John Glick

THE EXTRUDER AS DESIGN TOOL: AN EXPANDED USAGE

I wonder how many homemade or commercial extruders sit forgotten in a studio corner, gathering dust? Or how many only find limited use producing strap-type handles or an occasional hollow extrusion for a spout or lightweight handle. I recall my first extruder—a Brent. For over a year it sat alone, after the first moments of play had apparently exhausted my limited understanding of the device. I looked at the extruder on and off. It just glared back.

It was a year of transition for me. I drew page after page of pot ideas which I could not translate into clay simply because I had no methodology to make the needed contours and structural elements. After nearly ten years of work, with evermore complex, wooden, mold-formed slab constructions, my thinking was still oriented toward the hinged mold and its specific influences on pot form. It hadn't quite dawned on me that I had a versatile tool sitting nearby, merely waiting to be put to good use. One's proved (and favorite) technologies are hard to put aside, however, and while I had been able to continue evolving mold-influenced pots over the years, I really was resisting a change of technique.

A fortunate, if chance, criticism by a potter friend nudged me off the fence. I began to use, at first tentatively, ideas which had slowly been coming into focus on the extruder. My friend suggested that I should move on and extend my search past present solutions. She was right. I moved into a realisation of what extrusion is really about, and became aware that it was a technical system which could answer the need for new forms.

After several years of concentrating on the extruder, I have decided it is no more or less than any other tool or technique a potter might employ to reach a desired end. Like a unique series of brush strokes, a highly personal touch with a carving tool, or a special ability with glaze and color, the extruder is capable of being part of an expressive force. As with any effective technique, there must be sufficient motivational drive behind its use.

The motivation for using an extruder is to form ideas for proposed pots. Such ideas should not be limited by the format of the extruder *per se*, as it is only a device to eject plastic clay in a tubular configuration. One needs to coax out new ideas from its general capability. Perhaps it is necessary to turn one's vision "around" so that the extruder is not seen in a single way. One might stand off and look at the tool as a designer's aid, or as a contributor of building components, but certainly not as a dictator of form-ideas. Applied beyond its usual extent, the extruder becomes a valued addition to the potter's wheel, as well as to other techniques of handconstruction. I am excited by the potential for using extrusions in my work. The possibilities are beginning to mesh favorably with older, more familiar techniques, and are beginning to stimulate new ideas.

ABOUT CLAYS

Along with the essential element of design intuition, there should be an awareness of the way clay can be made to flow under pressure. This problem is encountered the moment one decides to begin using an extruder. Before successful extrusions can be expected, therefore, a few rules-of-thumb about clay qualities should be established.

In general, new, coarse, or "short" clays are disastrous to use in extruders (even those with proper die design). These types of clays tend to promote chattering, or fracturing, of the extrusion as it exits from the die. This is due largely to a lack of cohesiveness in the clay matrix, as much as to poor die design. Very stiff clay, even of the proper formulation, is physically difficult to move (assuming one uses a lever system), and is hard on all but the sturdiest dies. My choice for a clay type is a well-aged, very plastic, fine-grained body of medium-stiff consistency. If the clay is too wet, the extruded elements are easily distorted and stressed in handling.

DIE DESIGN: PRELIMINARY THOUGHTS

I have worked with a variety of die designs—from the simplest, made of modified steel washers, through more involved bridging dies for hollow extrusions, to multiple-layered dies for combining strength with workable materials for complex extrusions. These developed naturally, as pot-form ideas required increased scale, complexity, and versatility. Although I have not researched industrial extruder die technology, I sense that many of the same problems I have encountered have their counterparts in industrial situations.

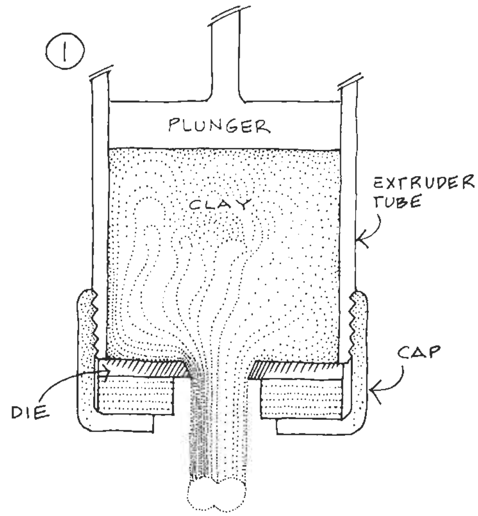
I find that pot ideas are great motivators, naturally stimulating one to learn what is necessary to accomplish new ideas. By stumbling through my own learn-and-discover process with tools, dies, and other potters' equipage, I have learned many valuable things—often, by failing at first. It is fair to say, however, that one does not need great mechanical know-how to carry out successful extrusion work.

