✓ (1) A.L. Gones: Recognition of coins
✓ (2) K.P. Chaidram: Statistical & mathematical methods used in Product Design
✓ (3) Pradeep Save: Insect Architecture.
✓ (4) Sunil Kohe: Use of scaling methods in psychophysiological assessment of physical fatigue.
✓ (5) Arvind Joshi: Expressions of agression in nature and man made world.
✓ (6) Milind Tamhane: Strength in forms.
✓ (7) Mohan Chandra: Communication through form (.... Architural) — Seminar Report
✓ (8) Ravindra Rajhans: Distortion of form on computer.

✓ (9) G. Nagarajan: Representation of Geographic data on the computer.
(10) Mohan Chandra: Use of Indscal in product design (Special Project / Seminar project)
Loose (11) Rajan Vernekar: Exploration of water forms
Late Received from Guide (see it the end of this Bound volume)
do (12) ✓ Girish V. Nalavade: Exploration in Flame forms

Pl. see Loose issues kept at the END of this volume, in the same section (X) Read. after binding was done. Very Late receipt. Hence loose.

RECOGNITION OF COINS

SPECIAL PROJECT

by
GOMES ALOYSIUS LINCOLN

RECOGNITION OF COINS

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GOMES ALOYSIUS LINCOLN

guide
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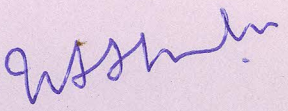
APPROVAL SHEET

This Special Project entitled 'Recognition of Coins', by Gomes Aloysius Lincoln is approved in partial fulfilment of the requirements for the Master's Degree in Industrial Design.

Guide: 

HOW PEOPLE RECOGNISE PATTERNS

In order to understand how people recognise the denomination of different coins in a fraction of a second, it becomes necessary to understand the whole process of how the mind works.

Among the most spectacular of our perceptual talents is the ability to recognise familiar pattern of sensory information. This talent allows us to reconise an old frine in a sea of faces, to identify a coin among many others at a glance.

How do we recognise a Rs.1/- coin ? Do we have a 'Rs.1/-' coin template that epitomizes the Rs.1/- coin, but will still allow us to recognise the coin when there is a change in graphics ? Or do we perform a hasty scan of the features of the coin and check each item against a master feature list for Rs.1/- coin: round , metallic, reeded edge, Lions on obverse, approximate size, etc. (If this represent a list of features and attributes, it could be a Rs.1/- coin but it also might be a Rs.2/- coin).

If the mind had to store a model of each coin and all its identifiable features, that would mean having to store millions of pieces of information. And each time a person wants to identify a coin, the mind would have to run through a million checks to identify the coin. This is definitely not what goes on in the mind considering the fraction of a second that it takes to identify a coin.

One possible explanation is based on template matching i.e. pattern recognition occurs when a match is made between perceived pattern and an abstract or idealised mental pattern. Some kind of abstraction of patterns is stored in long term memory (LTM) and this abstraction serves as a prototype. A pattern would then be checked against the prototype and if a resemblance were found, the pattern would be recognised. This prototypical-matching hypothesis in humans seems to be compatable with neurological economy and memory research processes, and allows for recognition of pattern that are unusual, but in some way related to the prototype.

When we see a coin the different senses detect the various features and form a perceptual image which is placed in storage(Chart 1). In the next part of the system called 'primary recognition', the perceptual image is tested against the prototypical image. In order to make this test,the primary recognition process uses information Long Term Memory (LTM)about the defining features of each coin. The primary recognition process searches LTM for features, and on finding a match, synthesises the coin and sends the recognised coin on for further processing.

