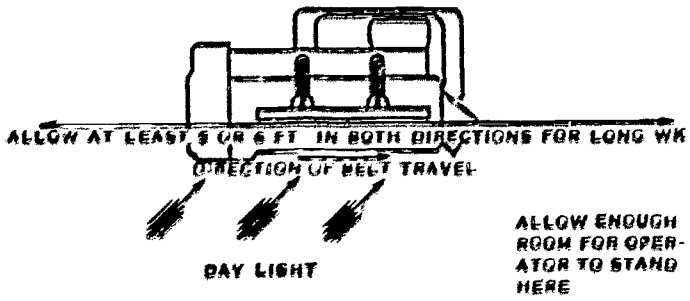


THE LATHE

A very fine arrangement of lathes is shown here. They are set at an angle of about 45° from the window wall so that the light coming in will flood the entire lathe bed and headstock. In this way a sufficient amount of light is thrown upon the work whether straight spindle turning or face plate turning is being done. If an overhead light is installed, it should be in back of the lathe.

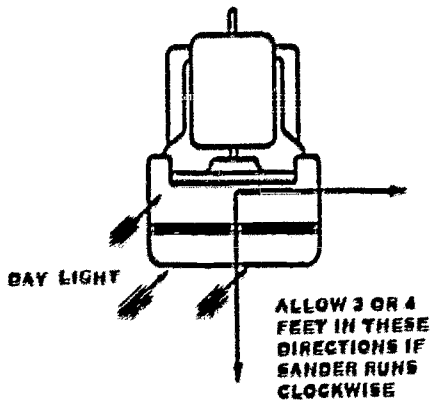
The diagonal position recommended also insures that work turning in one lathe will not be in line with other operators. With adequate shop lighting, the position of the lathe and the operator become less dependent upon natural light. High windows create less glare and student distraction, permitting the operator to face the wall or windows. This allows the head stock to be "in the shop," not against the wall, saving space and providing safer outboard turning.





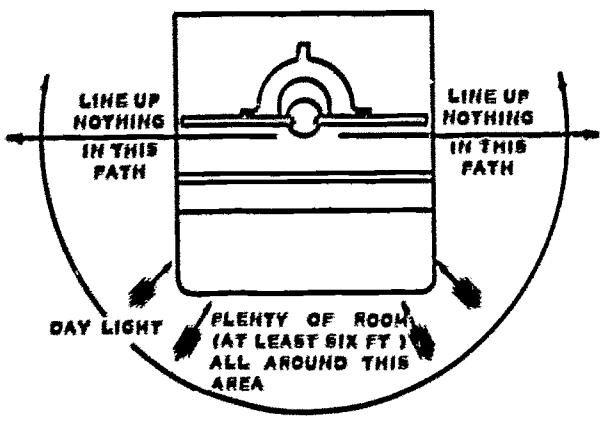
THE BELT SANDER

The illustration shows a belt sander in a horizontal position. The fence accessory has been substituted in the drawing for the cast iron table usually supplied with this sander. Daylight should come to the machine from the front as shown. The widest aisle should be on the operator's side of the machine.



THE DISK SANDER

Three or four feet of room in the front and to the right of the machine is generally enough for operation on a disk sander. Daylight should come from the left-hand side and onto the disk. No other precautions are especially emphasized.

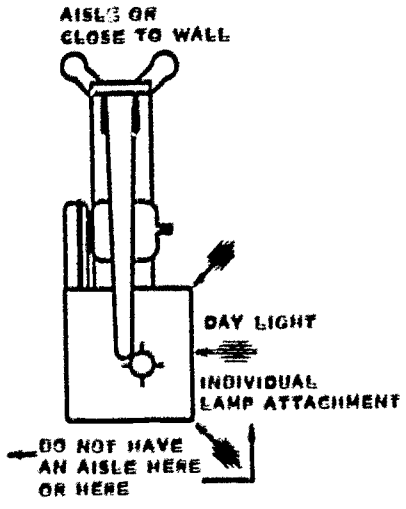


THE SHAPER

One of the woodworking machines that must be carefully operated is the shaper. It should be placed so there will be absolutely no interference from passing students and the work can be observed by the instructor at all times. Often it is placed in an area by itself. Light should come to the shaper from the front and both sides and at least 6 feet should be allowed in front and on both sides for the operator.

If possible, nothing should be lined up with the shaper on either side.

If projects call for the manufacture of long pieces of moulding, then the shaper can be placed along one of the walls.



THE SCROLL SAW

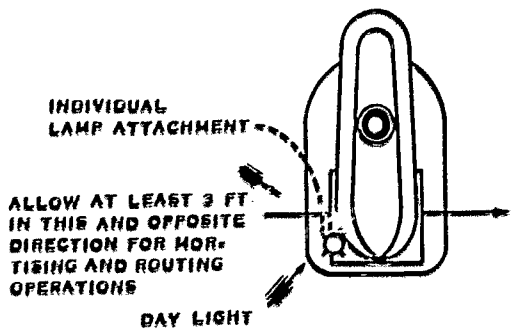
The scroll saw is used in more schools than any one other power-driven machine. It should be centrally located so that all students can have easy access to it. Since much of the work on this machine is fine in nature, an individual light is usually supplied with it. Consequently outside light is not so important.

In placing this machine be sure to allow enough room, at least 5 to 6 feet to the front and sides of the machine, so that the operator will have freedom. It is also well to place the machine so that the back faces the aisle.

THE DRILL PRESS

In the woodworking area, the drill press should be located against a wall with enough space allowed on either side for mortising work on all sizes of stock.

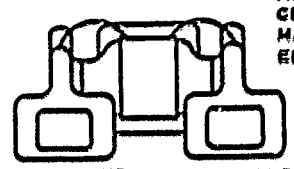
In a metalworking area the drill press can be placed in close quarters because the work generally is small in size. For accurate results on a drill press it is quite essential that an individual light attachment be provided. For this reason, it is not important to place the machine with reference to natural outside light. The back of the machine can be placed very close to the wall with a wide aisle in front of the machine.



WIDE AISLE IS ALLOWABLE ON THIS SIDE SINCE STOCK WORKED IS USUALLY SMALL. AISLE ABOUT 5 FEET WIDE

THE GRINDER

The grinder should be placed fairly close to the drill press or the lathe. It is most often used to sharpen the tools of these two machines. It can be placed fairly close to a wall or to machines. Since most of the work done on the grinder is small, an aisle may be permitted on the operator side.



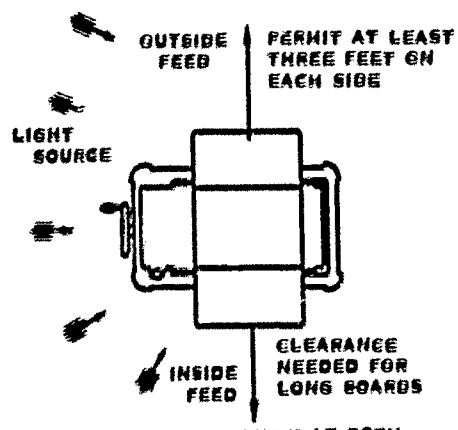
MAY BE FAIRLY CLOSE TO OTHER MACHINES ON EITHER SIDE

INDIVIDUAL LIGHTS BUILT INTO GUARDS

WIDE AISLE IS ALLOWABLE ON THIS SIDE SINCE WORK HANDLED IS SMALL IN SIZE

THE PLANER

The planer should be placed so that it is immediately accessible to the lumber rack and lumber storage. Obviously, ample clearance must be provided on both the infeed and outfeed sides to permit the planing of long boards. The light source should be such that the dimensional gauges and operating levers can be observed and safely handled.

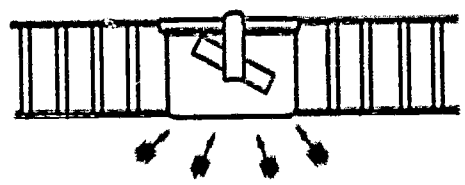


THE RADIAL SAW

This power tool is most serviceable when placed against a wall adjacent to the lumber rack. At least 12 feet of bench space on either side should be allowed so that long and heavy boards may be cut with ease and safety. A wide aisle should be provided in front of the machine to prevent interference with the operator.

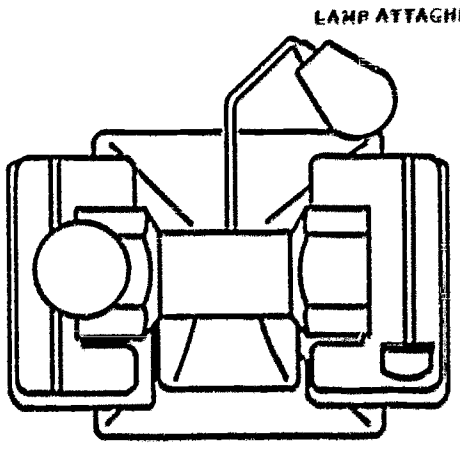
PLACING OF BENCHES

In most schools the most satisfactory arrangement of placing benches in the woodworking shop is to allow at least 30 inches between the vise of one bench and the back of another bench. The distance between benches from end to end should not be less than 24 inches. These dimensions should be the *minimum* amount of space allowed for the pupil. Here again, common sense must be used.



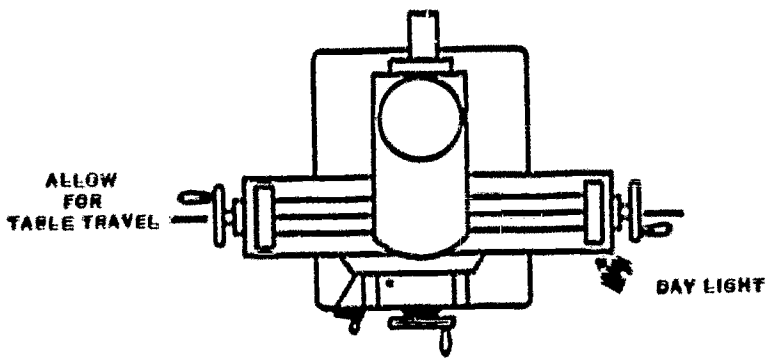
PROVIDE AMPLE LIGHT SOURCE TO ENABLE EASY READING OF DIMENSIONAL AND ANGLE DIALS AND CONTROLS

WIDE AISLE ON THIS SIDE

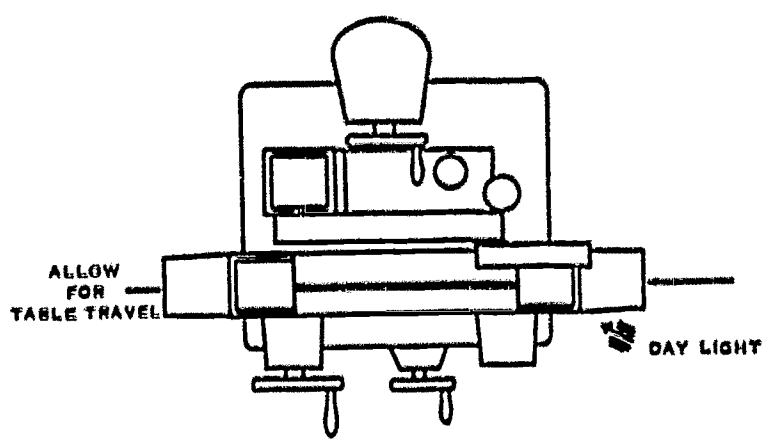


THE TOOL GRINDER

The Tool Grinder should be convenient to machine operations requiring frequent tool sharpening. Since practically all work performed with this type grinder is of a close nature, an individual light should be used for adequate illumination. Thus placement is not limited by either work size or light source. Sites along aisles, walls or at tool islands are good locations as long as adequate space is allowed at both ends of the machine for the operator and his work.



THE VERTICAL OR HORIZONTAL MILLING MACHINE



THE SURFACE, OR TOOLMAKER GRINDER

Since work pieces are usually of a similar size for both milling machines and surface grinders (generally no larger than the table surface), either machine can be located in moderately close quarters if ample clearance is allowed for table travel and aisle traffic. Care should be taken that a solid and level foundation is chosen for vibration-free operation of this type machine. If placed near windows, either unit should be positioned so that the light comes from the right and does not cast shadows on the work surface or interfere with the operator's vision. This problem is reduced when the machine is equipped with an individual lamp attachment.

LAYOUT
DEVELOPMENT

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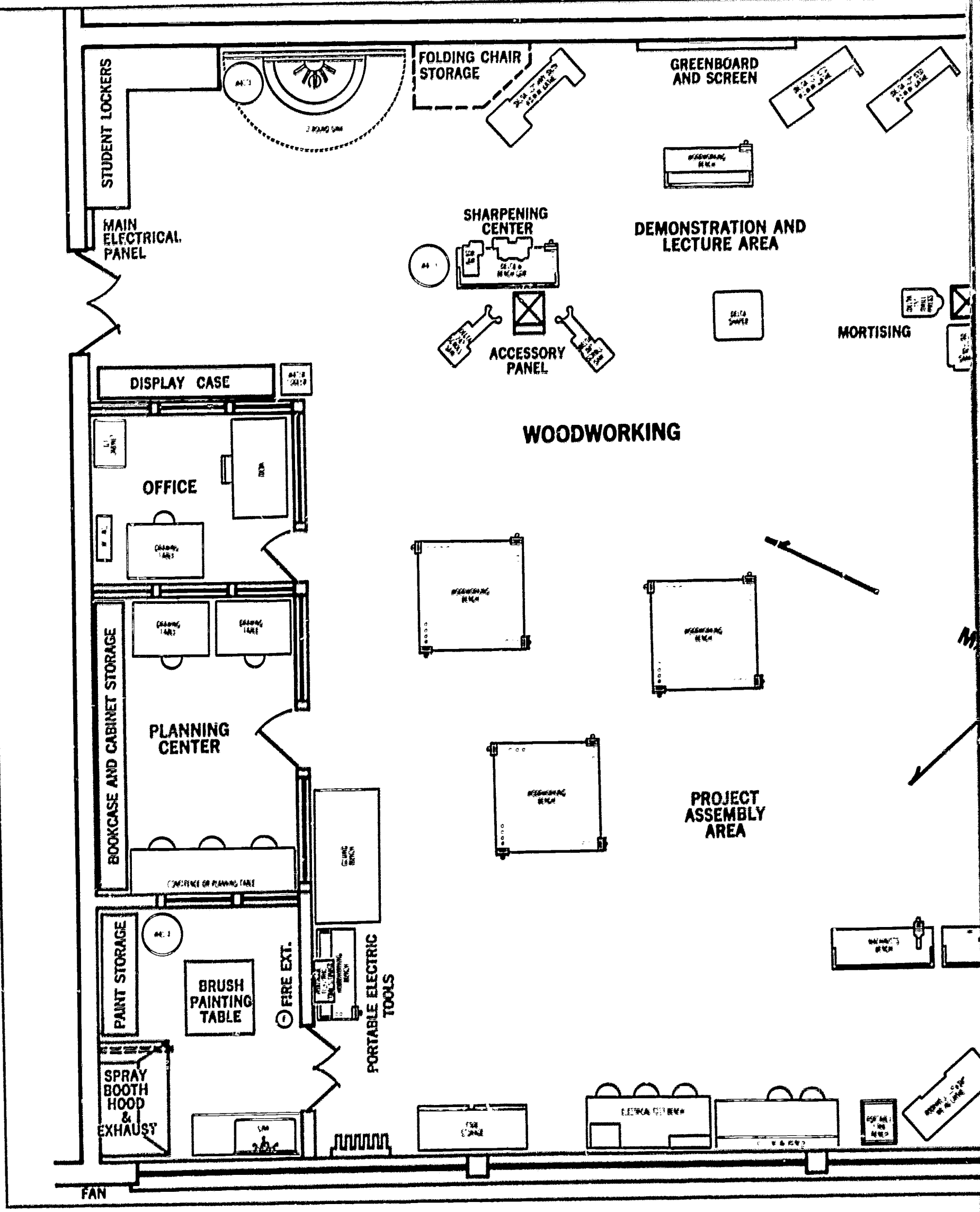
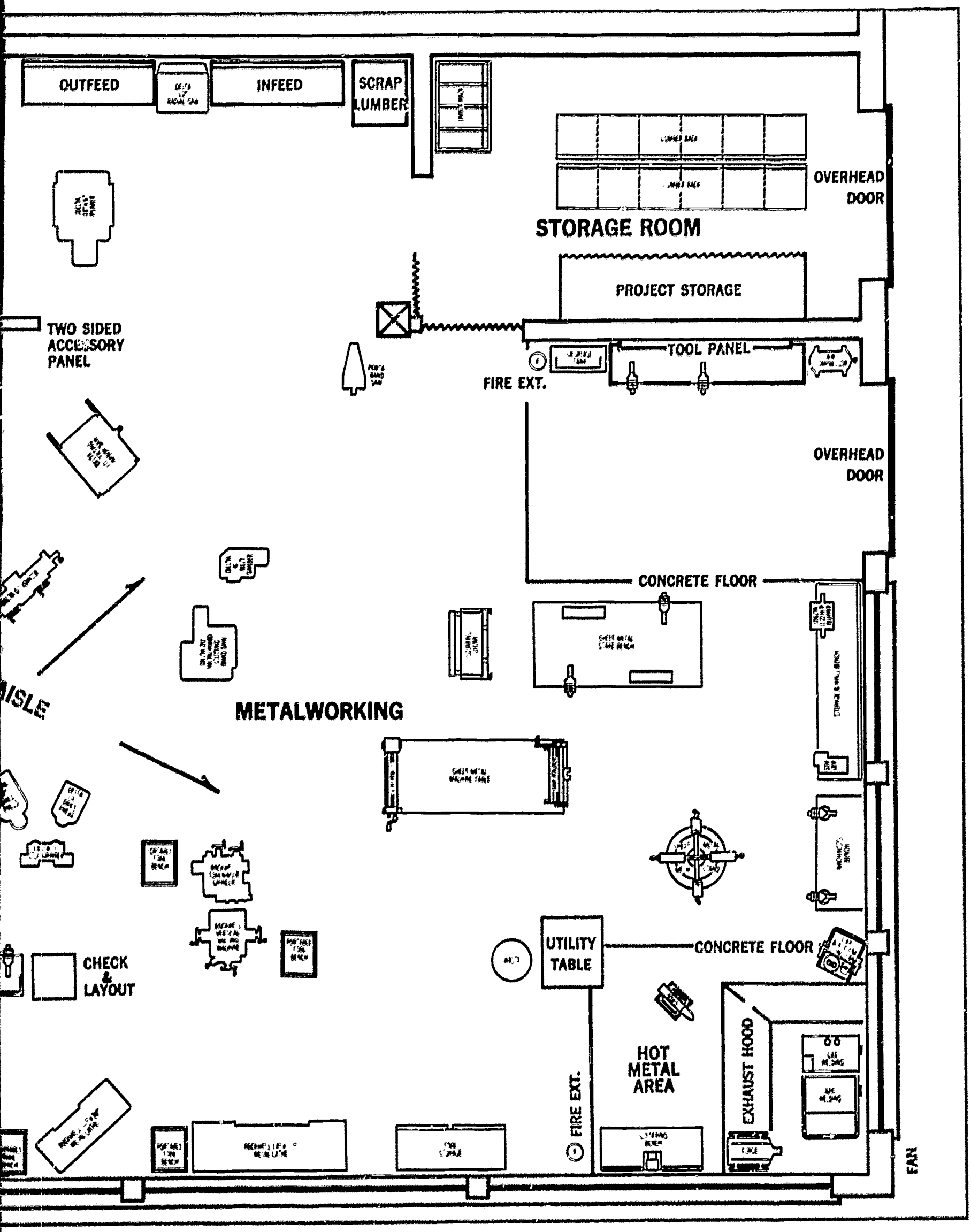


Developing the layout can be a formidable task when the planner is confronted with an architectural floor plan that indicates nothing but a blank floor area surrounded by necessary structural features. These features such as walls, columns, door placements, etc. limit, dictate or influence the planner's concept of what his shop layout should entail. An often used solution to this problem is to proceed only on intuition, arranging a few machines or the furniture in a selected area of the floor plan as a starter; then, with minor revisions, expanding the layout. This method is workable where knowledge and intuition are sound and the initial placement of equipment is logical relative to the complete layout.



Unfortunately, the final result remains an uncertainty throughout the planning state until the layout is completed. Such a hit-or-miss approach does not have the benefit of good pre-planning concepts which can assure fulfillment of the planner's objectives.