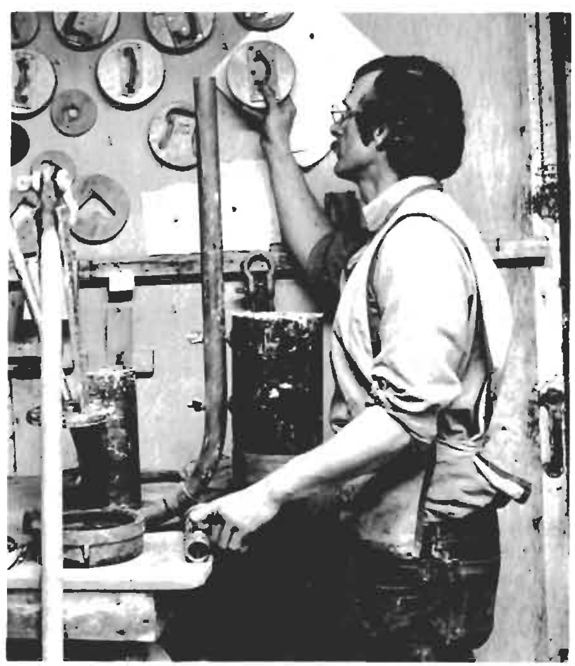
EXTRUSIONS: TECHNICAL BENEFITS AND FORM CONSIDERATIONS

The best technical reason for employing extruded components is that they are inherently stable. I have been slab-building over the years, and I have been keenly aware of the influence of forming techniques on the clay walls. I have made a variety of pot forms using plaster, biscuit, or wood molds. To some degree, all reflect the stresses imparted to the slab wall during distortion in the forming process, and at no time more than during the actual high-temperature firing.

Such is not the case with pots of extruded clay components, assuming they are properly extruded, wisely handled, and well assembled. To achieve stable walls and no warping at high temperatures, the clay must be made to flow readily across the die face and encounter no stressful obstruction during the ejection phase. (see fig. 1). It seems to me that helping the clay to finally exit in a <u>gentle</u> manner is the key to well-made extrusions. If the resulting component is handled without excess bending, dried to a useful state, and assembled well, it will tend not to reflect such stresses during high-temperature firing. The best indicators have come from a variety of box and lid constructions—some up to 24″ long—which have maintained near perfect lip-to-lip contact, fired to a dead flat C/10 (see photo A). Many of the form-ideas illustrated in this article could not have been done as easily by any other clay process, with the possible exception of slip casting.

A





B

COMMENTS ON EXTRUDERS

Earlier, I mentioned my first experience with the Brent 4″ extruder. This is a very practical tool. The plastic cap (mine is the threaded version) is easily cleaned by a quick brushup in water. When my need for larger extrusions became urgent, I fabricated a 6″ steel pipe and cap combination, which essentially duplicates the Brent configuration (see photo B). My source for the materials was a large, pipe speciality company which was able to cut, refine, and thread the pipe to specification, and to supply the threaded cap. A small machine shop lathe cut the end out of the cap, providing a suitable seat for the dies. I looked long and hard for a plastic cap which would be lightweight (the steel cap <u>is</u> heavy) and easy to clean, but no electric suppliers stocked anything larger than the 4″ scale used in Brent's solution.

Scrap metal yards can provide good parts for extruders, as can ingenious welding and homemade fabrications. I anticipate a future need for an 8″ or 10″ extruder. I have been pleased to find that the leverage required to extrude clay from my 6″ tool is very easily supplied by a 60″ arm. Actually, I use only about 48″ of the available length, regardless of die configuration. Mechanical or hydraulic assists could easily be applied to larger scale tools.

With larger scale extruders (6″, 8″, 10″), I anticipate the die opening will be fairly large and that extrusion resistance will be low. To overestimate the force required to accomplish the job would be an easy error. Die opening size, clay mass, and clay consistency add up to resistance encountered. Soft clay exiting through a ¼″-round hole is relatively difficult to extrude, due to slow exit speed and resistance. Soft clay exiting through a 1″ or 2″ opening, with much less applied force, fairly squirts out (see fig. 2).

