Arupa Foundation 7: Spirals in a Cube

Problem Framing, Active Silence and Implicate Visual Order

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Abstract:

This article revisits *Spirals in a Cube*, a Foundation exercise undertaken by M.Des students at IDC, IIT Bombay during 1985–87, to examine its pedagogic processes within the framework of **Arupa—the Implicate Order**. Rather than treating the exercise as historical documentation, the study seeks to extract generative principles relevant to contemporary design pedagogy. The problem was framed through the interaction of two geometric orders—the cube and the spiral—with inputs from D'Arcy Thompson's ideas of gnomonic growth, geometric order in Nature and exposure to prevailing relevant cultural orders.

The article examines how problem framing, material engagement, teacher–student dialogue and the wider IDC learning ecosystem created conditions for **Active Silence**—intense involvement with the potential to bring change in the learner's Inner Order. The unusually varied student outcomes are reconsidered as manifested Rūpas and retrospectively read at three levels: morphological territories, visual-language grammar, and metaphoric/generative leads. This analysis asks whether apparently diverse forms can reveal underlying orders that may be reopened pedagogically rather than treated as examples for imitation.

The study concludes by asking how such tacit and experiential processes can be articulated for **New Age Foundation pedagogy**, with AI used not as a shortcut to creative engagement.

It opens a subsequent inquiry into Naming, Narrative and Poetry as means for extending metaphoric imagination in design.

1.0 Introduction

Cube Lab, a new name, gives us a new platform to look at Foundation tasks done in the 1980s, at

IDC, IIT Bombay. Spirals in Cube done by M.Des students of 1985-87, is the second in Cube series.

The concern of the article is to extract from what has happened and structure what can happen in the pedagogy of 'Metaphoric Imagination in the 3D Form learning' in the framework of Arupa the Implicate Order. This involves

- Examining the task in 'Arupa the implicate order frame work' with focus on **Active Silence** and **Eco-system for Learning at** that time.
- Exploration of **Naming, Poetry, Narratives and AI artistry** as means for Pedagogy based on the creative outputs of the task as well as the process of creation.

This article examines the task in 'Arupa the implicate order framework'.

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2.0 Problem Framing

Problem Framing is an important 'pedagogic preparatory step' in the frame work of 'Arupa the Implicate order.'

2.1 Background

Problem Framing acquires an importance in Arupa frame as Inner Order of the Teacher/ Instructor is reflected. It is seen as a challenge and opportunity for the teacher. Often it may not make a difference to the student as the problem is new to him/her. But there is an internal dynamic between senior students who have already gone through the task and the juniors. Setting a new problem gives an advantage to the juniors, as the answers are not known to the seniors either. In studio frame work this acquires a significance.
I used to try to strive to vary the problems keeping the learning content in the same zone.

Surprising results in cube1- Identical halves with a visual surprise' with 1983-85 batch, made an impact at IDC. Yet I did not repeat or follow cube theme with the next batch but explored another theme: Family of Forms made by 'Turning' (1). Cube as a theme was waiting with me, as I was keen to adopt Japanese strategy of 'continuing with a same theme to extract full juice'.

2.2 New Strategic Direction

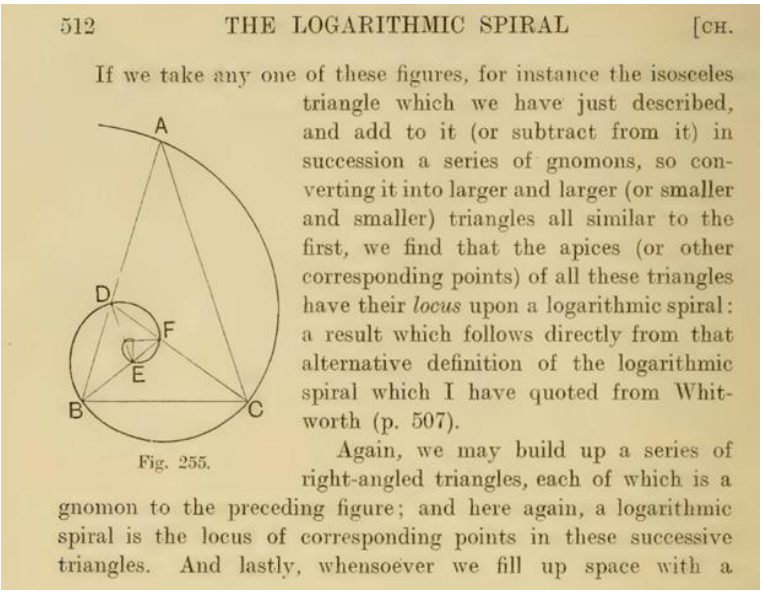
I also changed my strategy from the Cube1 task, where the problem was open-ended. I realised it would be better to incorporate specific knowledge inputs on aesthetic order. Golden Spiral attracted me. As I started looking for more information, spirals in D'Arcy Thompson's book 'On Form and Growth' (2) captured my imagination. I had acquired the abridged version of the book brought out by MIT Press, in 1980 when I briefly attended one of the undergraduate courses at MIT, as a UNESCO scholar.

