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Decorative ceramics for architectural applications

Robert J. Jarvis

DECORATIVE CERAMICS
for
ARCHITECTURAL APPLICATIONS

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introduction

Architectural embellishment has played an important role in the building of structures in various cultures and at many levels. In reviewing the architectural development of civilization, the human's need to decorate buildings becomes evident.

Walls and other architectural elements are very basic to man's existence. The function of excluding the physical elements and creating a space for habitation can be very simply met by six surfaces. Man, however, has not been content with mere walls; he has consistently embellished his architectural volumes with decoration. As early as prehistoric times man decorated the walls of his caves with drawings and paintings. The Egyptian structures are covered with hieroglyphics which augment the surface and the Greeks used ornamentation extensively on their buildings. From the temples of the Aztecs to the native cultures of South Africa and Nigeria, the need to decorate is evident.

Architectural embellishment is a result of the combining of two art forms: architecture and applied art. This combination is logical for these fields share common characteristics in that both are concerned with space, both are solid, and both are more fully appreciated when one touches them, walks through or around them. Architecture and applied art must complement one another, yet they are limited and defined by their differences in function.

Until the Industrial Revolution, the "master builder" concept had been prevalent. One man was architect and builder; he followed through by designing and executing all elements including site planning, furnishing the interior, and decorating the spaces. Out of this concept, only the more limited role of architect as we know it has survived.

Gaudi and perhaps Juan O'Gorman and Paolo Soleri are the last to fall into the category of the architect-craftsman-artist as one person. Others work by merely incorporating their embellishment into or onto the existing wall. There have been a few close attempts at total integration. Henry Moore approached Gaudi's total integration in his solution to the brick wall in Rotterdam (1955). Here, although the sculpture and the architectural "skin" became one, there is little feeling of integration. (See illustrations following this section.)

To me, it seems that the craftsman is beginning to emerge from his demise following the Industrial Revolution and to find his place in the architectural picture. It is for this reason that I have decided to work in the direction of architectural scale ceramics. In our fast-paced and highly technical society, the architect no longer has the time nor the ability to also be an "artist-craftsman". Our buildings today are such that embellishment is often desirable to bring the structures within the human scale or to make them more inviting. I feel there is a place then on the architectural "team" for another "Specialist".

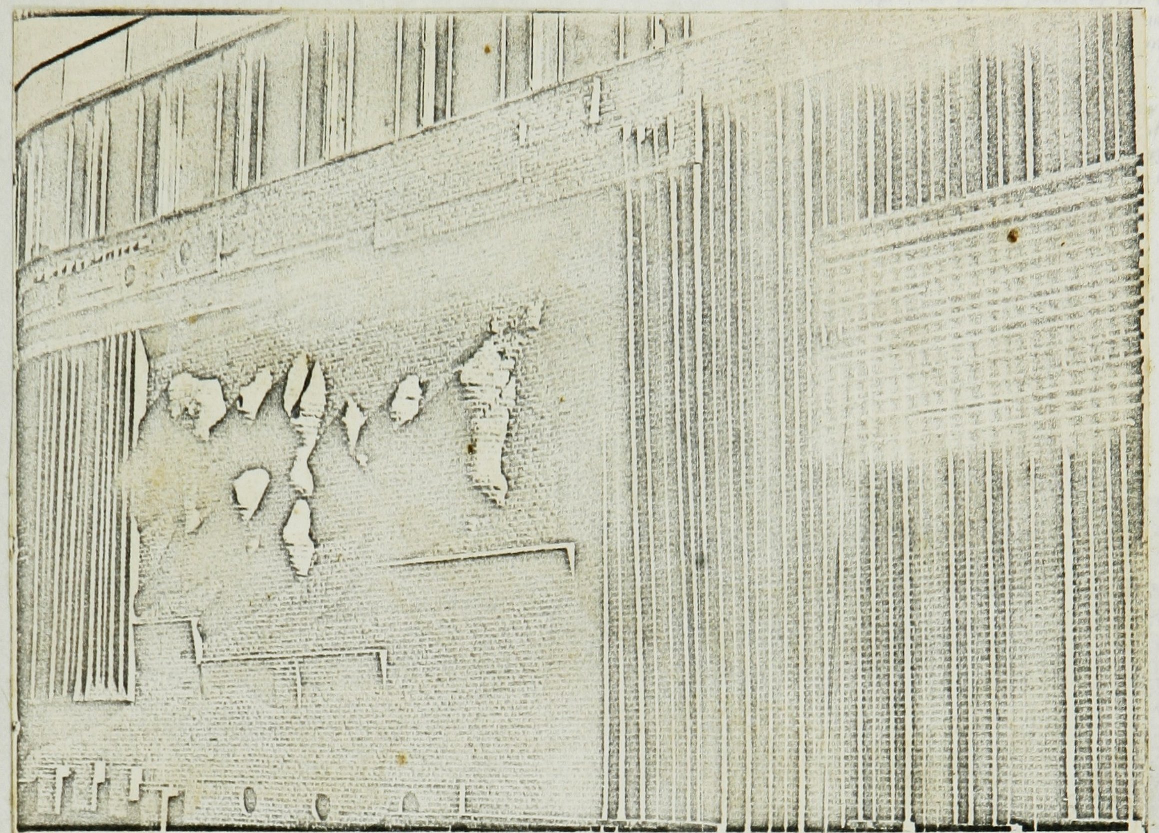
My own experience as Landscape Architect pointed out to me that, although there is a place for designer-craftsmen to work with architects, there is a critical shortage of craftsmen who are willing or able to fit in as one of the specialists in the total team. Yet, this team approach seems required to fill the requirements formerly met by the master builder.

In my mind the ceramics or other media used for decorative purpose should become an integral part of the structure. It should not merely be an interesting piece by itself which may at some time be placed on some building in some space. Instead, each piece should be created for a specific space so that it seems to be a true part of that space--not just a stuck-on or added surface treatment. Gaudi, I believe, has successfully accomplished this by plastically forming his structures so that the ornamentations involved are completely incorporated. In his case the decoration or sculpture actually modulates the form of the architecture.

However, due to time, space, and money, this thesis unfortunately had to be approached in a more academic sense. Many solutions were theoretical or done as an after-product to an existing space. Ideally each work would be specifically designed and executed for a known location and be installed as a part of the entire architectural structure.

68. Roofs and crowning members of the two gate lodges of the Park Güell. The two perforated pinnacles are actually chimney pots.

ANTONIO GAUDI



187 Wall Relief at Bouwcentrum, Rotterdam, 1955

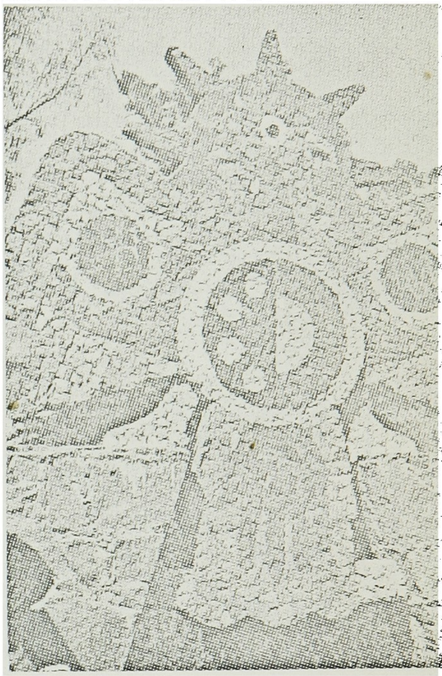
HENRY MOORE

entirely of mosaics and at one end of the
lava wall lighted by overhead glass has a
mals, butterflies and flowers, below which
from crevices in the lava.

*O'Gorman's affinity for the Aztec cultu
expressed in the forms of the house, whose
is a spiral stairs, which curves through th
moulds itself into a head, at once wall and
the Aztec past.*

*There is little in this highly personal hous
one that O'Gorman was one of the leaders
staunch group who broke away from Coloni
establish functional design in Mexico.*

PHOTOGRAPH BY ESTHER MC COY



C DETAILS FROM A HOUSE BY JUAN O'GORMAN

GORMAN

'Gorman was trained in architecture lways preferred painting, and in the University City he had his first op- o combine the two arts. As a pre- he execution of the library mosaic e spent many months searching for n all states of the Republic, some spe- d stones having been brought down sides on the backs of burros. To test and the quality of the stones, he ex- d with them in his own house in the Gardens, which has been building some

o
ew

STATEMENT by Juan O'Gorman

"The puritanism of our architecture today represents the exact antithesis of the plastic art of Mexico. This is because the principal characteristics of Mexican art are the pyramidal form of the composition, an exaggerated emphasis on the tri-dimensional volume, the dynamic asymmetry of the axis, the complex variety of decoration, the richness of form and color, and the supreme manner in which the building harmonizes with the landscape.