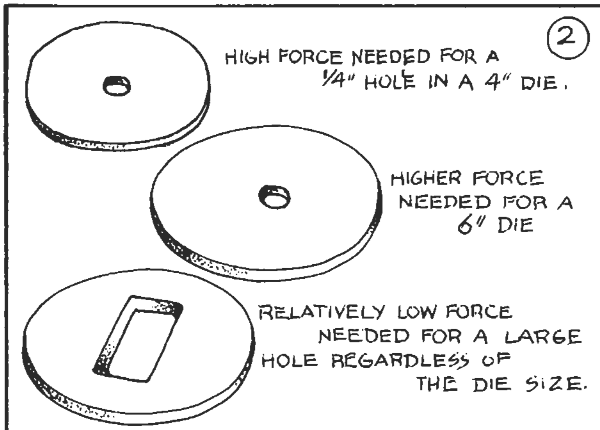
In determining the size of the extruder, versus the force required to accomplish work, one has to take into account the total cross-section of a small extruder as compared to a larger one. This may be best illustrated by asking you to imagine the ¼″ die installed in both a 4″ and a 6″ extruder. Both devices will give the impressions of excessive resistance to the plunger stroke. The 6″ extruder, naturally, will have more cross-section of resistance and a greater mass to move, to achieve results. The impression is that it will take longer and feel harder to produce results with the 6″ extruder than with the 4″ extruder, because less cross-section offers less resistance. We can say force (F) equals pressure (P) times area (A): $F = P \times A$. As the area of the die opening increases, pressure to produce results (extrusions) lessens. In practice, whenever a needed component is small enough to fit the 4″ extruder, it is produced with that tool. Larger needs are satisfied by the larger extruder. However, the extruder itself, while an important part of the concept, is less crucial to successful extruding than the die design.

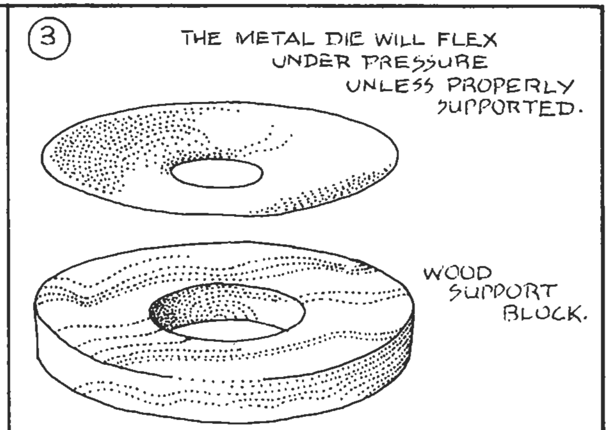
DIE DESIGN: TYPES AND MATERIALS

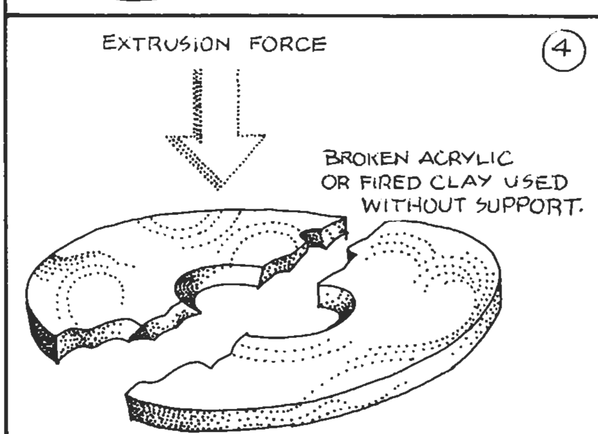
The following comments are aimed at defining die designs, from the very simple to the fairly involved. I have attempted to show examples which use commonly available materials and which do not require excessively complicated fabrication procedures. I am aware that other materials (steel, aluminum) might solve problems related to strength more directly than the solutions I offer, but these metals may also present greater fabrication problems, which could conceivably cancel any strength gains.

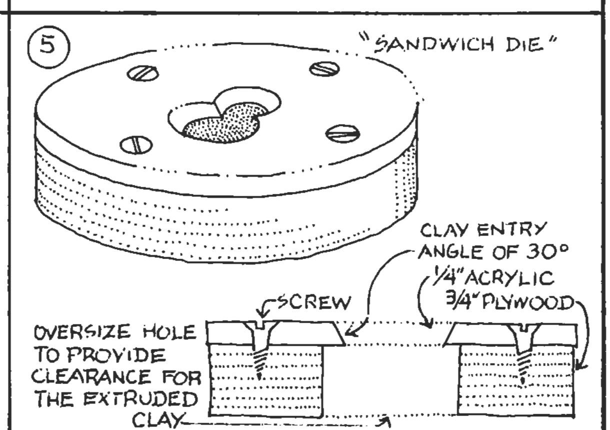
THE "BAD" DIE

Some classic examples of "bad" die design follow, to be looked at as reference points.









