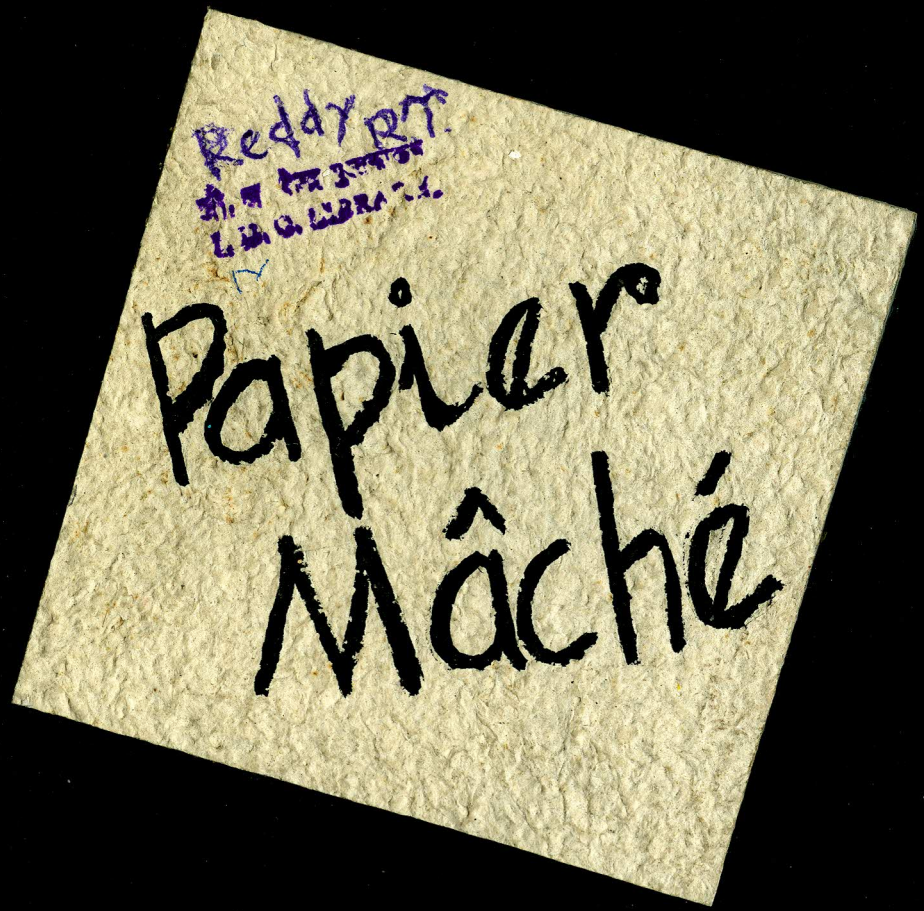
Reddy RT.
Papier
Mâché

PAPIER MACHE

SPECIAL PROJECT

By

Ravi T.Reddy

Submitted in partial fulfilment of the requirement
for Master of Design degree in Industrial Design

Guide
Asstt. Professor V.P.Bapat

INDUSTRIAL DESIGN CENTRE
INDIAN INSTITUTE OF TECHNOLOGY
BOMBAY - 400 076

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APPROVAL SHEET

This Special Project entitled 'Papier Mache by Ravi T.Reddy is approved in partial fulfilment of the requirements for the Master degree in Industrial Design.

Guide : Bapat

Chairman :

Internal Examiner :

External Examiner :

ACKNOWLEDGEMENTS

My sincere thanks to Asstt. Prof.V.P.Bapat for initiating me into this exploration, and for his help and guidance at every stage of the project.

IDC

IIT-Bombay

April,1989

Ravi T.Reddy

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1. FOREWORD

Papier Mache is a modelling material consisting of a mash of paper used with a binder and moulded round a shape to make functional and decorative objects. It is a cheap and easy material to use and has the advantage of drying naturally to a hard and durable substance without necessarily having to be baked like clay.