What was attractive in Thompson's approach was that he started decoding biological processes through 'geometric order'. His Innovative grids to look at fish and logarithmic spirals in growth of snails, etc., connectable Golden Spiral, were a great inspiration. He adopted 'Gnomon'- an ancient Greek concept, to show the mathematical correlations in biological growth order. He proposed that many natural forms grow **gnomonically** giving examples like

- shells,
- horns,
- antlers,
- A spiral can be seen clearly in the cross section of snail shell seen below:

*A **gnomon** is a part added to a geometric figure so that the enlarged figure **retains the same shape and proportions as the original**. In Thompson's example, seen below, successive gnomons generate a series of similar triangles, whose corresponding points trace a logarithmic spiral.*

A gnomon construction in triangles illustrates the basis for logarithmic spiral. We can see below Δ ADC as a gnomon of ΔBDC, leading to the bigger ΔABC. The process can go on inwardly or outwardly and joining the end points of the larger sides gives the spiral.



512 THE LOGARITHMIC SPIRAL [CH.

If we take any one of these figures, for instance the isosceles triangle which we have just described, and add to it (or subtract from it) in succession a series of gnomons, so converting it into larger and larger (or smaller and smaller) triangles all similar to the first, we find that the apices (or other corresponding points) of all these triangles have their *locus* upon a logarithmic spiral: a result which follows directly from that alternative definition of the logarithmic spiral which I have quoted from Whitworth (p. 507).

Fig. 255.

Again, we may build up a series of right-angled triangles, each of which is a gnomon to the preceding figure; and here again, a logarithmic spiral is the locus of corresponding points in these successive triangles. And lastly, whensoever we fill up space with a

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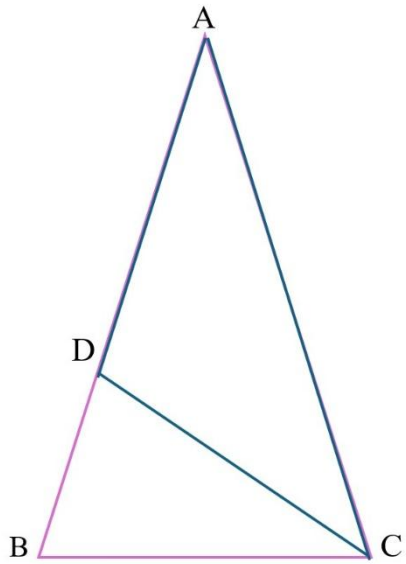

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Thompson's decoding of 3D form in shells is an important input to designers, to get a 'feel' of geometric order at a system level in Nature.

This back up information admirably suited for new theme in the cube series.
Setting a 'Theme' with pattern inputs as a strategy was different from tasks set earlier like

- **Cube 1**: Divide the cube into two identical halves with visual surprise: geometrical constraint with open-ended metaphoric field. There was limited scope for hands on experience / kinaesthetic sense operation.
- **Family of turned forms**: Find a **Family Identity** through a metaphor which manifests in one unit. Create a family of forms with that **Identity**, by varying aesthetic parameters like scale, mass, proportion, etc.

2.3 New Scope

Golden proportion and the Golden Spiral provided an entry through proportion and aesthetic order. This led to a wider exploration of spirals in Nature. D'Arcy Thompson's '*On Growth and Form*' opened an additional direction—gnomonic growth and logarithmic spirals as geometric orders underlying biological form. These became inputs for framing *Spirals in a Cube*. *Such relationships are now readily encountered through dynamic digital visualisations. At the time of the exercise, however, they formed part of a deliberately constructed knowledge input to the studio.*

3.0 IDC Ecosystem for Learning

The Ecosystem at IDC at that time was charged with intense involvement of Faculty and students. Listed below are background of inputs:

- A detailed presentation made by me on spiral geometry, golden spiral and its manifestation in Nature (shells, flowers, etc...), in addition to 'Cultural connotations like coiled 'kundalini shakti' for Spiritual Awakening in Indian Tantric tradition
- A previous task done by the same batch: Masks in Clay
- Exposure to results of task done earlier: Cubes with identical halves with an element of surprise. (3)
- Tasks done by immediate seniors like 'Family of turned forms', and 'Akshara Devata in Clay' (4)
- Some seniors doing advanced Form elective in which 'Surrealism of Salvador Dali' was taken as basis of inspiration to arrive at Product forms like Bird Telephones.
- Active involvement of a ceramic designer Abdul Gaffoor as co-instructor.
- High expectation from people around.
- Individual dialogues with me and Mr. Gaffoor in physical translations, over-night workings