There are five basic steps which should be employed in the "forming" stages of a shop or laboratory layout. The above plan is a result of these steps. On the following pages these considerations will be defined, along with other features that contribute to modern day principles of good design. At the same time, the above plan will be developed from its initial stages utilizing these up-dated concepts.

A comprehensive general laboratory or shop, as might be planned for a moderately small school, will serve as a good example in pointing out the basic steps of pre-planning. It also allows for the use of a number of innovations which separately or together can enhance the effectiveness, whether for the purpose of renovating an existing facility or creating a brand new one. In this example, we will work with the following:

Hypothesis:

There will be only one industrial education area in the school plant.

There will be no classroom or separate storage area available.

The shop or laboratory will serve grades 10, 11 and 12.

Facilities should be as comprehensive as is practical.

The curricula is to encompass woodworking, sheet metal, machine shop, power mechanics and basic electronics with emphasis on the first three.

This is to be a "one-teacher" shop or laboratory.

Normal class size is to be approximately 30 pupils.

Length of period is to be 50 minutes.

The allocated space measures 54 x 89 feet (ceiling 12 feet) and is a room physically attached to the school plant.

Foremost among preliminary assumptions that must be taken into account by both the architect and shop planner alike are state department recommendations or minimums for square footage per pupil. While they vary from state to state, factors of 75 to 125 square feet of work space per pupil and a minimum of 300 to 500 square feet for material storage are generally accepted requirements for this particular size area and the subjects to be taught. Thus, with 4,644 square feet available, we have assigned 3,750 square feet for the main work area to adequately handle 30 students. We have allocated 266 square feet for the material storage room with additional storage available within each subject area. This will leave 770 square feet for other facilities that we may desire such as office, planning center, finishing room, etc.

Once these relative and necessary facts are established and an official architectural drawing is available, we are ready to proceed. (Unfortunately, in many instances preliminary research is not done and architectural plans are the first step in tailoring new construction to both overall community needs and individual curricula.)

A copy of the "first draft" structural drawing is a necessity for determining the unchangeable mechanical and architectural considerations, i.e., ceiling and window sill heights, door dimensions, etc. Such a drawing is not absolutely necessary when working with an existing room but a blueprint will save considerable time and assure accurate data and working dimensions.

A. LAYOUT THE FLOOR PLAN IN A CONVENIENT SCALE . . . LARGE ENOUGH FOR EASY REARRANGEMENT OF EQUIPMENT SYMBOLS AND READING THE COMPLETED LAYOUT*

The floor dimensions of 54 x 89 feet are reasonably close to the normally accepted length to width proportion of 2 to 1. This is frequently considered the ideal proportion and the most convenient for the various needs of industrial education. However, one major structural problem is encountered and it is a common one. Three support columns are present which could unfavorably influence the shop plan. Their inconvenient placement, one-fourth of the way into the room, could isolate an area too small to be really utilized effectively. Their tendency to disrupt activity and traffic is compounded by their proximity to both inside and outside entrances.

One other problem is evident. The fact that auxiliary space for classroom, storage, etc. is not provided, means space saving methods will have to be used wherever possible if all necessary training facilities are to be included.

It is at this point that the architectural plan usually stares back at the planner with its blank floor area and structural peculiarities. This is where the planner can ease the situation with a little pre-planning before going ahead with his arrangement of benches and machines. By systematically dividing the layout into functional segments, the hit-or-miss approach is eliminated. In its place are definite reasons for every item included in the finished plan.

**A scale of 1/4" to a foot is perhaps the most commonly used scale for this purpose as a number of two-dimensional scale templates for either drawing or cutout are available in this size. A more sophisticated and expensive, but less readily available method, is to use three-dimensional scale models.*

B. BLOCKOUT GENERAL LOCATIONS OF MAJOR AREAS . . . WITH THE FUNCTION OF EACH DICTATING A LOCATION THAT WILL AID YOU IN ADMINISTERING THE AREA AND PROGRAM. MAKE ROUGH SKETCHES FIRST ON A SEPARATE PIECE OF PAPER UNTIL A SATISFACTORY SOLUTION IS WORKED OUT. THEN, TRANSFER YOUR DECISIONS TO THE DRAWING.

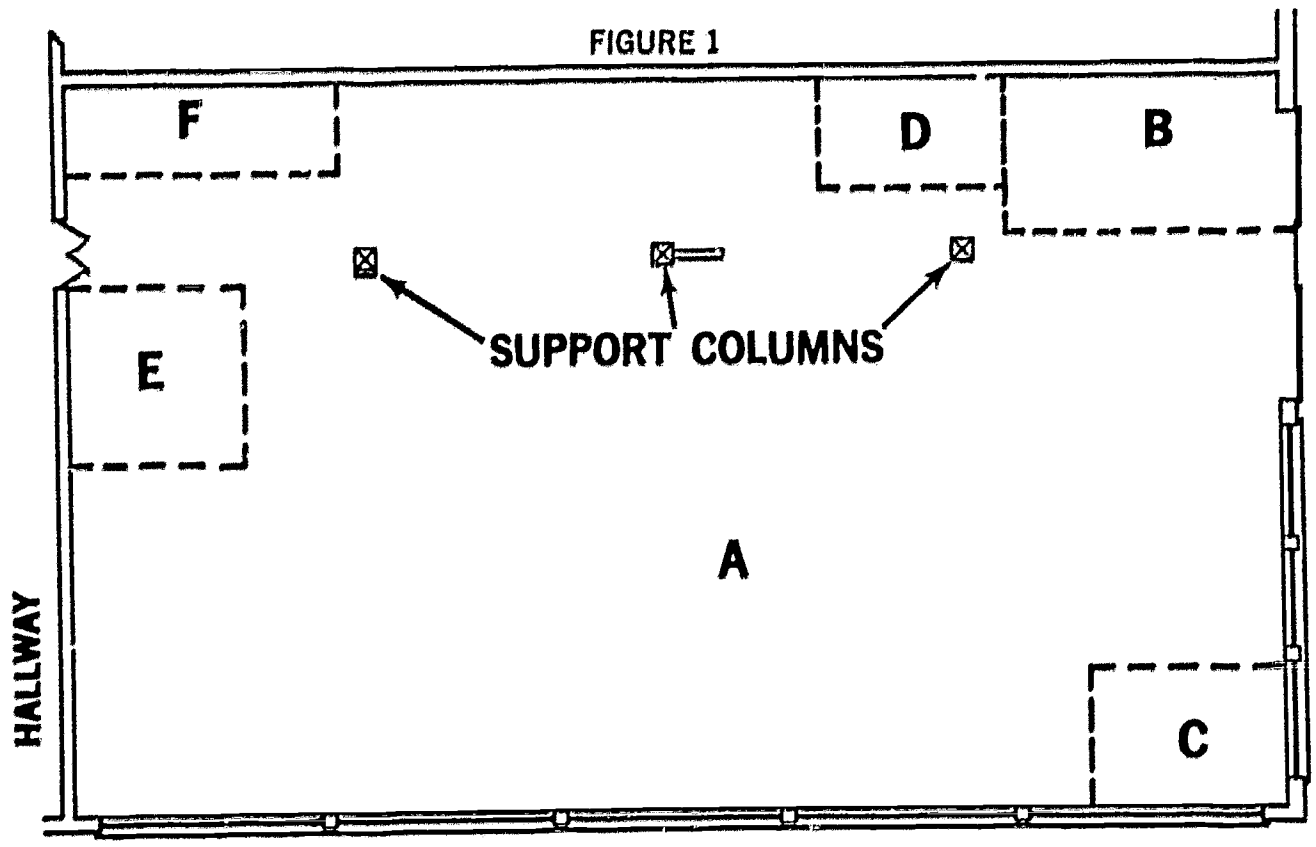
a. The main work area (see Fig. 1) would naturally fall here to take advantage of the large uninterrupted expanse of space as well as proximity to the outside wall and the even distribution of natural light from the windows.

b. We have located the material storage area at "B" for it has the advantage of proximity to a large outside service door that facilitates easy delivery of supplies. In addition, the area is well placed for a disciplined flow of material.

This facility should measure at least 10 x 20 feet.

c. A small hot metal area has been included in the metalworking shop. It is isolated from all other activity as much as possible due to the hazards of handling molten metal, etc. A corner location serves this purpose, plus provides good

FIGURE 1



illumination from two window walls. These walls also offer the advantage of easy ventilation. In addition, gas forges and foundries have a relatively high operational noise level. They should be removed as far as possible from hallways or inside walls which may transmit this noise to nearby classrooms.

d. Locating the instructor's office at "D" reasonably meets the requirements for easy viewing and supervision of exits and student activity; however, the line of sight is somewhat disrupted by three nearby support columns.

e. "E" is a better location as all requirements are still met. Interference by the columns is negligible and the storage room will not obscure the view of the outside doors. The generally accepted minimum space requirement for the office area is 55 square feet.

f. The wash area was located adjacent to the main entrance. This location will be consistent with the basic concepts of traffic flow as well as being within easy monitoring distance of the instructor's office.

Since power mechanics and eletronics are not prime subjects in this shop and their facilities will not be extensive, location of these two activities can await further development of the layout.

Future expansion is always a possibility. While demands of this nature are only second guesses at best, adaptability of the plan for a minimum of reorganization should be kept in mind. In our initial planning, 125 square feet of work space per pupil was established. This will permit additional enrollment, new equipment or extra shop subjects to be reasonably accommodated without going below space-per-pupil minimums. It is quite probable that if future construction were to take place adjacent to this shop or laboratory, it would occur at one or both windowed walls. Architects usually plan for such contingencies by designing for a MINIMUM amount of structural change. Therefore, by locating basic and reasonably permanent facilities, such as wash and office areas, near the hall entrance, the probability of their relocation at a future date is minimal.

C. DETERMINE FLOW OF MATERIAL AND STUDENTS . . . WITH A LOGICAL PLACEMENT OF PROCESSING AREAS FROM STORING RAW STOCK TO APPLYING FINAL FINISH. TRAFFIC CONSIDERATION SHOULD INFLUENCE MATERIAL FLOW AND PLACEMENT OF EQUIPMENT.

In general, the shop should be planned to provide a relatively unbroken flow of material handling with as little backtracking as possible. The fabrication area would naturally be adjacent to the processing operations while forming, cutting and dressing equipment should be situated near the stockroom. This sequence is fundamental and will aid in scheduling mass production experiences, if taught. More important, it will prevent the loss of student time caused, for example, by walking the length of the laboratory or shop from the storage room to the radial saw.

Material flow can take any direction: curved, parallel or diagonal to walls, 90° turn, "U" turn, etc., as long as it is practical for an efficient and safe shop operation. For the sake of simplicity, we will use a straight line to develop an example of material flow.

Four general areas are visualized emanating from the storage area (Fig. 2). In this particular situation, the material storage is located in one corner so the general flow of material is planned to fan out across the room in a diagonal direction toward the finishing area at the opposite corner of the layout. The usual and more

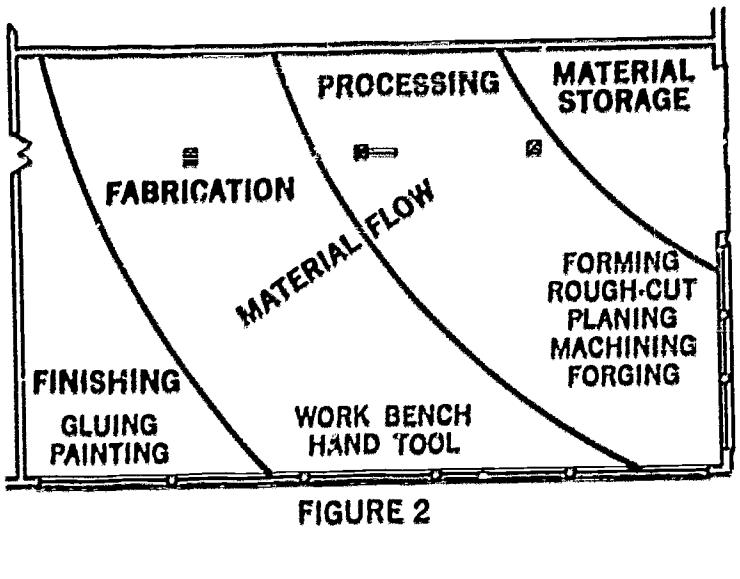


FIGURE 2

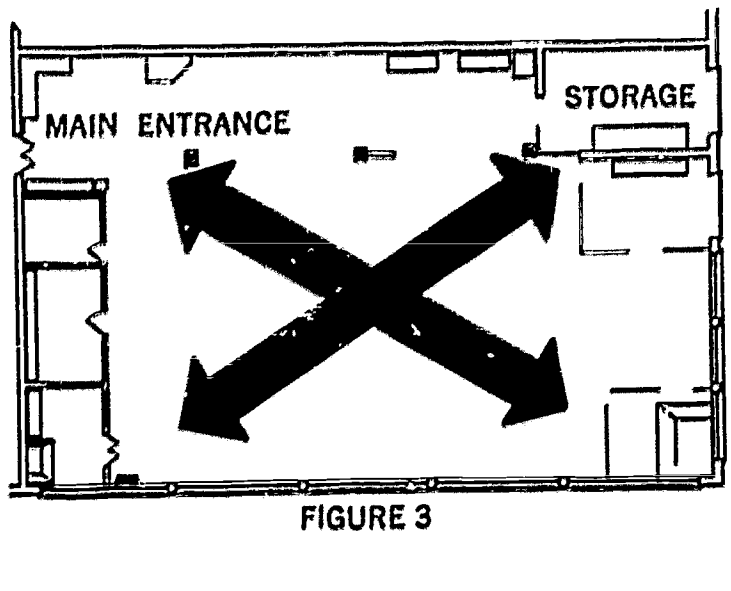


FIGURE 3

conventional direction, paralleling lateral dimensions of the room, is adequate but a diagonal orientation offers additional advantages worth considering.*

A diagonal orientation within a rectangular room allows a larger and longer expanse along the material flow route in which to space out work stations for optimum clearance and safety. A fundamental fact is that ample working space must be left around all power equipment as well as work benches.

A more efficient and controlled traffic pattern is possible by using the diagonal concept. Subsequent location of machines and furniture will tend to influence the general aisle arrangement (Fig. 3.) in a direction similar to the material flow. Less "zig-zags" and 90° turns will have to be negotiated where traffic can be directed toward the corners instead of "dead ending" at the walls. This will provide a slightly less complicated route to virtually any work station in the shop.

As shown in Fig. 3, all four corners are firmly unified within the total plan by an aisle organization based on adequate access to the wash entrance and storage area. Direct access to all heavy and constantly used facilities assures a less disruptive and more disciplined flow of student traffic.

As a result of employing the diagonal concept, corner areas usually find themselves situated on the periphery of major activity. These are good locations for special learning activities requiring minimum distractions and some degree of isolation. In Fig. 2, there are at least two such areas at the lower left and right. We have already allocated one of these to hot metal work which meets the criteria for a restricted location. The remaining corner is an ideal site for either a planning area or finishing room. Both should be dust free. Finishing work should have priority as this particular corner is farthest removed from the proposed site of dust producing machines and is located adjacent to an outside wall for easy ventilation. It also serves as the terminal point for the material flow route.

Since, in a comprehensive general shop, neither of these activities engage a large or consistent number of students, only limited facilities need be planned. By reserving a 10' x 12' corner area for finishing operations, we have enough space remaining for a 10' x 14' planning center.

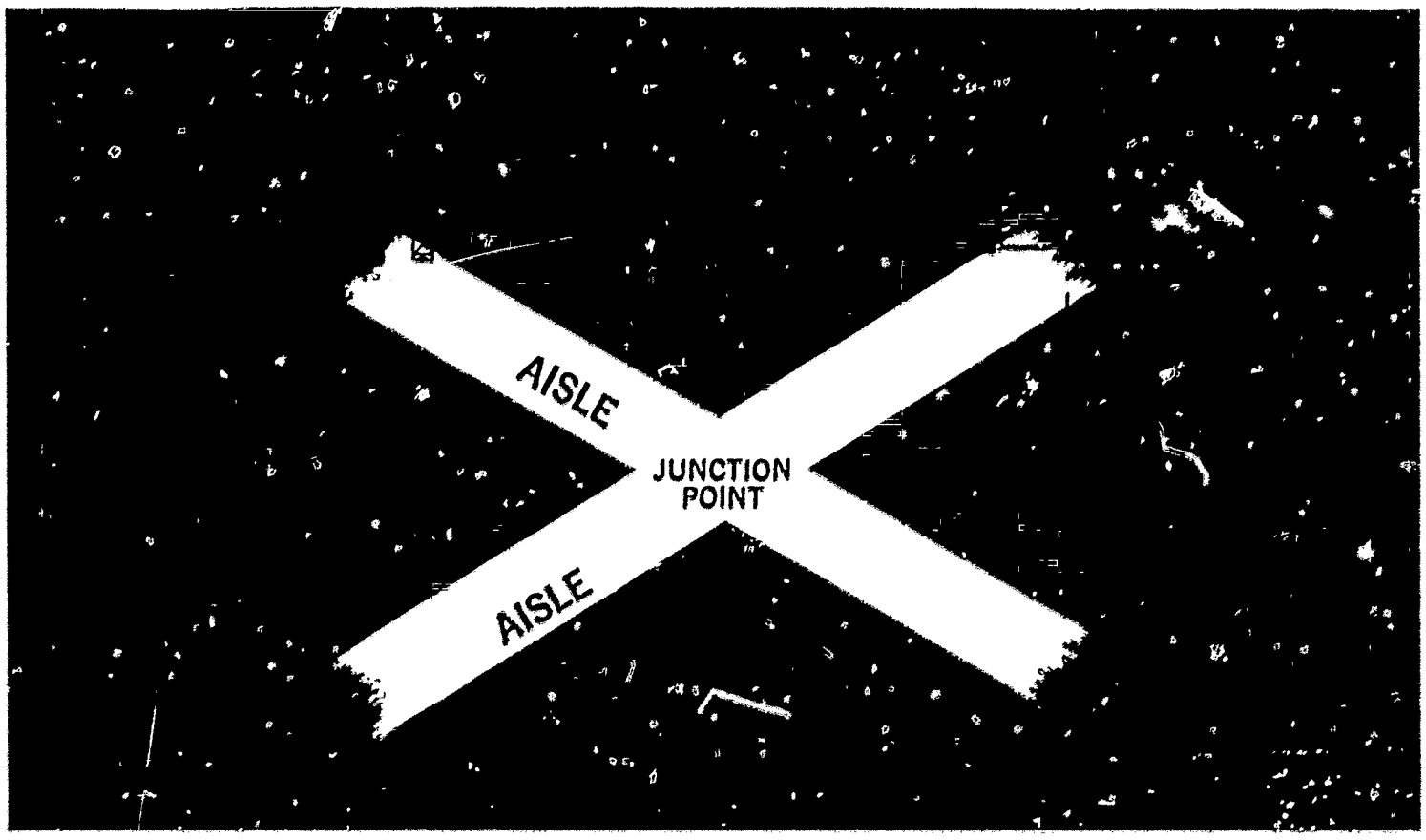
When either activity is a separate and distinct teaching area, larger accommodations are required. In these circumstances, a finishing room occupying approximately 5% of the total floor area is ideal whereas a planning center requires up to 10%.

With the completion of steps A, B and C, the initial and most difficult problems of pre-planning are solved. Demarcation of specific activities and location of the needed equipment will become much more evident. What the previous steps really establish are "coordinates" that suggest the possible location of the various activities making up the total facility. This is the result of the material flow line crossing the storage, processing, fabrication and finishing areas (Fig. 2) and its subsequent influence on the traffic pattern.

*Where dimensions are more confining, limiting the possibility and advantages of a long flow line, it can, in many cases, be extended in another logical direction. If this were the case in our example, the extension could be run from the present lower left terminal point, upward toward the top left, stopping short of the entrance area.

D. BLOCK OUT THE MAIN SHOP OR LABORATORY INTO LEARNING ACTIVITY AREAS . . . ALLOWING SUFFICIENT SPACE IN EACH TO ACCOMMODATE BOTH WORK STATIONS AND MATERIAL HANDLING.

The plan now goes "functional." Much must be kept in mind to assure that what is put on paper now can be lived with later on.



An easy way to do this is first to determine the main aisles of the traffic pattern. Their location is tentative since they can be moved or turned later as the occasion arises to accommodate various equipment locations.

In Fig. 4 we develop this principle by dividing the layout into four sections. One aisle is plotted diagonally from the storage area to the finishing area, augmenting the material flow and at the same time splitting the room between woodworking and metalworking. The latter is assigned to the half nearest the windows for the advantages of natural light, also for continuity with the hot metal operation. A second aisle* extends from the wash area to the hot metal site and again divides the layout into machine and hand tool operations and, in effect, actually cross indexes the manipulative activities.