Even in folk architecture today we find these characteristics, which in my estimation are the general traits which synthesize the Mexican manner of expression.

The poverty-stricken people of Mexico, who

The same traditions are at work in tas, their dress and their pottery.

The extraordinary art which flourish huac, center of the culture of Ameri to the ground by the Conquistado deep roots remained in the eart through the Colonial period, the In and the Revolution, the Mexican p tinued to produce and still produce art.

The Baroque of the 18th Century to the popular taste of Mexico duri onial period, due to the fact that the and the Mexican Baroque in gen wide appeal through its profusion

technical section

Clay Body:

To work on an architectural scale requires a clay body with some rather demanding characteristics. The primary consideration, that of controlled shrinkage, was deemed necessary and critical. As I anticipated having to work for specific spaces, it was therefore important to have control over the amount of shrinkage. Other considerations were fast firing capability for economy, limited warpage for functional fitting, unglazed body color for use in the unglazed state, weather resistance, and fair amount of plasticity.

As a starting point, research was done into commercial ceramic tile bodies. It was discovered that the majority of the bodies recently used industrially for ceramic tiles utilized wollastonite. This ingredient seemed largely responsible for two desirable characteristics: low shrinkage and rapid fire (often ten-minute bisque and thirty-minute glost firing).

> "Wollastonite ($CaSiO_3$) is a naturally occuring calcium silicate. Wollastonite imparts low moisture, expansion, reduced drying and firing shrinkage, higher fired strength, improved heat shock, faster firing, easy pressing, better bonding, superior electrical properties to bodies, glazes, porcelain enamels and frits. Wollastonite applications in the ceramics industry can be classified in two general groups: as a replacement for flint and limestone, and as a new material for producing bodies and glazes of superior properties.

PROPERTIES

Specific gravity	2.9
ph (10% slurry)	9.9
Coefficient of expansion (100% $CaSiO_3$)	$6.5x10^{-6}$/mm/mm/^oC
Melting point	1540^{o}C
Solubility in H_2O	.0095/gm/100cc
P.C.E.	cone 18
Molecular weight	116

CHEMICAL ANALYSIS

SiO_2	50.90%
CaO	46.90
FeO	0.55
Al_2O_3	0.25
MnO	0.10
MgO	0.10
TiO_2	0.05
Loss on ignition	0.90
	99.75%

Wollastonite is a natural mineral and has almost the chemical formula of theoretical calcium silicate. Its most outstanding characteristics are its brilliant whiteness, its chemical and physical uniformity, and its fibrous nature which is easily controlled by mechanical means from a granular material to long, needle-like crystals."[1]

The reason for the desirable characteristics of low volume change and ability to withstand rapid firing appears to be that in wollastonite the silica occurs in the inverted beta form, and thus eliminates the quartz inversion which normally accounts for volume change and slower firing cycle.

In view of the above, it seemed logical that wollastonite should be tried. Additionally, since drying ability and low shrinkage were desired, it seemed that coarse particled clays should compose a large portion of the clay body. Therefore as tests for a plastic low-shrinkage body, fire clay and ball

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[1]"Materials for Ceramic Processing", Ceramics Industry, Vol 94, No. 1, Jan. 1970, p.144.

clay were decided upon as a base in the proportion of 2:1. The starting point then became:

1 part North American Fire Clay(North American Refractories Co.)

1 part AP Green Fire Clay (AP Green Co., Mexico, Missouri)

1 part M&D ball clay (Kentucky-Tennessee Clay Co.)

or 1 part Kentucky "Special" ball clay (Kentucky-Tennessee Clay Co.)

To this base, wollastonite C-1 was added for low shrinkage and rapid firing. "G' Grog (AP Green Co.) was also added to "open up" the body and Bentonite was tried for increased plasticity. Also several quick fire bodies as used commercially were tested. See exhibit A.

From these results it appeared that wollastonite did in fact seem to be a good potential ingredient. From here a series of tests were performed to test M&D and Kentucky "Special" with varying quantities of wollastonite (for shrinkage). Several sources of iron (Albany slip, Barnard clay and Redart clay) were tried for color range and Frit 3110 for its effect on maturity. See exhibit B.

These tests showed some very good results as far as low shrinkage was concerned. Two percent was the approximate average amount of fired shrinkage and 6 - 8% was the total shrinkage for cone 1-9. A unique trend was observed. Within the range of 10-20% wollastonite, the shrinkage stabilized with

±0.5% for cones 1, 5, and 9. Realizing the human error factors involved in making a standard test bar, ±0.5% can be interpreted as being negligible. Therefore wollastonite in these proportions would, as verified by retesting, stabilize shrinkage in the cone 1-9 range. See exhibit C.

Since the fired shrinkage averaged only 2%, an attempt was then made to try and reduce the dry shrinkage. Increasing grog or coarse particled clays was considered undesirable as a sacrifice in plasticity was not desired. The answer then appeared to be a reduction in the water content--hence, less water volume to be evaporated. Research was done into the use of plasticizers, theorizing that if a plasticizer was added to the mix, less water would be required for the same degree of plasticity. Two plasticizers were tested----Glutin and Additive-A Clay Conditioner 1, Type 2 (Kimberly-Clark). Both solutions gave negligible results. Although it was true that the body required less water plus additive to make the clay particles plastic enough to adhere to one another under slight pressure or extrusion, the amount of water required to make the body useable and plastic enough for normal hand fabrication was the same as without artificial plasticizers.

Other means of reducing water content were also explored. Wetting agents were investigated only to find that "as the surface tension of the water is decreased by the addition of wetting agents, the workability is decreased."[2] Next, deflocu-lation was investigated as a means of reducing water content while not sacrificing plasticity. However, it was found "that the clay-water systems in which no charge is developed on the clay particles show the highest yield points and plastic properties. Those clays having absorbed monovalent cations which results in charge development or deflocculation have low or no yield point, hence no plastic properties."[3]

Thixotropic conditions were considered as a means of lower water content, but it was decided that additional thixotropic conditions would not be desirable for the fabrication techniques to be employed. The bodies tested so far showed very slight thixotropic conditions. Other means of reducing water content were not sought out for it was found that the amount of shrinkage decrease obtainable is a case of diminishing returns for decrease of water. See exhibit D, showing the relationship between the shrinkage and water content.

After realizing that there did not appear to be a means of decreasing dry shrinkage without sacrificing plasticity or other desirable characteristics, it was decided to follow up on previous tests. "6D" from exhibit B was chosen as having

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[2]W. G. Lawrence, (ed.), Clay-Water Systems, (Publisher and date unknown), p. 59.

[3]*Ibid*, p. 57.

the most desirable characteristics, with all factors taken into consideration. Although some tests with Kentucky "Special" ball clay did yield lower shrinkage, M&D ball clay yielded similar results, but with better maturity and a color more to my liking. Therefore, "6D" (North American fire clay 33.3, AP Green fire clay 33.3, M&D 33.3, wollastonite (Cl) 20 and grog 10) became the base. Exhibit E shows the results of tests for color range, maturity, and 6-8% shrinkage. Sources of color from base body were: Albany slip, Barnard clay, Redart (Cedar Heights) clay and Fe_2O_3 for sources of iron. Spodumene, ambligonite, and lepidolite as lithia minerals to modify color and work for warm yellow-oranges, bone ash and Frit 3110 were tried for effect on maturity and color. Ilmenite, Rutile and Granular Manganese were also tried for their respective color effects. C-6 wollastonite was tried as a substitute for C-1 wollastonite, with slightly lower shrinkage figures resulting. C-6 wollastonite was not used as a follow-up, as the School for American Craftsmen had C-1 in stock in larger quantity at the time of the tests. See Exhibit E for test results and Exhibit F for photographs of acceptable bodies.