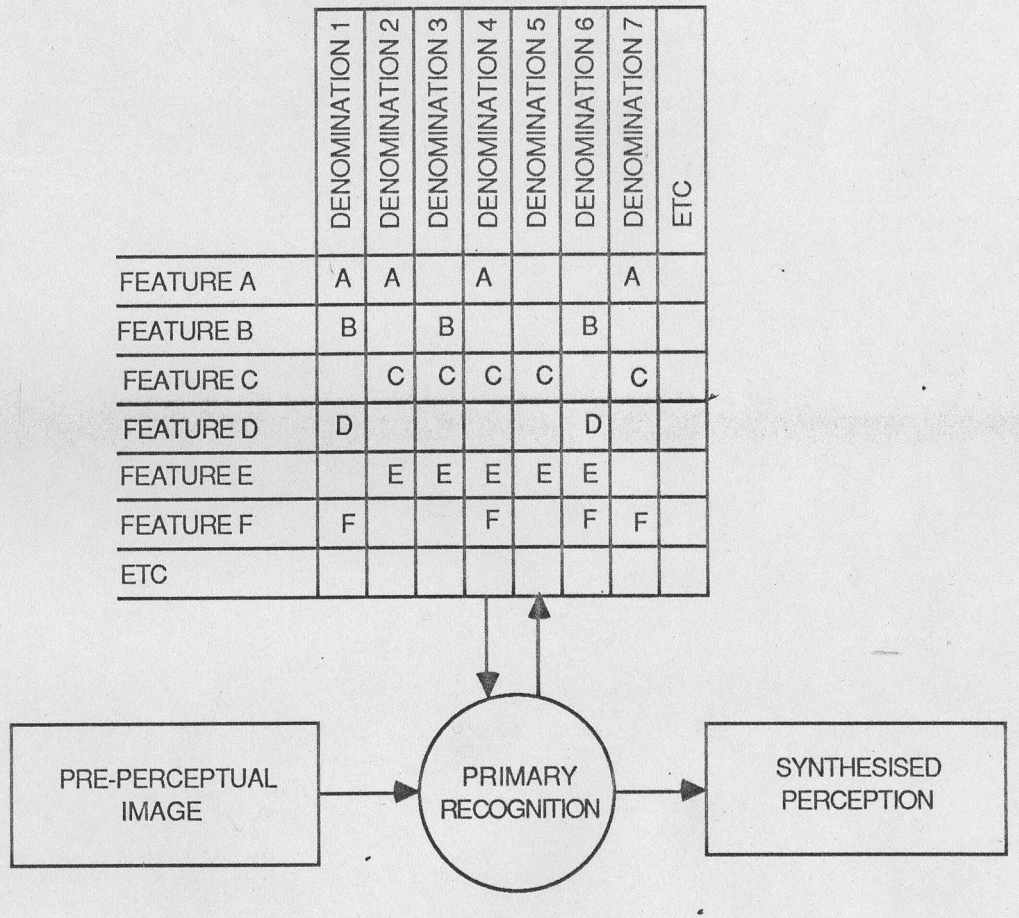


CHART 1: TRANSFORMATION OF A PRE-PERCEPTUAL IMAGE INTO A SYNTHESISED PERCEPTION

The above explanation of recognition theory makes the following predictions:-

1. Where features of two patterns (objects) overlape(eg. denominations 2, 3, 4,and 5 have the same C and E features). - the chances of identifying the pattern correctly will be reduced (in a given small time span).
   - time required for recognition is thus more in order to ensure correct identification.
   - discrimation being more difficult, more recognition cues are to be stored in memory (hence a larger memory capacity utilisation is called for).
   - people have to rely on lower order cues (more recognition time is required).

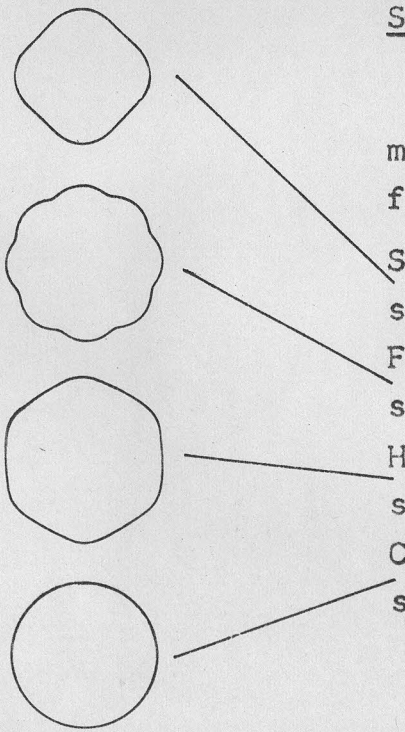
2. If patterns(objects) keep changing regularly (major changes like size of Rs.1/- coin, type of graphics)then
   - more than one prototypical image has to be maintained for the same denomination (since several patterns exist simultaneously).

From the prediction of the above theory the importance of features in recognition is evident. Manipulation of these features can contribute positively towards reducing recognition time and improving chances of correct recognition; or negatively, towards increasing recognition time and increasing the chances of making mistakes.

