Introduction

Visva-Bharati University is one of India's major Central Govt. funded autonomous university located in Santiniketan,West Bengal. It was founded by Rabindranath Tagore who called it Visva Bharati, which means the communion of the world with India.

Silpa-sadana is the one of the department coming under Visva –bharati university, which is founded by Rathindranath Tagore in 1921.He is the youngest son of Rabindranath Tagore. Silpa-Sadana is a pioneering institute in India in developing cottage and small scale industries. It has two units: Training and Extension Wing.

Shantiniketan one of the renowned place in India for art and crafts being an engineer turned design student, I would like to expose myself in crafts and craft based design for a holistic design approach. which would introduce me to a new perspective of product design.

Also from my two experience in Industry and from the discussion and suggestions from Prof.Rao, Prof.Sandesh and Prof.Kumar Esan the idea of doing the internship in Santhinikethan seems convincing .

As a product design student I am very keen to work with lighting design, and from the facilities of shantinikethan pottery is one of the suitable medium to pursue my interest. Hence I choose ceramics as my area of internship

What is ceramics……?

A ceramic is an inorganic, nonmetallic solid prepared by the action of heat and subsequent cooling. Ceramic materials may have a crystalline or partly crystalline structure, or may be amorphous (e.g., a glass). Because most common ceramics are crystalline, the definition of ceramic is often restricted to inorganic crystalline materials, as opposed to the noncrystalline glasses, a distinction followed here.

Ceramics can be defined as inorganic, non-metallic materials that are typically produced using clays and other minerals from the earth or chemically processed powders. Ceramics are typically crystalline in nature and are compounds formed between metallic and non-metallic elements such as aluminum and oxygen (alumina – Al_2O_3), silicon and nitrogen (silicon nitride – Si_3N_4), silicon and carbon (silicon carbide – SiC), etc.

The word Ceramic is derived from a Greek word 'Keramos' meaning 'potter' or 'pottery'. Keramos in turn was originated from a Sanskrit root – meaning 'to burn'. Hence, the word Keramos was to infer 'burned substance' or 'burned earth'.

Ceramics have been accompanying the human race since ancient times. Archaeologists have unearthed man-made ceramics that date back to at least 25,000 BC. Primitive Ceramics were made of basic earthen materials like clay and were burnt in domes. Human inventiveness gradually started with firing these articles at higher temperatures to attain harder Ceramic articles. This desire of getting harder substances steered the human races to invent better firing techniques. The human zest and nature's mystery have come a long way from basic earthen wares to modern world advanced ceramics.

As Ceramics are made of earthen materials, they are the most compatible products with the nature. Ceramics are the only materials which are nature friendly and therefore they are free from decays due to gradual natural impacts like corrosion, erosion, abrasion, thermal shocks, etc. Even though Ceramics are brittle; they are the only materials which subsist to see the races to come. Hence, we may call them a strong-fragile part of human life.

Fig.2.1 Different products in ceramics

Types of ceramics

1.Terracotta (Firing temperatures between 750-1000 degree C)

Terracotta, Terra cotta or Terra-cotta (Italian: "baked earth", from the Latin terra cotta), a type of earthenware, is a clay-based unglazed or glazed ceramic, where the fired body is porous. Its uses include vessels (notably flower pots), water and waste water pipes, bricks, and surface embellishment in building construction, along with sculpture such as the Terracotta Army and Greek terracotta figurines.

As compared to bronze sculpture, terracotta uses a far simpler process for creating the finished work with much lower material costs. Reusable mold-making techniques may be used for series production. Compared to marble sculpture and other stonework the finished product is far lighter and may be further glazed to produce objects with color or durable simulations of metal patina.

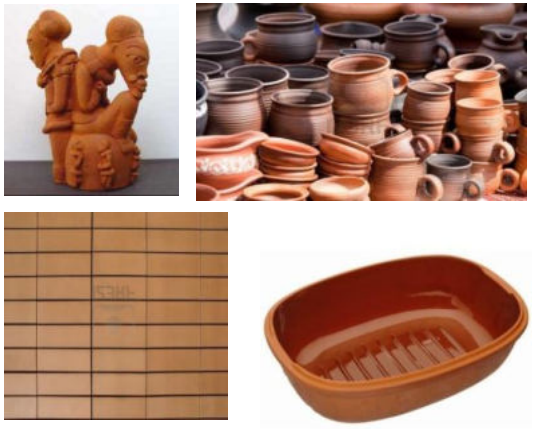

Fig.3.1 Terracotta products

2.Earthenware (Firing temperatures between 1000 and 1150 °C)

Earthenware is one of the oldest materials used in pottery. After firing the body is porous and opaque, and depending on the raw materials used will be colored from white to buff to red.

Earthenware articles may sometimes be as thin as bone china and other porcelains, though they are not translucent and are more easily chipped. Earthenware is also less strong, less tough and more porous than stoneware, but is less expensive and easier to work. Due to its higher porosity, it must usually be glazed in order to be watertight.