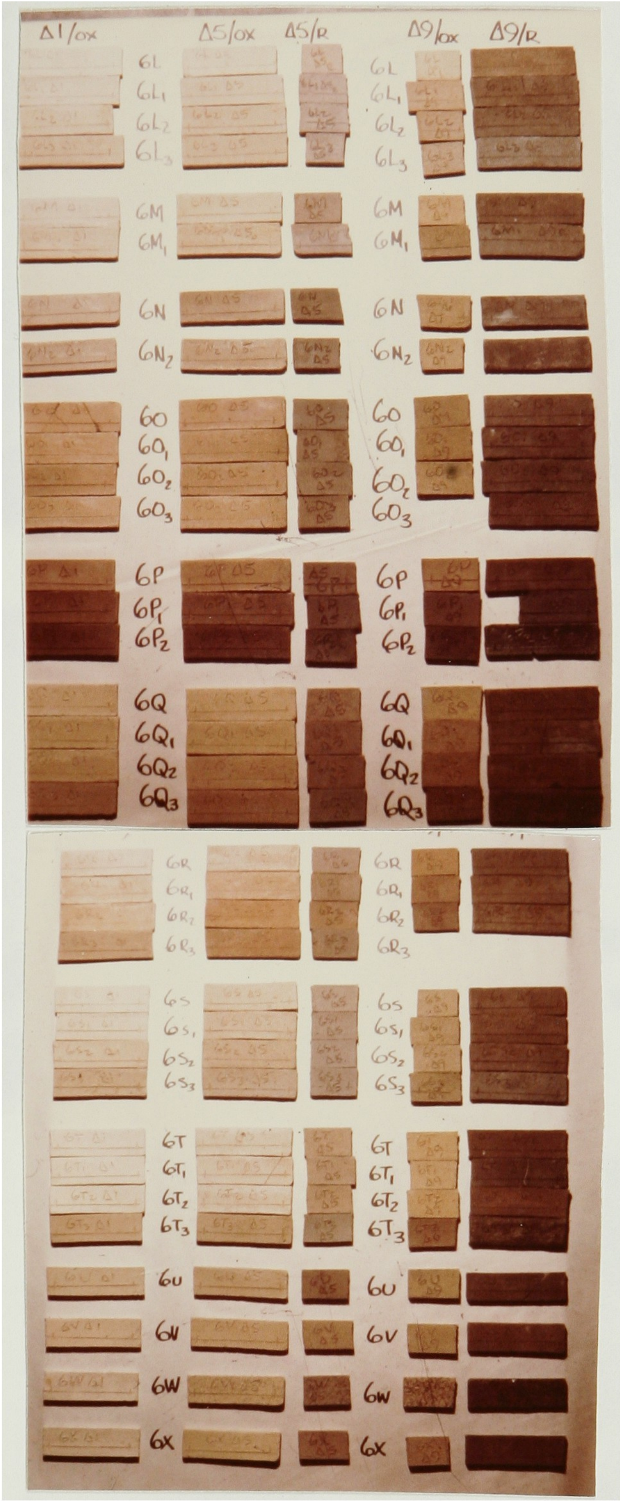
These bodies present deceptive test results in that the absorbtion rates appear to be rather high as a rule. However, to the touch and by appearance the bodies appear to be very vitreous, similar to low porosity stoneware. The conclusion drawn (and substantiated by cutting open bodies) is that the body is vitreous but that there is a network of interior cavities and air pockets present which hold water, thus giving a higher absorbtion rate to an otherwise tight body.

The body with "6-D" base and 10% Frit 3110 was decided upon to be tried on a large scale. In use it was discovered that at cone 8-10 the body tended to blister and appeared to bloat. This condition worsened when glazed. Tests were tried (12" squares) with decreasing amounts of Frit 3110 both glazed and unglazed. It was found that with 10% of Frit 3110 both bare body and glazed areas blistered. With 5% of 3110, the bare body essentially did not blister, but the glazed or sealed area did. With 0% of 3110 there was no blistering present in the bare or glazed areas. The body with 10% of 3110 was tried at cone 5 and no blisters occurred either glazed or bare. In view of this, the frit was dropped from later bodies so as not to take the chance of blistering even though the color and maturity the frit yielded were desirable.

As far as glazes for this body were concerned, most typical stoneware glazes tried worked well, except that the body had a slight tendency to drink up the glaze at higher temperatures (cone 9) and particularly upon refiring pieces the glaze seemed to sink into the surface. Follow-up glaze tests were tried with several different approaches. The first series of tests used increases in silica since I thought the body might be starved for silica and that it was dissolving the silica out of the glaze----thus appearing to eat into the body. This however did not seem to be the case, for increases in flint did not improve the situation. Next, wollastonite was tried as a source of silica, hoping that the compatibility with the body would help. Again the results were not encouraging. The next avenue of approach was the possibility that the make-up of the glazes used was such that earlier glass formation was dissolving the body. But adjustments in the glaze formulas to retard glass formation did not help. After these tests, it was found that the body without Frit 3110 did not present these problems. Also by bisquing at a higher cone (06-04) instead of cone 08, and using slightly heavier glaze applications, the body with or without Frit 3110 worked well with most glazes tried.

In conclusion, and after using this body for large-scale work, it meets and exceeds the original desired characteristics. The body has good color and can be easily modified; it has rather low and stabilized (for cone 1-9) shrinkage of 7%; it dries well for flat tiles as well as large pieces with thick and thin sections; it fires safely even in thick sections; it is plastic enough to be thrown; it has a desirable texture and is dependable.

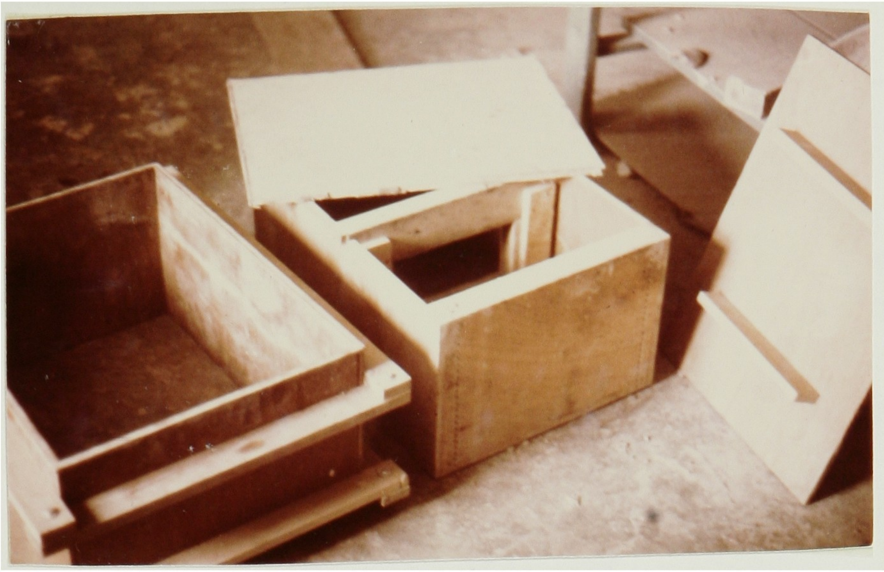
EXHIBIT F



CLAY BODIES 6L–6X COLOR RANGE

EXHIBIT H

PHOTOGRAPHS OF SLAB MACHINE



COMPONENT PARTS

ASSEMBLED
READY FOR CLAY

SLAB READY TO BE SLICED OFF

EXHIBIT A – TEST RESULTS

PLASTIC LOW SHRINKAGE BODIES:

	1	2	2a	2b	3	3a	3b	4	4a	4b	4c	5
ARG FIRE CLAY	[illegible]	33.3	33.3	33.3	33.3	33.3	33.3	25	25	25	25	0
N.A. FIRE CLAY	25	33.3	33.3	33.3	33.3	33.3	33.3	25	25	25	25	0
M&D BALL	0	0	0	0	33.3	33.3	33.3	0	0	0	0	
KY. SPEC. BALL	25	33.3	33.3	33.3	0	0	0	25	25	25	25	50
WOLLASTONITE (C1)	0	0	0	0	0	0	0	25	25	25	25	50
BENTONITE	0	0	0	0	0	0	0	0	0	0	3	2
"G" GROG	25	0	15	30	0	15	30	0	15	30	30	0

"QF" – QUICK FIRE BODIES:

	1	1a	2	2a
TALC	68	68	34	34
WOLLASTONITE	0	0	34	34
KY. SPECIAL	29	0	29	0
EP KAOLIN	0	29	0	29
BORAX	3	3	3	3

NOTE: ALL 4 OF QF BODIES WITHSTOOD A 10 MIN. BISQUE.

BODY	% H_2O	PLASTIC INDEX (1-10)	DRY SHRINK	% FIRED SHRINKAGE Δ1	Δ5	Δ9	% ABSORPTION Δ1	Δ5	Δ9	REMARKS
PLS										
1	27	9−	7	10	10	11½	13.0	13.0	7.0	
2	30	6+	6	10	11	13	9.5	8.0	2.0	
2a	27	6	6	10	11	13	13.5	12.0	4.5	
2b	26	6−	6	9½	9½	12	13.3	13.5	5.3	
3	28	7+	7½	13	14	14½	6.3	3.2	14.0	BLOATING?
3a	25.3	7	7	12	12½	13	9.5	4.5	12.5	BLOATING?
3b	24.5	6-7	6½	10½	11½	12	10.0	7.5	8.5	BLOATING?
4	30	5	6	8	7	7	16.0	14.5	6.5	SL. THIX.
4a	27	5	5½	6½	7	8	16.0	15.3	10.6	SL. THIX
4b	24.5	5+	4¾	6½	5	7½	17.0	15.0	11.0	SL. THIX
4c	23.5	5−	5¼	6½	5½	7½	15.0	15.8	9.5	
5	37	6	5½	6½	8	MELTED	19.0	9.5	X	[illegible]
QF										
1	35	7	5½	6½	8	13	17.0	19.0	2.4	THIX, FINES W/CRUST
1a	34	5	4½	7	5½	13	22.5	19.0	2.9	THIX., CRUST
2	31	7+	5	6	6½	MELTED	18.5	17.0	X	VERY THIX, CRUST
[illegible]	[illegible]	5+	5	5	6	MELTED	20.5	22.0	X	VERY THIX, CRUST