4.0 Active Silence: key for change in Inner Order

It is interesting to observe 'Active Silence' a 'total involvement of a student in Learning', has potential to cause a change in 'Inner Order' of a learner as seen in feedback. Often, such change in 'Inner Order' remains 'Tacit' as it is internalised over a period as a part of I-factor of an Individual. We cannot plan or induce 'Active Silence' in others. We can only create conducive eco-systems.

- **Milind's feedback**:
  Milind Tamhane
  Product Design Batch 1985-87

I recall your brief- Imagine Spiral in the cube- material- Plaster of Paris. Keep in mind Cube must not lose its identity; the outcome should not be copy of any existing object! As a Mechanical Engineer in previous life, Cube meant a Solid body with a firm base on ground, and there have to be 4 vertical edges which should not loose identity. Now within this cube there has to be Spiral carved, imagined. Spiral for me then was conch- शंख, the one used at Puja. Here comes Rao sir's indicator that the final shape should not resemble existing object. I recall spending reasonable time sketching the object, showing the concept to Rao Sir. Now I thank him for there were absolutely no opinion shared, no spoon feeding, probably a hint that there is this wonderful material PP which would be friendly initially to listen to the tools- Brocken hacksaw blades with tips created by us on the grinder! Our first experience with PP.
Cube to me also signified number '4', so the conches can be four, merging at the base and growing to 4 corners. While the natural conches have beautiful curves and shine, my 4 conches, need to have initial forms towards flat surfaces- gradually going towards curved surfaces. Also, I tried creating a 90-degree step as the spirals grow. Incidentally,

not planned, the number of spiral revolutions is 8- 2x2X2!
The piece, as Gomes tells, is still available at my parent's place and has travelled from Indore to Pune. What a journey. And thank you to have made me revisit!

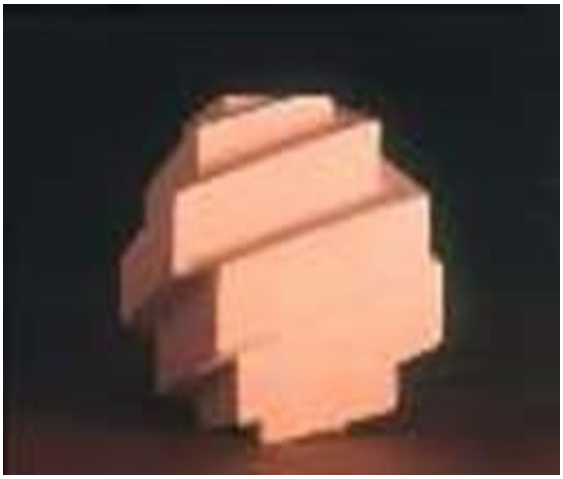
5.0 Spiral cube Solutions

Batch: 1985-87

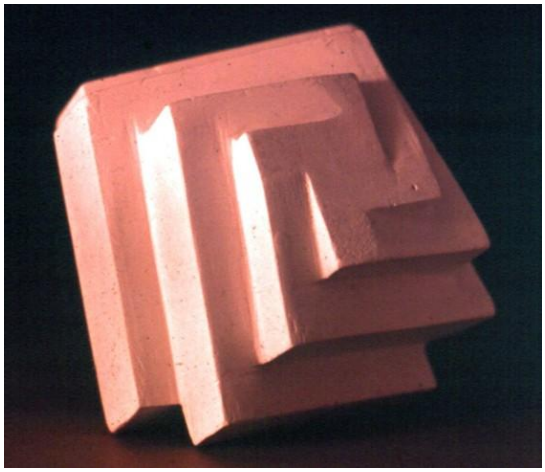
Even as we will look at the solutions below, I want to emphasize that *Naming was neither suggested nor used as means for Imagination* during the task. I started giving the names, now, to facilitate communication.