Fig.3.2 Earthenware products

3. Stoneware (Firing temperatures between 1180 and 1280 °C)

Stoneware, which, though dense, impermeable and hard enough to resist scratching by a steel point, differs from porcelain because it is more opaque, and normally only partially vitrified. It may be vitreous or semi-vitreous. It is usually coloured grey or brownish because of impurities in the clay used for its manufacture, and is normally glazed

Five categories of stoneware have been suggested, which are

1. Traditional stoneware
2. Fine stoneware
3. Chemical stoneware
4. Thermal shock resistant stoneware
5. Electrical stoneware

Fig.3.3 Stoneware products

4. Porcelain

Porcelain is a ceramic material made by heating materials, generally including clay in the form of kaolin, in a kiln to temperatures between 1,200 °C(2,192 °F) and 1,400 °C (2,552 °F). The toughness, strength, and translucence of porcelain arise mainly from the formation of glass and the mineral mullite within the fired body at these high temperatures.

Fig.3.4 Porcelain products

5.Bone china (Firing temperatures between 1200 and 1400 °C)

Bone china is a type of soft-paste porcelain that is composed of bone ash, feldspathic material and kaolin. It has been defined as *ware with a translucent body* containing a minimum of 30% of phosphate derived from animal bone and calculated calcium phosphate. Developed by English potter Josiah Spode, bone china is known for its high levels of whiteness and translucency, and very high mechanical strength and chip resistance

Fig.3.5 Bone china products

Different applications of ceramics

•Art and craft

•the construction industry depends on the use of ceramic materials. This includes brick, cement, tile and glass. Cement is used to make concrete which in turn is used for roadways, dams, buildings and bridges. Uses of glass in the construction industry include various types of windows, glass block and fibers for use in insulation, ceiling panels and roofing tiles. Brick is used for homes and commercial buildings because of its strength, durability and beauty. Brick is the only building product that will not burn, melt, dent, peel, warp, rot, rust or be eaten by termites. Tile is used in applications such as flooring, walls, countertops and fireplaces. Tile is also a very durable and hygienic construction product that adds beauty to any application.

• The electronic industry would not exist without ceramics. Ceramics can be excellent insulators, semiconductors, superconductors and magnets. It's hard to imagine not having mobile phones, computers, television and other consumer electronic products.

•Ceramics are excellent insulators. High voltage insulators make it possible to safely carry electricity to houses and businesses

•Orthopedics has advanced greatly with the aid of Ceramic artificial bones. Surgeons are already using bioceramic materials for repair and replacement of human hips, knees, shoulders, elbows, fingers, eyes and wrists. Ceramics are also being used to replace diseased heart valves. Dentists are using ceramics for tooth replacement implants.

•Refractories, such as kiln linings, gas fire radiant, steel and glass making crucibles

•Whiteware, including tableware, cookware, wall tiles, pottery products and sanitary ware

Fig.4.1 Applications in art and craft

Fig.4.2 Ceramics for constriction

Fig.4.3 Ceramic high tension Insulators carrying electricity to houses and businesses.

Different applications of ceramics

•Ceramics play an important role in addressing various environmental needs. Ceramics help decrease pollution, capture toxic materials and encapsulate nuclear waste. Today's catalytic converters in vehicles are made of cellular ceramics and help convert noxious hydrocarbons and carbon monoxide gases into non-toxic carbon dioxide and water. Advanced ceramic components are starting to be used in diesel and automotive engines. Ceramics' properties like – light weight, high-temperature resistance and wear resistance result in more efficient combustion and significant fuel savings

• Modern iron, steel and non-ferrous metal production would not be possible without the use of sophisticated refractory materials that are used to line high temperature furnaces, channels and ladles. Metals make automobiles, machinery, planes, buildings and thousands of other useful things possible.

•Space Shuttle program, gas burner nozzles, ballistic protection, nuclear fuel coatings of jet engine turbine blades, ceramic disk brake, missile nose cones, bearing (mechanical

•Ornamental objects like necklace, year rings etc

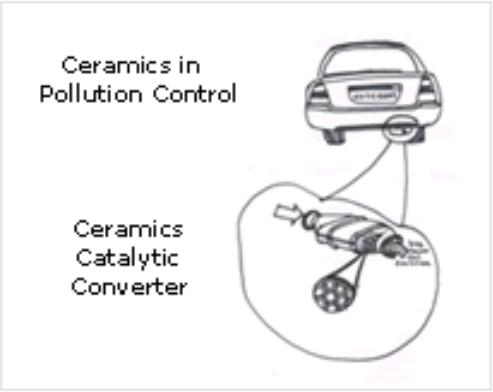

Fig.4.4 Ceramics for Automobile industry

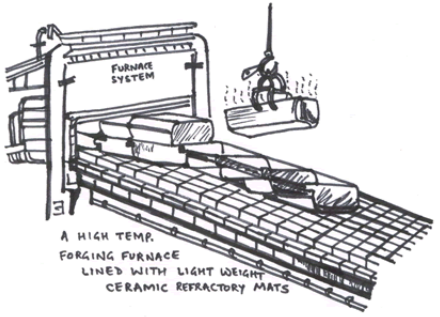

Fig.4.5 Ceramics to metal production

Advantageous and properties of ceramic

Advantageous

•High hardness
•High mechanical strength
•Dimensional stability
•Resistance to corrosion or chemical attack
•Weathering resistance
•High working temperature
•Low or high thermal conductivity
•Good electrical insulation