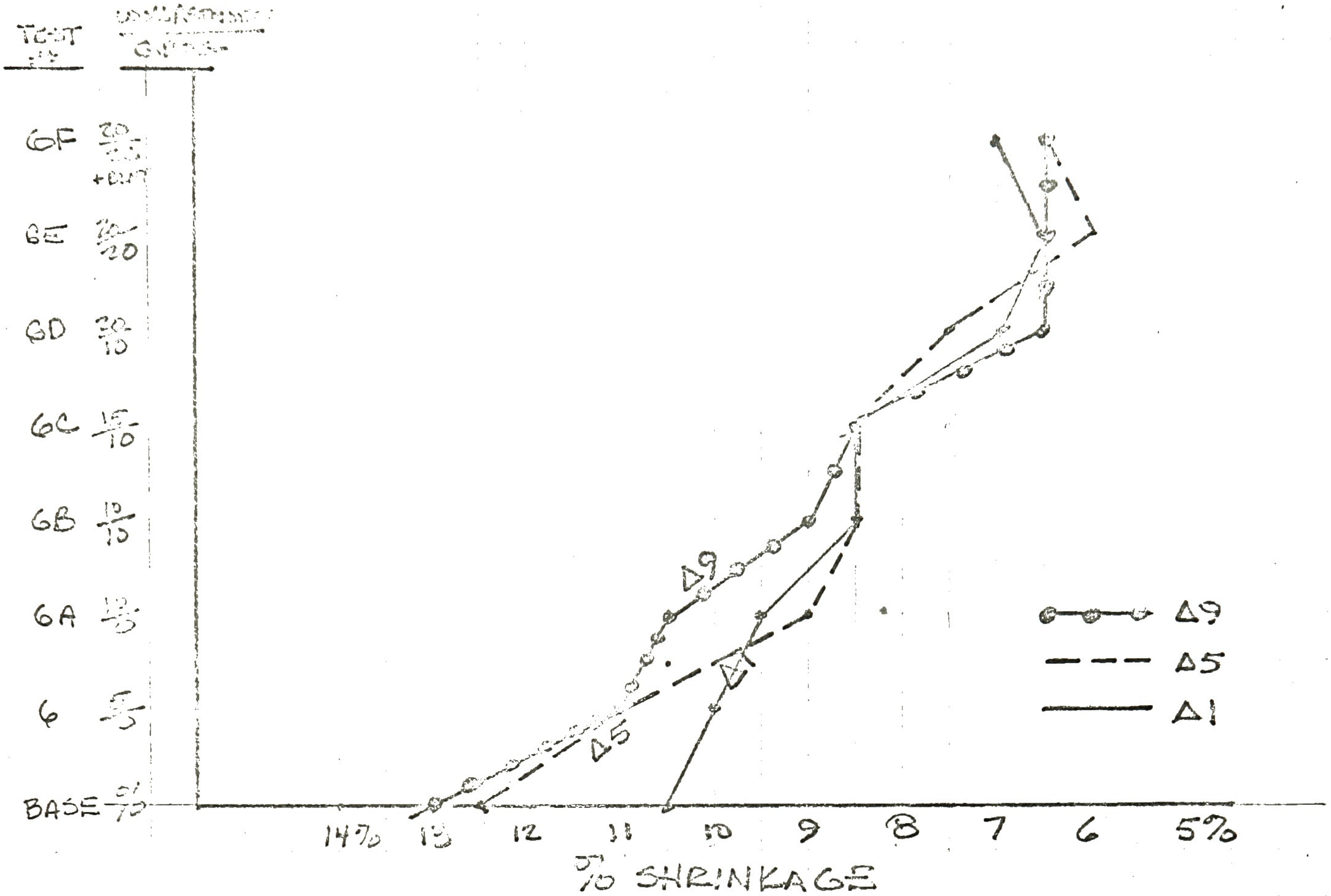
[illegible] B - TEST RESULTS

BODIES.	6 A B C D E F G H I J	7 A B C D E F G H I J
A.P.G. FIRE CLAY	33.3 →	33.3 →
N.A. FIRE CLAY	33.3 →	33.3 →
M & D BALL CLAY	33.3 →	
KY SPEC BALL		33.3 →
WOLLASTONITE (?)	5 10 10 15 20 →	5 10 10 15 20 →
BENTONITE	2 →	2 →
G. GROG	10 → 20 20 10 →	10 → 20 20 10 →
ALBANY SLIP	10	10
BARNARD CLAY	10	10
RED ART CLAY	25	25
FRIT 3110	10	10

NOTE: TEST 6GA, 7GA, RUN WITHOUT WOLLASTONITE

BODY	% H_2O	PLASTIC INDEX 1-10	DRY SHRINK	% FIRED SHRINKAGE A08	A1	A5	A9	% ABSORPTION A08	A1	A5	A9
6 BASE	27	8	7.0	9.0	10.5	12.5	15.0	13.8	7.9	3.2	3.4
6	25.5	8+	6.5	8.0	10.0	11.0	11.0	12.0	7.4	5.8	3.5
A	25	7+	6.0	7.0	9.5	9.0	10.5	13.8	6.9	8.0	3.5
B	23.5	8	6.25	7.5	8.5	8.5	9.0	14.0	8.5	9.2	5.7
C	24	7+	6.5	7.0	8.5	8.5	8.5	16.2	10.1	11.4	7.5
D	23	7	5.25	5.5	7.0	7.5	6.5	13.4	9.5	11.4	9.0
E	22.75	7	5.0	6.0	6.5	6.0	6.5	13.5	10.2	12.0	11.6
F	23	6+	5.5	6.5	7.0	6.5	6.5	14.0	11.0	12.6	11.0
G	24.25	6-	5.75	6.5	7.0	7.5	7.0	12.8	9.8	11.0	1.9
GA	21.5	8	7.0	8.5	11.0	11.0	11.5	13.2	8.3	7.3	5.5
H	26.5	8	6.0	7.0	8.5	7.0	6.5	14.0	11.0	12.5	10.1
I	28	9	7.0	7.5	10.0	9.0	8.5	13.8	10.7	8.6	2.1
J	26	8	6.0	7.5	7.5	7.5	7.5	11.8	6.2	9.9	4.1
7 BASE	30	7+	6.25	7.0	11.0	11.5	11.5	16.2	13.0	9.6	3.5
7	28	7+	5.5	6.5	8.5	8.5	10.0	19.0	12.0	12.0	4.2
A	27	7+	5.0	6.0	8.0	7.5	8.0	19.0	12.0	12.6	7.0
B	25.5	6	5.0	5.5	7.0	7.5	7.5	17.6	13.8	13.8	8.5
C	25	6+	5.0	5.5	7.0	7.0	7.0	17.8	13.4	14.8	13.5
D	25.5	6	4.75	5.5	6.5	5.5	6.5	13.8	14.0	15.6	14.0
E	25.5	[illegible]	4.5	5.0	6.5	5.5	5.5	13.6	17.0	16.0	14.4
F	31	7	6.0	5.5	8.0	7.0	7.5	16.6	15.0	13.4	13.2
G	31	8	6.25	6.5	8.0	8.0	9.0	16.2	15.0	14.4	0.6
GA	23.5	7	7.0	8.0	11.5	12.0	12.5	16.5	15.2	[illegible]	4.0
H	33.75	6	6.0	6.5	7.5	7.5	10.0	17.7	12.4	[illegible]	0
I	?	9+	7.0	[illegible]	9.5	8.5	9.5	17.1	12.2	13.2	1.4
		8-	7.0	8.5	9.5	8.5	7.5	9.4	10.2	11.6	1.4