This is only a foundation. Boundaries are not fixed but we want to separate machine and hand tool operations as much as possible in the interest of safety. The considerations for minimizing the noise distraction of power tools and the localizing of dust producing equipment for dust collection purposes are fundamental. The activity area required for each subject taught is dependent on the number of work stations planned and the demands of material handling. More space and freedom is usually necessary at a woodworking bench than at a machinist bench.

*Cross traffic situations, particularly along main thoroughfares, should be kept to a minimum. When they do occur, adequate space must be provided at the JUNCTION POINT to avoid congestion. See Fig. 4 and finished layout.

E. SELECT AND PLACE EQUIPMENT . . . KEEPING IN MIND PRINCIPLES OF MACHINE ARRANGEMENT THAT WILL AID INSTRUCTION.

This is the stage of "shop planning" where no two people will plan the same laboratory in exactly the same manner, for now the layout becomes a matter of individual preference and requirements.

Using either the template drawing or cutout technique, equipment symbols can be arranged according to the planner's training, requirements and judgment. The section entitled "List of Considerations," beginning on Page Seven of this book, provides specific information on the arrangement of individual machine tools.

Several attempts at rearranging may be required before a satisfactory plan is devised. Cutouts have the advantage here as no erasing is necessary when changes are made.

Each learning activity should be an efficient, definable unit with its own non-conflicting traffic and routine. Placement of machines should reinforce this pattern and, where possible, be placed for progressive and interrelated operations. Storage of tools most often used should be situated within the area. Students should seldom have to leave the area other than to obtain stock from the storage room or make use of machine or power tools at general work stations. Consideration for continuity and a harmonious effect on adjacent areas must also be kept in mind. Notice in the finished layout that the area devoted to metalworking is subdivided into hot metal, sheet metal and machine activities. Each area is self contained, yet, the aisle arrangement conforms to the overall traffic pattern. Furthermore, equipment common to all three operations is easily reached, i.e., the utility table is close to the hot metal area as is the tool panel.

Electronics and power mechanics are separate activities in relation to the other subjects taught but each is logically placed and has its own

FIGURE 5

LEARNING ACTIVITES

	WOOD WORKING	MACHINE SHOP	POWER MECHANICS	SHEET METAL	ELECTRICAL
POWER TOOLS	10" TILTING ARBOR SAW 6" JOINTER 18" PLANER 10" RADIAL SAW 15" DRILL PRESS/ MORTISING ATTACH. 12" DISC SANDER TWO SCROLL SAWS THREE 12" WOOD LATHES SHAPER 6" EDGE TOOL BENCH GRINDER	14 x 30" METAL LATHE TWO 10 x 24" METAL LATHES VERTICAL MILLING MACHINE	½ H.P. BUFFER TOOLMAKER GRINDER PORTA BAND SAW		
LOCATED AT THE JUNCTION OF THE 2 MAIN AISLES FOR EASY ACCESS	SANDER/GRINDER 20" METAL–WOOD CUTTING BAND SAW 6" BELT SANDER		SANDER/GRINDER 7" STANDARD GRINDER 17" DRILL PRESS 15" DRILL PRESS		
	CUTTING—PORTABLE ELECTRIC TOOLS		DRILLING—PORTABLE ELECTRIC OR AIR TOOLS		
	FINISHING—PORTABLE ELECTRIC TOOLS				

area of independent activity. The electrical bench is located in a clean section of the shop. Power mechanics is situated close to the outside service door so that all types of equipment can be easily brought inside. The demonstration and lecture area is convenient to the main entrance to eliminate confusion and congestion in assembling students. Folding chairs are indicated but students might just as easily be seated on stools at the woodworking benches. If desired, leather craft and plastic work also could be performed at these benches. If either subject were to be expanded, they could be moved into part of the project area. In programs where extensive classroom theory is to be taught but no outside classroom is available, up to ten percent of the total shop floor may have to be devoted to an assembly area.

Perhaps the foremost safety consideration to keep in mind when arranging equipment is to think in terms of open space, for it can serve many purposes including traffic and access control, buffer space or to isolate dangerous operations. Safe working and passing space around machine and work stations must be determined. Also, every attempt should be made to position machinery for a correct approach by the student operator. Notice again in the finished plan the proportionate expanse of open space surrounding the Tilting Arbor Saw, Jointer, Planer and Shaper. Space also is used as a buffer on the outfeed side of these machines, for ample access to wash, storage and tool panel areas; to accommodate material handling in the woodworking bench area; to separate the power mechanics and sheet metal area, and to separate the woodworking machine shop areas and the electrical bench.

Keep in mind that unnecessary duplication of equipment is as much at odds with good design concepts as not providing enough equipment. Naturally, some tools used in one learning activity have application in another. An effort should be made to place such equipment in a practical location that will cause a minimum of cross traffic from one area to another. In our example, we have solved this problem by placing the 6" Belt Sander, the Band Saw and Drill Presses between the wood and metal areas at the junction of the two main aisles.

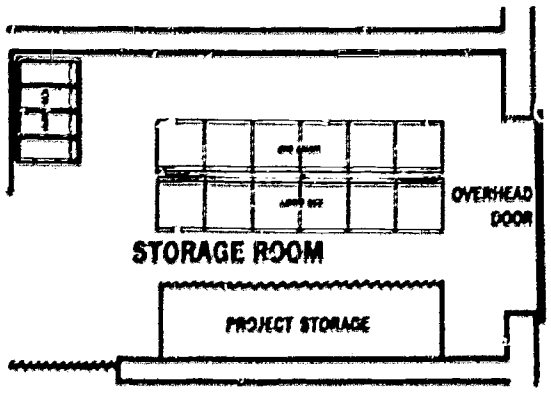
Unnecessary duplication also produces unnecessary cost. Cost is not usually the responsibility of the planner but it should certainly be a part of his concern. He must choose a selection of equipment that will adequately assure program objectives and do it within budget limitations.

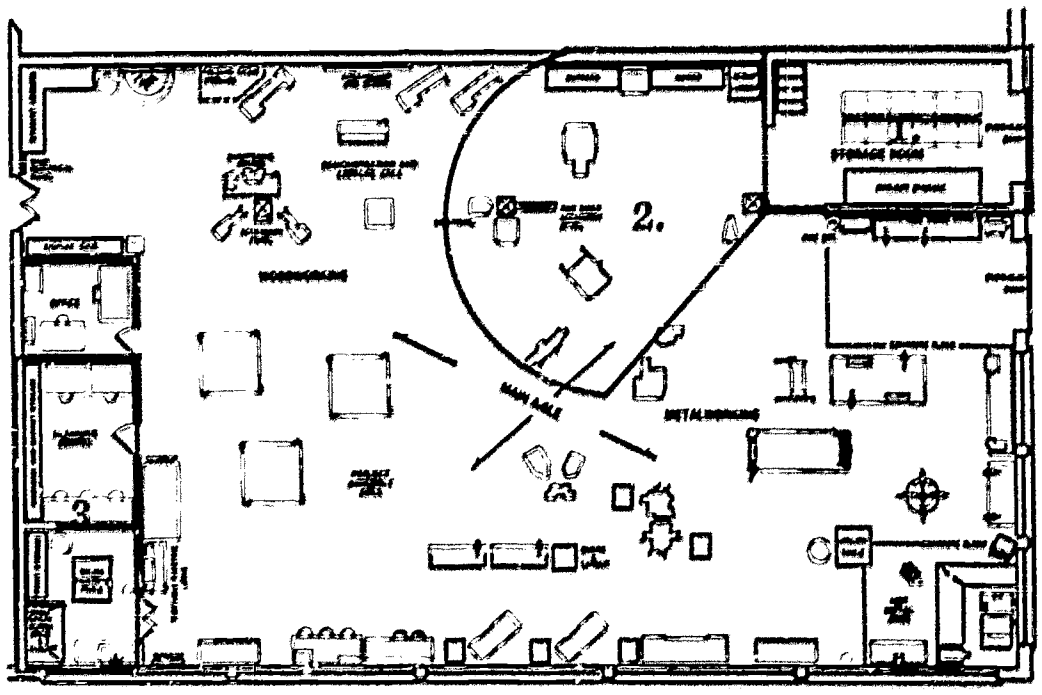
Fig. 5 illustrates the solution of this problem as applied to the Stationary and Portable power tools selected for our plan. Each horizontal box with its related tool indicates which learning activities share in its use. By eliminating duplication of these particular items, we have reduced the cost of power equipment by approximately one-fourth. Applying the "rules of thumb" as covered in the Section, "Purchasing Principles," the shop will cost approximately $42,500.00 when fully equipped. Power tools will average 40% of this figure (each furnished, where practical, with three phase motors, magnetic starters and all safety features).

After all requirements are met and the layout developed to the satisfaction of the planner, several copies should be made in case the original were to become lost. The layout is now ready for its final stage, approval and adaptation by those people responsible for making the plan a reality from a curriculum and budgetary point of view. Good design will be a major factor in acceptance of the plan. Errors of ommission and misplacement of equipment are difficult as well as expensive to rectify later; they also are indicative of poor planning. The five steps we have outlined and discussed are keys to good design through proper pre-planning. When followed as a general guide, the planner will be able to design with authority and conviction.

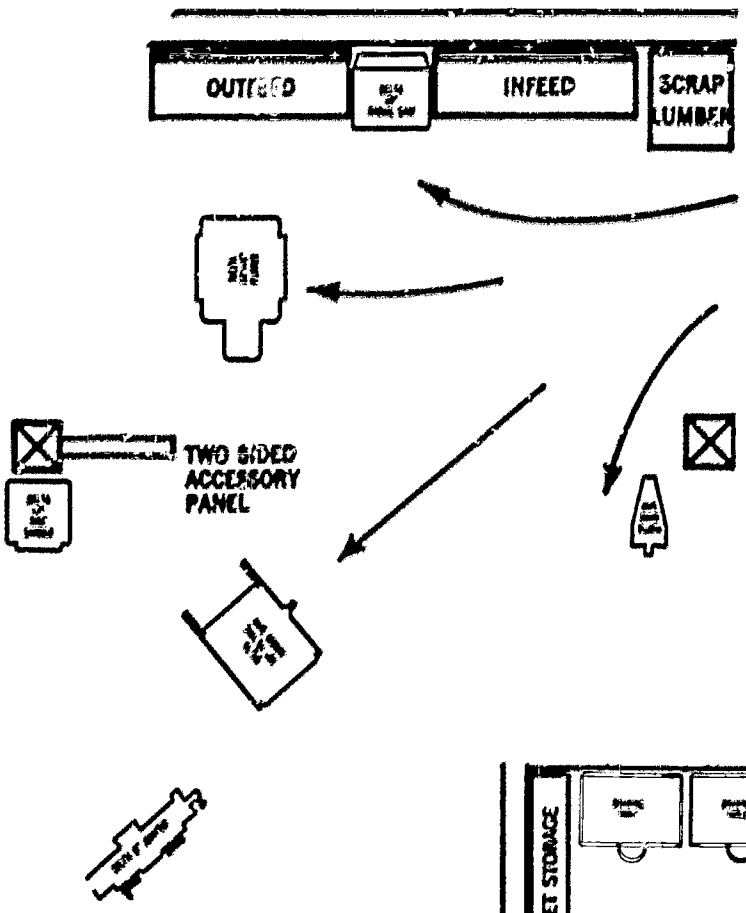
On the next three pages, several features of the finished plan that indirectly influence the layout are explained.

1. STORAGE

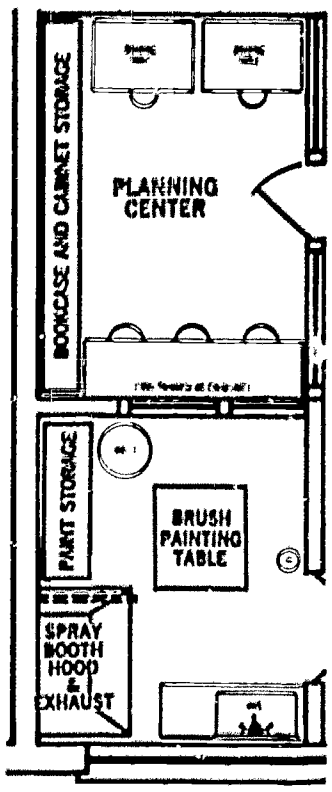




2. POWER TOOLS



3. PARTITIONS



1. DECENTRALIZED STORAGE will help conserve space and increase efficiency by reducing student traffic. Dead storage of bulk supplies should be located adjacent to an outside service door for convenient delivery. Use of horizontal or vertical racks depends on space limitations and personal preference. Lumber should be stored in a dry and ventilated area. Live storage for tools and projects must be provided. Open tool panels in each workshop conserve student time and travel, helping them associate proper tool selection with a particular activity. This provides for easy checking of tools. Space underneath benches and tables is excellent for storage of hardware, small amounts of raw stock or even small projects. Volatile materials should be stored to minimize and isolate the potential hazards involved. Paint cans should be kept in steel cabinets. The hot metal shop of the example is a small one and can be adequately served by a portable gas welding unit. However, where larger welding installations are concerned, fuel storage facilities outside the building should be planned with "tap-off" pipes running into each work station. Storage for student projects and personal belongings is always a problem and should be well thought out. In the example, project storage has been provided in the stock room. Additional storage is available at either the work benches which are equipped with underneath compartments, or at lockers near the entrance area.

2. POWER TOOLS used to cut lumber and metal to a usable size should be in proximity to the storage room. Notice in the example how they are laid out to intercept the material flow to both wood and metal areas. All machine tools should be placed so that the outfeed is not in line with nearby work stations.

3. PARTITIONS should be of the "non-load bearing" type. A more permanent wall is expensive to remove in case of future reorganization or expansion. Where practical, partitions should be of the "see through" type for monitoring all student activity, i.e., half glass for office, plan-

ning center, and at least wire mesh entrances for closed storage rooms or tool cribs. Suitable size windows should be included in all finishing rooms, enclosed spray booths and automotive drying ovens.

4. PERSONAL SERVICES should be planned into the laboratory or shop, both for convenience and efficiency. Student lockers or shelving for books and clothing should be near the entrance to keep these items out of the main area. A wash-up sink and water fountain and, where possible, a lavatory should also be included near the entrance.

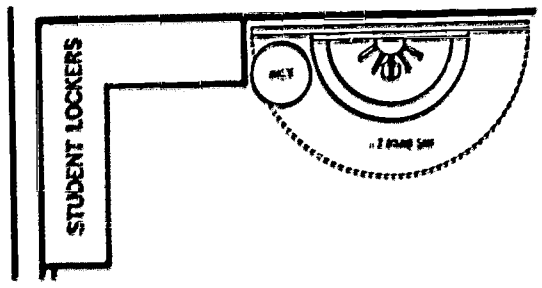
5. TOOL ISLANDS conserve space taken up by machine tools and allow 360° access from all areas of the shop or laboratory. They serve both general and individual work station activities as long as safe freedom of movement is provided for the operation of each machine. They may be clustered in any convenient configuration* of two or more machines that are peculiar to one area or common to several. One or more islands can be placed between areas, serving both as an effective traffic controller and boundary line, separating divergent activities such as the two islands connected by an arrow in the example. These are situated between the wood and metalworking areas. Tools may also be grouped around (but not fastened to) columns making use of this usually non-productive area.

*Exceptions are those machines that demand unobstructed clearance on all sides such as the wood shaper.

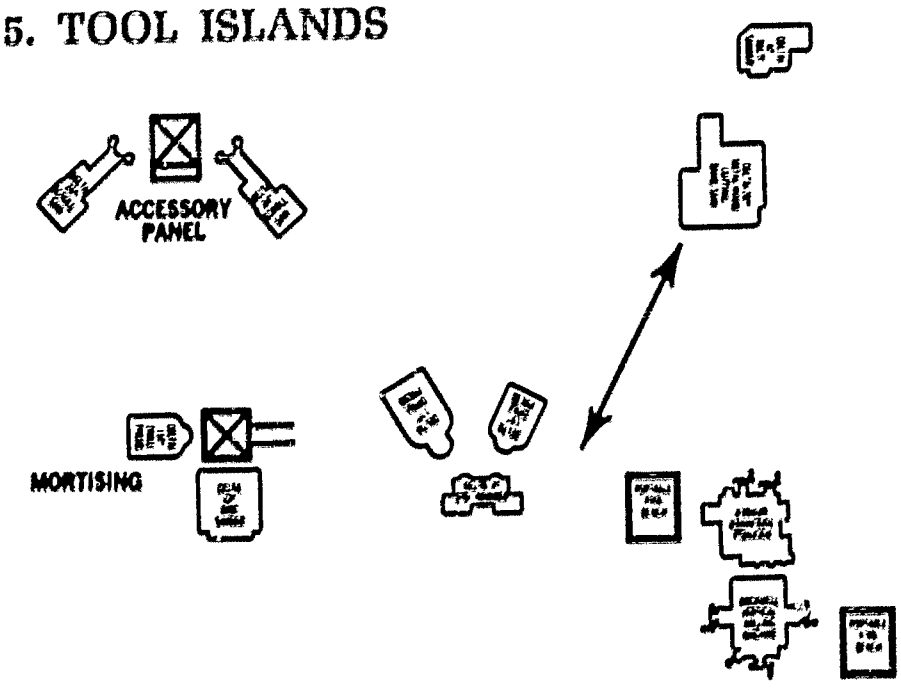
6. PANIC SWITCHES should be strategically located around the entire shop or laboratory and their locations known by all the students. They should be wired to cut off power to every machine. Each machine should be equipped with a magnetic starter that will prevent the motor from automatically starting again once the power is restored.