Properties

•Plasticity
•Porosity
•Malleability
•Texture
•Color

Clay

Clay is a, substance which we know as a deposit which is extensively distributed over the surface of the earth. It is found almost everywhere but differs greatly in its purity. This deposit has been produced by the decomposition of various rocks. As these decomposed products have been acted upon by water, the various original materials have been separated, leaving deposits of various kinds. The various changes which take place upon the minerals present in the earth's crust, in order that clay may be produced is according to the results Of Forchhammer shown in the formula

A120 3 , 2Si0'2 + 2H20‘

Properties of the clays include plasticity, shrinkage under firing and under air drying, fineness of grain, color after firing, hardness, cohesion, and capacity of the surface to take decoration. On the basis of such qualities clays are variously divided into classes or groups; products are generally made from mixtures of clays and other substances. The purest clays are the china clays and kaolins. "Ball clay" is a name for a group of plastic, refractory (high-temperature) clays used with other clays to improve their plasticity and to increase their strength. Bentonites are clays composed of very fine particles derived usually from volcanic ash. They are composed chiefly of the hydrous magnesium-calcium-aluminum silicate called montmorillonite. See also fuller's earth.

There are basically two types of clay. These are called Primary clay and Secondary clay.

PRIMARY CLAY – primary clay has remained in the same place for millions of years, never moving from the position where it began life as granite rock. The color of primary clay is white. Primary clay is not very plastic and not the best clay for being mounded and shaped.

SECONDARY CLAY – secondary clay is the kind of clay which we have been using. As you will now be aware, it is a very plastic like material, being able to be worked into various shapes and forms. Secondary clays unlike primary are not found in the same place as where they started life as Granite Rock. Rather other millions of years, they have been moved and carried around by flowing water, usually settling in the side of riverbeds.

Also secondary clay differ from primary clays in terms of colour. Where as Primary clay is only white, secondary clay comes in a variety of colors. Ranging from RED to YELLOW and BLACK to GREY. The reason for these different colors is due to the fact that they have been moved around. What happens is that on their journey they have come into contact and mixed with different minerals. These different minerals have mixed with the clay and are responsible for producing the different colors.

Clay body preparation

This process involves through mixing of various raw materials according the combination grinding and producing a mixture with requisite amount of water for the next stage of the process - shaping or fabrication.

Generally there are two common methods -dry process and wet process. The dry process is comparatively new and becoming more and more popular for non-clay bodies, but now increasing used in clay containing bodies also. The advantageous this process is that uses only enough water, 4-8% to obtained the exact consistency and thereby avoid the removal of excess water by filter-press and other methods , and shrinkage prolonged drying and other difficulties of wet process. The advantages of dry for the clay containing bodies is that since no filter-pressing is carried out any soluble salt present in the raw material remains in the body and can cause difficulties in the manufacture by interfering with deflocculating or reducing plasticity. In the case of non clay bodies, binder and plastisisers or lubricating materials are added to the dry mix.

Wet process - this process is common for most of the whiteware industries. A general flow diagram of wet process is given in the below figure.

In this process the raw materials like feldspar, quartz rocks or some hard clays received in lump form have to be crushed or roll crusher before they can be fed in the grinder. After crushing the material to be loaded in to the ball mill (for large amount) or in the pot mill (for small amount) along with requisite amount of water (50%) and pebbles for grindings up to 24 hours to obtained the required size. The product of the crushing and the grinding operations has to be graded using a nest of sieves to remove over size materials. In the case of plastic materials (feldspar, quarts, etc.) are separately treated ,ie clay blunged and non -plastic ball milled ,each product is separately screened before mixing. The plastic and non-plastic materials are fed into blunger similar to that used for clays and blunged for two to three hours. The slip from the blunger after screening passes through a magnetic separator, an essential equipment of whiteware plants which removes free magnetic particles present in the raw materials. The slip material after passing through magnetic separator is led to an agitator for temporary storage till it is sent to the different performing stations depending on the shaping methods. For plastic forming method the next step is the dewatering of the slip. For this purpose the common equipment used is filter -press which removes the excess amount of water under pressure and solid particles retained in the filter cloth, forming a cakes has to be passes to the de-airing pug mill for the escape of entrapped air from the body mix.

In the case of semi-dry or dry pressing , the most convenient methods of dewatering is spray drying. The slip form the agitator pump to the spray drier chamber and sprayed through a series of atomizing nozzles. The droplets get dried in contact with hot air so that when they reach the bottom they are little spheres, mostly hollow , with moisture content of 46%. The product (granule) from the spray drier is carried to the storage bins or hoppers, directly on the top of the hydraulic press. For casting some deflocculating agent (like STPP, $NaCO_3$, Na_2SiO_3, etc) has to be added to slip during agitation.