IBIT C – SHRINKAGE PLOT



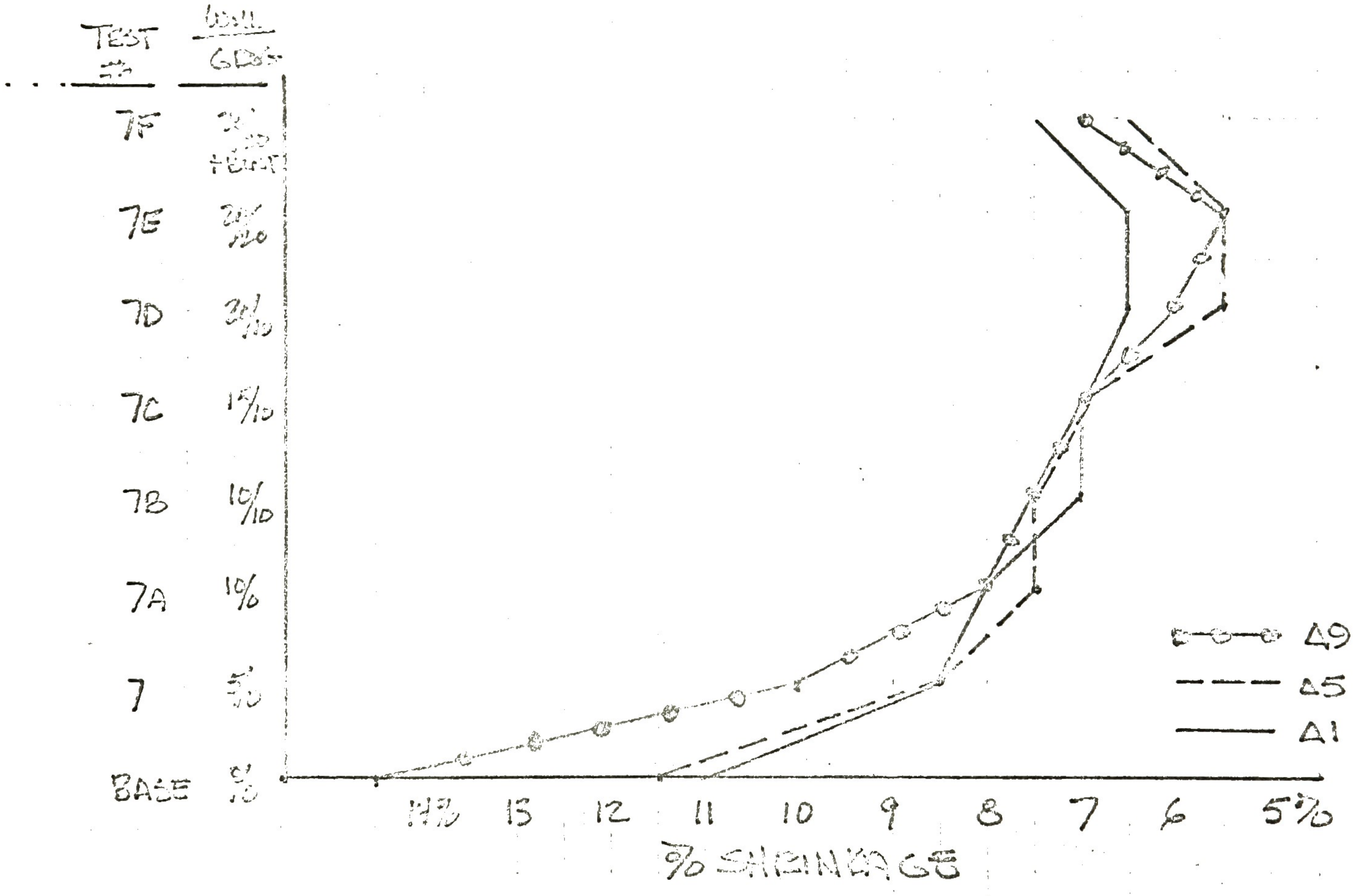
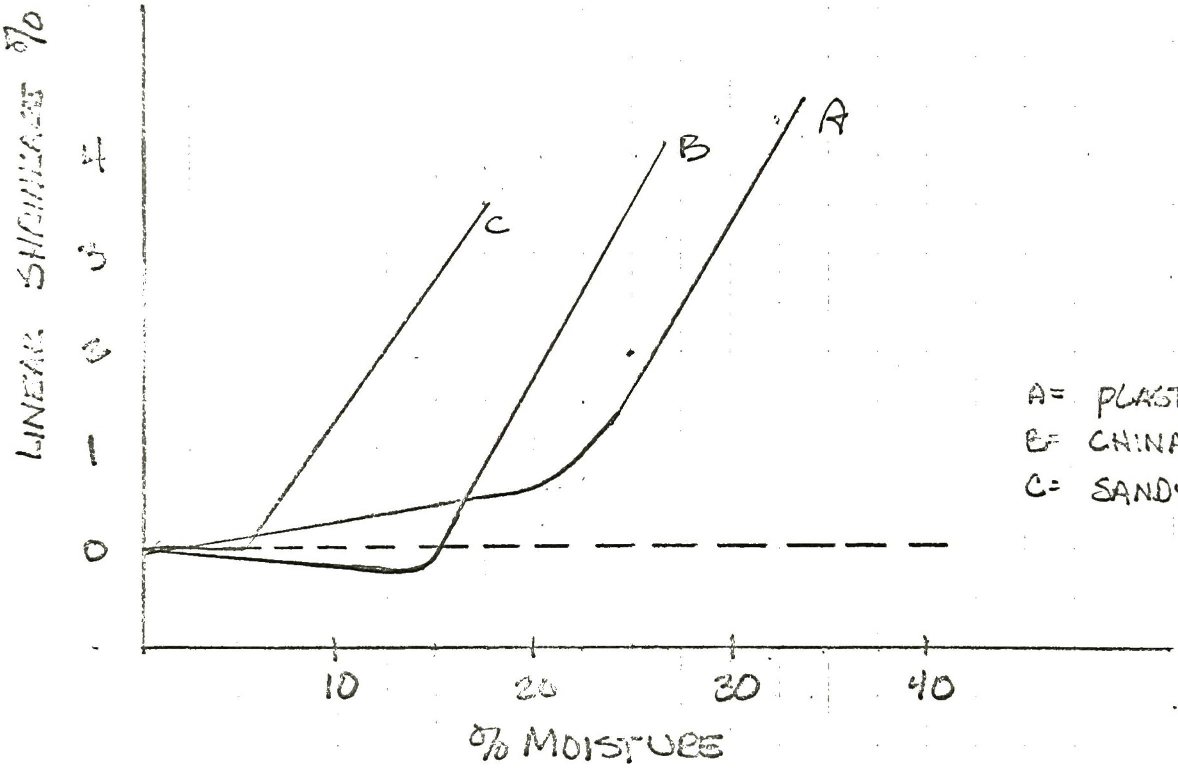


EXHIBIT D – RELATIONSHIP BETWEEN SHRINKAGE AND WATER CONTENT



RELATIONSHIP BETWEEN THE SHRINKAGE AND WATER CONTENT DURING THE DRYING OF CERAMIC MASSES [4]

... D R.W. GRIMSHAW, THE CHEMISTRY & PHYSICS OF CLAY, LONDON, 1959, P.5

EXHIBIT E - TEST RESULTS

BODIES 6:	L	1	2	3	M	1	2	3	N	1	2	3	4	O	1	2	3	P	1	2
APG FIRE CLAY	33.3	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
N.A. FIRE CLAY	33.3	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
M&D BALL CLAY	33.3	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
WOLLASTONITE (C-1)	20	→	→	→	→	→	→	→	→	10	15	→	→	20	25	30	20	→	→	→
G. GROG	10	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
FRIT 3110		5	10	15		5	10	15			5	10								
ALBANY SLIP					10	→	→	→												
BARNARD CLAY									10	→	→	→	→							
RED ART CLAY														25	→	→	15			
Fe_2O_3																		2	5	10

CONTINUED:

BODIES 6:	Q	1	2	3	R	1	2	3	S	1	2	3	T	1	2	3	U	V	W	X
APG FIRE CLAY	33.3	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
NA FIRE CLAY	33.3	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
M&D BALL CLAY	33.3	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
WOLLASTONITE (C-1)	20	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	
G GROG	10	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
FRIT 3110				10				10				10				10				
SPODUMENE	5	10	15	15																
AMBLIGONITE					5	10	15	15												
LEPIDOLITE									5	10	15	15								
BONE ASH													4	6	8	8				
ILMENITE																	3			
RUTILE																		5		
GRAN. Mn																			3	
WOLLASTONITE (C-1)																				20