7. LATHE PLACEMENT should take optimum illumination factors into consideration. Whether the lathe faces the windows or the shop area, depends on both the window height and the

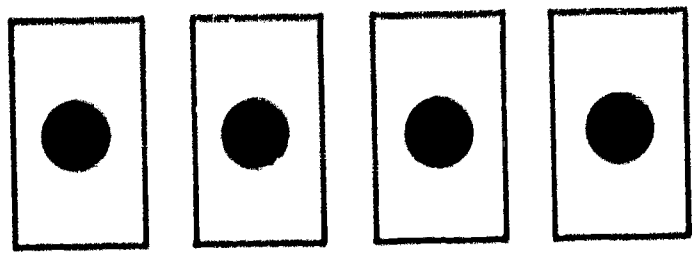
4. PERSONAL SERVICES



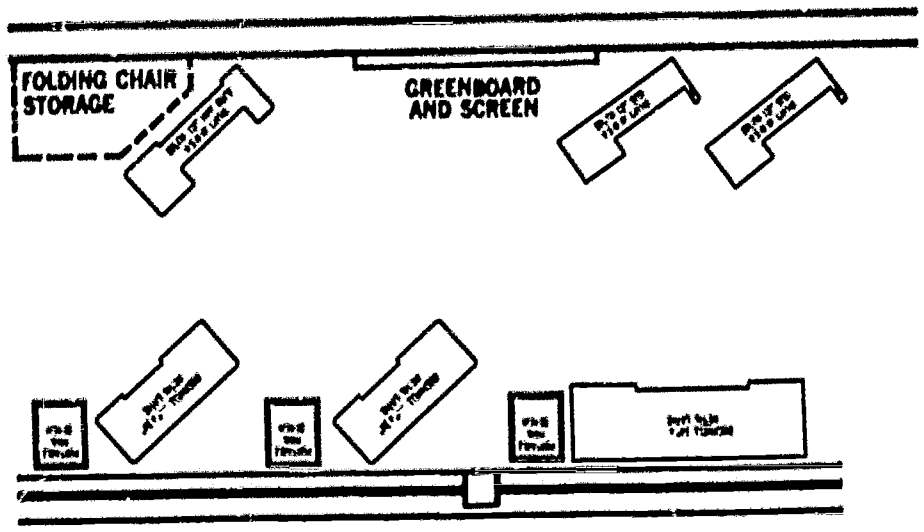
5. TOOL ISLANDS

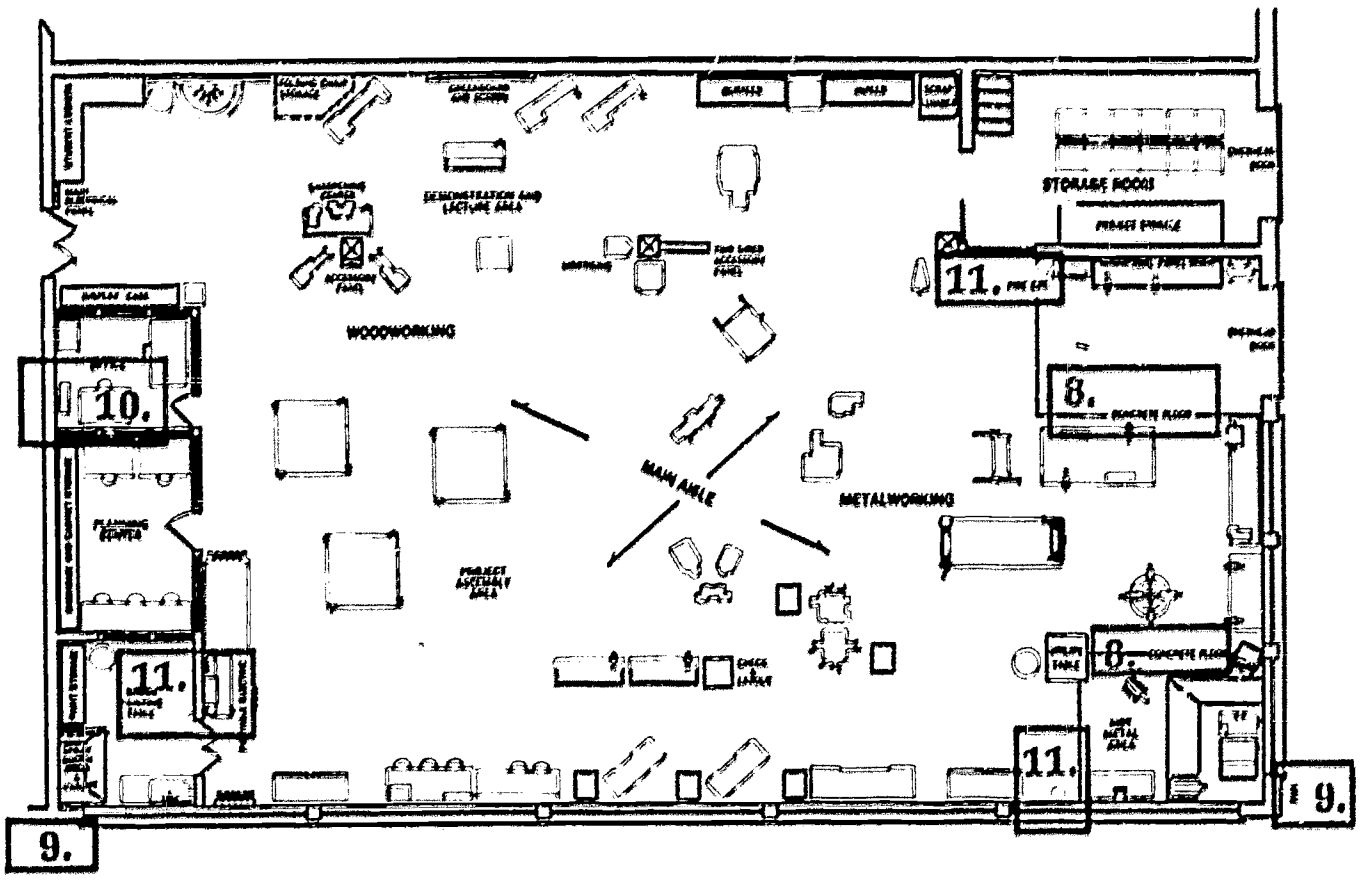


6. PANIC SWITCHES

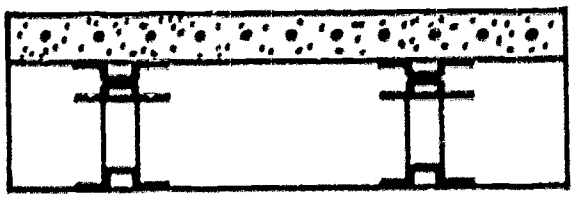


7. LATHES

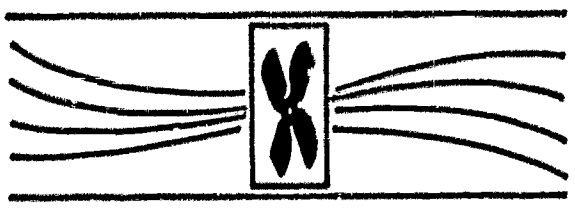




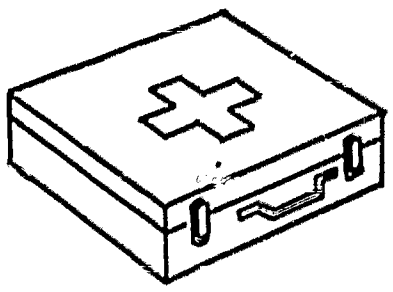
8. FLOORS



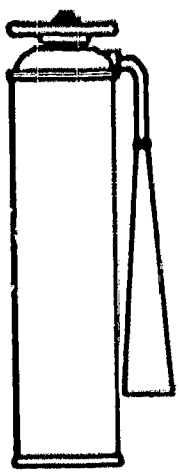
9. VENTILATION



10. FIRST AID



11. FIRE EXTINGUISHERS



quality of the shop lighting. Location near a window is ideal but not always possible. The plan illustrates both set-ups. Notice the precautions taken to minimize a potential problem of student access behind each lathe. A position paralleling the wall is one solution. Another solution (and one which makes better use of limited floor space) is to position each machine at an angle up to 45° to the wall and place a small cabinet or bench behind it, eliminating all but deliberate access.

8. FLOORS should be of concrete wherever a fire hazard exists or work involving water or oil is performed, i.e., hot metal, ceramics, power mechanics. Areas involving heavy machine work could also qualify for this type floor. Resilient floor tile or wood (plank or end grain blocks) are suitable for the remainder of the areas. Non-skid mats or other safety material should be placed at the operator's position for all machine work stations.

9. VENTILATION is the architect's responsibility as far as the overall shop is concerned. Separate exhaust systems are needed for the finishing rooms and hot metal operations and should be included when planning the location of these activities.

10. A FIRST AID KIT is necessary equipment and should be readily available. Its presence should be constantly evident to all students for psychological value.

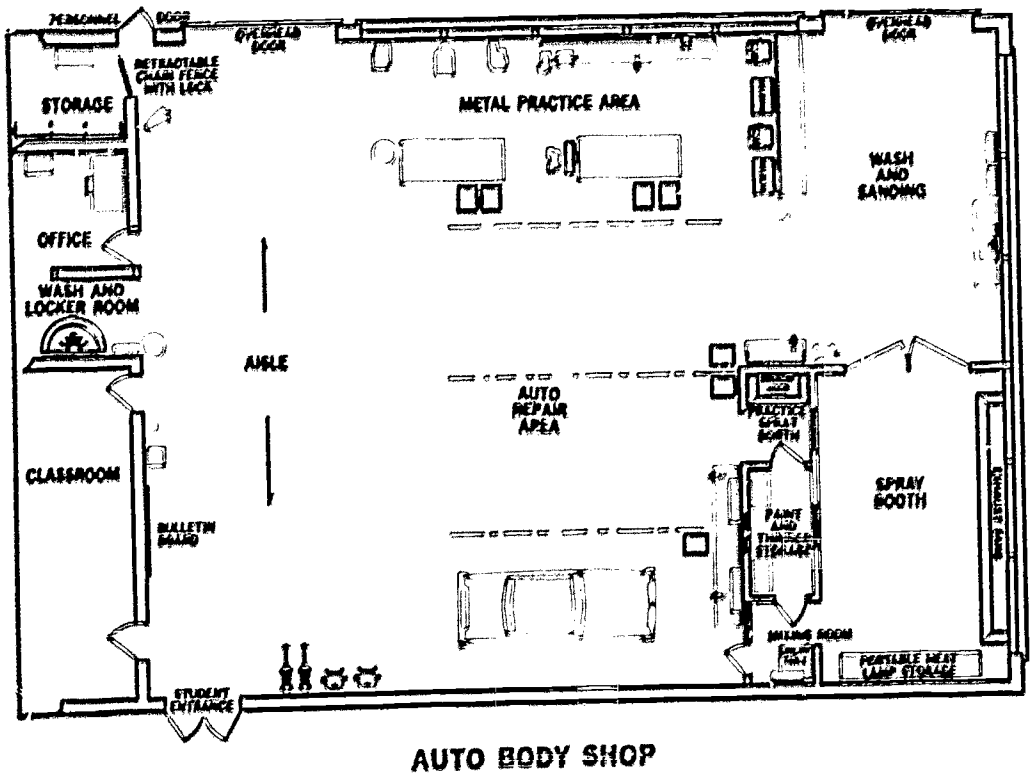
11. FIRE EXTINGUISHERS should be placed in close proximity to all activities constituting a potential fire hazard. It is desirable to position extinguishers in a recessed wall niche or suspend them approximately five feet above the floor. They also are strategically located for quick access from any part of the shop or laboratory. As a rule of thumb, one should not need to travel more than 100 feet to secure fire fighting equipment. Be sure to check local and state fire codes.

SAMPLE PLANS

Classification: Senior High School
Type: Auto Body Shop
Grades: 10-11-12
Subjects Taught: Body Repair
Metal Work
Auto Finishing

Number of Students: 26
Square Feet Per Pupil: 120

Auto Body Shop—Three activities are provided with a work space for five to seven cars. The car stall nearest the metal practice area is open at both ends, permitting car movement between body repair and finishing activities. Notice that volatile materials are stored in a separate and closed room. This room, along with the spray booth, is equipped with observation windows as well as adequate exits in case of emergency.

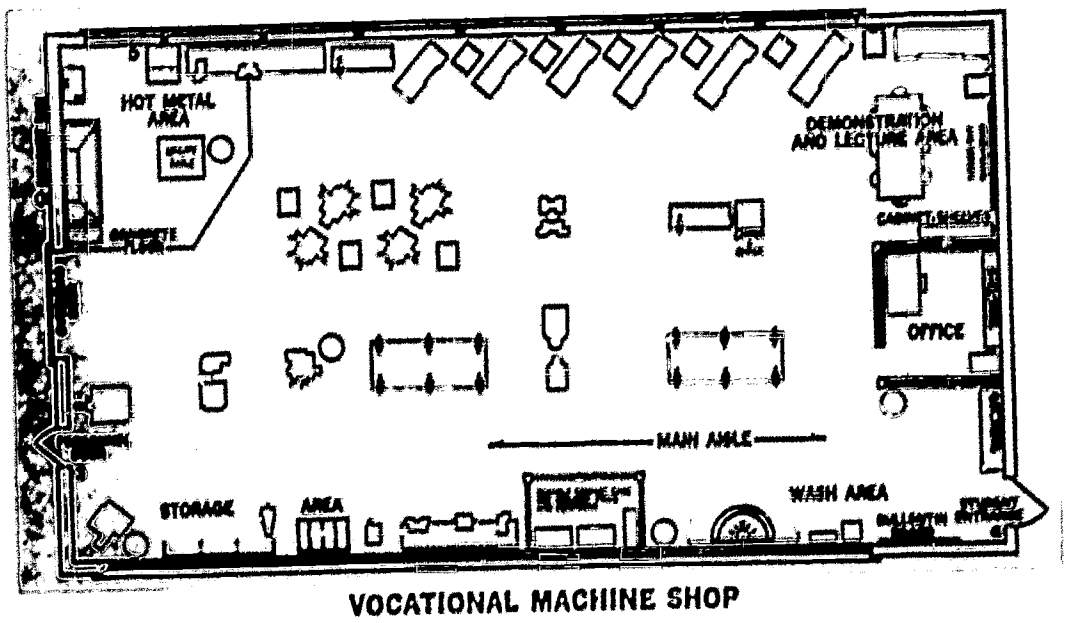


AUTO BODY SHOP

Classification: Vocational-Technical High School
Type: Machine Shop
Grades: 10-11-12
Subject Taught: Machine Tool Operation And Related Technical Training

Number of Students: 28
Square Feet Per Pupil: 89

Vocational Machine Shop—A number of space saving techniques are used in this layout. A formal aisle organization, almost totally dependent on the main aisle, is used to control and channel traffic in an orderly and predictable fashion. Another technique utilized is the restriction of relatively mobile activities, such as bench work, to one-half or less of the shop and to provide close proximity to the tool and material storage. Providing storage racks within the main shop itself is also effective. Notice the use of "back-to-back" tool islands to conserve space; also, how the four milling machines are turned to conform with the width of the surrounding aisles.

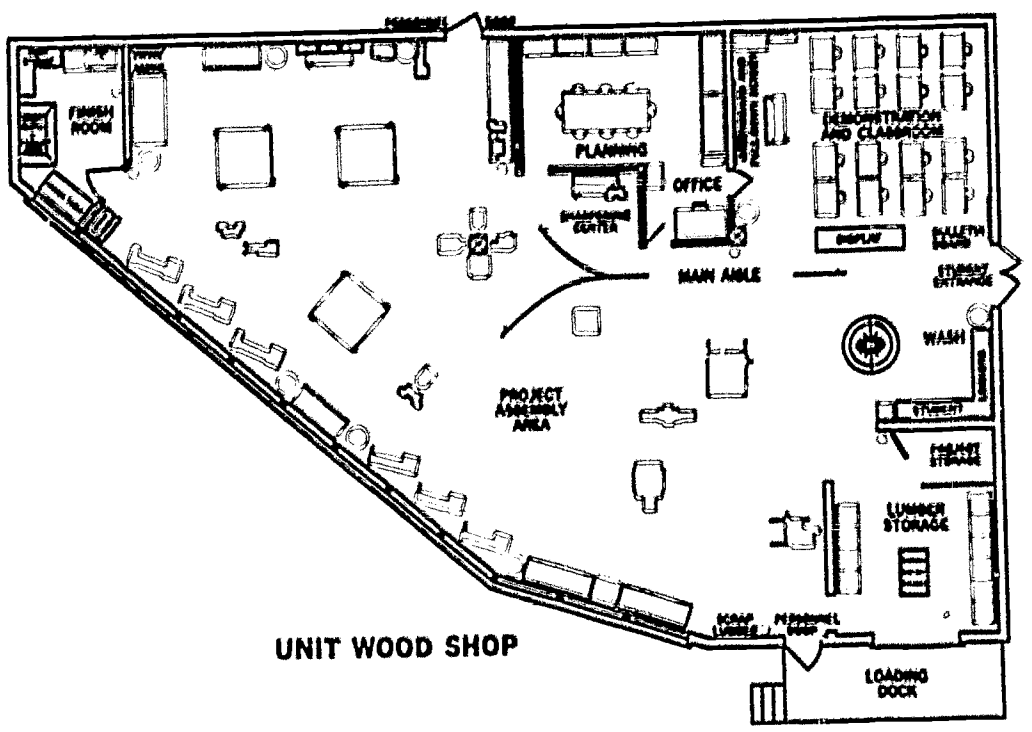


VOCATIONAL MACHINE SHOP

Classification: Senior High School
Type: Unit Wood Shop
Grades: 10-11-12
Subject Taught: Light & Heavy Wood Work

Number of Students: 32
Square Feet Per Pupil: 86

Unit Wood Shop—An unusual room configuration is illustrated in this layout, one that might be found in an older building or associated with similar wedge-shaped floor plans as evidenced in some new school construction. Converging walls that form acute angles demand adequate planning. In this case, the design is based on material flow paralleling the predominate outside wall and terminating at the narrow end of the shop. This allows the finishing room to make use of a restricted and odd-shaped area where large material handling space is not required. Three columns also influence this plan. They serve to divide the classroom from the main shop and also provide the basis for the main aisle organization. Notice, they are also responsible for a centrally located office that does not interfere with student traffic or material flow.



UNIT WOOD SHOP

EQUIPMENT
SPECIFICATIONS

EQUIPMENT
SPECIFICATIONS

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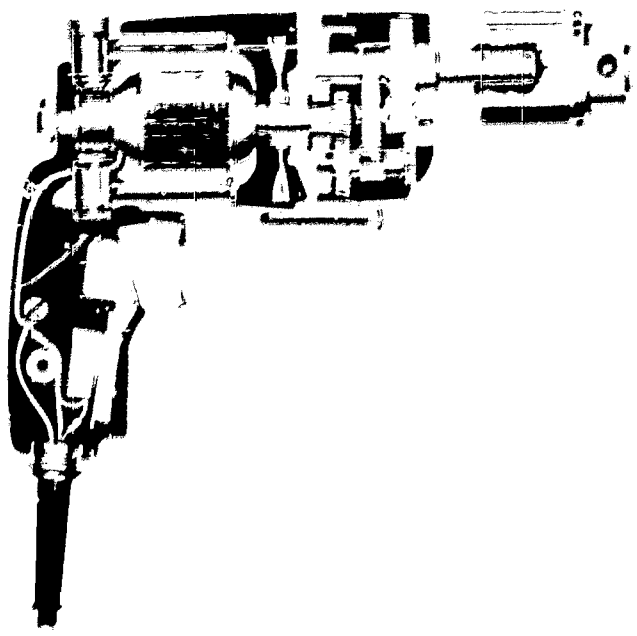
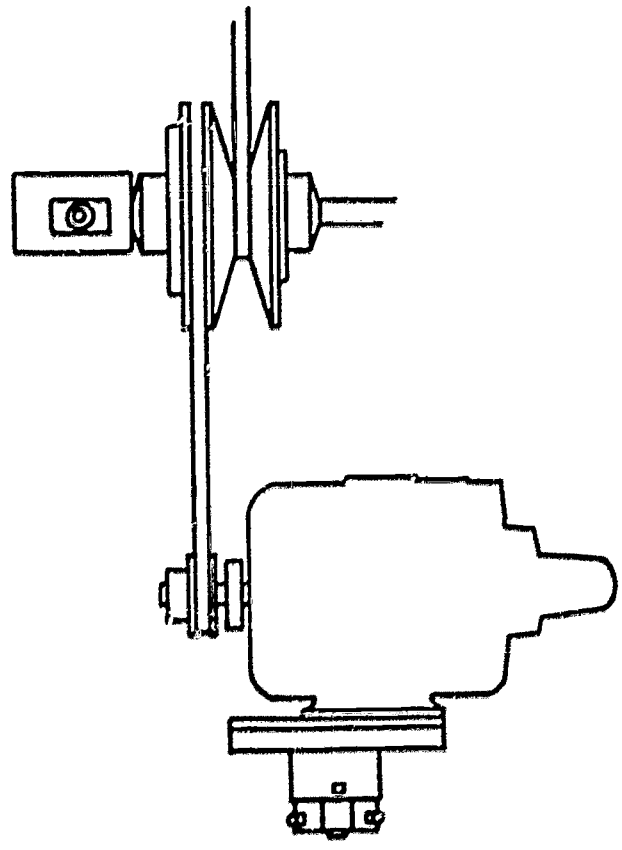




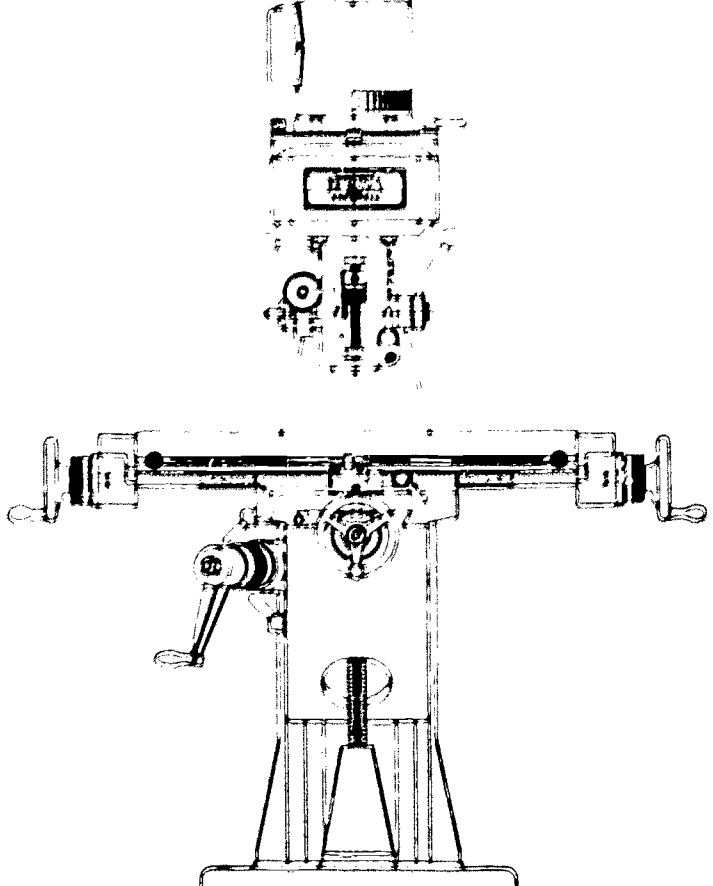
Basically there are two major reasons why any purchaser writes specifications. One is to obtain the exact equipment needed and wanted for a specific job. The other is to obtain the best price on this specified equipment. Since the writing of specifications is both time consuming and costly, every effort should be made to attain these primary objectives.