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Clay body preparation

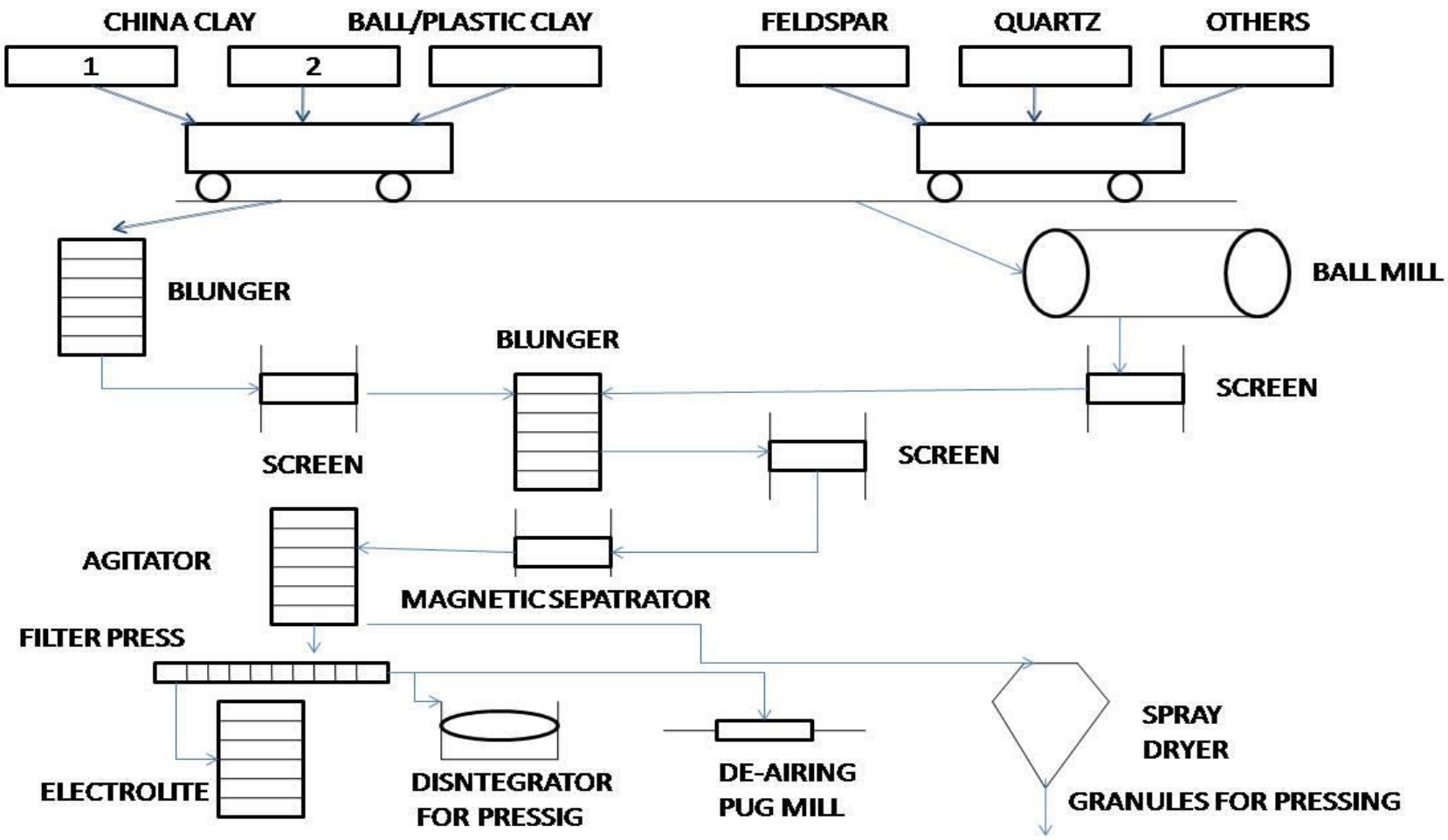

Fig.7.1 Flow chart for wet method body preparation

Tools in pottery making

Generally pottery tools are divided into four major categories:

- Shaping Tools
- Rolling Tools
- Cutting/Piercing Tools
- Finishing Tools

SHAPINGTOOLS

Potter's Hands - The potter uses his hands to knead (press and squeeze) the clay so as to eliminate air bubbles thus making the clay soft, smooth and manageable to work with. In addition, while spinning on the potter's wheel, the potter uses his/her hands to shape the clay into the preferred design.

•Potter's Fingers/Thumbs - The potter at times may use his/her fingers/thumbs to create designs, impressions or decorations on the pots before they are dried.

•Potter's Wheel - This wheel can be manually operated by hand, by stick or can be foot/pedal driven. Today some are run by electric motor. The potter's wheel is used to mold, shape and spin the clay to make the pottery even.

•Pug Mill - This machine is used to break up blocks of raw clay into smaller and smaller pieces. This process is continued until the clay reaches a consistency where it could be kneaded and eventually stretched like rubber bands.

•Bucket of Water - The potter uses a bucket of water to keep his/her hands moist while shaping the clay on the wheel.

•Water - Water is used to keep the clay moist (as it dries out easily) and thus manageable for moulding.

•Sand - Sand is added to the clay to give it the right texture/consistency desired by the potter.

•Clay - It is the mud or earth that is dug up/extracted from the ground and is the basis of all pottery designs.

•Slip - Slip is a mixture of clay and water that is used as cement to join together two or more clay pieces when creating a new design.

Fig.8.1 Potter's wheel

Fig.8.2 Pug mill

ROLLING TOOLS

Rolling Pin - Like the potter's hands, the rolling pin is used for kneading and thus preparing the clay.

CUTTING /PIERCING TOOLS

Moulds - These are models that are shaped in the forms of birds, bells, people, etc. and are used to create exact replicas of these.

•Blades/Edges/Knives - The potter may use these to make decorative designs or grooves on the pottery piece.

FINISHING TOOLS

Kiln - A hot oven that is used to fire the pots after they are created and glazed so as to make them hard.