This craft of making objects is an ancient one. Soon after the Chines discovered how to make paper,2000 years ago, they began to experiment with papier mache. The interest in this craft declined for hundreds of years untill the French revived it in the 18th century. They called it 'papier mache' meaning literally chewed up paper. They used it to make trays, boxes and even furniture which were often inlaid with mother of pearl.

India also boasts of a papier mache tradition. Especially so in the Kashmir region where highly finished decorative articles like small boxes and containers are made. Papier Mache craft forms ar important part of Kashmir Handicrafts. Traditionally, in the rural areas, the grain containers that are made with bamboo or cane strips, are sealed with papier mache. This seals the tiny holes in the container as well as strengthens it.

Though the potential of this material is enormous, its exploration has remained to that of the craft level. The objective here would be to extend the boundaries of

exploration of papier mache to suit an Industrial Designer in model making at various studios in the design process, within the confines of the Industrial Design Centre here at the Indian Institute of Technology-Bombay. Such an exploration would be beneficial in the following ways :-

- It would extend the scope of model making at IDC
- May possibly result in substitution of hither to conventional model making materials to save time, energy and resources at IDC
- Would foster a deeper understanding of paper mache.

2. COMPOSITION AND PREPARATION

MASH

Mash is the chief ingredient and forms the basic raw material. Mash may be made from any waste paper. It is for this reason that modelling with papier mache is very inexpensive. The following kinds of waste paper are available in plenty at IDC

1) Newspaper 2) Drawing sheets 3) Butter sheets
4) Corrugated box board 5) Office stationary
6) Tinted paper 7) Mount Board.

In addition to the above the following kinds can be obtained when required.

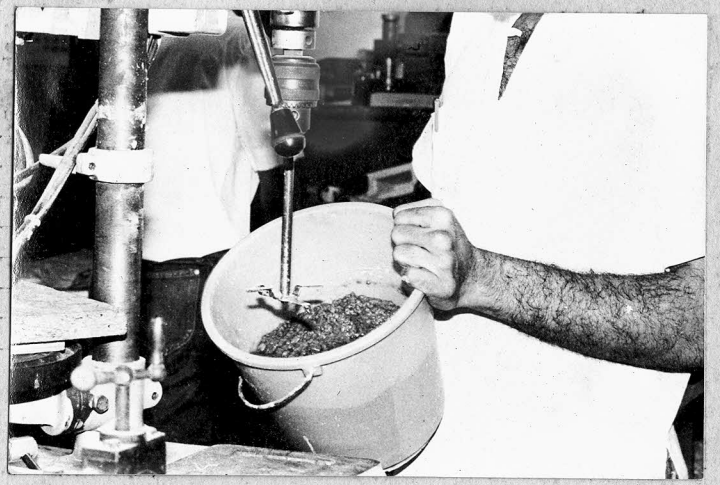
1) Tissue paper 2) Paper Napkins 3) Paper towels
4) Coloured paper napkins etc.

Waste paper in IDC, instead of being thrown away can be stored and utilised for papier mache modelling, thus increasing utility

MASH PREPARATION

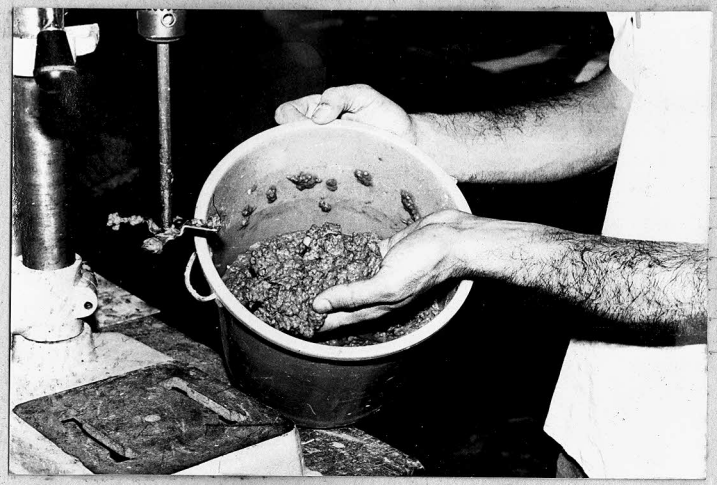
Torn pieces of paper (about 4 cm x 4 cms) should be soaked in water for an hour or so, untill the paper is completely saturated with water. After the paper has soaked, a blender has been used to beat it to pulp. A blade can be fashioned or an old mixie blade can be used along with a rod in such a manner so that it can be fixed to the vertical drilling machine. The wet