Photographs by Bob Vigiletti, Drawings by Aleksis Lahti

MATERIALS:

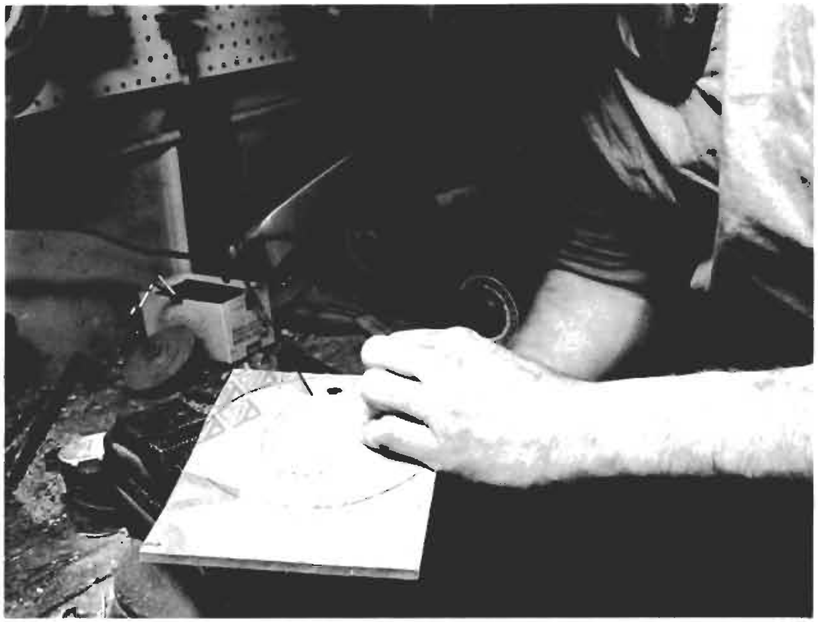
Galvanized metal, acrylic, wood, or fired clay.

1. Galvanized Metal. Bends under pressure and distorts extrusion. During exiting of extrusion, sharp edges tend to tear and chatter all but extremely soft or very well aged, fine-grained clay. Ease of fabrication: moderate. Cost: none. (See fig. 3.)
2. Acrylic or wood, used alone. Stronger resistance to extrusion pressures, but still inclined to break in large scale dies, if used alone. Inclined to disrupt clay as it exits, if feed principle is not understood and incorporated. Ease of fabrication: good. Cost: none. (See fig. 4).
3. Clay, high fired. Prone to breakage if not well supported in die holder, and easily broken if dropped. Some tendency to fracture extrusion if feed principle is missing. Easy to make.

The principal cause for the failure of these die types to perform well has to do with being unaware of the need for a feed or lead-in area near the exit hole. Holes through thick materials which have parallel sides do not offer an easy path for the clay, as clay attempts to flow across the die face on its way out.

ELEMENTS OF A MORE FUNCTIONAL DIE

A sandwich of 1/4″ acrylic sheet and 3/4″ plywood offers needed strength for resistance to extrusion pressures (see fig. 5). Naturally, metal of 3/8″ thickness would do very well, if fabrication time were no problem. Note the clay-feed concept, which leads the flowing clay more gently to the exit face of the die. This, combined with proper clay choice, totally eliminates the terrible fracturing of the clay surface that requires so much cleanup time (or it totally breaks the extrusion), and tends to negate the convenience and usefulness of the extruder. Clay that exits smoothly is ready to use whenever needed, and, it is much less inclined to have acquired stresses from the die itself or from unnecessary cleanup processes that were required to correct faults in the structure or surface. In fact, the components that result from correct pro-



C

D

cedures exit with a "polished" surface—a surface free of grog scratches and ready for the assembly and the finishing processes.

FABRICATION OF ¼" *ACRYLIC.*

Use pilot drilling and coping saw to complete the cuts, and various files to define and enlarge the cross-section (see photo C). Then file a 30° relief or "slope" for entry portion leading to the exit side. (I wrap medium-grit sandpaper on a file and polish the contours of the exit hole. This imparts the "shine" to the clay surface, rather than leaving a series of parallel score marks from a rough final edge on the die.) Three-quarter-inch plywood should be cut to fit snugly into the die holder to eliminate leaks of clay around the outer diameter of the disc (see photo D). The plywood should be cut with an oversized hole in the center, to allow the extrusion an easy, free passage (see photo E). Care must be taken to leave as much wood as necessary to support the potentially weak areas of the die. The die assembled by wood screws secured through acrylic, in countersunk holes. The plywood is soaked with several coats of urethane for long life and for protection during washing up.