5.1 Shelled Cube

Student: not recorded



5.1.1

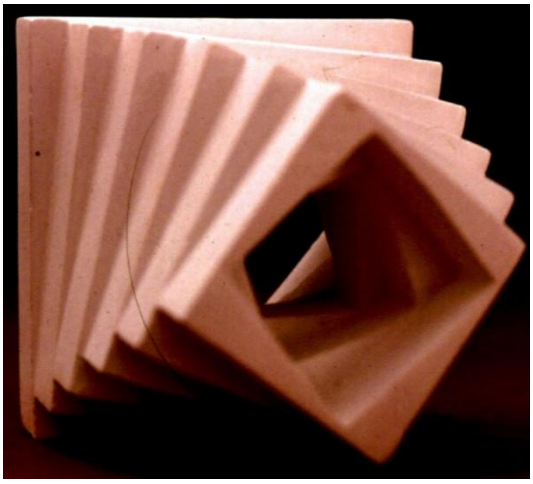


5.1.2

5.2 Tunnel Squared

Student: **Lincon, Aloysius, Gomes**

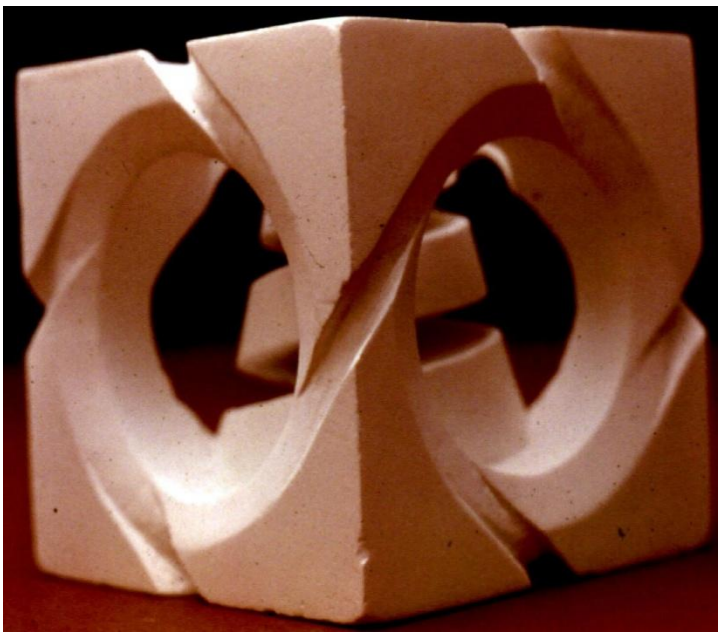
5.2.1



5.2.2

5.3 Coiled Cube

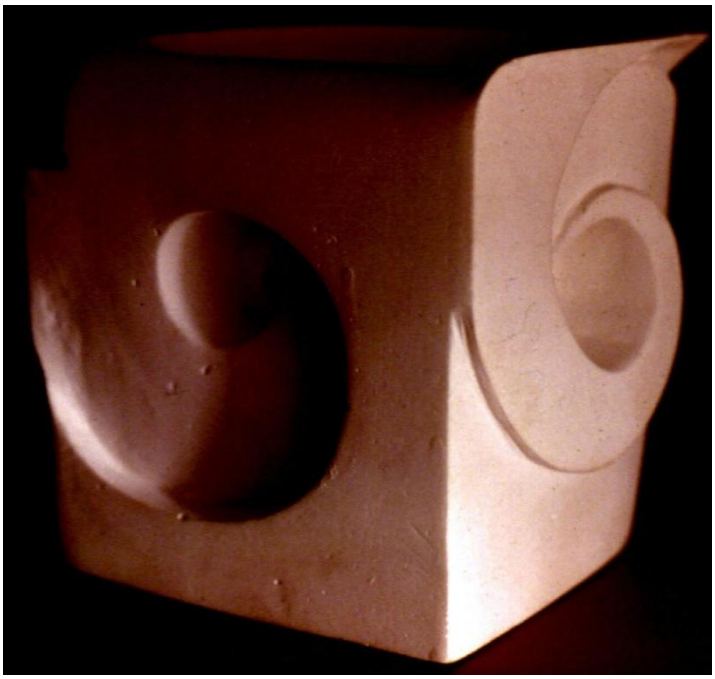
Student: **Rajan Vernekar**



5.3.1

5.4 Lotus Cube