TORN PIECES OF PAPER BEING SOAKED IN WATER



WELL SOAKED PAPER, BEING BEAT INTO PULP WITH THE HELP OF A MIXIE BLADE AND THE VERTICAL DRILL.

BLENDING



MASH - A GREYISH MIXTURE, QUITE SOFT AND VERY WET.

QUANTITY OF MASH, BEING MEASURED BY A MEASURING JAR.

paper is then beat into a pulp using this. As the paper is being torn into smaller particles, it absorbes more and more water. Sufficient water should be added as and when required to facilitate efficient blending. Pulp can be made in small batches. This produces a good working mash, but if a finer textured mash is required, it should be allowed to blend for a longer period. There is a limit to which the mash can be blended beyond which it cannot be made any finer. In cases where a finer mash is required, the mash can be blended in a Ball mill or a kitchen grinder. After blending, the paper pulp is strained to remove most of the excess water. The fineness of the mash also depends upon the type of paper used and the fineness decreases in the following order of priority.

1) Tissue paper 2) Paper napkins 3) Butter sheets
4) Drawing sheets/catridge paper 5) Office stationary
6) News paper 7) Tinted paper 8) Mount board
9) Corrugated box board.

ADDITIVES

When we have made our mash we will have a greyish mixture quite soft and very wet. This mixture by itself is useless. To give it the properties that papier mache has, additives have to be added to the mash. The additives serve the following functions :-

Binder - The binder increases the adhesion between the

particles in the mash.

Filler - When added to mash it acts as a filler making the mash more denser and solid.

Vehicle - Makes mash more workable and finished pieces tougher.

Preservative- Keeps the mash from going sour and protects the finished piece from fungus

Colouring- When the paper is being mashed water soluable colours can be added to make the whole mash coloured.

Other Additives - There is a wide range of other additives that can be added to mash to give it a particular kind of property, colour, or surface finish. Some of them that have been tried out are plaster, sand/fine silica, saw dust, zinc oxide. The effect of addition of each material to mash will be dealt with in the later chapters.

The materials that belong to each functional head, have been divided into three categories according to the made of usage. The following page gives a list of the materials.

		TRADITIONAL ADDITIVES	CONVENTIONAL ADDITIVES	OTHERS
BINDER	-	Wheat/Flour Glues Natural Glues	Fevicol/Water soluble Glues	Epoxy Glues
FILLER	-	Fenugreek (Methi)	Calcium Carbonate (Whiting)	Saw dust/Fine sand/Plaster/Zinc
VEHICLE	-	Wheat/Flour Glue	Linseed oil	
PRESERVATIVE	-	Fenugreek (Methi)	Clove oil	
COLOURING	-	Vegetable colours	Water soluable colours	Acrylic/Emulsions/ Varnish/Lacquers

BLENDING ADDITIVES WITH MASH

Mixing the various additives with mash is an easy job and takes very less time. Mixing should be done in small convenient batches. The following steps give a well mixed mash.

1) Excess water is strained of from the pulp with the help of a cloth.
2) The pulp is put into a bowl, the whiting is sprinkled on and stirred into the pulp. The blender need not be used for this step.