•Glaze/Paints - Glazes /Paints are put on just before firing the pots to make them look fancier and more decorative and to make them harder and more durable.

•Paintbrushes - These are used for applying the glazes/paints.

•Though most of the tools mentioned above are basically used by all potters worldwide, Bunty O'Connor, part owner of Ajoupa Pottery in Carapichaima Trinidad, notes that each individual potter has his/her own unique set of tools for use. At Radika's Pottery in Chaguanas, it was discovered that the most useful of tools are basically home-made. Some of these are:

•Piece of Thread - Also called the "Chounee". This is used for cutting off the pottery piece from the potter's wheel.

•Plastic Fork - Helps in making indents or other decorative designs on the item created.

•Sponge - This is used for smoothing the surface of the clay pot while spinning on the wheel just as masons do when smoothing semi-dried cement surfaces.

•Iron Pole - The potter uses this for cleaning off excess sludge from his hands.

•Cocoyea Stick - This is used by the potter for measuring so as to evenly attach one piece of pottery onto another.

•Scraper - A hard piece of plastic, wood or bamboo that is used for cleaning off any excess sludge from the pot.

•Exacto Knife - This is used for creating designs on the pot while still leather hard.

Fig.8.3 Rolling Tool

Fig.8.4 Mould for pottery

Fig.8.5 Kiln for pottery

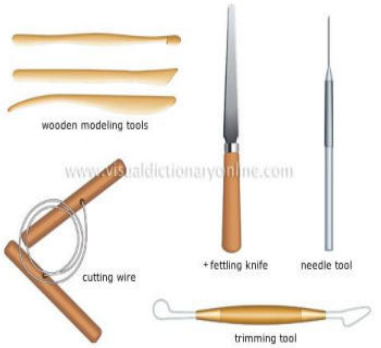

Fig.8.6 Tools for throwing processes

Different process in pottery

"Hand building" is working with clay by hand using only simple tools, not the pottery wheel. Before potters had the wheel, they were creating beautiful pots and clay forms using clay, their hands and fingers, and basic hand tools. There are five important technique for creating different crafts and products. Which are:

1. Pinching process
2. Coiling process
3. Slab making process
4. Casting process
5. Throwing process

1.Pinching process

Begin a pinch pot by forming a lump of clay into a smooth sphere that fits the size of the hand. While holding the sphere of clay, press the thumb into the center of the ball, half-way to the bottom. While revolving the ball in one hand, press the walls out evenly with the thumb into the inside and the fingers on the outside. Smooth the surface with a damp sponge

Fig.9.1 Exploring the pinching process

Fig.9.2 Form exploration in tea pot.

2.Coiling process

Coiling is a method of creating pottery. It has been used to shape clay into vessels for many of thousands of years. It ranges from Africa to Greece and from China to New MexicoIn this method first coil of plastic clay is made and then the wall of pots are made by those coils. Coil method helps in adding layers of clay and building up the wall of the pot, thus giving more freedom to make larger pots.

Fig.9.3 Process involved in Coiling.

Fig9.4 Hand on experience in Coiling process: Candle shade and bowl

3.Slab making process

Slabs can be used to make the most basic of forms to the most complex. This broad approach to slab work shows a wide variety of building methods and illustrates the work of many high-profile ceramic artists using this forming technique.