FEATURES OF COINS

Important features which serve as recognition cues for coins which are currently in use in the Indian Monetary system are

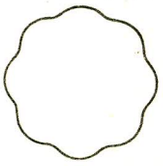
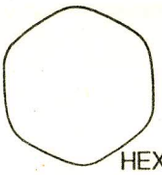
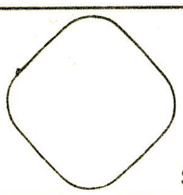
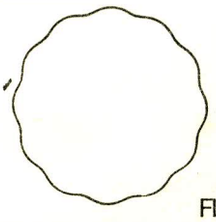
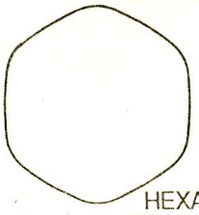
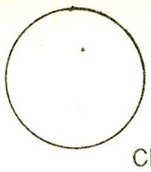
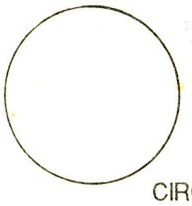
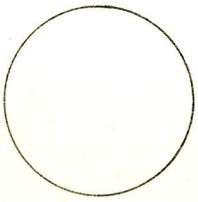
- SHAPE AND ORIENTATION
- SIZE AND WEIGHT
- METAL AND COLOUR
- GRAPHICS
- EDGE TREATMENT
- SURFACE TREATMENT



SHAPE AND ORIENTATION

Shape and orientation are important features and can be manipulated to provide better recognition cues. There are four shapes of coins in the present Indian monetary system.

Square shaped	1 paise and 5 paise coins are square in shape.
Flower shaped	2 paisa and 10 paisa coins are flower shaped
Hexagonal shaped	3 paisa and 20 paisa coins are hexagonal in shape.
Circular shaped	25 paisa, 50 paisa, 1 rupee, 2 rupees and 5 rupees coins are all round in shape.

NOMINATION	SHAPE & ORIENTATION	SIZE & WEIGHT	METAL & COLOUR	EDGE TREATMENT
1 PAISE	 SQUARE	 SMALL	ALUMINIUM	PLAIN
2 PAISA	 FLOWER	 SMALL		
3 PAISA	 HEXAGONAL	 SMALL		
5 PAISA	 SQUARE	 BIG		EDGE
10 PAISA	 FLOWER	 BIG		
20 PAISA	 HEXAGONAL	 BIG		
25 PAISA	 CIRCULAR	 ϕ 19 SMALLEST	COPPER	REEDED
50 PAISA	 CIRCULAR	 ϕ 24 SMALL		
.00 RUPEE	 CIRCULAR	 ϕ 26 ϕ 28 MEDIUM	COPPER-NICKEL	REEDED
				

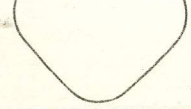
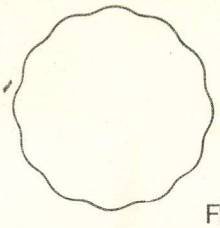
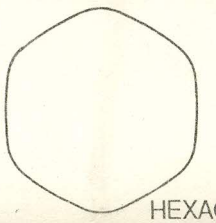
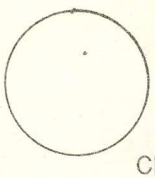
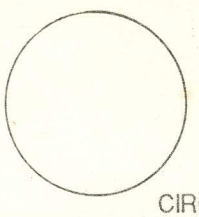
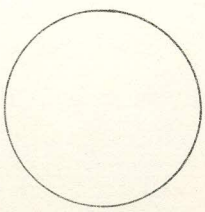
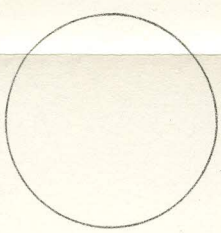
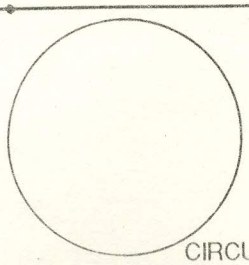
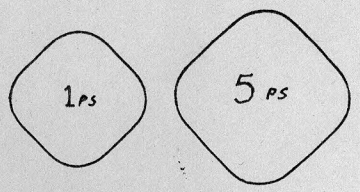
5 PAISA	 SQUARE	 BIG	NICKEL	EDGE
10 PAISA	 FLOWER	 BIG		
20 PAISA	 HEXAGONAL	 BIG		
25 PAISA	 CIRCULAR	 ϕ 19 SMALLEST	COPPER	REEDED
50 PAISA	 CIRCULAR	 ϕ 24 SMALL		
.00 RUPEE	 CIRCULAR	 ϕ 26 ϕ 28 MEDIUM	COPPER-NICKEL	REEDED
.00 RUPEES	 CIRCULAR	 ϕ 28 BIG		EDGE
.00 RUPEES	 CIRCULAR	 ϕ 31 BIGGEST	NICKEL	EDGE