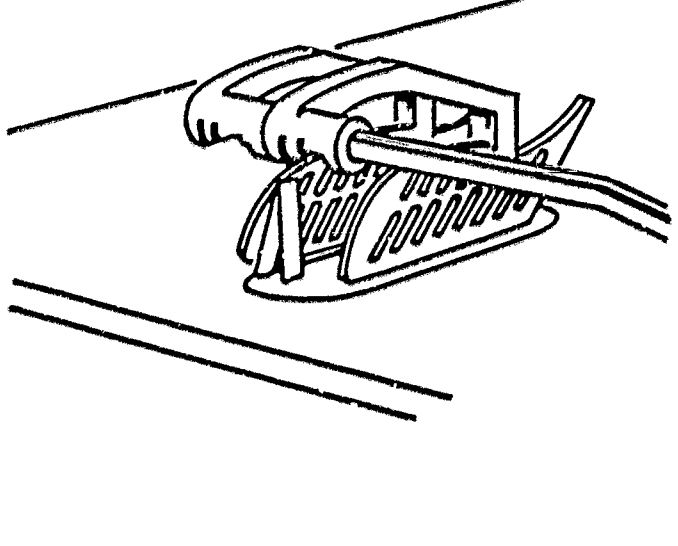
These two points should possibly be one all-inclusive objective since, to separate them in many cases, is either momentary or educational folly, assuming that some "educational" and "financial" research was done before the specifications were written.

The most expensive equipment may cost more than the tax structure or budget will support; by the same token, however, the least expensive may not meet the requirement for quality or for educational use. Based on this general premise, the purchaser must now write his specifications in order to obtain the "best value" within his allowable price range.

Specifications should be arrived at and written after a complete investigation of the educational values involved. For example, is the tool basically well engineered? This might also give the instructor a chance to teach or to indicate good design, which is certainly a part of industrial education. Certainly, some thought should be given to safety, not only for the student or the operator, but also of the machine itself. Some thought might also be given to the versatility of the equipment; i.e., will it perform various jobs other than those generally intended without creating either an unsafe operating situation or causing damage to the machine? Are needed and correctly engineered accessories available from the same manufacturer?

Other more intangible requisites should also be considered when writing specifications for equipment. The manufacturer's reputation should be taken into consideration, also that of the distributor from whom the equipment actually will be purchased. Are these two organizations as a team interested in industrial education or are they interested only in "selling equipment?" Consideration also might be given to the teaching aids or other helps available from either the distributor or the manufacturer, including factory trained personnel in the field. The quick availability of parts is a factor which has a definite bearing on education since downtime on a machine oftentimes has far reaching effects on the instructor's educational program.





When involved in the details of equipment specification writing, some thought should certainly be given to the differences between "physical data" such as weight and detailed dimension versus "educational value," such as desirable safety or student-use features, and the various intangible benefits involved. On any one piece of equipment, regardless of its size or type, furniture or tools, every effort should be made to insure that all needed items are specified. This could involve the desired motor, controls, or even accessories, and/or tooling needed for actual operation. A drill press without a motor would be similar to a desk without a chair. This type of thing happens frequently enough to mention as a pitfall, regardless of how ridiculous it may seem. The manufacturer's catalog or specifications should be used as a check for possible errors in this category. Local legal requirements also enter into the picture in many cases in regards to the "tightness" of the specification, the use of terms such as "or equal," or "approved equal." When specifications are written only on relatively unimportant "machine data" information, it would seem that little consideration is given to the educational, safety, versatility or longevity values of the equipment.

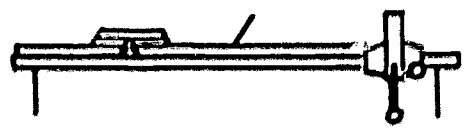
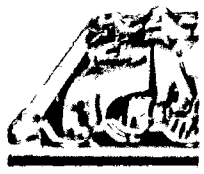
By writing the specifications around the specific features that match your educational need, by including all necessary items for correct operation, and by accepting nothing less when the bid is awarded, you insure yourself and your students that the "hardware" is matched to your program—not too large, too small, too expensive, too cheap, or otherwise inadequate.

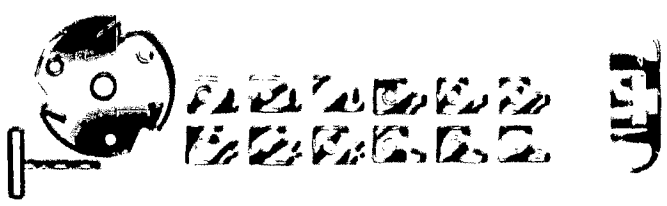
One of the most important benefits is the fact that the equipment is matched to your prior educational specifications and objectives. In too many cases a director or teacher is forced to build his course of study around existing equipment or layouts. This system of "first-things-first" makes good educational sense. Incidentally, it also places equipment advertising copy, multi-colored brochures, and sales experts in their proper prospective as part of your normal investigating process.

The first stated reason for writing specifications is by far the most important, when based on the educational need. The best price is still vital, but only if the specifications are met by the bidder.

If these general ideas were followed, it would have far-reaching effects in improving the quality and design of even the best equipment made today in relation to the needs of industrial educators.

Example of a specification written with justification to insure obtaining the needed "features" important to education—as opposed to dimensional and "Machine Data" specifications.

10" Tilting Arbor Saw: to include extension wings; single control "jet lock" micro-set rip fence to be  self-aligning for accuracy and ease of operation; fence to ride on tubular guide bars; to include a  safe, modern guard with retracting splitter; table to have "T" slots;  three V-belt drive to run between sealed-for-life ball bearings on the arbor assembly to insure long life and vibration-free operation; blade to tilt to the right  away from the operator's hand, for safety; trunions to be mounted and located on extreme front and rear of cabinet for  perfect alignment and accuracy; motor to comply with or exceed National Electrical Manufacturers Association (NEMA) standards; Manufacturer to have available  safety nomenclature charts and other  instructional aids for the machine; machine and major accessories to be shipped with  complete parts and instructional manual; manufacturer to have available a complete line of accessories

 for the machine. Specific model to be _____

_____ 2 HP, 3 Ph, 230 V, magnetic starter—delivered ready-to-run.

PURCHASING
PRINCIPLES
AND COSTS
PURCHASING
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LONG RANGE—OR "PLANNED PURCHASING" FOR REPLACEMENT—DEVELOPMENT—IMPROVEMENT

Most industrial arts and vocational education teachers agree that it is difficult enough to handle all the various problems connected with teaching a subject, maintaining equipment and planning a work schedule without having to "fight" for new equipment.

One of the best aids that the typical instructor or director may find as a solution to this problem is to make an outline of the complete program. First of all, the objectives should be clearly defined and the instructional methods used to attain the objectives clearly stated. Second, he should justify his program as it relates to the school district, community or area in which he teaches. Specifically, he also should prepare an estimate of the costs involved in carrying through the program's objectives. These should cover not only the expendable items which normally are purchased from year to year but also the purchasing of new equipment to open up new areas of "industrial investigation" or to replace older equipment now obsolete.

The benefits derived from even a simple program such as this would aid industrial arts and vocation industrial education in many ways. One of the benefits would be better public understanding of the principles and objectives behind the specific instructor's program and, therefore, better public support. Certainly, the school board's annual job of budgeting would be made easier if the industrial education department indicated not only how much would be needed yearly but also how much would be potentially spent over a five-year or ten-year span if its objectives were to be achieved. Short and long-range planning such as this would result in a better industrial education department, assure more equipment and make for better instruction. This, in turn, would make the instructor's job easier, more rewarding and the level of education should greatly improve.

In other words, a goal should be set giving the overall program objectives, instructional needs and equipment requirements which could be readily understood by any supervisor, any board of education and any school community at large.

A program such as this would enable the industrial education department to better meet the needs of the community and, if desired, it could work closely with the mathematics, science and physics departments to meet our nation's long-range educational objectives.

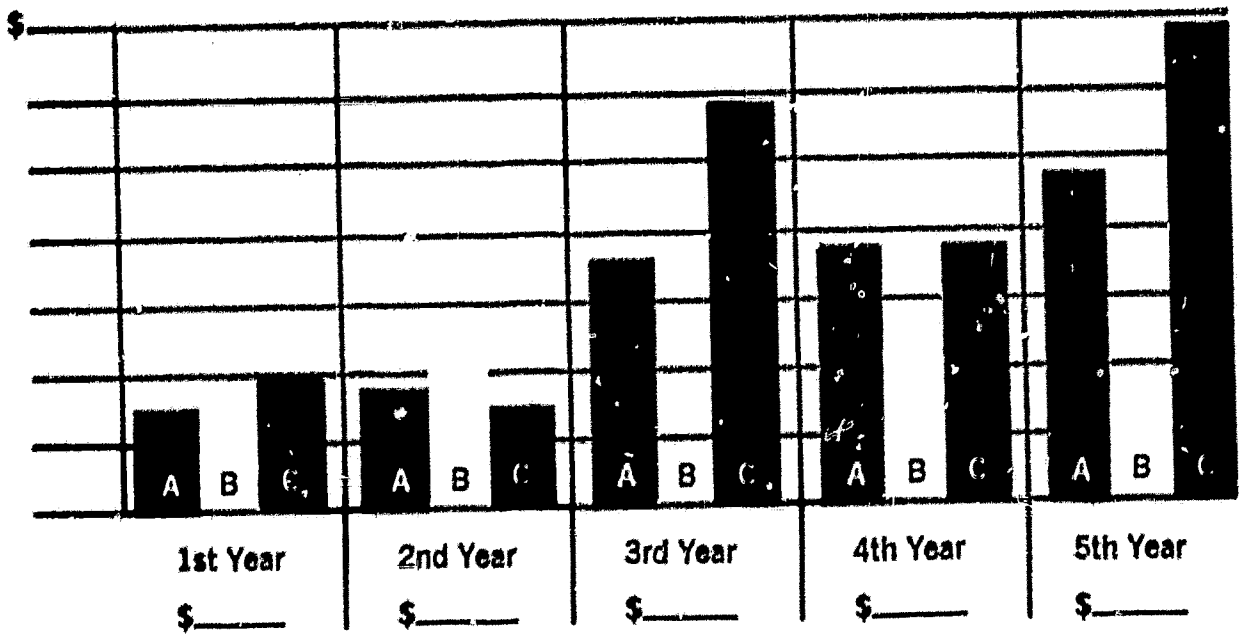
This plan could be adjusted to meet almost any situation; furthermore, it could be as complicated or as simple as the situation might require.

EXAMPLE:

A. ■ Instructional Supplies—for all types of expendable supplies, plus small hand tools.

B. Repair and Replacement of Instructional Apparatus—includes all types of fixed equipment.

C. ■ Capital Outlay for New Acquisitions—covers the purchase of all types of new equipment.



1st Year (Normal supplies; re-finish benches; new vises and new grinder)

2nd Year (Normal supplies; replace table saw and recondition jointer; new shelving and paint storage cabinet)

3rd Year (Normal supplies, including plastics; recondition scroll saw; new shaper, new plastics bench, heater and buffer)

4th Year (Normal supplies; recondition metal lathe; new lathe chuck and accessories)

*5th Year (Normal supplies, including increased metal stock; recondition precision tools; new additional small metal lathe)

*Attainment of objectives for the Industrial Education Program as planned 5 years before. Obviously, this should be a continuous and overlapping process.

VALUE ANALYSIS IN PURCHASING

The problems of school purchasing have mushroomed in recent years as jointures, mergers and consolidations have pyramided many modern school systems into organizations of corporate proportions.

This physical growth has been accompanied by increased purchasing responsibility for the administrator. He has, in effect, the same problems faced by an industrial purchaser. How can he tell when a bargain really is a bargain? How can he know what to look for in unfamiliar items? How much service and advice can he rightfully expect either before or after a purchase is completed?

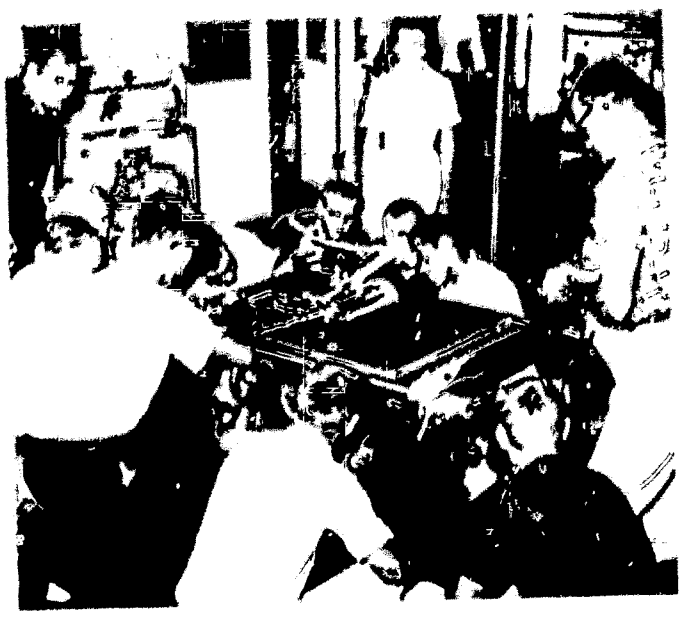
These and other ulcer-producing questions have no pat answers. However, by applying four principles of value analysis used by many industrial purchasing agents, the school administrator will be able to make purchases confidently and on a systematic basis that should satisfy even the harshest critics. These four principles are:

Quality
Service
Safety
Real Cost

Let's take these principles one by one and apply them to the purchase of industrial education equipment. Some administrators might think an objective evaluation of drill presses, lathes or other power tools is beyond their ability. An industrial purchasing agent, when faced with the same problem, applies the four principles of purchasing.

Quality doesn't wear a neon sign. It is intangible and, in effect, is the sum total of a manufacturer's reputation and integrity. A good reputation requires time, yet cannot be achieved through time alone. A manufacturer who turns out the same model for years will have a reputation, but it may be a reputation for making out-dated equipment.

At the same time, "improvements" that are nothing more than useless gadgets detract from the reputation. It is here that integrity comes into the picture. A manufacturer in a competitive situation may feel pressed to use cheaper materials, add a few fancy knobs and market the resulting machine as a "major advance." If



he resists the temptation, that's integrity. If he not only resists but continues to make fine equipment with actual improvements, that's progress. Put them together and that's quality.

ASK PERTINENT QUESTIONS

Although a busy adminstrator doesn't have time to probe the corporate history of a company in his search for quality, he still can ask a few pertinent questions, and the answers will either justify or negate continued negotiations.

In addition, the administrator should ask for a list of schools where the equipment is in use and request their candid comments. Is the equipment doing all the salesman said it would? How long has it been in use? Has the school purchased items from this manufacturer before? Would they buy them again?

With these answers, the administra. . .l have enough information to be reasonably sure of buying quality. Any reputable manufacturer w.ald welcome such a test.

Service, the second guide to purchasing, is sometimes overlooked in the buying process. Too late, the buyer finds that the needed part is stocked at only one location and will take weeks to deliver. Imagine your industrial education program severely curtailed because a drill press or lathe is out of service for lack of a minor part. Industry calls this "down time" with probable financial problems. To the school administrator, it's lost "education time" with possible accompanying discipline problems. With local distributors, franchised parts outlets or factory branches located throughout the country — oftentimes a requirement and necessity for a reputable maufacturer — this does not happen.

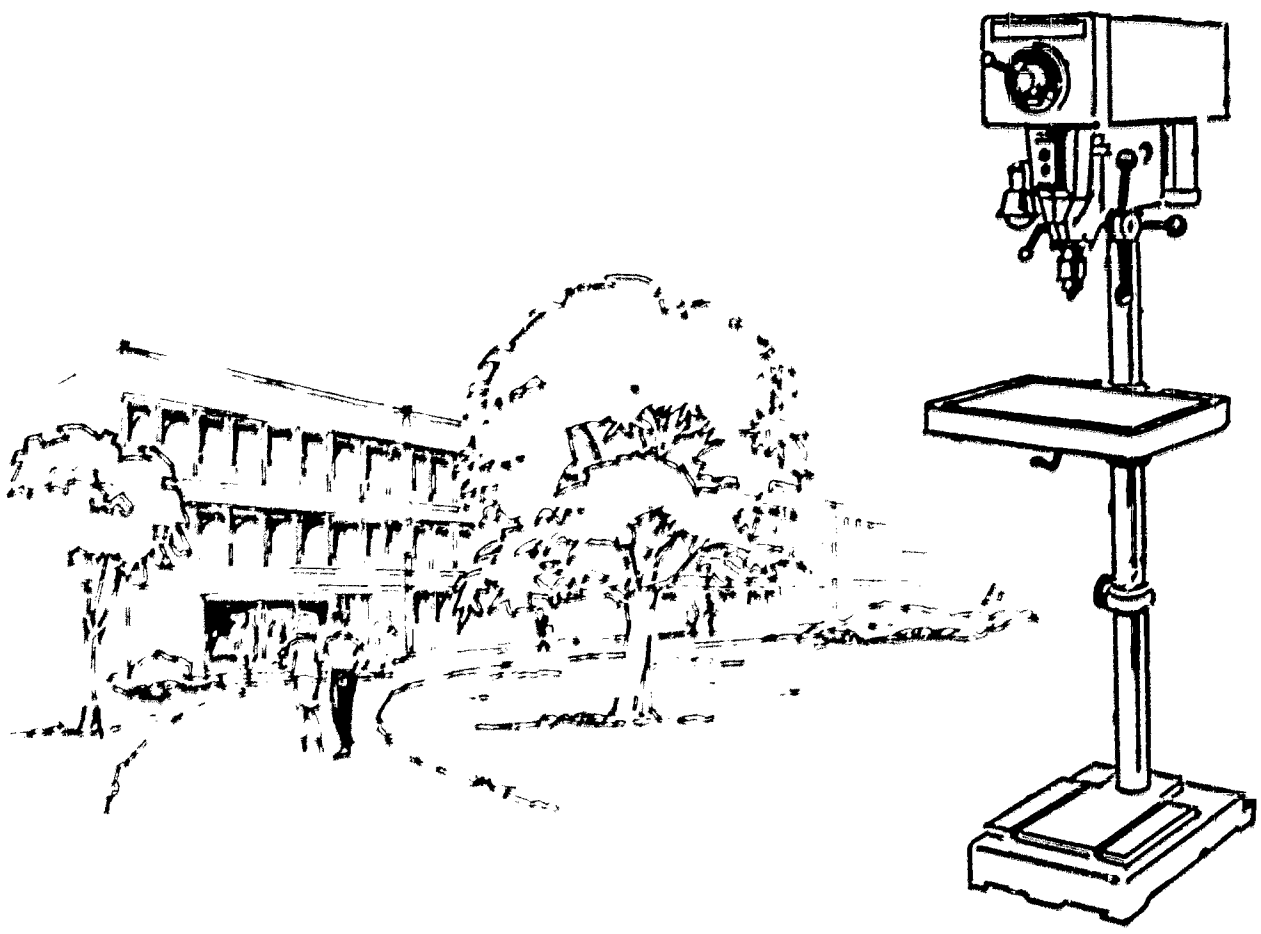
Service should not end with easily available spare parts and an instruction manual. Service must be a continuing part of the sale. Trained factory field men should be available on reasonable notice to examine malfunctioning equipment. The manufacturer and distributor should provide maintenance and instructional aids to help the teacher, the students, and the school get the most from their machines. You would expect no less when you buy an automobile, so why should you settle for less in your professional purchases?

Safety, the third guide to the purchase of power tools, or to any other product, must go far beyond the general feeling that safety is adequate if guards are provided over belts or pulleys or if a conventional hood is placed over a saw blade. Here, again, safety must be thought of as a built-in requirement that traces its origin back to the original design of the tool. Does the machine merely provide the usual mechanical and electrical safety features or is the inexperience and curious nature of the students also taken into account? A few minutes spent investigating safety features in detail might save many hours at a later date explaining to parents how an accident happened, through no fault of the student.