Student: **Pradeep Save**



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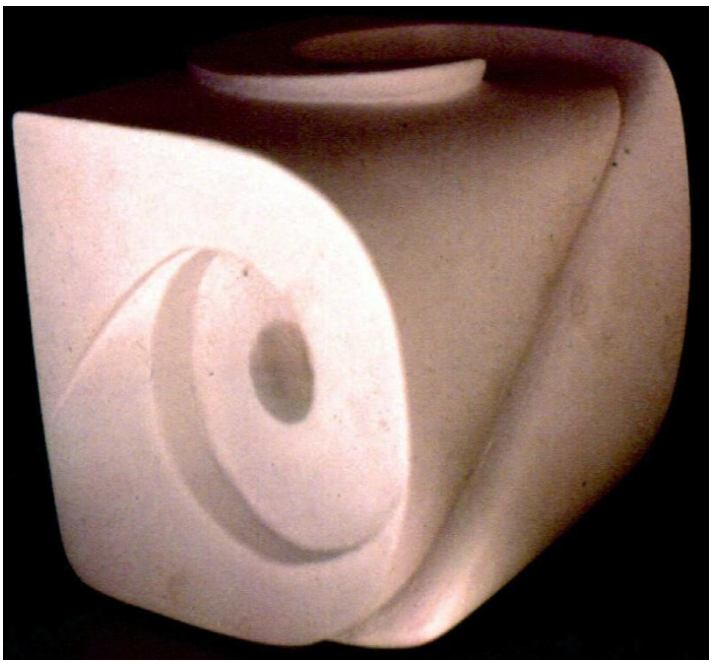

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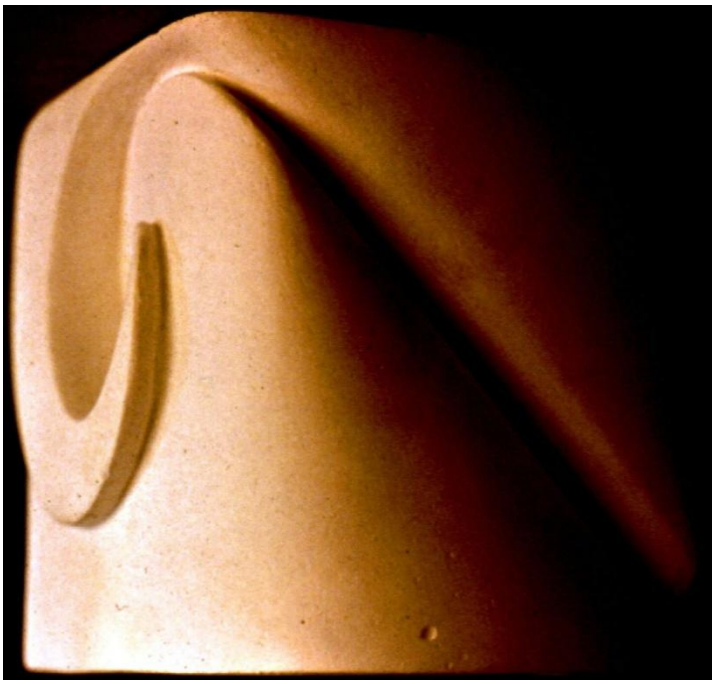

5.4.3

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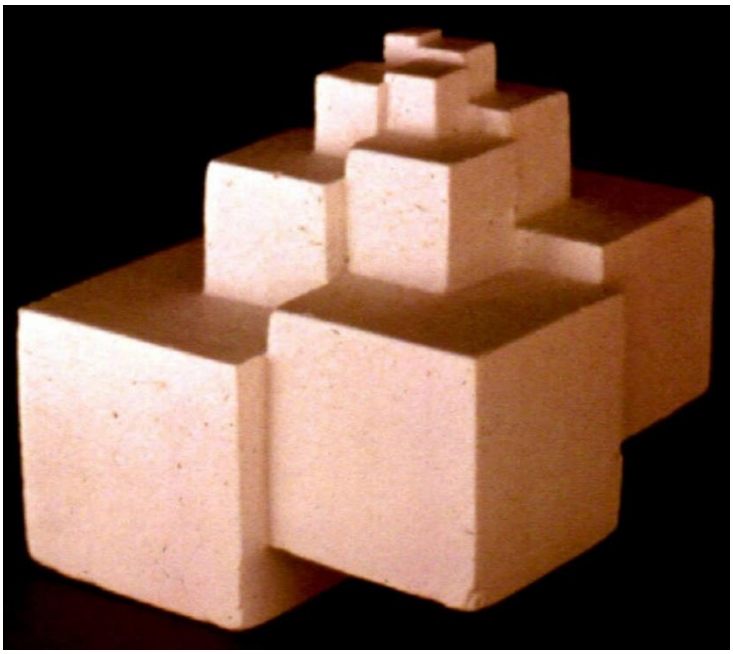
5.5 Cubes in Ascent