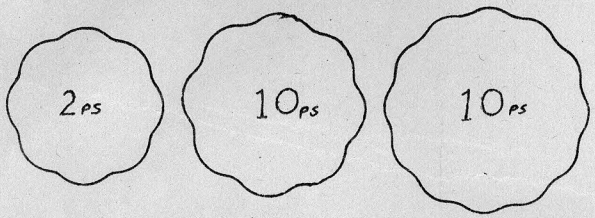
CHART 2

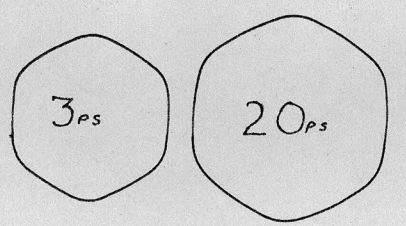


SIZE AND WEIGHT

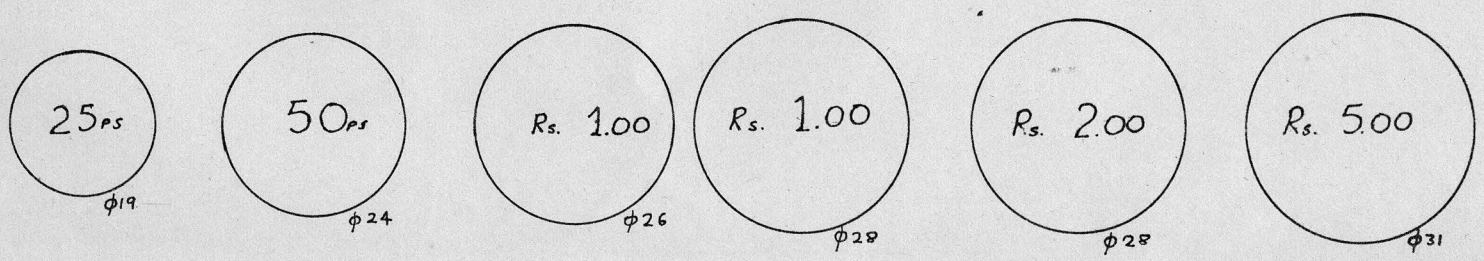
Size along with shape plays a major role in recognition of coins. Prominent size difference exists between

1 paise and 5 paise
2 paisa and 10 paisa
3 paisa and 20 paisa





Among the circular coins noticeable difference in size exists between the 25 ps, 50 ps, 1.00 rupees/2 rupees and 5 rupees. However the difference in size between the 50 paisa, new 1 rupee, old 1 rupee and 2 rupee is barely noticeable. This has resulted because of the introduction of the new Rs.2/-coin which is of the same size as the old Rs.1/- coin. This led to introduction of a smaller Rs.1/- coin which is somewhere between the 50 paisa coin and the Rs.2/-/old Rs.1/-coin in size.



Among the smaller demomination (below 25 paisa) shape and size are two features whose contribution is sufficient to affect recognition; since they involve three basic shapes of coins and two prominently noticeable sizes.

However for 25 paisa and above coin, all being round and size differences being small, the person has to fall back on other features (Metal/graphics) for recognition.

METAL AND COLOUR

Coins currently used in India are of two materials, Aluminium and Copper-Nickel. 1 ps, 2 ps, 3 ps, 5 ps, 10 ps, and 20 ps are made of Aluminium (i.e. all non-circular shaped coins are made of Aluminium).
25 ps, 50 ps, Rs.1/-, Rs.2/-, and Rs.5/- are made of copper-nickel (all circular shaped coins are of copper-nickel).

In the case of smaller denomination coins since shape and size already help in identification; it is of no consequence that all these coins are of the same metal (colour).

Metal doesn't aid recognition in the case of 25 ps and above denomination coins, since all these circular coins are of Copper-Nickel. Thus this variable is not manipulated properly to aid recognition.

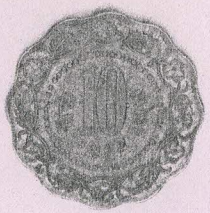
It is important to note that as the monetary system value drops, the face value drops and this points towards using smaller size coins, or newer cheaper materials (which is not so easy for want of cheaper materials). Hence the only alternative is to decrease the size.