Fig9.5 Process involved in slab making

Different process in pottery

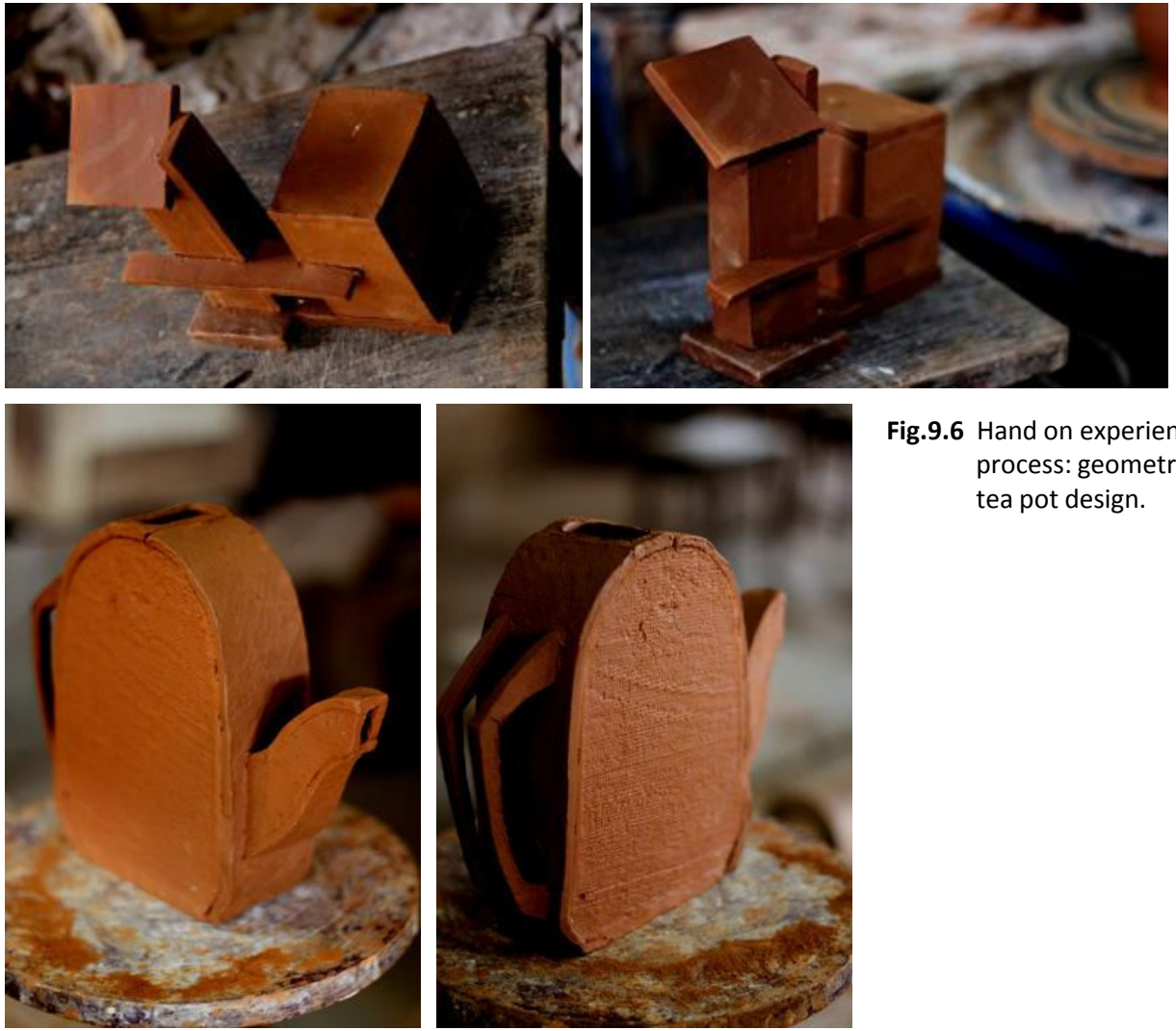

Fig.9.6 Hand on experience in Coiling process: geometric shape exploration and tea pot design.

4.Casting process

In casting method two piece mold is made with plaster. And then it is poured with the slip of clay.

Fig.9.10 Process involved in Casting process

5.Throwing process

One of the most common methods potters use in creating objects out of clay is to use a potter's wheel. Throwing is the process of shaping the lump of clay using the wheel. This takes some practice in order to succeed and then to produce some pleasing shape. It is one of the most exciting, expressive and impressive skills in pottery making

Fig.9.11 Process involved in Throwing process

9.Development of hanging flower pot cum lighting product

Design brief

To design and development a flower pot cum lighting product in ceramics for hose boats, resorts and Kerala style homes. Which will be emphasis the Kerala cultural and traditional arts.

Objectives

- To understand and get hand on experience in different process in pottery
- Observe and study the Kerala traditional art and festivals
- Express Kerala traditional art and festivals though product

Study parallel products in the market

Fig.11.1 Study of hanging ceramic lighting products in existing market which are producing experience lighting.
Observation: Direct light from a light source will produce less experience in viewer's eye.

Mood board

Fig.12.1 Mood board from Kerala cultural, important festivals and architecture. The target markets are Kerala traditional style home and house boats, So which is very essential to incorporate the culture in the product.