Student: not recorded



5.5.1

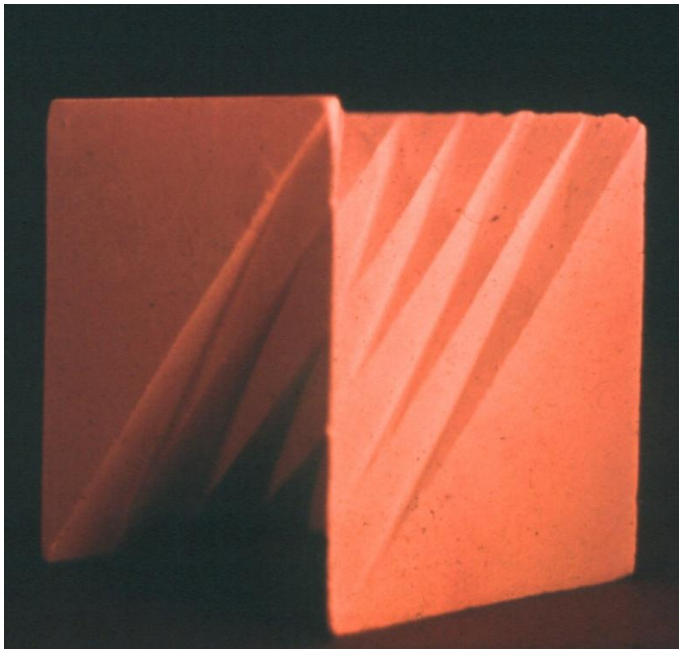
5.6 Cube Kamala

Student: **Milind Tamhane**

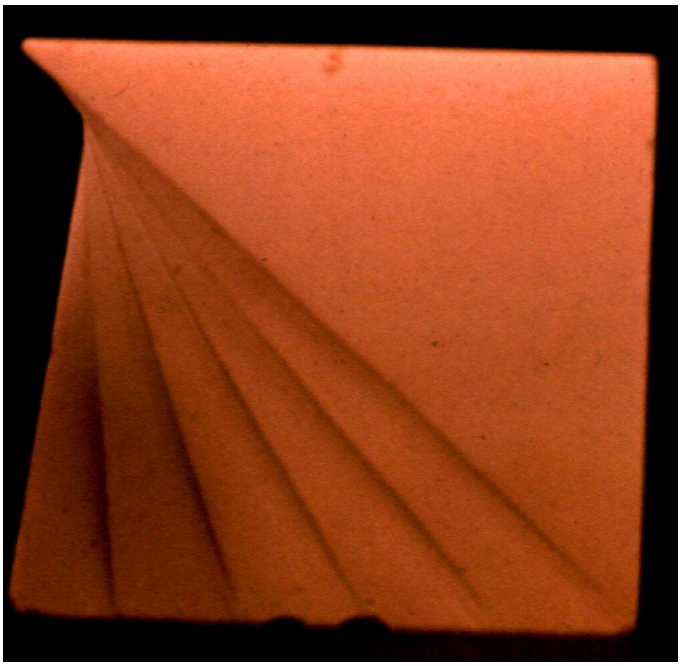
5.6.1

5.7 Spiral Within

Student: **Girish Nalavade**



5.7.1



5.7.2

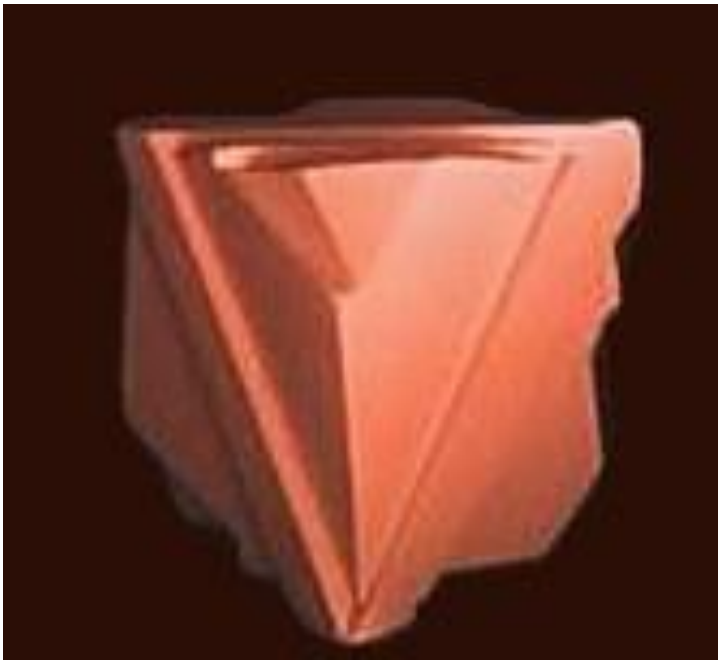
5.8 Spiral Surround

Student: **Ravindra Rajhans**

5.8.1

5.9 Tetra cube Spiral

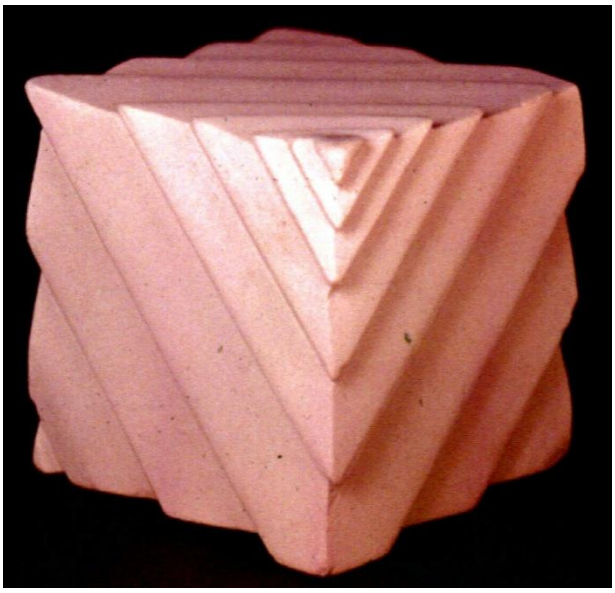
Student: not recorded



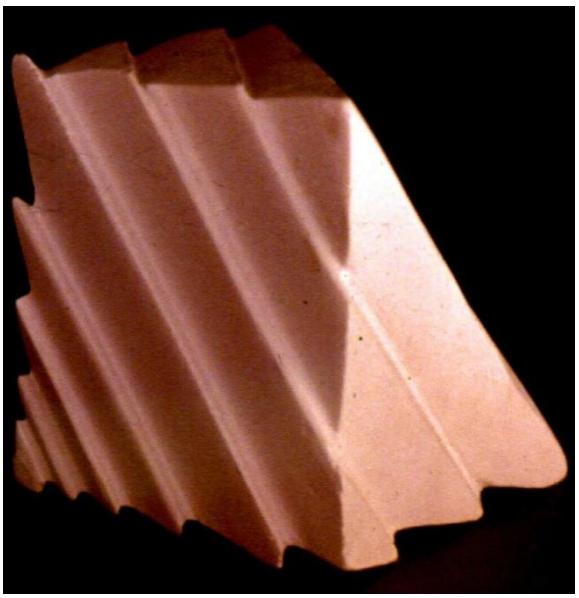
5.9.1

5.10 Vortex Folds

Student: not recorded



5.10.1

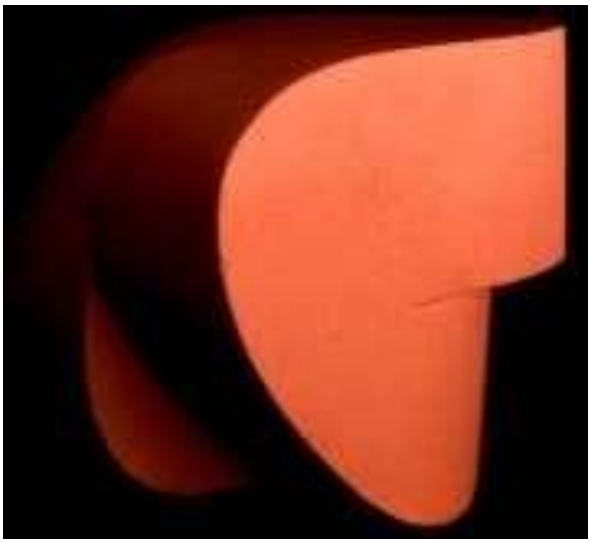


5.10.2

5.11 Endless Cubed

Student: **Nagarajan, G**

5.11.1



5.11.2

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6.0 Inferences and new leads

Inferences are drawn after a review to find new directions for New Age Pedagogy.

6.1 Based on what has happened

Reflecting on the above **Spiral–Cube Interpretations** and the process that took place following conclusions can be drawn:

- The problem setting strategy was successful. It was not completely open-ended with “free creativity” akin to an ‘Art expression’. It was in a creative problem-solving mode with a brief. It had carefully chosen constraints, a cube, with known properties, demanding to explore its multi-dimensional traits and an aesthetic guide-line of using logarithmic spirals (similar to golden spiral) occurring in Nature for metaphoric inspiration.
- The generative constraints created a field within which unforeseen outcomes emerged.
- One feedback we got in spite of long gap, indicates, ‘Active Silence’, an immersed participation of a student has the potential of bringing change in the ‘Inner order’ of a participant.
- In addition, Milind’s account which says there was "absolutely no opinion shared, no spoon feeding" and then describes how the material, tools, cube and spiral began directing his thinking, reminds us **Donald Schön's "reflective conversation with the materials of a design situation."** Schön specifically describes designing as involving active sensory appreciation, moves, responses from the material situation, unintended consequences and changing intentions (5)