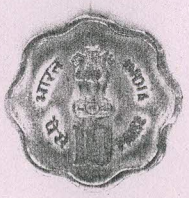
This decrease in size results in new coins of smaller size coexisting with the old coins. Thus a single denomination coin may exist simultaneously in two sizes or two materials. This results in an additional burden on the recognition pattern and thus increases recognition time and also chances of mistakes.

EDGE TREATMENT

All the non-circular shaped, aluminium coins have plain/smooth edges, while the circular shaped, Copper-Nickel coins have reeded edges. This feature only helps seperate between the two groups but doesn't aid recognition of any particular coin within each of the group.

DENOMINATION GRAPHICS





There are two types of coins: those with the Lion on the obverse and the denomination value on the reverse, and those with the Lion and the denomination value on the obverse and a theme on the reverse.

In the former type, the denomination value on the reverse is in big numbers. eg. 1 ps, 2 ps, 3 ps, 5 ps, 10 ps, 20 ps, 25 ps, 50 ps, Rs.1/-

In the latter with denomination lion on obverse, the denomination may be either in big numbers (eg. 5 ps, 10 ps, 20 ps, 25 ps, 50 ps, Rs.1/- Rs.2/- and Rs.5/-)
or it may be in small numbers (eg. 10 ps, 20 ps, 25 ps, 50 ps, and Rs.1/-)

Thus there are 5 different sizes/types of denomination graphics in case of 10 ps coins, and 4 different sizes/types of denomination graphics in case of Rs.1/- coin. In case of 10 ps coin the shape and size are sufficient to facilitate recognition, but in the case of Rs.1/- coin where size and shape are not as effective in aiding recognition, denomination plays an important role. However the existence of 4 different sizes of denomination graphics only adds to the confusion and thus increases recognition time.

The presence of themes only adds to the confusion. The 50 ps, Rs.1/- and Rs.2/- coins may all have the same theme on the reverse. Thus the recognition boils down to size (which is not very distinct) and then to graphics and surface pattern. This implies that recognition is only from one side of the coin (i.e. obverse) in those coins which have themes on the reverse.

In all circular shaped coins having the denomination graphics on reverse and the lion on obverse, recognition through surface graphics is only from the reverse side since all these coins have the same lion emblem on the obverse side.

SURFACE TREATMENT

There is no fixed pattern of surface treatment. There are some surface treatment that are unique enough to serve as recognition cues.

eg.

Flowers on new 50 ps coin

Notches on Rs.1/-coin

However the presence of notches on Rs.2/- coin, 25 ps coin as well as on the Rs.1/- coin adde to the confusion. Few people are aware that there are 8 notches on the Rs.2/- coin, 7 notches on the Rs.1/- coin and 6 notches on the 25 ps coin. Too many notches become a negligible factor from recognition point of view as it is difficult to differentiate between 8 notches (Rs.2/-), 7 notches (Rs.1/-) and 6 notches (25 ps) at quick glance. Thus in this case, surface treatment instead of adding to recognition value creates more confusion.

25 paisa

Rs.1/-

Rs.2/-

The following common observations were made when different people asked to pick up coins of particular value from a mixed lot of Indian coins.

- 1 ps, 2 ps, 3 ps, 5 ps, 10 ps, 20 ps, 25 ps, and Rs.5/- coins were picked up immediately without hesitation or much rearching time.

This is because othese coins have distinct shapes and sizes, i,e. the small size 1 ps, 2 ps, 3 ps, 25 ps coins and the big size 5 ps, 10 ps, 20 ps, Rs.5/- coins. As a result of the sound recognition cues provided by shape and size, the people need not have to rely on other features like denomination graphics, edge treatment, surface treatment and metal for recognition of these coins.

- When asked to pick up 50,ps, Rs.1/- and Rs.2/- more time was taken.

This is because all the above coins are circular shaped, have reeded edges and are made of Copper - Nickel. Thus in this case shape was only able to identify the coins as from the above group (of 25 ps, to Rs.5/- denomination value). Size difference being relatively small, it is not a prominent differentiating feature. Hence graphics and surface treatment are the two major factors, contributing towards recognition of these coins.

- Lots of people mistook the new Rs.2/- coin for Rs.1/- coin. Even when the error was pointed out they flipped the coin over at least twice before they realise and accepted the error.

The new Rs.2/- coin is the same size as the old Rs.1/- coin, and has almost similar surface treatment as the new smaller sized Re.1/- coin. (Rs.2/- coin has 8 notches on the surface, Rs.1/- has 7 notches on the surface).

- Few people picked up or ventured to pick-up coins with the theme side facing upwards.