SEE NEXT SHEET FOR TEST RESULTS

[illegible] E - CONTINUED

BODY	% H2O	PLASTIC INDEX	DRY SHRINK	% FIRED SHRINKAGE A1	A5	A9	% ABSORPTION A1	A5	A9	REMARKS
L	23.0	6	5.5	7.5	6.5	7.0	10.6	10.2	8.0	
L1	20.5	6+	5.25	7.5	7.0	6.5	8.0	9.2	5.5	
L2	20.0	6-	5.25	7.5	7.0	7.0	6.9	6.3	4.1	
L3	20.0	6	4.5	7.5	6.5	7.0	6.4	4.8	3.8	
M	21.0	8	5.5	7.5	6.5	7.0	11.0	10.3	0	
M1	21.0	8	5.0	7.0	6.5	5.5	9.3	9.9	4.1	
M2	20.5	8	4.75	7.0	5.5	5.5	8.0	6.7	9.2	BLOATED A9
M3	20.5	8	5.0	7.0	6.5	4.5	8.2	5.5	19.0?	
N	20.5	6	5.0	7.0	7.0	6.5	10.8	9.5	0	
N1	21.0	7	5.5	8.0	8.0	8.0	9.3	8.3	4.7	
N2	22.5	7	5.5	7.0	7.0	7.5	11.2	10.1	3.0	
N3	22.0	6	5.5	8.0	8.5	6.5	8.3	8.4	5.5	
N4	21.5	7	5.0	9.0	7.0	6.5	6.3	6.1	5.1	
O	22.0	9-	5.0	6.0	7.0	7.0	8.3	8.6	1.0	
O1	23.0	8	4.5	6.5	6.5	6.5	9.4	9.8	4.3	
O2	N.T.	8+	5.0	7.0	7.0	6.5	10.8	11.2	4.6	
O3	21.5	7+	5.0	7.0	6.5	7.0	9.3	9.6	5.3	
P	21.5	8	5.5	6.5	7.0	7.0	10.6	10.7	6.2	
P1	22.0	8	5.0	7.0	6.5	6.0	10.4	10.4	0	
P2	N.T.	7+	5.25	6.5	7.0	7.0	11.1	11.3	3.3	SL. BLOAT A9
Q	N.T.	6+	5.0	6.5	6.5	6.5	10.8	11.3	3.7	
Q1	20.5	6+	5.0	6.5	5.5	6.5	10.3	10.8	5.1	
Q2	21.0	7+	5.5	6.5	5.5	6.0	12.0	11.5	0	
Q3	20.0	7+	5.0	7.0	6.5	6.0	6.9	7.5	5.8	
R	21.3	7+	5.25	7.0	7.0	6.0	10.4	10.1	3.9	
R1	21.5	7+	5.5	6.0	6.5	6.0	12.7	12.2	1.6	
R2	20.75	7+	5.0	5.0	5.5	6.0	13.0	12.1	0	
R3	19.5	8	5.0	6.0	5.5	B	9.2	7.6	N.T.	BLOATED A9
S	21.3	6+	5.25	7.5	7.0	7.0	9.3	9.1	4.4	
S1	21.5	7+	5.5	7.5	8.0	7.0	8.5	8.7	3.5	
S2	22.0	7	5.0	6.5	6.5	7.0	8.3	7.4	3.2	
S3	21.0	7+	5.0	7.0	7.0	6.5	5.8	4.1	6.2	
T	22.0	8	5.0	6.5	6.5	7.0	10.8	11.0	5.0	
T1	22.0	7-	5.0	6.5	6.5	6.0	10.3	10.3	2.1	
T2	23.0	8	5.5	7.5	7.0	7.5	11.1	12.8	5.1	
T3	21.0	7+	5.0	7.5	7.5	8.0	7.3	[illegible]	0	BLOATED A9
U	20.0	7	5.25	7.0	7.0	5.5^{3}	10.4	11.0	4.1	
V	20.0	8+	5.0	6.5	6.5	6.0	10.8	10.4	7.1	
[illegible]	[illegible]	[illegible]	5.0	7.0	6.5	6.5	11.0	11.0	3.5	
[illegible]	[illegible]	[illegible]	.5	6.5	6.0	6.0	10.8	12.6	[illegible]	

GLASS FUSING

I had an interest in developing a system for fusing glass to clay in such a way that the glass would be transparent. As the area of glass formation is a complex subject in itself, I will only mention that I tried batching my own glass, using typical empirical formulas for bottle glass, crystal glass, window glass, as well as crushed "Coke" bottles, several other glaze/glasses, and commercial glass.

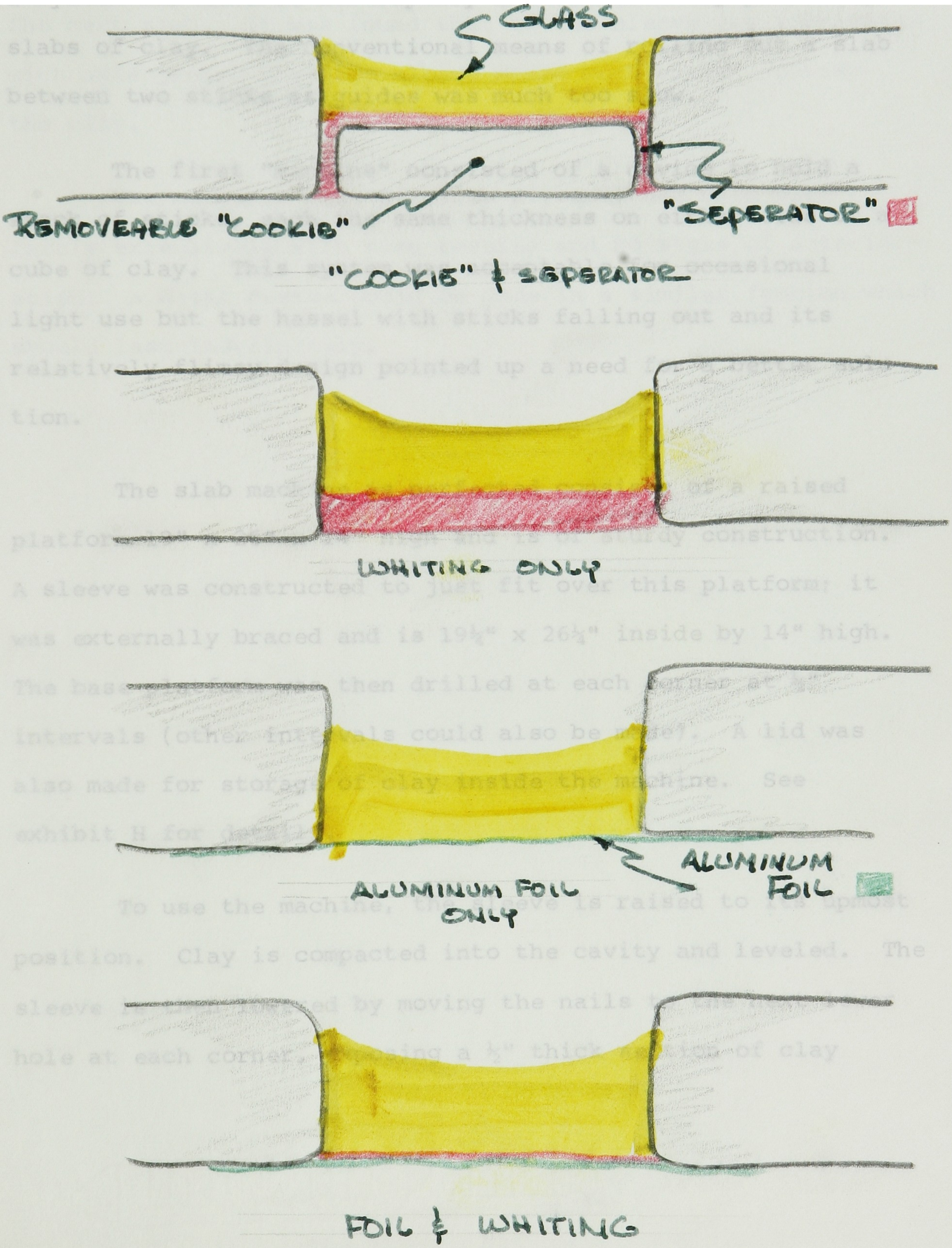
It so happened that a glass produced by Blenko Glass Company, Milton, West Virginia, fit my clay body well and was available in several colors with quality control. Whereas I did not care to spend the time to fully develop my own glass for a limited use, and since Blenko glass worked well, I used this commercial glass.

To use the glass as a puddle glaze was no problem, but to get the glass into a cut-out area in the clay, without a backing, was the problem. I first tried fabricating the cut-out by saving the "cookie" from the cut-out and using it as a backing, isolating the glass by a separator. This proved unsatisfactory as the "cookie" tended to bind and get fused into the opening, defeating my purpose. I then tried using several materials as a filler for the cut-out, later to be washed out if there was no interaction with the glass. $CaCO_3$ (whiting), alumina, fire clay, Zirconiumoxide, and Magnesite were tried at cone 04. Whiting worked the best, but left a lumpy surface after the whiting was removed. Alumina was smooth but a fine layer of alumina was taken up into the glass, creating opacity. The other materials all yielded poor results.

The final solution was to use aluminum foil. The foil worked well, but here and there areas were fused to the glass. This was not undesirable as it added an "antiqued mirror" effect and was not entirely opaque. The best solution was to use aluminum foil "painted" with whiting. This was rather smooth and did not affect transparency of glass to any extent. See exhibit G.

EXHIBIT G

GLASS FUSING TECHNIQUES



SLAB MACHINE

Whereas I envisioned using uniform slabs frequently, a system was desired for rapidly and consistently producing slabs of clay. The conventional means of rolling out a slab between two sticks as guides was much too slow.

The first "machine" consisted of a device to hold a stack of sticks, each the same thickness on either side of a cube of clay. This system was acceptable for occasional light use but the hassel with sticks falling out and its relatively flimsy design pointed up a need for a better solution.