Real cost, the final guide to purchasing, is not the original cost of the tool. Real cost is the value received for the amount paid, and only the buyer can set the value standards.
The administrator must determine the over-all educational goal of his school before he begins to determine real cost. Is the industrial arts or vocational education program a broad one? Then, he must be prepared to purchase a wide range of tools, including a number of specialized machines. If, on the other hand, the program is limited in scope, the administrator should concentrate on purchasing power tools that offer some flexibility.

IS BIDDER RESPONSIBLE

Some administrators mistakenly believe they must, under law, purchase goods and material at



the lowest price. Although state laws vary, the general rule is that purchases must be awarded to the lowest *responsible* bidder meeting the specifications, not the lowest dollar bidder. Although the two may be the same, they are not necessarily synonymous.

Many man hours of professional knowledge are used to write specifications, with both education and these four principles of purchasing in mind, only to be disregarded completely in favor of a low dollar bid. This unfortunate situation has far reaching effects on education, from all aspects, and possibly on future dollars spent to change, repair or otherwise correct an original error in purchasing. Don't confuse "best value" with "best price." Unfortunately, there are no established government standards for the tool industry as there are for drugs, dairy products and foods. Therefore, the purchaser must rely on the reputation and integrity of the manufacturer and experience of others.

The final decision is seldom easy and not always correct, but if the administrator is sure of his educational goals, and if he has applied the four principles of purchasing, he can face the future and the taxpayer with assurance.

The vital question, "How much will it cost?" is always present, even in the initial stages. This dollar figure is a very relevant thing and any "educated guess" must be made with as many factors in mind as possible:

General Shop—Unit Shop—
Specific Areas—
Wood, Sheet Metal,
Machine Shop,
Graphic Arts,
Automotive,
Electronic,
Plastics and Crafts.
Orientation—
Wood Shop—
Cabinet or construction.
Industrial Arts or
Vocational or both.
Project oriented or
technically oriented.
One or two or more instructors.
Junior High School—Senior High School.
Size of Shop, Size and Quality of the Equipment.
Number of Students.

The following "rules of thumb" may be of help, if tempered with on-the-spot information.

1. Average Cost of Stationary & Portable Tools per laboratory or shop, $7,000 to $10,000.
   This could be from $4,000 for a limited Junior High School Program to $25,000 or more for a Unit or Vocational Machine Shop.
2. Rough Formula for IE potential
   Total cost of new school × .01 = IE Dept. Budget.
   Sample: $4,000,000 × .01 = $40,000
   The Industrial Education portion of the school budget could run more in an "Industrial" community than in an academically-minded community.
3. Tools in a laboratory or shop average 40% of cost.
   This is defined as Stationary and Portable power tools, Electric or Air and Machine Tools. It would be higher in a Vocational or Unit Shop.
4. Allied equipment averages 60% of cost.
   This is defined as lockers, benches, hand tools, storage racks, and other similar items. It could be lower in a Vocational or Unit Shop.

The amount of money originally designated for Industrial Education dictates many of the detailed plans for the curriculum, equipment and physical layout.

SCALE
OUTLINES
SCALE
OUTLINES
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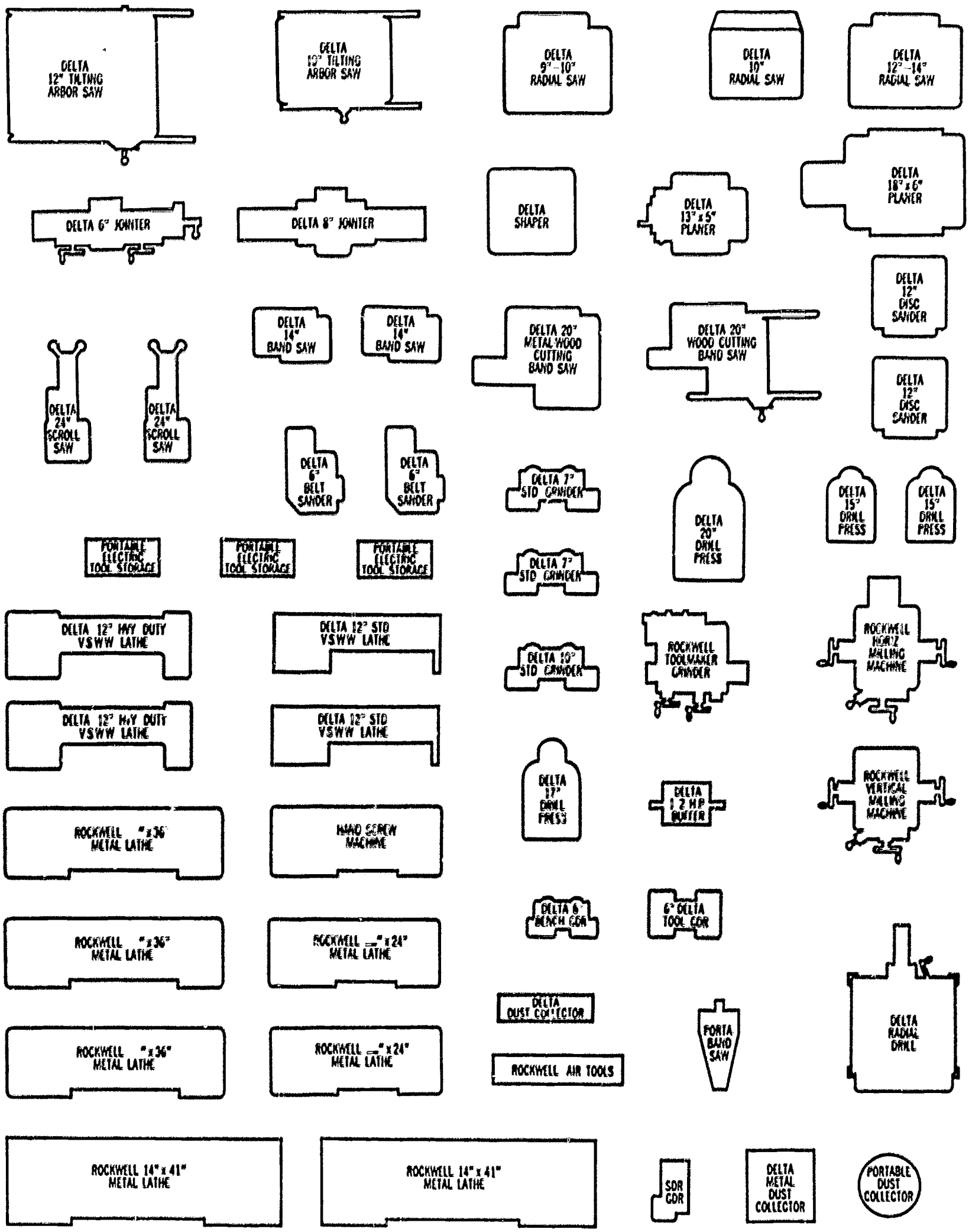
OUTLINES

SCALE OUTLINES OF ROCKWELL INDUSTRIAL MACHINES

Scale—1/4"=1'-0"

Use these Machine Templates to assist you in locating the power tools in your shop. If you desire, you can remove this page to facilitate your tracing the templates onto your shop plan; or each template can be cut out and placed directly on your layout. This page may also be reproduced if additional copies are needed.

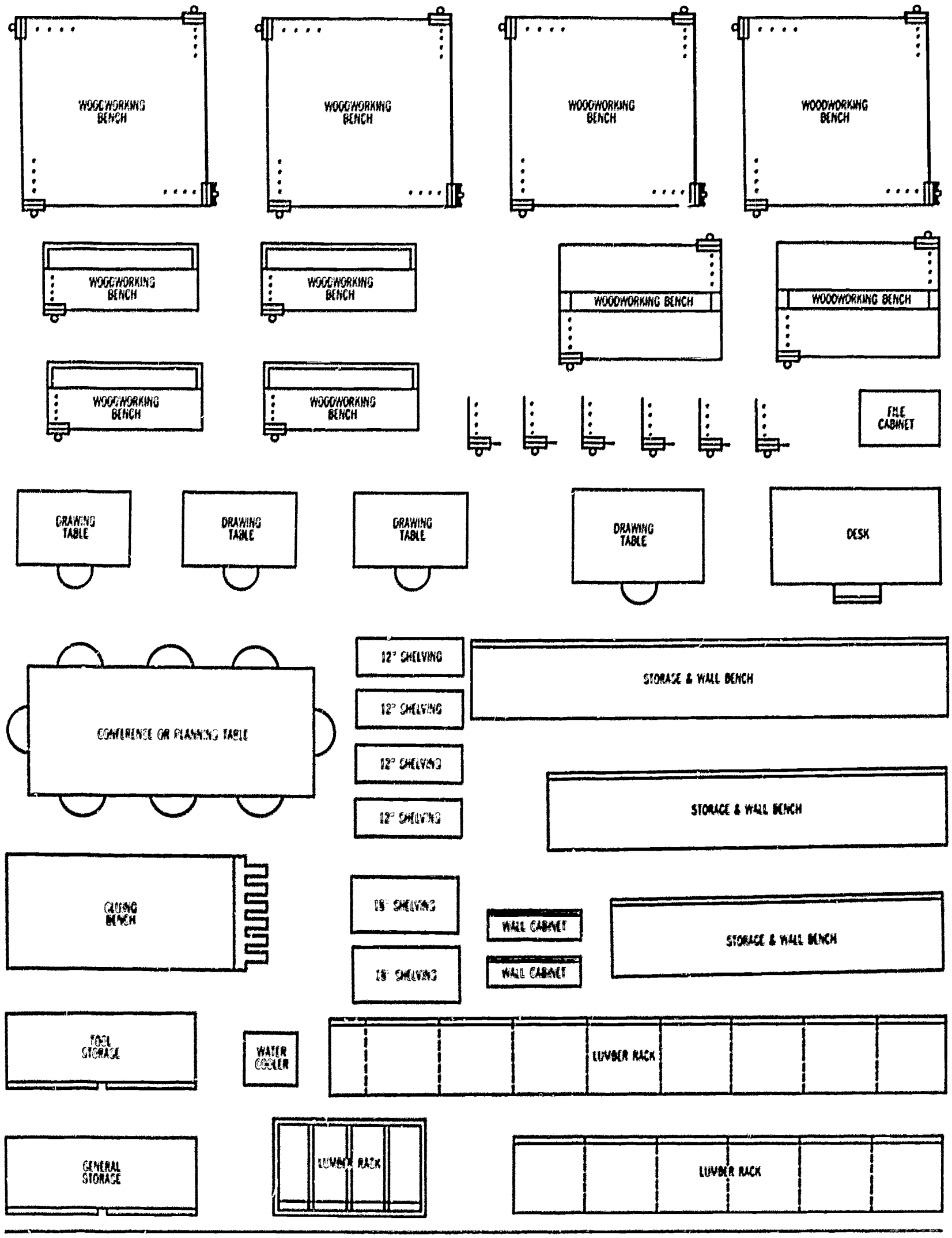


For additional copies of this form request AD-1735

SCALE OUTLINES OF ALLIED SHOP EQUIPMENT

Scale—¼"=1'-0"

These templates represent the major types of additional shop equipment that may be considered when laying out your shop plan. This page can be removed to aid you in tracing the templates onto your shop plan or, if desired, you may cut out each template and place it directly on your layout. This page may be reproduced if additional copies are needed.



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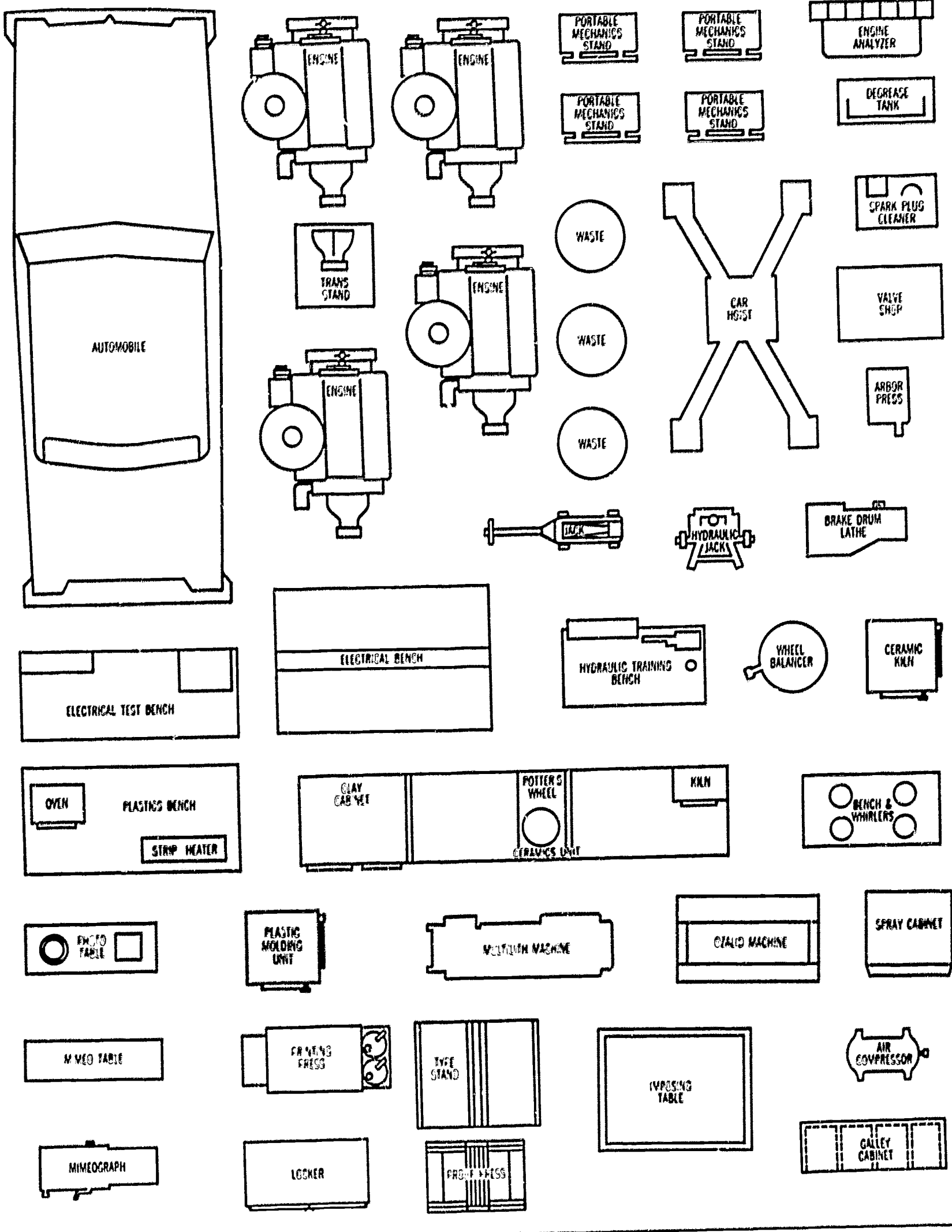
For additional copies of this form, request AD-1737

SCALE OUTLINES OF ALLIED SHOP EQUIPMENT

Scale—1/4"=1'-0"

These templates represent the major types of additional shop equipment that may be considered when laying out your shop plan. This page can be removed to aid you in tracing the templates onto your shop plan or, if desired, you may cut out each template and place it directly on your layout. This page may be reproduced if additional copies are needed.

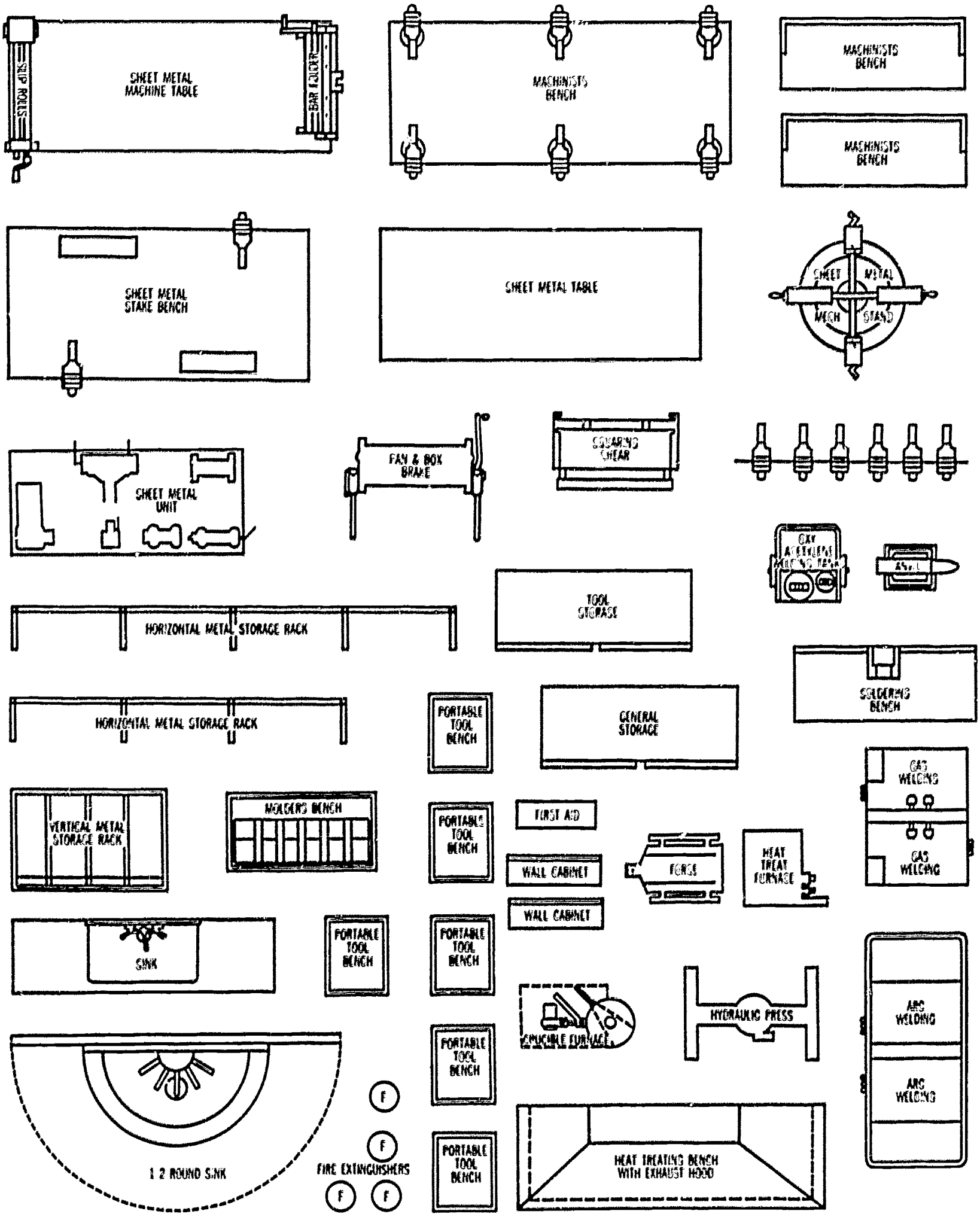


For additional copies of this form, request AD-1738

SCALE OUTLINES OF ALLIED SHOP EQUIPMENT

Scale—¼"=1'-0"

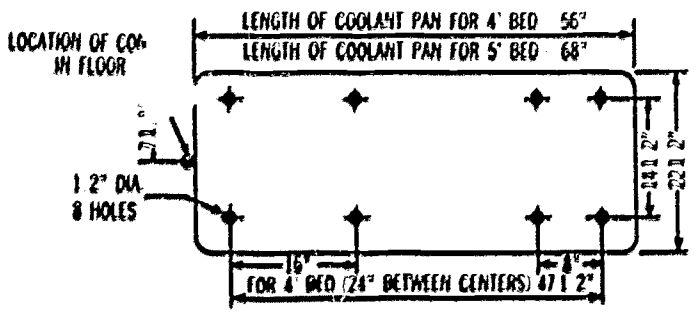
These templates represent the major types of additional shop equipment that may be considered when laying out your shop plan. This page can be removed to aid you in tracing the templates onto your shop plan or, if desired, you may cut out each template and place it directly on your layout. This page may be reproduced if additional copies are needed.