GENERAL

It takes approximately twenty minutes to fabricate a simple solid-handle die, using acrylic and a plywood disc and sticking the die in place with clay before it is placed in the extruder (see photo F). For complicated dies, fabrication time can be up to one and one-half hours or more. The cost is reasonably low. It should be noted that some dies require added support to withstand stress in weak areas. This can sometimes come from a prop placed under the die, or it can come from a hanging support on the inside of the extruder itself.

SOME DIE TYPES AND RESULTING EXTRUSIONS
STRAP-TYPE HANDLE, USING ACRYLIC

The simple strap-type handle, using acrylic doesn't necessarily require a plywood backup if the die opening is fairly large, usually more than 1" square; otherwise, a multi-use, plywood backup disc is best. Fabrication only requires a drill and files, and sandpaper for polish. After extruding the clay, I handpull (wet stroke) the handle to give a pleasant taper and proper contour (see photo G).

E

THE BRIDGING OF DIE-HOLLOW EXTRUSIONS

Fabrication of die is done out of various steel washers, bent nails and silver solder, using a propane torch. Contours in the die are filed prior to assembly. The die is held in position on the plywood support disc for use. This can becomé complex in elaborate extrusions. Bridging can be eliminated by handing the core from a stud in the extruder tube, but alignment of the die core can be a problem (see photo H).

DIE FOR PRODUCING WALL COMPONENTS

The construction of the die for producing wall components is the same as that of other stacked dies. Applications: fabricated forms, boxes, trays, planters, etc., used with slab bottoms and/or tops. A very large scale is easily obtainable, and lip details and decorative beading can easily be incorporated (see photo I).


F


G


H


I

J

K

L

M

VARIATION USING TOP AND BOTTOM WALL COMPONENTS/LOCKING LIP

Advantages of this variation include the fact that the lid component has a well-defined flange, eliminating fussy detail work in the assembly. It is assembled freehand, or combined with molds (see photo J).

COMPLETE BOTTOM AND TOP EXTRUSIONS, AS NEEDED FOR A BOX FORM LIDS

The lid die can extrude the total lid except for end components, which come from a second die (see photo K) or the lid may be designed to eliminate the need for an added end piece. This is accomplished by distorting the clay during its plastic state to form a proper end shape. The resulting lids are extremely stable in firing, and they have well-defined flanges that fit well. Average wall thickness is ¼″.

BOX BODIES

The complete side wall, with lip detail and bottom, is extruded in one piece. Note the use of the pipe to provide support for the die during the stress of the extrusion process (see photo L). Figure shows the "tongue" area, which usually requires props to support the flexing tendency in the die under pressure. A second pair of hands is helpful in easing the newly extruded box body onto a waiting wareboard for stiffening prior to assembly. A simple mitered cutter guide prepares the box body for the addition of end pieces (see photo M). The end component is mitered in a similar fashion prior to scoring, slurry-brushing, and assembly. The resulting combination for forms is dried slowly under thin plastic film for three to five days, before being allowed

N

to dry normally. Photo N shows various uses for a single box bottom die, which can form the basis for a serving tray or a box component.

TILES

A great variety of tile forms is possible with acrylic and plywood dies. Both flat or more complex edge and special use tiles are able to be extruded readily. Note the cuts in the back surface of the tiles; they provide an interlocking effect with mortar as the tile is laid (see photo O). To allow for drying and firing shrinkage, an oversized guide should be used, to manage the job of properly sizing the elements. For a very large run of tiles, a pugmill would be the logical choice, rather than the hand extruder.

CLAY NOTE

All of the pots illustrated in this article were fabricated from my normal throwing body, and they were fired to C/10 in a heavily reducing atmosphere. We have used this formula for fifteen years, with good success.

JOHN GLICK'S CLAY BODY FOR EXTRUSION WORK
(Used in a very well aged condition)

Cedar Heights Goldart fireclay	200 lbs.
A. P. Green Missouri Dry Mill fireclay	75 lbs.
Kentucky O. M. #4 ball clay	25 lbs.
Grog, 20 mesh	24 lbs.
Potash feldspar	12 lbs.
Flint	9 lbs.

John Glick is a production potter and frequent workshop leader who, with his wife Ruby, runs the Plum Tree Pottery, 30435 W10 Mile Rd., Farmington, MI 48024.

O

P