Ideation

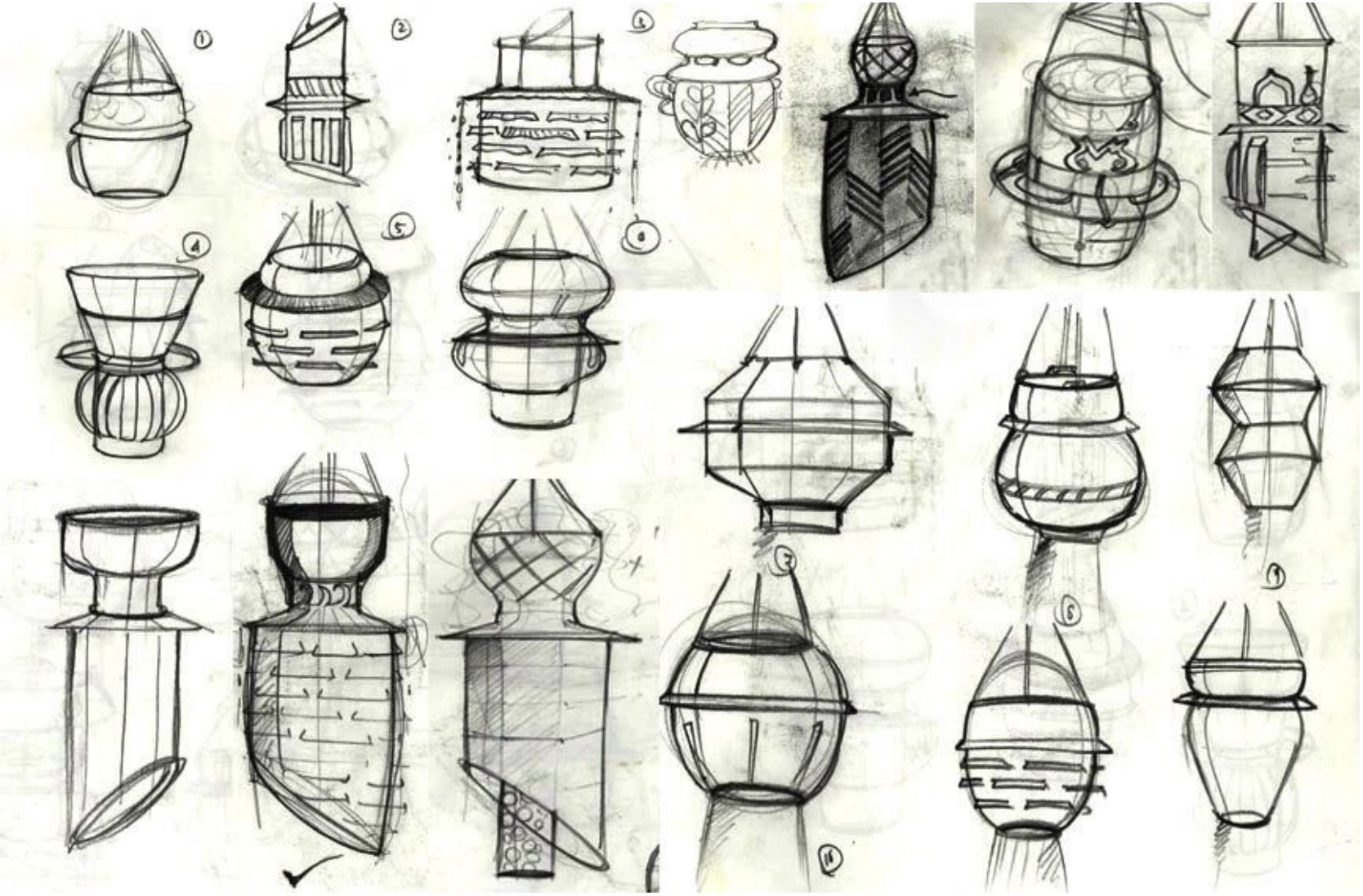

Fig.13.1 Concept sketches inspired from Kerala art and culture. Basic form abstracted from traditional art called Kadhakali.