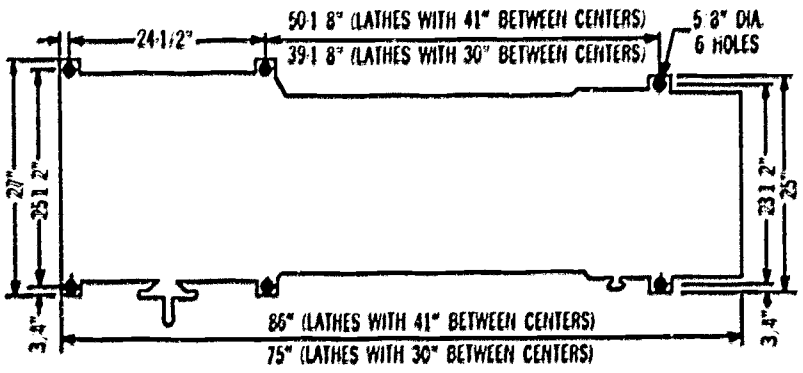
For additional copies of this form, request AD-1736

FLOOR SPACE AND MOUNTING HOLE DIMENSIONS FOR ROCKWELL INDUSTRIAL MACHINES

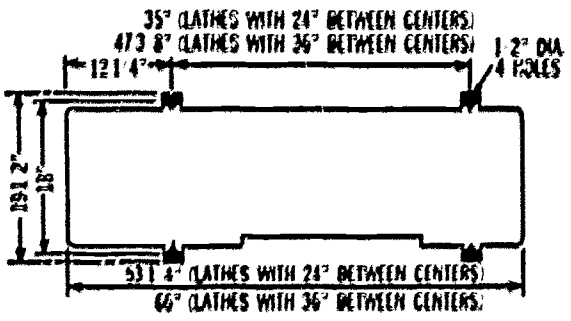
The following drawings are not necessarily to scale nor intended to serve as templates. Their purpose is to provide necessary dimensions for accurate positioning of machines and possibly securing them to the shop floor.



HAND SCREW MACHINE

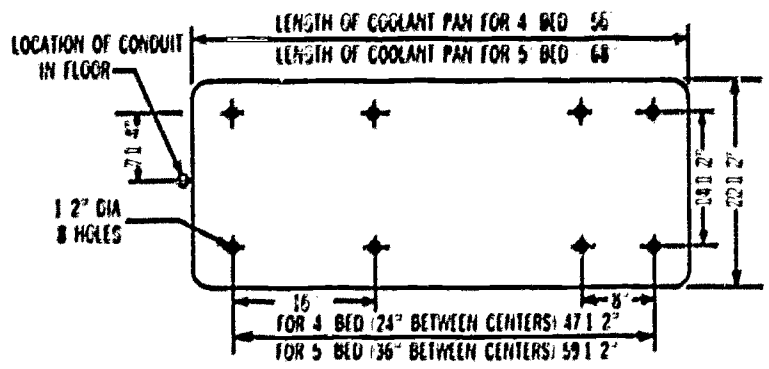


14" METAL LATHE

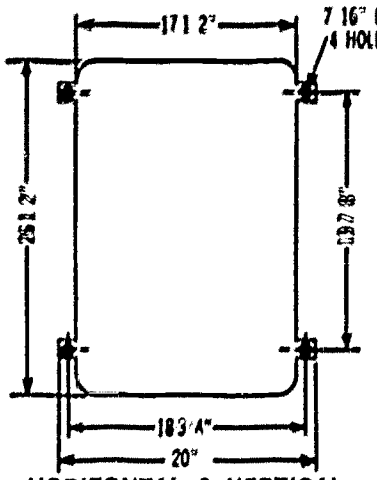


10" METAL LATHE

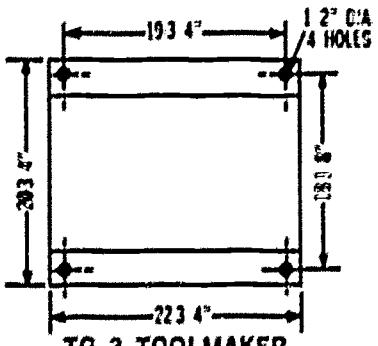
BOLT HOLE DIMENSIONS



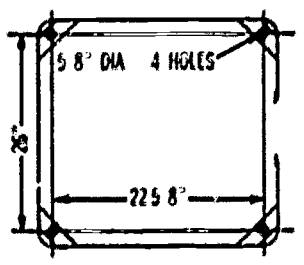
11" METAL LATHE



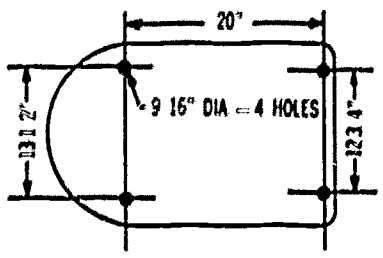
HORIZONTAL & VERTICAL MILLING MACHINES



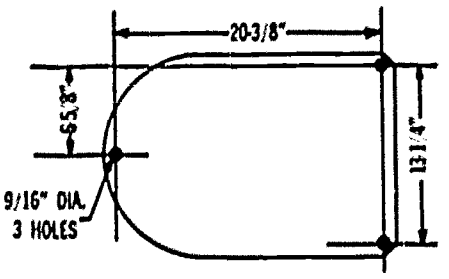
TG 3 TOOLMAKER GRINDER



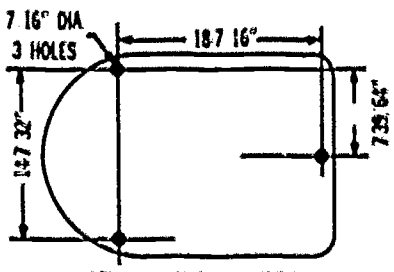
12" TILTING ARBOR SAW



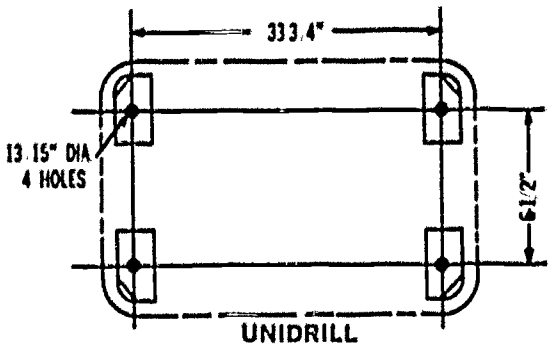
20" DRILL PRESS



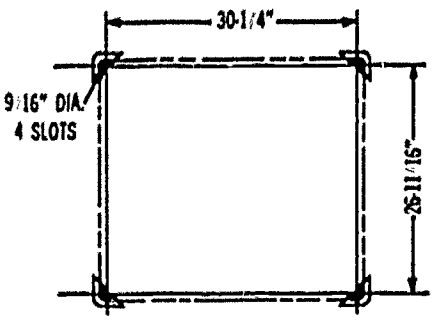
15" DRILL PRESS



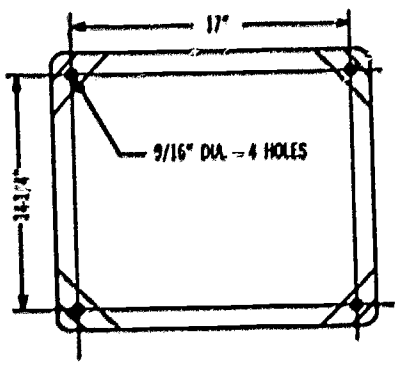
17" DRILL PRESS



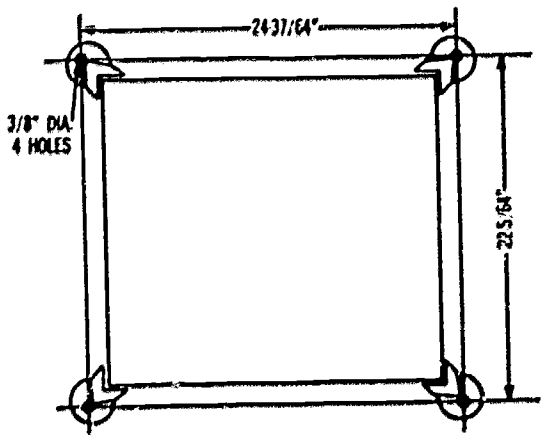
UNIDRILL



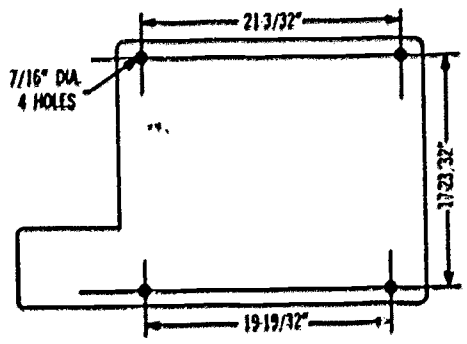
RADIAL DRILL PRESS



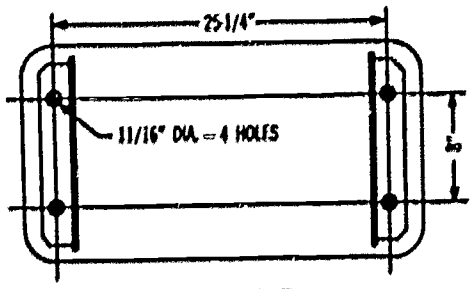
8" JOINTER



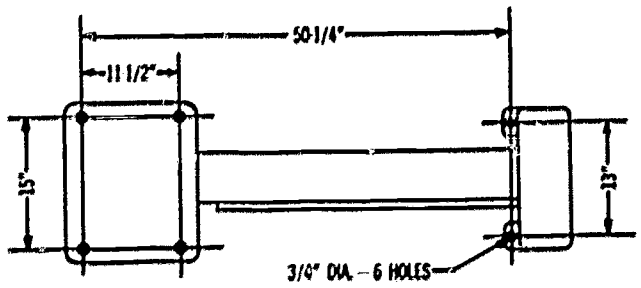
10" TILTING ARBOR SAW



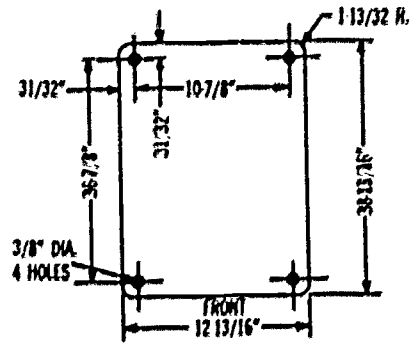
20" BAND SAW



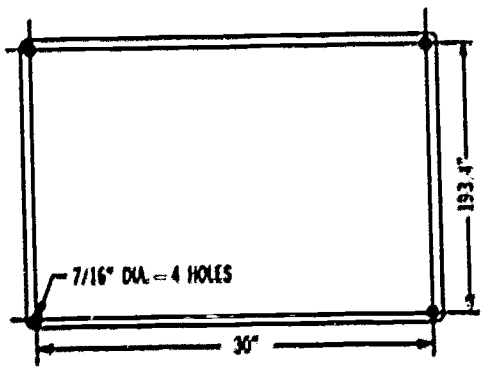
13 x 5" PLANER



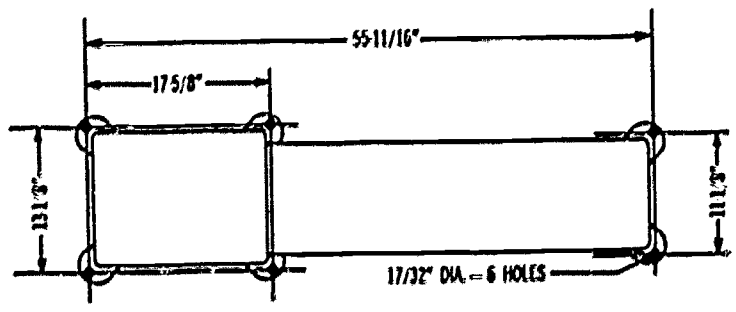
12" WOOD LATHE



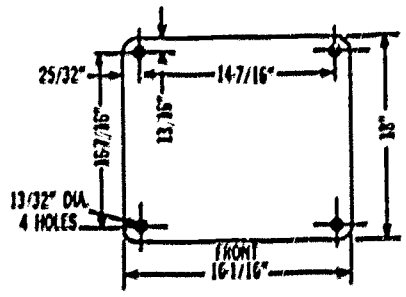
24" SCROLL SAW



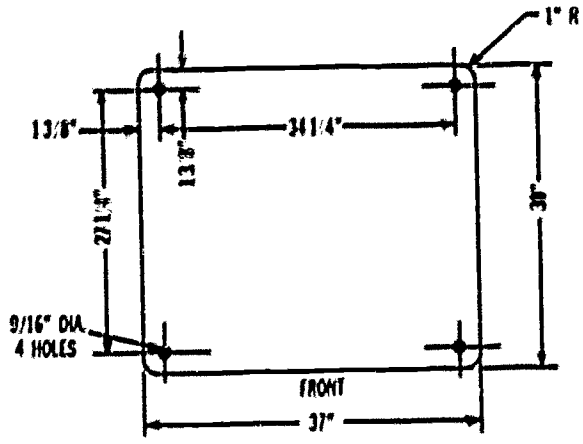
18 x 6" PLANER



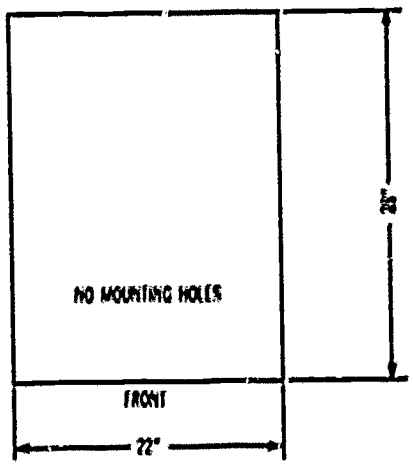
12" GAP BED WOOD LATHE



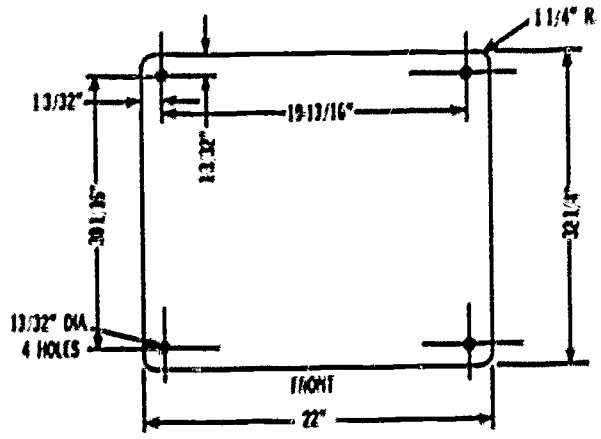
12" SANDER



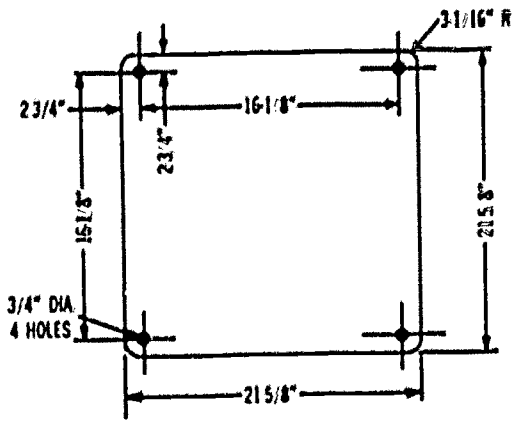
12"-14" RADIAL SAWS



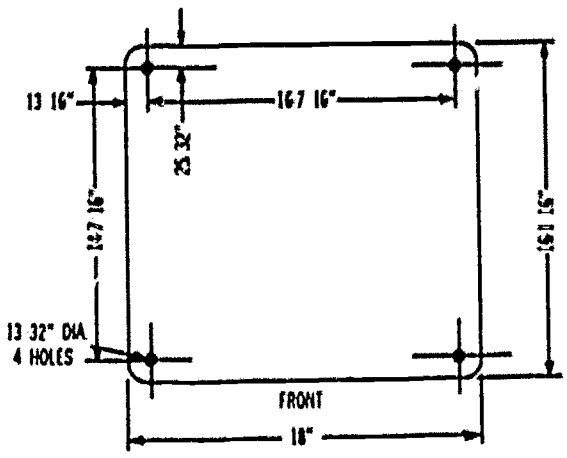
9"-10" RADIAL SAWS



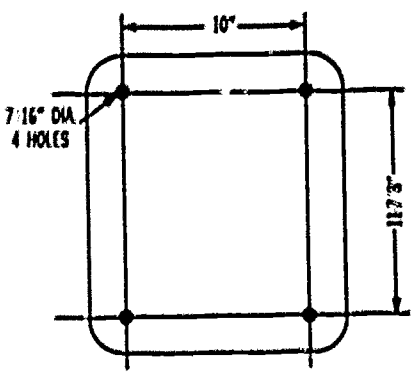
10" RADIAL SAW



WOOD SHAPER



6" BELT SANDER



6"-7"-10" GRINDERS

AIDS AVAILABLE
AIDS AVAILABLE
AIDS AVAILABLE
AIDS AVAILABLE
AIDS AVAILABLE

Teaching aids cover a great variety of media from film to hardware, books to charts. Many of the most valuable aids are actually "instructor produced" or built and fit exactly into a specific curriculum.

The major problem any manufacturer or publisher has in producing a teaching aid is to make it meet the various objectives of literally thousands of course outlines. In some cases the instructor can write his own complete course outline around a "commercial" teaching aid but, in most instances, commercial aids are a help, an addition, or are used to broaden the student's background. Often, commercial aids encourage further and deeper investigation into a specific subject or problem area.

As an instructor, you have at your disposal many free or inexpensive aids, whether you are in the field of industrial arts or vocational industrial education. Complete lists of manufacturer-produced aids are published annually in leading Industrial Education Journals.

Actual samples of commercial aids, or literature describing them, are available from most manufacturers or their local distributors. After obtaining this information, a definite format can be set up to help evaluate their possible use in your specific teaching situation. *For example, the format could follow this form:*

1. Original purpose: Safety, better mechanical operation, background information, nomenclature, or a combination of these.

2. Type of aid: Chart, film *(type and kind)*, model, book.

3. Cost of the aid: Free, nominal charge, expensive.

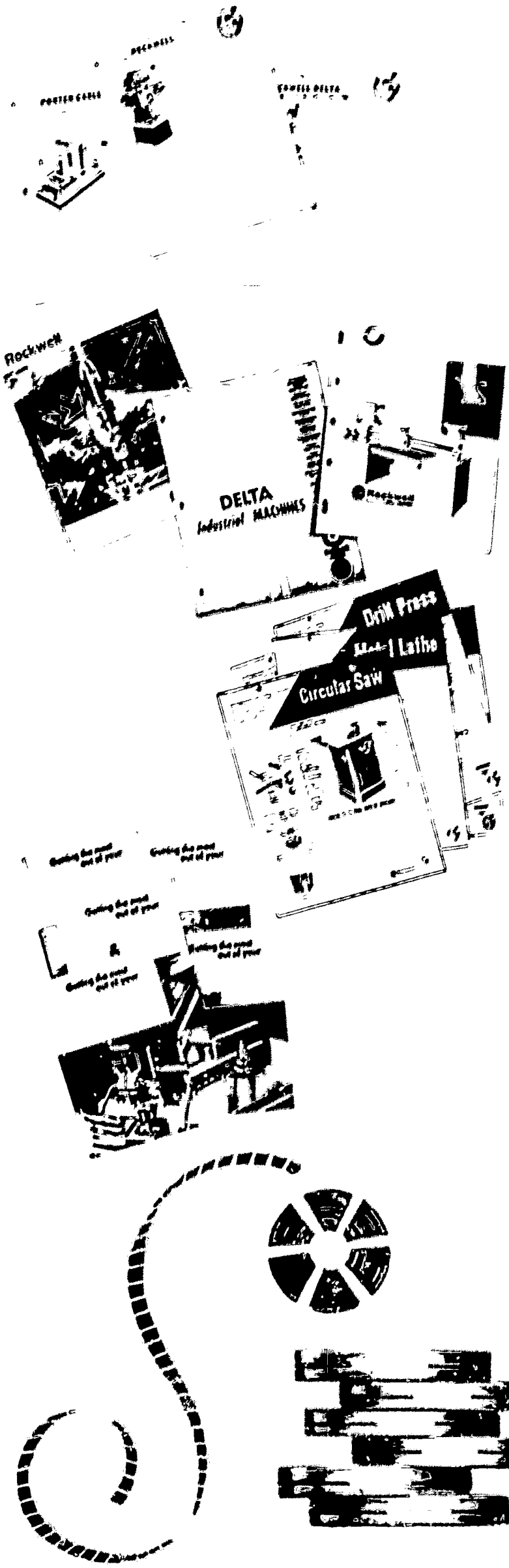
4. May be kept or must be returned.