COMPOSITION AND PROPORTIONS (table 1)

NO:	PAPER MASH		ADDITIVES											
	TYPE	QTY: (in ml)	BINDER		FILLER		MEDIUM		PRESERVATIVE		COARSE ADDIT:		MISC:	
			TYPE	QTY:	TYPE	QTY:	TYPE	QTY:	TYPE	QTY	TYPE	QTY:	TYPE	QTY:
1	Newsprint	500											Maida & Methi	200
2	"	"	Fevicol	2tsf	Whiting	1tsf	Linseed oil	2tsf	Clove oil	2drps				
3	Drawing sheets	500	"	"	"	"	"	"	"	"				
4	Butter sheets	500	"	"	"	"	"	"	"	"				
5	White tissue	500	"	"	"	"	"	"	"	"				
6	Coloured tissue	250	Fevicol	1tsf	Whiting	1tsf	Linseed oil	½tsf	Clove oil	2drps				
7	Corrugated brd:	500	Fevicol	2tsf	Whiting	2tsf	Linseed	1tsf	"	"				
8	News print	250	"	"	Whiting	3tsf	"	"	"	"	Saw dust	125 c.c		
9	"	125	"	"	Whiting	2tsf	"	"	"	"	Saw dust	100 c.c		
10	News print	250	"	"	"	"	"	"	"	"	Silica	125		
11	"	"	"	"	Zinc oxide	2tsf	"	"	"	"	Plaster	6tsf		

Index: ∘ tsf = tea spoonful
∘ c.c. = cubic centimeter

Note: volumes are approximate; accuracy is not required

3) The linseed oil is then added and mixed. At this stage the mixture becomes more workable.

4) The glue and the preservative are then added and the whole mixture is thoroughly blended. To ensure better mixing, the mixture may be squeezed between the fingers.

PROPORTIONS OF VARIOUS ADDITIVES IN THE MIX

The proportions in which the various additives are mixed, plays an important role in determining the workability of the papier mache and also the properties of the dryed piece. Table 1 gives the various compositions/ proportions tried out in the samples.

Paper pulp along with water can be stored for many days. Sufficient water should be added to keep the pulp moist Once the binder and other additives are added it cannot be stored for a long duration.

3. WORKING WITH MASH

In many ways the prepared mash resembles day. It can be modelled into shapes, it can be given a smooth surface by pressing it with a knife or a spoon, it can be rolled into layers between sheets of newspapers. But mash is not entirely clay. It is so soft that it is difficult to model any form larger than a few inches high. If too much water is squeezed from the mash, though it makes it firmer, it makes it harder to handle. Instead of responding to fingers, it becomes obstinate and tends to form lumps. For these reasons mash is usually applied to the surface of a core, made of paper, card board, wood or other materials. In spite of these difficulties mash can almost be treated in the same way clay is treated.

The surface of the mash can be made quite smooth by buttering it with a knife or spatula. However, the smoothness disappears as the mash dries so the final surface has a characteristic rough grain. A smoother surface can be obtained by giving the mash another treatment with the spatula when it is almost dry. In this state mash resembles a leather hard condition of clay. The material can no larger be modelled, but the surface can be made smooth and its smoothness will remain after the work has dried.

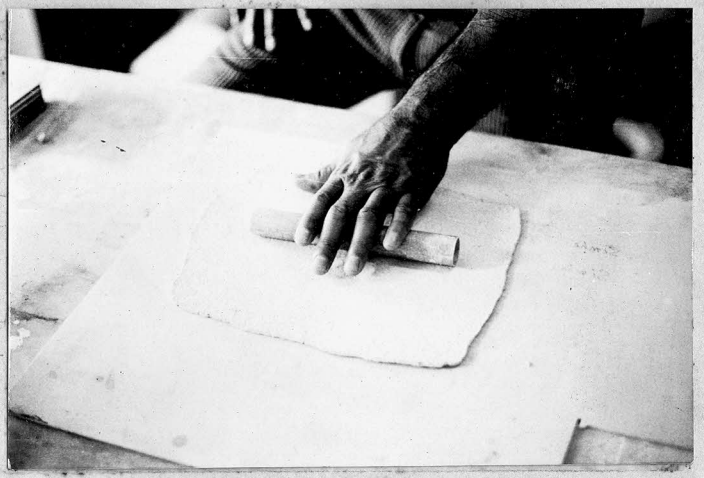
APPLYING MASH

Mash can be best put on a cardboard construction or a mould by bare hands .