50 paisa

Rs.1/-

Rs.2/-

This is because some 50 paisa, Rs.1/- and Rs.2/- coins have same theme on reverse side. To add to this the size difference between these three coins is not prominently distinguishable. Thus giving rise to greater chances of making mistakes in identifying these coins.

From the above observations it would seen that the different features of coins are randomly assigned without the existence of any pattern or order. However if we look back at the history of coins from British Regal issues . onwards (i.e. from 1862 onwards), it is possible to draw clues as to the reasons for the present systems of coins.

- Upto 1910 all coins were of circular shape and were made of copper, silver and gold. From 1906 most denomination which were previously in copper were minted in Bronze, those which were in Silver were minted in Copper- Nickel, while those which were in Gold were discontinued.

- 1911 saw the introduction of the first non-circular shaped coins - i.e. square shaped 1/2 anna and 2 anna; and flower shaped 1 anna and 4 anna. These three basic shapes continued to be minted uptill 1947.

- After independence from 1947 - 1957 the monetary system remained unchanged i.e. 4 pice = 1 anna and 16 annas = 1 Rupee. At this stage all shape, sizes, materials and graphics which existed prior to independence were adopted into the new monetary system.

- From 1957 - 1963 the Naya Paisa was in existence (100 Naya Paisa = 1 Rupee). The same shape and materials of the old anna coins were adopted with changes in size (reduced). The 1 pice coin was replaced by the 1 Naya paisa of the same shape; the 1 anna coin was replaced by the 2 Naya paisa coin; the 2 anna coin

was replaced by the 5 paisa coin; the old 4 anna coin was replaced by the 10 Naya paisa coin; the 1/4 rupee coin was replaced by the 25 Naya paisa coin; the 1/2 rupee coin was replaced by the 50 Naya paisa coin adopting the same old shapes.

At this stage there were two circular shaped coins of the same material (Nickel) but of different sizes; 2 flower shaped coins of same materials (Copper -Nickel) but different sizes; one circular shaped coin of different material (Nickel-Brass); and one square shaped coin of Copper-Nickel. Recognition at this stage was simple and relied on shape size and material. Graphics and surface treatment played a minor role.

- From 1964 onwards all Naya Paisa coins were replaced with paisa coins(100 paisa = Rs.1/-) . At this stage two new denominations were introduced - a hexagonal shaped 3 paisa coin of aluminium and a circular shape Rs.1/- coin of Nickel but distinctly bigger in size then the 50 paisa coin.

- In 1965 the circular 1 paisa coin was replaced by a small size square shaped 1 paisa coin aluminium. Its shape and size was the same as the old 1/2 anna coin which has been discontinued in 1955. In 1968 a new circular shaped, Nickel - Brass 20 paisa coin was introduced. By 1972 all denominations below 20 paisa (i.e. 1 paisa, 2 paisa, 3 paisa, 5 paisa and 10 paisa)

were being minted in aluminium; the 20 paisa in Nickal-Brass while the 25 paisa and 50 paisa were minted in Copper-Nickel and the Rs.1/- in Nickel.

At this stage(1972) there were :-

- 2 square shaped coins both made of aluminium, the smaller size being 1 ps, and the bigger size being 5 paisa.
- 2 flower shaped coins both made of aluminium, the smaller size being 2 ps, and the bigger size being 10 ps.
- One circular shape coin made of Nickel-Brass, which was the 20 paise coin.
- Three circular shaped coins having reeded edges, of same colour(Copper-Nickel/Nickel) and of three distinct sizes; the smallest being the 25 paise, the middle size being 50 ps, and the biggest size being the Rs.1/- coin.

Although there were 4 circular coins, recognition at this stage (1972) was aided by the difference in size (25 ps, 50 ps, Rs.1/-) and the difference in material/ colour (20 ps coin). In the Rs.1/- coin issued in 1969 bearing Gandhi's bust on the reverse caused no hinderance to recognition eventhough the denomination in figure was not mentioned on the coin.

- Replacing the circular shaped 20 ps, coin by a hexagonal shaped aluminium coin of the same demonimation in 1982 simplified recognition.

However the introduction of themes on the reverse side of the coins, the introduction of Rs.2/- coin which was the same in size and shape as the Rs.1/- coin, and further the introduction of the new smaller Rs.1/- coin has added to the confusion and made it more difficult to distinguish the different circular shape coins.