Final concept

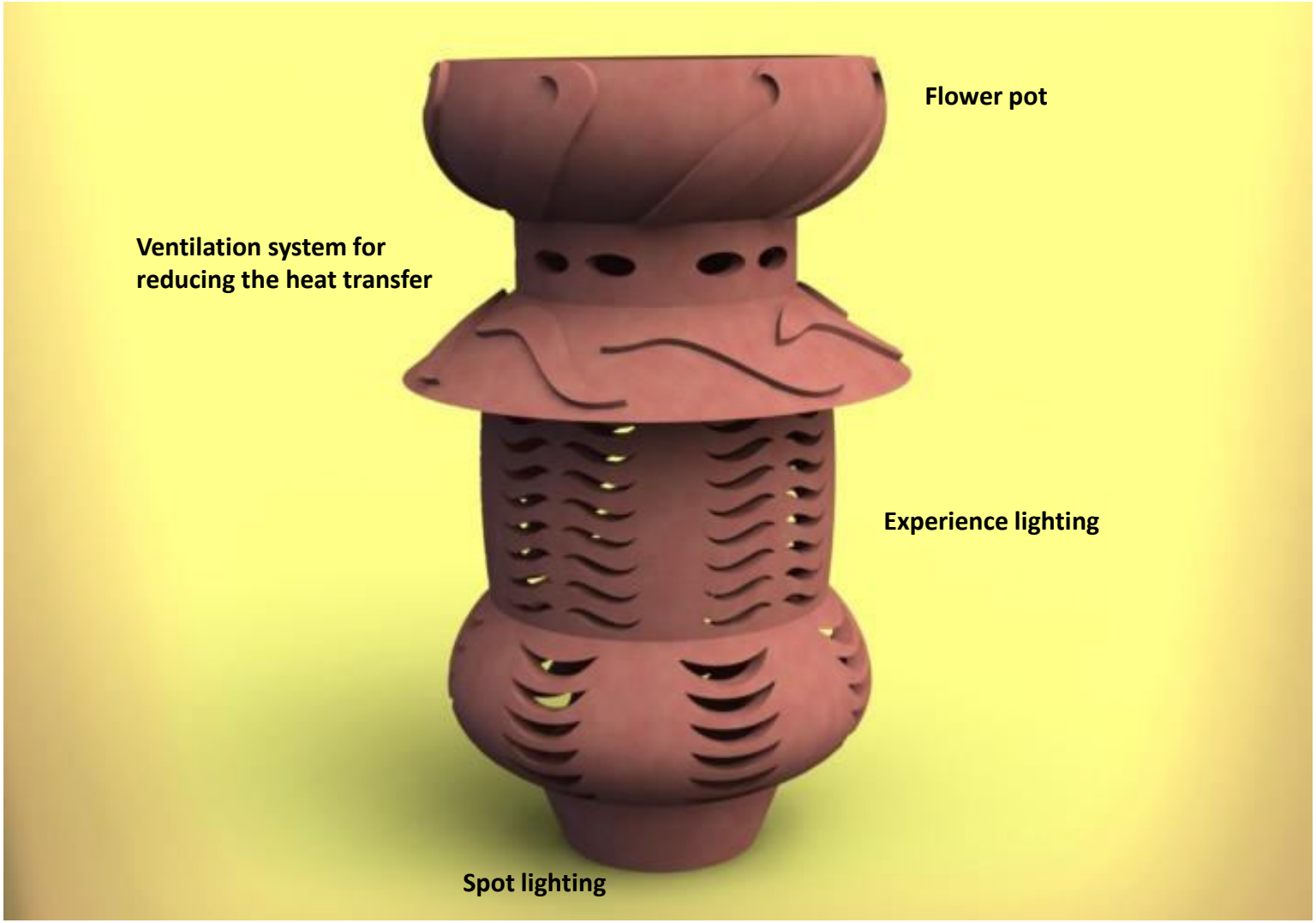

Fig.14.1 Final concept model in Solid works

Model making

1.Preparing the clay

Fig 15.1 **1**) Mixing and grinding the clay in Ball Mill **2**)Drying on plaster of paris block **3**) Wedging: Wedging is the process of mixing the clay by hand by rotating and pressing a clay ball on a table. The purpose is to thoroughly homogenize the clay and to remove all air bubbles. This is particularly important, as the presence of air bubbles in the clay will result in explosions in the kiln as the air pockets expand and burst

2.Throwing

Fig.15.2 basic shape of the product is achieved by throwing process. Product is done by three parts by throwing and assembled them together by using clay slip.

Throwing different parts and assembling

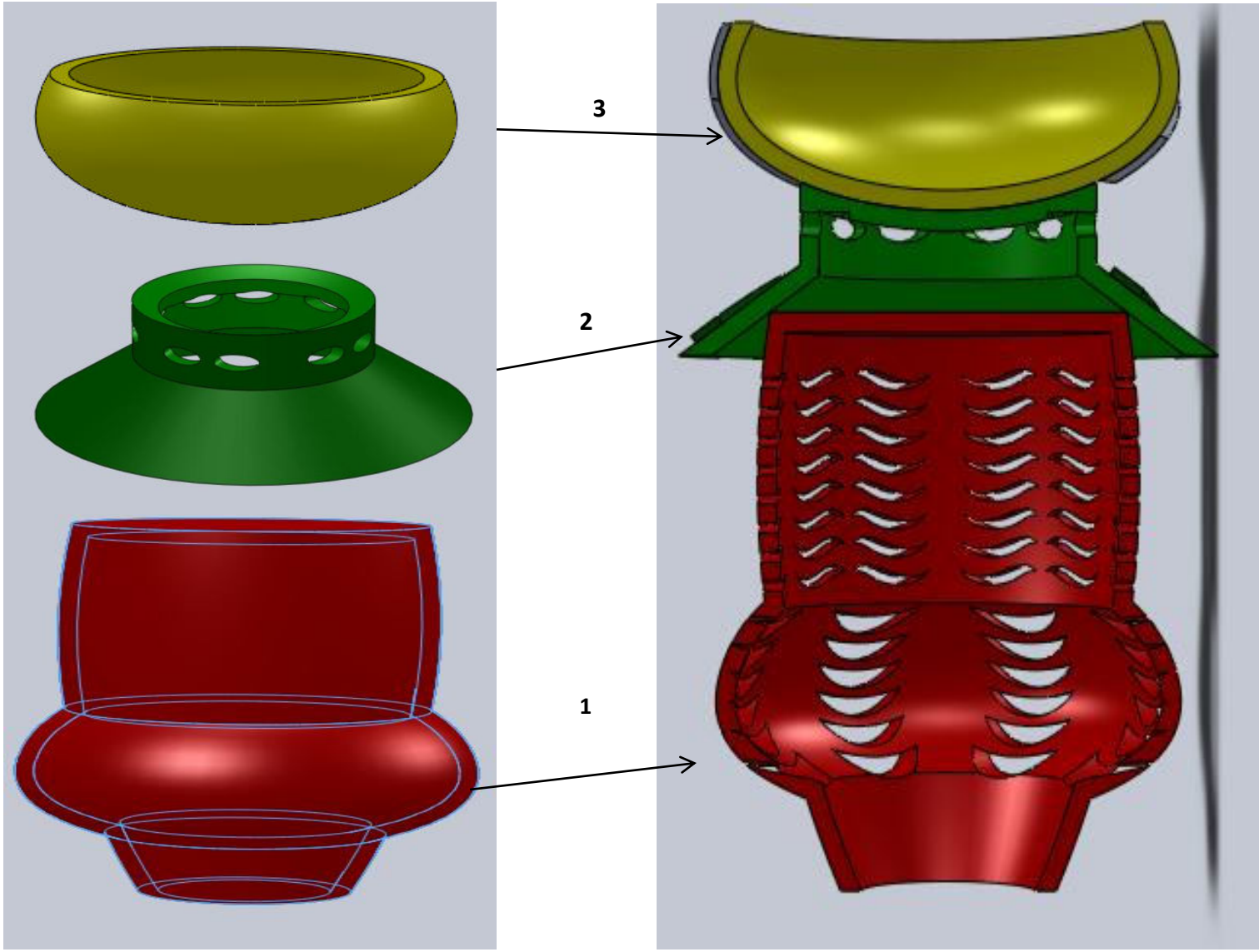

Fig.16.1 Product is done by three parts by throwing and assembled them together by using clay slip. Dissembled and cross section view of the product in CAD

Decorating the product

Fig.17.1 Decorating and piercing the product using slab making process and knife

Final product

Fig.17.1 Illuminating final product

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