MASH BEING ROLLED BETWEEN SHEETS OF NEWSPAPER.

EVEN LAYER OF MASH READY TO BE TRANSFE-RED ON A FLATTISH. MOULD

MASH BEING SMOOTHENED BY A LIGHT ALUMINIUM PIPE.



MASH - SMOOTHENED BY A SPOON OVER A MOULD.

MASH - APPLIED TO THE MOULD BY HAND.

Almost anything can be used as a mould from clay moulds, plastic bottles, plastic moulds to crumpled paper. If the card board construction or any other type of mould is to be left integral with the piece, then the surface to receive mash should be brushed lightly with glue. A little water added to Fevicol would do. Then the mash must be pressed firmly in place. In cases were the mould has to be separated from the piece i.e. in the case of plaster moulds, then any type of oil and soap solution can be used as a release agent. Machine oil, leaves a yellow image on the mould side of the piece. If this is not wanted then any other colourless oil like coconut oil, can be used.

When an object is composed of mostly flat surfaces, mash can be rolled into a layer between sheets of newspaper and then transfered on to the base form or mould. This method ensures a layer of uniform thickness of mash on the base form or mould. In case the object consist of curved and intricate surfaces, then care should be taken to ensure application of a uniform thickness of mash. A method of throwing small balls of mash on to the base form or mould ensures a firm and dense layer. The mould is covered by layer by layer in this manner. This should be done systematically, so as not to repeat on the areas where it has already been done.

After a layer of mash has been applied, it can be treated in many different ways. More mash can be put on and

REMOVING THE DRIED PIECE FROM THE PLASTER MOULD

VERY EASY TO REMOVE FROM A MULTI PIECE MOULD

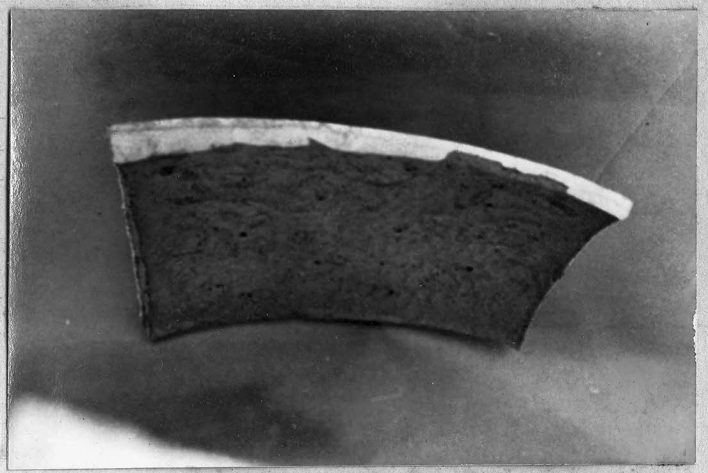
INTRICATE DESIGNS CAN BE OBTAINED ON MASH. VARIOUS MOULDS...

built up into a form quite different from the underlying core, or small portions of mash may be added and modelled into surface decorations.

TEXTURING

Different textures can be obtained on the surface by press ing various materials on to the wet surface, such as a fabric with coarse weave, a brush or even a fork.

FLAT PIECES ARE MORE PRONE TO WARPING.



CHARECTERISTIC TEXTURE OF MASH.

VARIOUS FORMS . . .