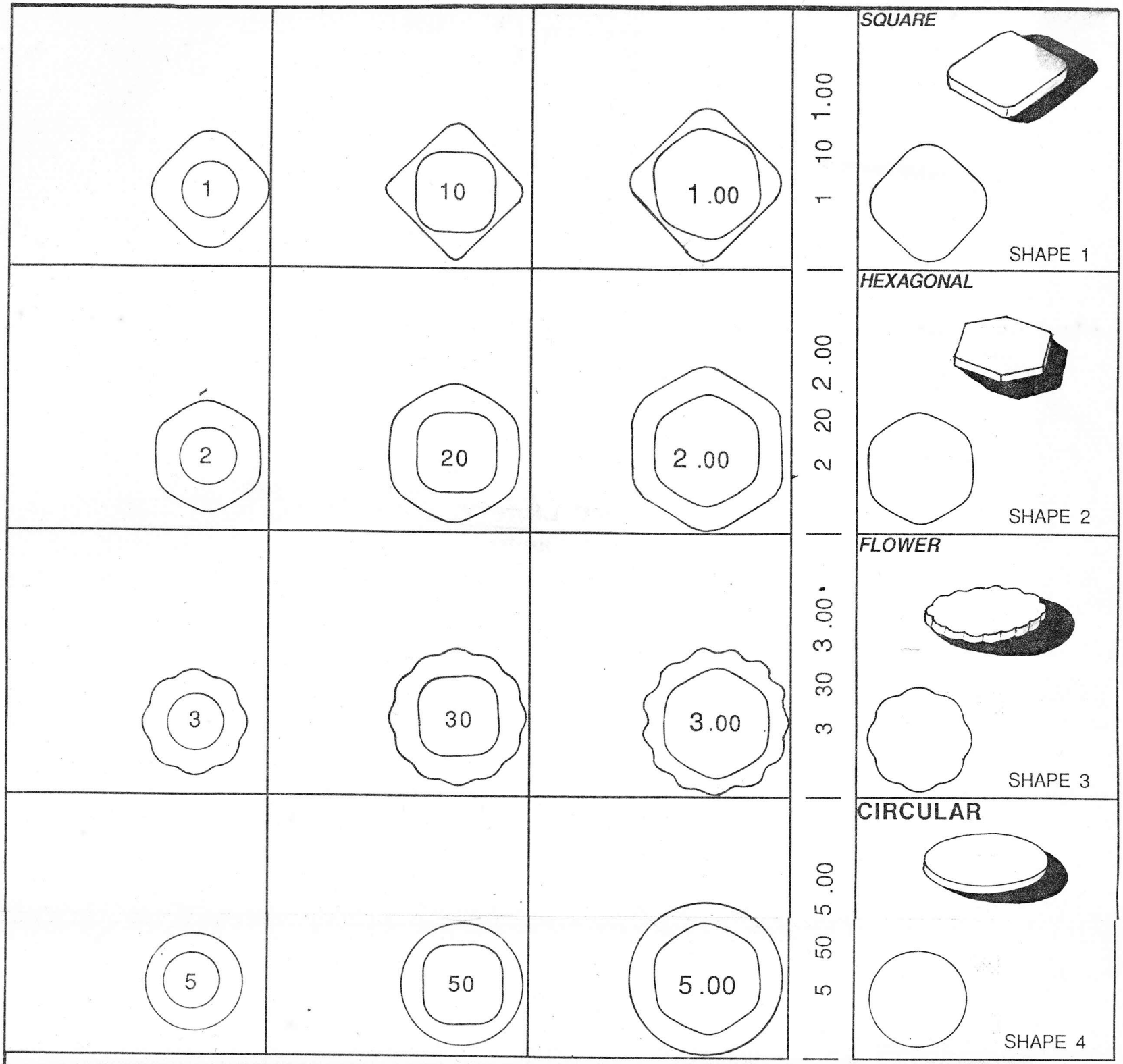
HYPOTHESIS

In order to understand better how the different features can be varied in designing coins so that they contribute positively towards reducing recognition time and also reducing chances of mistakes, a hypotetical system of coin has been suggested (Chart 3).

In this hypothetical system of coins, each of the features has been manipulated to achieve a positive contribution towards recognition. The system of coins is designed keeping in mind the requirement of blind and poor sighted people. The factors which play an important role in recognition of coin for them are shape, size and weight, edge treatment and surface treatment.

The use of four very distinct shapes and three distinguishable sizes in itself is not sufficient to aid recognition. What further aids the recognition is the fact that the denomination of the medium size coin is 10 times that of the smaller coin; and the denomination of the biggest coin is 100 times that of the smaller coin. Thus the small medium and big sizes of coins bear a relationship with units, tens and hundreds denomination value.