The slab machine as perfected consists of a raised platform 19" x 26" x 14" high and is of sturdy construction. A sleeve was constructed to just fit over this platform; it was externally braced and is 19¼" x 26¼" inside by 14" high. The base platform was then drilled at each corner at ½" intervals (other intervals could also be made). A lid was also made for storage of clay inside the machine. See exhibit H for details.

To use the machine, the sleeve is raised to its upmost position. Clay is compacted into the cavity and leveled. The sleeve is then lowered by moving the nails to the next lower hole at each corner, exposing a ½" thick section of clay

19" x 26". A "harp" or wire is then used to slice off a slab ½" thick, the top of the sleeve acting as a guide. The slab is then lifted off and the machine is ready to be lowered for the next slab. It was found that if the sleeve was lubricated with axle grease that the sleeve moved much easier against the clay.

The machine, made of scrap plywood, has been used fairly extensively with good results and no signs of deterioration. A metal device could be made in a similar fashion which should last indefinitely.

executions

1. "SEMI-MASS PRODUCED" TILES--MODULAR:

As an adjunct to the main theme of my thesis--original works--I experimented with developing a tile that could be produced rapidly, used in a variety of ways and be modular. The idea was that the tiles could be produced and bisqued during a slack time in a studio operation and then used later by themselves or as a part of a larger wall covering or as a background for an original work. Upon knowing their specific use, the tiles would be glazed accordingly.

The first system tried in any quantity consisted of a flat 12" by 12" tile with a series of raised and randomly undulating strips of clay, the ends of the strips being uniformly spaced. Both "straight" and right-angle tiles were made. By utilizing a "slab-machine" and a jig for spacing the strips, tiles could be made rapidly. The clay body used was a common stoneware throwing body, which did warp and crack. At this point, the shortcoming of the clay body was of no concern, since the purpose was to test the concept only.

The photographs following illustrate the completed tiles. Photo #1a shows a closeup of one "straight" tile. Number 1b shows the straight tiles utilized as a simple over-all textured background; #1c being a closeup of same. Photo #1d shows the tiles used to surround a center panel, which could be any area to be highlighted. In #1e both straight and right-angle tiles are used to set up a pattern--still a rather modest overall background effect, but yet with something going on. Photograph #1f utilizes the same tiles, but adds color to emphasize the pattern and to illustrate that the same tiles can be used either as a subtle background or as a statement in, of, and by itself.

The conclusion drawn after completing this set of tiles is that, although it is true that they are hand-fabricated and no two tiles are alike, they approach machine-made tiles. Originally I had thought that I could "go one better" than the machine made tiles already on the market, but after this trial I began to realize that in order to produce tiles rapidly and modular (hence repetitive system) there are many built-in limitations. My conclusion is that, since I do not wish to become a machine, I should leave these tile systems for machine production.

As a followup, a bolder and less repetitive system was sought. Photos #1g and #1h illustrate the use of a similar tile but used only as a pattern and not as an entire wall covering. The spacing is still modular but each strip of clay becomes a stronger statement. The wall is designed to be executed in a way that the undulating strips of clay would be imbedded in the wall--the wall itself becoming an important factor or negative space. The wall could, however, be executed with flat tiles as a background and the selected tiles to have the raised pattern. These photos are of a "styrofoam" mockup. A plaster cast was made of one section. This mold was then used as a press mold. A tile was thus produced to show the feasibility of this system (Photo #1i).

2. LANDSCAPE MURAL:

The first attempt at a "sculptural" or free mural is illustrated in photograph #2. The approach was to take an abstract sketch and to interpret it into a mural with dimension. This was a technique I had used as a landscape architect in designing exterior spaces.

The clay was applied to an upright easle, the design sketched on and then the relief and texture sculpted. The mural was later cut into kiln-sized pieces and then hollowed out from the rear.

This piece was an important step and factor in determining future murals. During the process of cutting sections and removing them from the easle for hollowing out, I began to realize the value of not limiting the clay to a rectangular outline. I also realized that the wall becomes an important and effective factor in the design of wall "coverings" or murals.

However, the mural was mounted in the rectangular form as originally conceived because it looked obviously like a rectangular form with a piece missing when I attempted to disregard some pieces. For this reason, the mural was executed as a rectangle and the idea of using the wall itself was the jumping-off point for future "walls"

Clay Body Used:

Cone 9 reduction

North American Fire Clay	60
Redart Clay (Cedar Heights)	20
Jordan Clay	20

3. CERAMIC COUNTER TOPS:

My ideas of working for a specific space and with the client's wishes in mind were given the opportunity for testing when I received a commission to design and execute tiles for two bathroom counters.

The first obstacle was that the client (an interior designer) was looking for someone to execute some painted tiles with birds, trees and flowers in the French or Dutch style. I did not feel competent enough in painting and did not desire to "China paint" some tiles and therefore sold the client on the idea of letting me do sketches of designs in a "mosaic style" for the counters. Keeping in mind the client's tastes for the "realistic" or "non-abstract" and also a fondness for "stoneware feeling", several sketches were worked up and the client then enthusiastically approved of my designs.

The photos in series #3 illustrate the completed counters. Photos #3a show the master bath. The total area was 7'-0" x 24". The back and one end required back-splash tiles; the front and other end required bullnose tiles. Photos #3b show the guest bath, with total area of 5'6" x 22" and back splash only. The sinks, which were scalloped in shape, and the fixtures and the counter already determined when I received the commission. Therefore, this was a good test for my clay body as a precise fit was required. In both bathrooms, the color schemes were also already established and my choice of glazes necessitated fitting to the established color scheme.

The completed counters were installed with no problems as to the tiles fitting the existing counters and fixtures. The clients are very pleased with the result--now a focal point of their home. Upon viewing the counters in their total environment--that is, with other fixtures, drapes, linens--these counters, in my opinion, are very successful.

Clay body:	North American Fire Clay	33.3
	AP Green Fire Clay	33.3
	M&D Ball Clay	33.3
	C-1 Wollastonite	20
	Frit 3110	10
	Grog	10

4. MODEL FOR LARGE SCALE MURAL:

The idea of letting the wall become an important part of a mural seems to have a lot of merit. One consideration is that by utilizing the wall, less clay needs to be used and hence there is less work in execution for the potter--- which on large-scale work becomes an important factor. By utilizing the wall, there is immediately more of a sense of integration of the mural into the building, rather than as a "covering". The wall can be used very effectively as a negative space. The elements of the wall can be specified or controlled. For example, the texture can be dictated by the decision to use smooth or rough concrete, various types of brick, etc. Using the painters perogative, subtle changes may be made relatively easily in the color of the wall--- unlike the major work needed to change the color of a clay wall.

Photo #4 shows a solution to a mural envisioned as being approximately thirty feet in length. It is to be set into a common brick wall (red background), and to use commercial glazed tiles or glazed brick for flat yellow and white areas. The relief areas are to be executed in clay. In the model, relief was exaggerated for photographic reasons. The idea was to let the wall and its plane intrude into and integrate the mural, and not to have the mural be a rectangular form stuck on the wall.

5. FRAMED AND HUNG MURAL:

Although I like the idea of working with a specific space and being able to have the form as an integrated part of the structure, which it embellishes, I decided to try a more traditional approach---that of a mural that is mounted, suitable for hanging in a variety of locations.

Photograph #5 shows my solution to this problem. The idea was to work within a rectangular frame, but to reflect upon the idea of integrating the form and the surface. I surrounded the clay form and then allowed the clay to move in and out of the surface. I had in mind an organic growth and the way in which its roots wander in, about and embed themselves.

The clay was left mostly unglazed for tactile as well as aesthetic reasons. As it was presumed that the mural would be viewed closeup, a form that would be intriguing to the touch was also sought.

Clay Body:

Cone 5 reduction

North American Fire Clay	33.3
AP Green Fire Clay	33.3
M&D Ball Clay	33.3
Frit 3110	10
"G" Grog	10
C-1 Wollastonite	20
"Fiberfrax" (Carborundum)	.25%

Fiberfrax mixed into body during pugging process.

6. TWO FORMS AND WALL:

Utilizing the concepts developed, especially that of using clay as elements in/on the wall, a wall was tried using two forms of clay. The objective was to use two clay forms, to have them relate to one another and to establish a total relationship with the wall itself. By not trying to "cover" the wall, a feeling of integration was sought. The wall was to be an eight foot square surface. The total composition of clay and flat wall were conceived of as a complete mural, and the wall was to be modulated by use of color and/or line.

The clay forms were designed to be set into a concrete wall. For practical reasons, the execution as photographed consists of clay forms bolted to a plywood panel eight foot square. Photographs 6a-d illustrate the solution in various stages. Photo #6a shows the clay forms on a plain panel, #6b is a sample of using the painted line alone, and #6c and #6d show the final solution of line and color.