5. Group use, individual use.

6. Is shop or laboratory equipped to use this aid: Wall space, projector, floor space.

With this and possibly other "factual" information, you can decide on the possibility of using a specific commercial aid in your program. Your needs can be easily matched to "what is available" and "what is not available." An intelligent decision can then be reached concerning the entire question of teaching aids. "Do I need them? If so, must I invent my own, use an available commercial aid, or adapt and change an existing aid to fit my objectives?"

Some of the aids available from Rockwell Manufacturing Company are illustrated here, others are listed in our literature and displayed at national school conventions. Teaching aids, both commercial and teacher-designed, certainly have their place, but the objective and purpose should be clear, even to the student. They should match or augment your course of study.



ROCKWELL AIDS FOR SCHOOL SHOPS

IN PURCHASING—

A. SPECIFICATION GUIDE SHEETS
These spec sheets cover stationary and portable power tools and come in a special folder. Each sheet contains a picture of the tool, machine data, written specification and catalog numbers. There are over 80 separate sheets in the complete set. (no charge)

B. CATALOGS
Separate catalogs, with complete listings of all accessories, are available with suggested list prices. The complete line of Rockwell Power Tool products includes Rockwell Machine Tools, Delta Industrial Machines, Delta Light Industrial Tools, Delta Radial Saws, Porter-Cable Portable Electric Tools and Rockwell Portable Air Tools. Separate brochures are also available covering many individual items. (no charge)

IN TEACHING –

A. WALL CHARTS
The 17 × 22" wall charts in sets of 20 cover both portable and stationary tools, and contain nomenclature, operating and safety suggestions. They are printed in two colors, mounted on heavy box board with two brass grommets for hanging. The surface is also coated with varnish, making them durable and easy to clean. Sold only in sets. ($4 per set)

We also have available 8½ × 11" copies of these wall charts, three-ring punched for student notebooks. These charts contain 20 copies of all 20 charts, or 400 sheets. This cost breaks down to 15c per student. Sold only in sets. ($3 per set)

B. INSTRUCTION MANUALS
These popular hard bound textbooks give beginning students complete instructions on safety of operation and use of accessories, practical short cuts and shop hints, also include maintenance and adjustments for stationary power tools. Books are available covering the following tools: Drill Press, Circular Saw, Abrasive Tools, Lathe, Shaper, Band Saw & Scroll Saw, Radial Saw.

A book is also available on Practical Finishing Methods; there also is a series of project books. ($1 per book)

C. FILMS
We have 16mm sound synchronized color film available on a loan basis covering the following nine tools: UNISAW, Grinder, Metal Lathe, Band Saw, Wood Shaper, Wood Planer, Jointer and Cut-Off Machine. They are mailed out from local Regional Offices or film agencies. (no charge)

D. STUDENT ACTIVITY CHART
This wall chart is printed with four separate charts on each side. The instructor actually has eight separate charts for his use in individual project completion, ratings or other similar records. (no charge)

E. POWER TOOL INSTRUCTOR
This magazine is published three times a year and is mailed free to most industrial education teachers and directors throughout the United States. It is a professional type magazine, and not an advertising sheet. Approximately 45,000 copies are printed, each issue containing articles by well-known educators and leading articles of interest to all industrial educators. (no charge)

F. FLYING CHIPS AND DELTAGRAM
This subscription magazine is aimed at the home workshop enthusiast and school shop instructor. It is primarily a project magazine, but also contains other information concerning power tool instruction and safety. It is published six times a year and subscription rates are 1 year, 6 issues at $1.75; 3 years, 18 issues, $4.00; 5 years, 30 issues, $6.00.

G. CRAFTSHEETS
A collection of 60 individual sheets covering the technical aspects of wood and metalworking. For instance, there are separate sheets covering drill sizes, hinges, belt speeds and much other useful information. These craftsheets run 75c a set. A two ring binder is also available at 50c.

IN PLANNING

A. AMP RATING CHART
This sheet gives the horse power, revolutions per minute and amp rating for both single and dual voltage motors in single phase and three phase. This information is helpful to architects and educators involved in planning when figuring total amp draw, outlets, etc. (no charge)

IN SERVICE

A. PARTS & INSTRUCTION MANUALS
Individual parts and instruction manuals accompany each machine on delivery. They are also available free of charge to replace lost manuals. Complete parts manuals are also available for use by maintenance personnel and directors. (no charge)

B. PARTS DISTRIBUTOR LIST—DELTA
A complete list of all authorized Delta Parts Distributors is given, including their address and phone number. (no charge)

C. FACTORY BRANCH LIST—PORTER-CABLE
This list contains the location and phone number of every Porter-Cable factory branch. In addition to the 14 branches, there are also 120 Porter-Cable authorized service stations in the United States and Canada. (no charge)

Any of these specific items or more information concerning them can be obtained by writing:

School Aids Department
Power Tool Division
Rockwell Manufacturing Company
Rockwell Building
Pittsburgh 8, Pennsylvania

This list contains only the major printed or mailable items indicating our interest in Industrial Education. We would be glad to write you further concerning other less tangible evidence of our service to education.

AUTHORIZED DELTA PARTS DISTRIBUTORS

ATLANTA, GEORGIA Rockwell Manufacturing Co.
1495 Northside Drive, N.W. • Phone: Trinity 6-2691

BUFFALO 4, NEW YORK Karle Saw Company, Inc.
138-150 Chicago St., Cor. So. Park Ave. • Phone: TL-3-8053 or 8054

CHARLOTTE 1, NORTH CAROLINA Industrial & Textile Supply
1300 South Mint Street • Phone: Franklin 6-6411

PORTER-CABLE FACTORY BRANCHES

CALIFORNIA, Los Angeles 7 — 2400 S. Grand Ave.
San Francisco—55 Potrero Ave.

DISTRICT OF COLUMBIA, Washington—1717 Hamlin St., N.E.

FLORIDA, Miami 42—4505 N.W. 17th Ave.

SOURCE CHECK LIST

SOURCE CHECK LIST

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Whether educational specifications, equipment specifications or physical layout, planning involves "personal opinion" to a high degree. In addition, no two communities are exactly alike, either in educational needs and desires or in financial ability. This makes it improbable that a specific plan can be used "verbatum," time and time again for different school systems. Existing laboratory or shop plans and planning suggestions as published by manufacturers, federal and state agencies, and often found in educational magazines, should be used ONLY as a guide or for background reference material. Your plan for your school should be personal, unique and reflect the thinking of your community.

It is an accepted fact that the more information which can be reviewed, the better final plan will evolve. In view of this, a "bibliography" of some type is appropriate. Rather than print a specific list of pamphlets, books and articles for review —and possibly miss some of the most important —we submit the following as a check list of various sources for material on any industrial education question, whether it be planning, building, purchasing, methods of operation or curriculum.

A. MAGAZINE PUBLISHERS

Various administrative and technically-oriented magazines publish excellent articles, devote complete issues, and even publish separate material concerned with shop or laboratory planning or other related subjects. For instance, every April issue of "Industrial Arts and Vocational Education Magazine" is devoted to school shop planning. Every April issue of "School Shop Magazine" contains a list of available free or inexpensive teaching aids and a list of suppliers. The latter magazine also publishes a separate book entitled, "Modern School Shop Planning."

Most school administrative magazines periodically devote space to industrial education per se and oftentimes to specified planning and purchasing problems.

B. TEXT BOOK PUBLISHERS

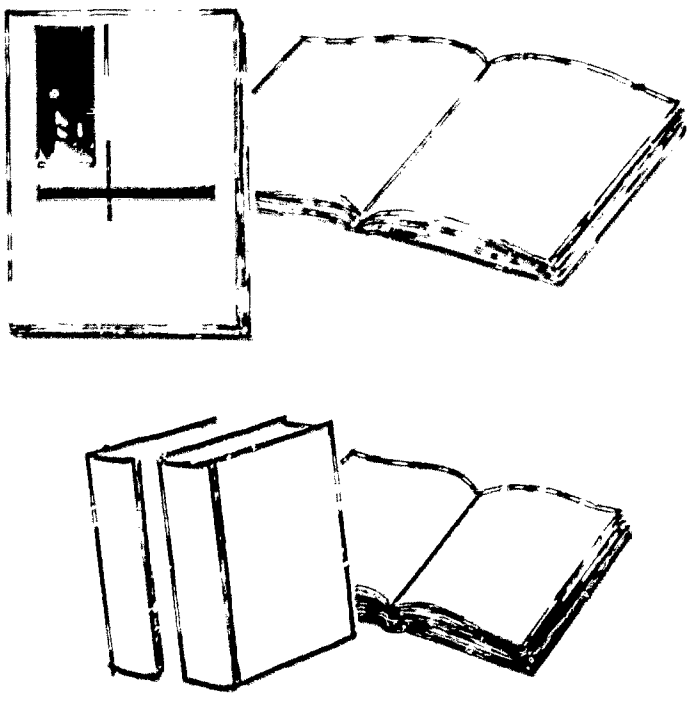
There are a number of publishers who specialize in Industrial Arts and Vocational Industrial Education subjects, including books and information on planning. These publishers are excellent sources of information in addition to what they print and publish.

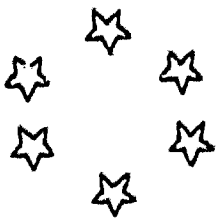
C. STATE DEPARTMENTS OF EDUCATION

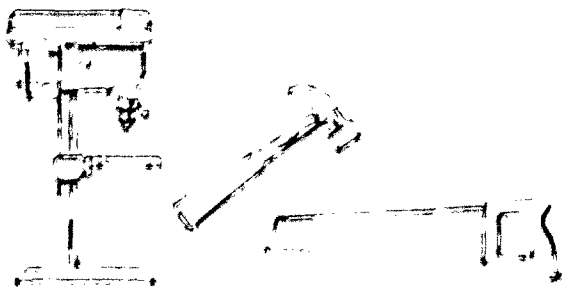
Every State Department has a Director of Industrial Arts, Vocational Education, Vocational-Agriculture, TI&E and/or other similar officers, regardless of title, who are well acclimated concerning all subjects involving industrial education. Many departments also publish various books, booklets and brochures concerned with both the philosophy and specifics of industrial education in their particular state. Various states also have area coordinators or other "traveling" representatives of the State Education Department available at the local level.

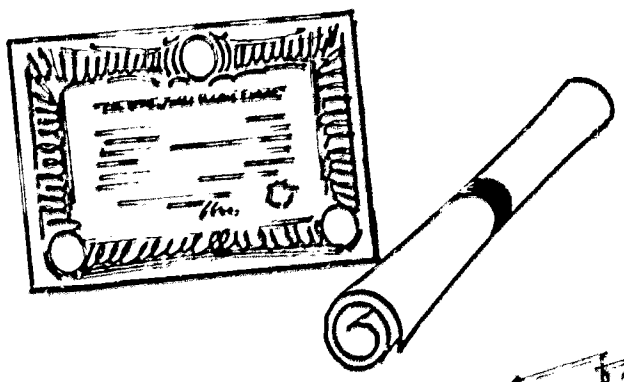
D. FEDERAL GOVERNMENT

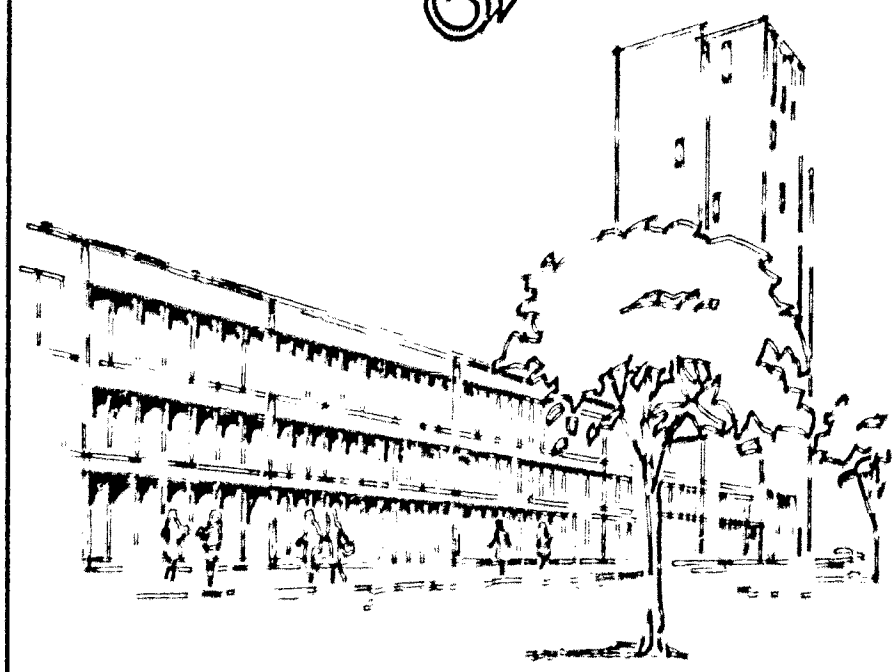
Naturally, the U.S. Department of Education under the Department of Health, Education and

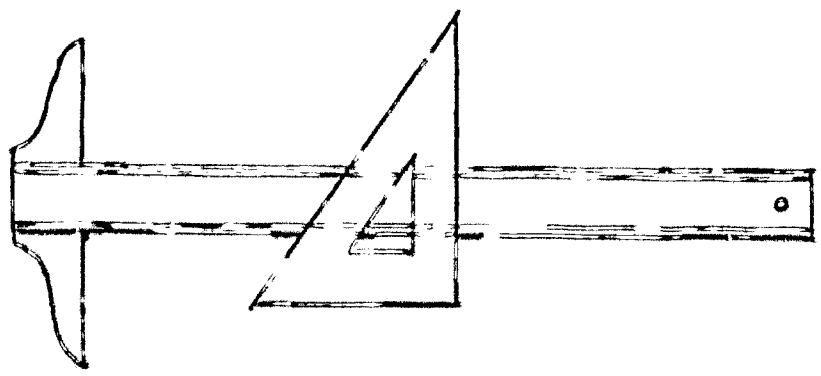


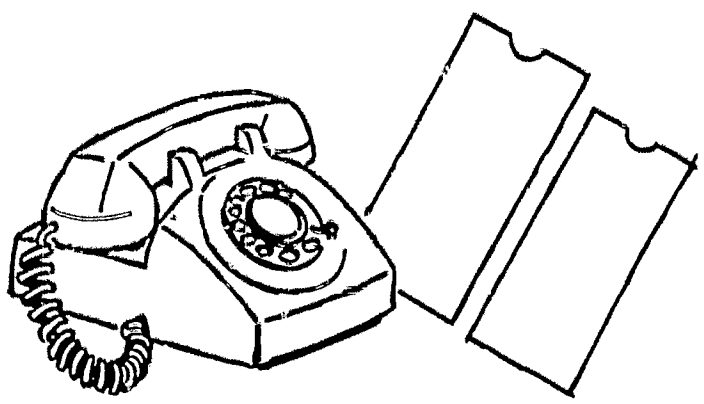












Welfare is an excellent source for information, booklets and material concerning any subject in this related field.

E. SUPPLIERS
Manufacturers of hardware, tools, benches or other allied equipment are often excellent sources of information and make available, often at no cost, aids in planning, servicing and teaching.

F. ASSOCIATIONS
The various national associations concerned with industrial education, to name a few, The American Industrial Arts Association, the American Vocational Association, the National Safety Council, the American Institute of Architects, American Technical Association, and many others are excellent sources for information. Many publish internal organs concerned with their particular area. Two excellent examples would be the "Journal of American Industrial Arts Education" and the "American Vocational Journal."

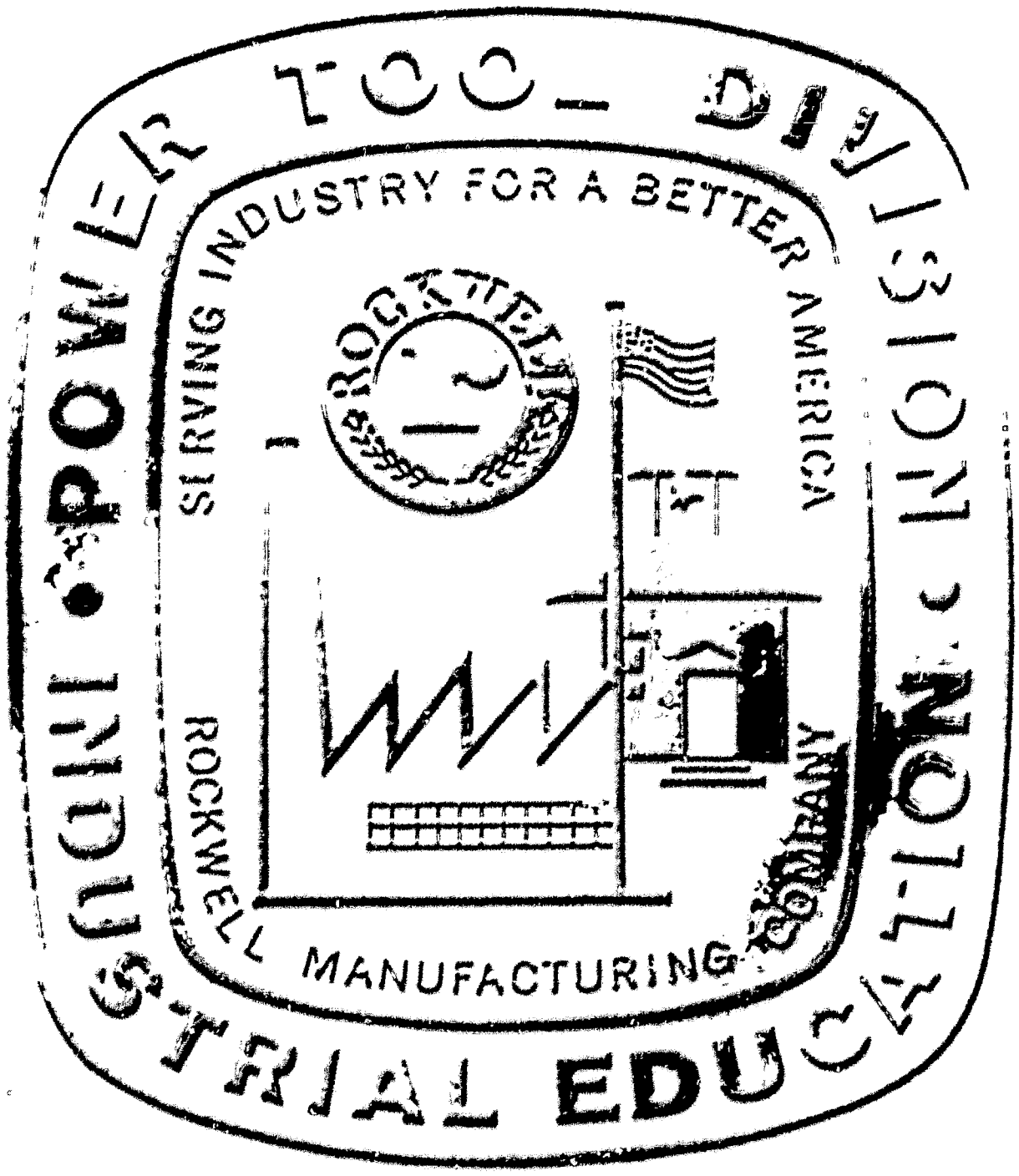
G. MAJOR CITY SCHOOL SYSTEMS
Most large city systems, of course, have department heads or assistant superintendents who have, over a period of years, designed workable objectives and plans for their own school system. These involve curriculum, material lists, planning guides, construction and building information. In most cases, they have brochures available covering these subjects.

H. COLLEGES
Most teacher training colleges and universities with industrial education, industrial technology or industrial arts departments are well equipped to answer questions concerning any industrial education subject. Many are willing to actually plan or help develop shop layouts for local schools.

I. ARCHITECTS
Because of their past experience in planning industrial education facilities, many architects are well qualified to advise a school customer concerning potential costs, including various construction details. Many architects are willing to review past building projects concerned with industrial education with a potential school customer.

J. OTHER SOURCES
In many areas various service-minded corporations involved in either construction or financing have material available or have been previously involved in area planning. This list might include the local Telephone Company, the local Electric Company, the local Gas Company, the local Banks, Railroads and Insurance Companies. Civic groups are concerned and oftentimes are willing to help with general questions about the future growth and needs of their area. These might include the local and state Chamber of Commerce, the Junior Chamber of Commerce and even many fraternal organizations.

This list undoubtedly could be increased, but it is felt that the organizations listed above cover the subject from a financial, mechanical and educational point of view well enough to obtain a rather complete picture if adequate investigation is made.



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