4. DRYING AND RESULTS

DRYING MASH

The drying of mash can be hastened by putting it in strong sun light. The time taken for thorough drying may be anywhere between 24 hours to 48 hours, if the object is placed in sunlight. Drying indoors would take a much longer time. Drying indoors, can be hastened by putting it under a fan.

Faster drying can be done by putting the object in an oven. Care should be taken so as not to let the object get scorched. The temperature should not be over 150°F. The oven door should be kept open and the object should be examined at frequent intervals. The piece should be removed as soon as it feels dry to touch.

REMOVAL FROM MOULDS

The piece should be removed from the mould only after it is thoroughly dry. The piece may break or tear if it is pulled out before it is dry.

WARPING

All papier mache pieces are apt to warp, as they dry. Hastening drying by placing in sunlight or in an oven, increases warping. Especially in the case of very large flat surfaces, warping is more. These must be allowed to dry slowly under weights. Addition of fine silica in mash reduces warping and gives a much stronger and denser piece.

RESULTS

The results vary according to the composition and proportion of additives in the pulp. It has been found that news paper, butter paper and drawing sheets, can be grouped together because they have almost similar fibre size and give the same finish. The difference is in the colour of the dried piece, generally, shades of gray. On the other hand corrugated box board gives a coarser finish and a different colour i.e. brown. Tissue paper and paper napkins give the finest finish.

Addition of coarse fillers like sand/silica and saw dust, make the dried piece more denser and stronger and less prone to warping. The surface also imbibes the qualities of the coarse fillers. For example saw dust when added to mash gives a finish almost like hard board. It is dark brown in colour and the saw dust particles are seen on the surface. The best results have been got from adding fine silica to mash. This eliminates warping and gives a very dense, and strong piece. The dried piece almost resembles asbestos. Plaster on the other hand when added to mash makes it brittle especially so when excess of it is added. Any substance that would react with water would not be compatible with the mash and binder. A sheet along with samples has been enclosed to give a first hand idea of the results obtained.

SAMPLE SHEET (unfinished pieces)

1. NEWSPRINT
MAIDA PASTE AND METHI

2. NEWSPRINT
FEVICOL ; LINSEED OIL ; WHITING; CLOVE OIL

3. DRAWING SHEETS
ADDITIVES AS IN 2.

4. BUTTER SHEETS
ADDITIVES AS IN 2.

5. TISSUE PAPER
ADDITIVES AS IN 2.

6. COLOURED NAPKINS
ADDITIVES AS IN 2.

REFER TO TABLE 1 (page) FOR COMPOSITION AND PROPORTIONS.

SAMPLE SHEET (unfinished pieces)

7. CORRUGATED BOX BOARD
FEVICOL; LINSEED OIL, WHITING; CLOVE OIL

8. NEWSPRINT & SAW DUST
ADDITIVES AS IN 7.

9. NEWSPRINT & SAW DUST (more quantity)
ADDITIVES AS IN 7.

10. NEWSPRINT & SILICA (FINE)
ADDITIVES AS IN 7.

11. NEWSPRINT & PLASTER
FEVICOL, LINSEED OIL; ZINC OXIDE
CLOVE OIL

REFER TO TABLE 1 (page) FOR COMPOSITION & PROPORTIONS

5. FINISH

All workshop operations of cutting,grinding,drilling are possible on paper mash. Flat pieces can be easily cut using a paper/board cutter. Solid pieces of mash have to be sawn. Material canbe easily removed by grinding on the grinder but for fine finish of the edge, it has to be finished by hand on sand/emery paper. Material can also be removed with a file. A needle file can be used for fine work. Mash consists of short length fibres and drilling therefore does not give perfect holes, the drilled holes are very slightly misshapen. Buffing a well finished papier mash piece also has been tried. A sample sheet has been enclosed of papier mache pieces with workshop operations conducted. An important advantage of papier mache would be to be able to paste almost anything or to add material at any stage of its process. Material can be added to a dry piece and the added material becomes integral with the original piece. This property can be made use of in models when conceptualizing, during the design process.