Further all square coins are associated with 1 (1 ps, 10 ps, 100 ps) ; all hexagonal coins are associated with 2 (2 ps, 20 ps, 200 ps,); the flower shaped coins are associated with 3 (3 ps, 30 ps, 300 ps,) ; and the circular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1 10 1.00
2 20 2.00
3 30 3.00
5 50 5.00
SQUARE
SHAPE 1
HEXAGONAL
SHAPE 2
FLOWER
SHAPE 3
CIRCULAR
SHAPE 4
SHAPE &

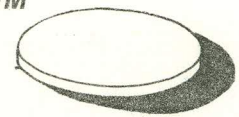
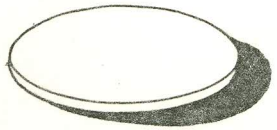
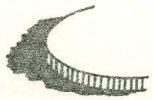
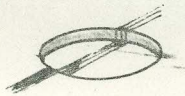
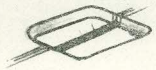
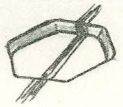
UNIT PAISA VALUES	TEN PAISA VALUES	HUNDRED PAISA VALUES	SHAPE & ORIENTATION
			SHAPE 4
SMALL  SIZE 1	*MEDIUM*  SIZE 2	*BIG*  SIZE 3	SIZE & WEIGHT
ALUMINIUM METAL 1		*COPPER-NICKEL* METAL 1	METAL & COLOUR
PLAIN EDGE  EDGE 1	*REEDED EDGE*  EDGE 2	*PLAIN EDGE*  EDGE 3	EDGE TREATMENT
CIRCULAR RELIEF  RELIEF 1	*SQUARE RELIEF*  RELIEF 2	*HEXAGONAL RELIEF*  RELIEF 3	SURFACE TREATMENT
STANDARD GRAPHICS	1 10	1 .00	
	2 20	2 .00	DENOMINATION GRAPHICS
SAME TYPE &	3 30	3 .00	
SAME SIZE DIGITS	5 50	5 .00	

CHART 3

shaped coins are associated with 5 (5 ps, 50 ps, 500 ps,).

For those who are not sure about the difference in size between a 1 ps, and a 10 ps coin, the edge treatment will help recognition. This can be achieved by having plain edges for the unit (smallest) and 100's (biggest) value of coins, and reeded edges for the ten value (middle). Thus all reeded edges will signify the tenth value, while the difference in size between the plain edged smallest and biggest sizes will be prominent enough.

Thus edge treatment strengthens the recognition cues provided by size and shape. Similarly metal/colour can also be manipulated to add recognition value.

The provision of circular relief (for unit values), square relief (for tens values), and hexagonal relief (for hundreds values) will help blind and poor sighted people. Thus they have to remember the association of relief with the units, tens and hundreds values and the overall shapes of coins with the 1,2,3,5, values.

In the above hypothetical system of coins -shape, size, edge treatment, surface treatment and metal contribute to recognition from both sides of a coin. Thus graphics need not play an important role in recognition since graphics is normally only on one side of a coin. Thus when some differentiating features are very distinct, then even if the other features are neglected, recognition is still possible within short span of time.

FUTURE SCOPE OF THIS PROJECT

This project has attempted to understand the recognition process followed by the human mind in identifying coins during daily use.

During the course of the project a number of observation have been made which seem to indicate the improper manipulation of the different features of recognition as a result of which the present confusion exists.

However, these observation only serve as clues for future use in designing coins. A more detailed study into each of these observation supported by circumstantial evidence would be necessary before these observation can be considered in designing. The following methods can be explored as a means of gaining a better understanding.

- Eye movement study. This is a direct approach to feature analysis. This lines of study presumes that if the subject gazes relatively long at a certain feature in a pattern, then he or she is extracting more information from that feature than from a feature only cursorily viewed.

- Another method of study is to present (slides of) coins randomly to a subject for 2 to 20 m sec., in 2 m sec increaments. The difference in recognition performance as the exposure time increases should be able to provide some interesting results.

A confusion matrix can be drawn up and showing the type of errors made by subjects viewing the briefly displayed coins.

- Another interesting method of study would be to try and understand what features aid the blind people in recognitising coins. In this case tactile inputs would be the most important and hence these would give interesting clues as to the contribution of features like size, weight, texture and surface finish.

- It would also be interesting to make samples of a hypothetical system of coins and try them out as different subject. This would give an idea as to whether too many differentiating features actually simplify recognition or add more confusion.

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