Clay Body:

Cone 9 reduction

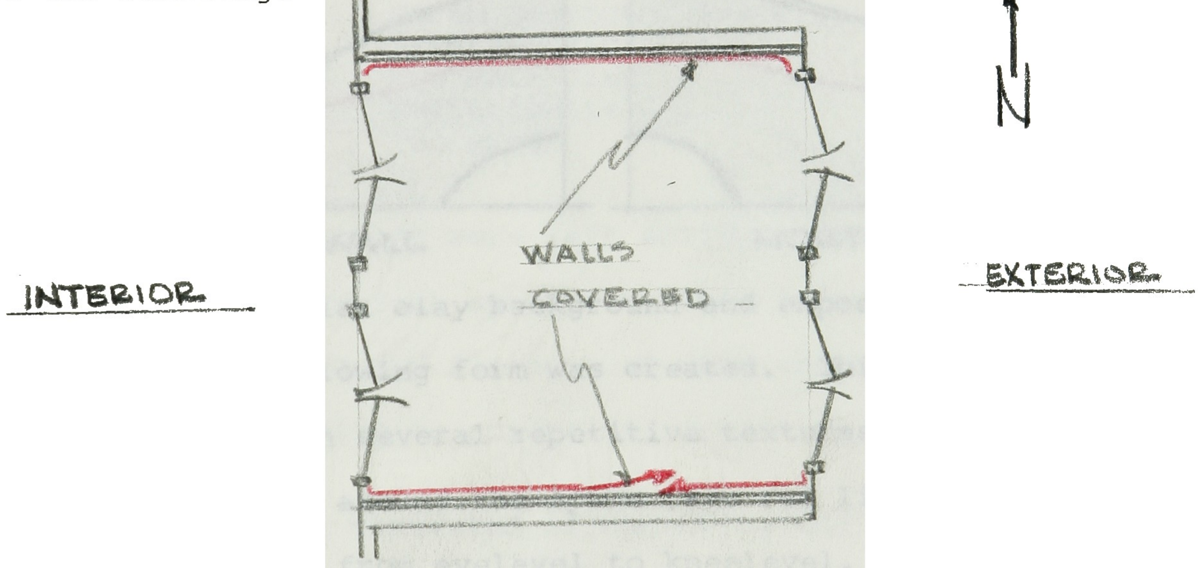
North American Fire Clay	60
Cedar Heights Redart Clay	20
Jordan Clay	20

This body was successfully fired without hollowing out this form. This was tried as a test to save time and handling for future work.

7. ENTRY WALLS:

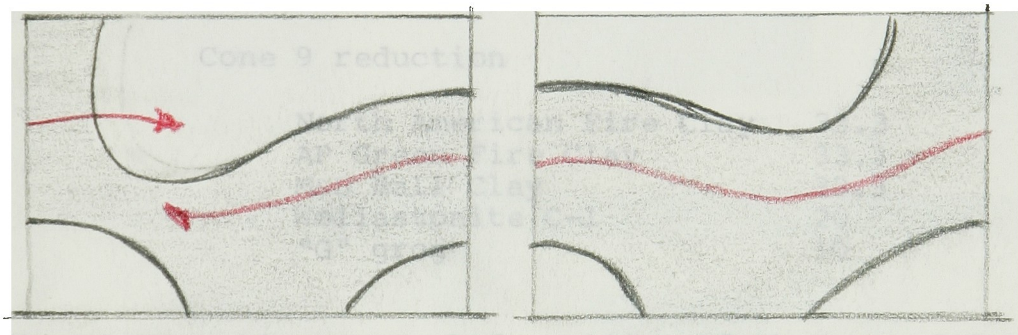
As a final project, a space was sought at R.I.T. in which to execute and install a decorative ceramic work. After evaluating various locations, it was decided to work with the two parallel walls at the entry to the Fine and Applied Arts Building.

As time and materials were both short, a "smaller" space was sought. Also, this space was a rather challenging one in that the space is very close and confining as well as a busy space. The space, approximately nine feet square and seven feet high, contains four sets of double doors, louvered ceiling, brick paving, light from outside and inside and fluorescent light within. This space also accommodates a sizeable student circulation as it serves as a main entrance to the building.



Sketch of Space Selected in Plan View

The design approach was to try to unify the space by having a design that was "continuous" from side to side. The clay areas on opposite walls would, if butted end-to-end or top-to-top or bottom-to-bottom, create continuous forms. This was done in hopes of unifying the decoration and attempting to create a feeling of walking through the space. The forms chosen were a reflection of the function of the space, that is, for people to flow through. The clay forms therefore were created with a flowing background of simple line and curve, to carry the viewer through the space and to again strive to simplify the already busy space. See sketch below of background form.



SOUTH WALL NORTH WALL

Upon this flat clay background and exposed wall, a simple and free-flowing form was created. This form is in slight relief with several repetitive textures. This raised form wraps around the space (see red line on plan view), undulating from eyelevel to kneelevel. The purpose of the raised area is to provide the visual enjoyment and also a tactile experience as one is hopefully carried visually, and passes through the space.

The clay body was left bare for its color and texture; black and white slips were used for some subtle accents. Puddle glazes were then used in small depressed areas of the textured form to add "sparkle" to the space in the changing light sources. Glass was fused into cutouts in areas that wrapped around the corners and could be viewed through the existing glass panels.

Photographs in series #7 illustrate the wall and details.

Clay Body:

Cone 9 reduction

North American Fire Clay	33.3
AP Green Fire Clay	33.3
M&D Ball Clay	33.3
Wollastonite C-1	20
"G" grog	10

The clay sections were left solid, and then cored from the rear with a one inch speed bit, this left a series of holes to aid drying and firing - as well as providing a surface for the adhesive to adhere to.

Installation consisted of cementing the clay pieces into 3/4" plywood panels with "U-Poxy" mortar cement (USM

Corporation, the Upco Division, 4805 Lexington Ave., Cleveland, Ohio 44103). This was done horizontally and then the panels lifted into place. As it was not determined if the school wished to have the work to remain permanently, the panels were only rested on the floor and held by braces out of sight above the existing false ceiling.


1a
MADE IN U.S.A.
1b
MADE IN U.S.A.
1c
MADE IN U.S.A.
1d
MADE IN U.S.A.
1e
MADE IN U.S.A.
1f
MADE IN U.S.A.
1g
MADE IN U.S.A.
1h
MADE IN U.S.A.
1i
MADE IN U.S.A.
2
MADE IN U.S.A.
2
MADE IN U.S.A.
3a
MADE IN U.S.A.
3a
MADE IN U.S.A.
3a
MAY 70
3b
MADE IN U.S.A.


3b
MADE IN U.S.A.
4
MADE IN U.S.A.
5
MADE IN U.S.A.
6a
MADE IN U.S.A.
6b
MADE IN U.S.A.
6c
MADE IN U.S.A.
6d
MADE IN U.S.A.
7a
JUN 70 19
7b
29 JUN 70
7c
JUN 70 17
7d
23 JUN 70
7e
JUN 70 25
7f
JUN 70 28
Conclusion

Conclusion

CONCLUSION

As stated in the introduction, the educational situation in which this thesis was done limited the extent to which my ideas could be carried.

Although it is possible to think in terms of large works, fully integrated with the structure and completed as a part of the whole, the time and money limitations existant in the academic situation seriously hinder full exploration. Also, the physical limitations of an institution such as R.I.T. play an important part in limiting the student. Availability of work space, other people using the same space, people walking on large pieces and cracking them, kiln space and size all are working against large-scale works.

This is not to say that the experiences gained during the course of the year were not valuable. To the contrary, I feel that I learned and benefited greatly from the experiences---experiences which have hopefully prepared me to be able to execute works such as I would like to do in the future. I feel that through the exposure of the various approaches taken, I learned many small and important lessons.

The obvious problems of a technical nature, such as getting large pieces through the drying, firing, and installation, were experienced. More important, however, was an introduction to the problems of scale---to learn that areas that look good on a small sample or test do not necessarily work well on a larger scale. It became evident that, as a general rule, textures and/or color needs to be either strong and conscious or small and weak so as to create a "shading" rather than to be an element of the design.

The value of a good clay body became apparent when the finished piece had to fit a given space, such as for the counter tops and for the entry space. Not only was fit important but dependable shrinkage made it possible to remake pieces which had been destroyed.

To work with a client, as in designing the counter tops, was an invaluable experience as I hope to be working primarily with and for clients in the future.

The progression of the works executed during the course of this thesis led to and strengthened the concept that, to be effective as architectural decoration, a degree of integration must be achieved with the surface itself. It is felt that the lessons and experience learned led to this conclusion and have provided the knowledge and background to enable me to undertake the type and scale works which I believe would be most successful---those which fit as an integral part of the whole, which are designed for a specific space with full consideration for the characteristics of that space and function.

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