COLOURING

Practically any paint and any method of putting paint on a surface can be used to decorate papier mache.
Colours that can be successfully used are tempera colours, poster colours, transparent water colours, exterior paints both water base and oil, laquers, vinyl paints, acrylics oil colours, fluoroscent paints - both oil and water base,

varnish enamels and screen printing colours. The durability of papier mache objects increases due to water proofing. Priming coats of glue, followed by base coats of vinyl white paint, then coloured with acrylics or coloured vinyls and a final coat of clear lacquer or varnish makes it totally water proof. Epoxy resin coating makes the piece very strong, water proof and durable. Duco paint has also been used.

The surface of mash has to be primed before colour is applied. Putty serves as a very good primer. Another type of primer that can be used is'Gesso'.
Recipe for Gesso :- Two table spoons of whiting into a container of water and the powder should be allowed to settle. The water should not be stirred. Excess water should be poured out. One tea spoon of Fevicol and one table spoon of linseed oil should be added and the mixture thoroughly stirred. The mixture should have a consistancy of thick cream. Gesso seales pores covers rough spots and dries with a hard, white surface that is good as base for paint. Colour can be sprayed, painted with a brush, or even applied with a cotton wad.

Various types of finishes that have been tried out can be seen on the sample sheet.

6. ADVANTAGES AND DISADVANTAGES

ADVANTAGES

Broadly speaking the advantages and disadvantages of papier mache are as under

1. Its a cheap economical and easy way of modelling costing nothing.
2. Almost any shape can be moulded out of it.
3. It dries naturally to a hard and durable substance.
4. Papier mache takes a very wide range of surface finishes and colours.
5. A lot of manipulation is possible with papier mache models the reason being that material can be easily removed and added at any stage.
6. Raw mash (without additives) can be made in large quantities and stored for a considerable time,to be used whenever required.
7. Papier mache gives a characteristic lovely texture, which can be used for decorative objects
8. It is very light in weight and does not break when dropped.
9. Papier mache can be used in combination with many other materials.

DISADVANTAGES

1. Preparation and mixing of mash takes some time.
2. Papier mache has very less dimensional stability. On drying they tend to warp and shrink.
3. A highly glossy and smooth finish like styrene objects is very difficult to obtain in papier mache objects.
4. Mash takes a long time to dry.
5. Papier Mache objects can be easily effected by water and fungus, if not treated properly.
6. Mash is difficult to mould for solid objects or objects one to two inches high, where a basic form work cannot be used.

7. USAGE IN IDC

The potential of papier mache being enormous, its application also as a professional modelling material are unlimited. It depends on the creativity of the individual to be able to use it imiginatively.

The papier mache work shop can form part of the ceramic studio at IDC. This is appropriate because there is a lot of commonality between clay and papier mache, and there are many materials as well as processes the use of which are common to both. Papier mache can be made use in the following areas in IDC :-

1. It can be used for rough models during the final concept presentation especially so, in the case of objects with a lot of curves and intricate detail. In such cases mash can be moulded on a rough form work
2. Papier Mache can replace styrene in situations where vacume forming may be difficult as in the case when a deep draw is necessary. Mash mixed with fine silica can be used to give dimensional stability and good finish.
3. Mash can also be used for making final models in appropriate situations, where in a rough finish is deliberately wanted.
4. FRP moulded parts can be first modelled in papier mache to check before the original mould is made. Moulded furniture can be tested in thus manner to simulate the final product. The parts can be

made strong by making the basic form work by wood or card board and then covering with mash.

5. There is also the possibility of taking impressions on semi dry mash of human body parts which may be useful for the ergonomics laboratory. But this has to be tried out, to know if it works. Shrinkage and warping may cause some problems. Mash with silica can be used to minimize shrinkage. The best profile for the seat of a chair can be determined in this way.

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