6.2 Reading ‘Manifested Rūpa: From Morphology to Generative Pedagogy’

The eleven solutions generated by the Spirals in a Cube task have an immense potential as ‘rupa’ manifestations of varied outcomes to identify possible ‘Arupa’ patterns for use in contemporary pedagogy. Visual strategies through which they became perceptually effective can be studied for generative possibilities that can be reopened for future learners (6). This becomes particularly relevant for contemporary Foundation pedagogy, where a pedagogue may have to guide a substantially larger number of students than in the earlier IDC studio. The teacher needs an expanded repertoire for recognising where a student is operating, what visual possibilities remain unexplored, and what kind of lead might open another direction without prescribing a form. Three levels of reading were thought of: Morphological Reading, Visual-Language Grammar, and Metaphoric/Generative Leads.

6.2.1 Level 1 — Morphological Reading

What kind of formal territory has appeared? An attempt was made to analyse the outcome by seeing them as solutions with a Morphology based on Geometric Order:

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Cube Solution	Morphology based on Geometric Order
1. Shelled Cube	Spiral shell morphology (progressive spiral growth)
2. Tunnel Squared	Tubular morphology (continuous passage/channel)
3. Coiled Cube	Coiled morphology (helical winding around an axis)
4. Lotus Cube	Radial flower morphology (petal-like radial organization)
5. Cubes in Ascent	Terraced / stepped morphology (layered upward growth)
6. Cube Kamala	Lotus morphology (radial layered unfolding)
7. Spiral Within	Internal spiral morphology (spiral enclosed within a volume)
8. Spiral Surround	Enveloping spiral morphology (spiral wrapping around a core)
9. Tetra Cube Spiral	Crystalline / faceted morphology (prismatic, tetrahedral facets guiding the spiral)
10. Vortex Folds	Folded surface morphology (continuous folded surfaces suggesting vortex motion)
11. Endless Cube	Continuous ribbon morphology (unbroken looping surface/path)

The eleven solutions appear to occupy five broad morphological territories. These are not intended as rigid categories. They provide the pedagogue with a provisional map of the solution field and reveal that the eleven works are not eleven unrelated formal events.

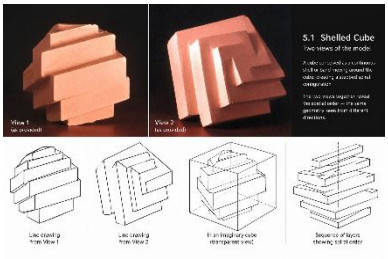
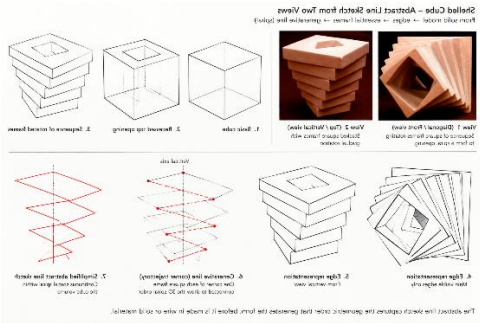
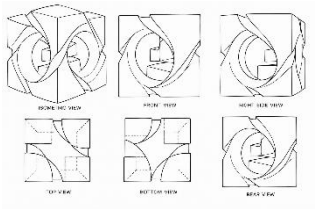
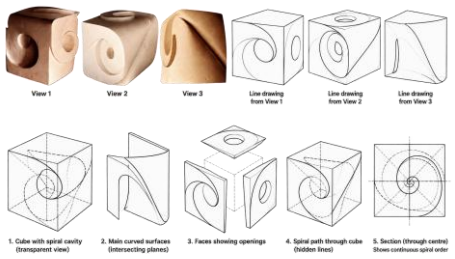
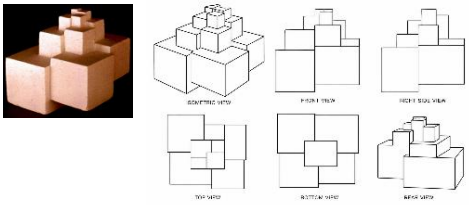
Morphological territory	Manifested solutions
Spiral / Coiled	1. Shelled Cube; 3. Coiled Cube; 7. Spiral Within; 8. Spiral Surround
Radial / Floral	4. Lotus Cube; 6. Cube Kamala
Layered / Terraced	5. Cubes in Ascent
Tubular	2. Tunnel Squared
Faceted / Folded / Continuous	9. Tetra Cube Spiral; 10. Vortex Folds; 11. Endless Cubed

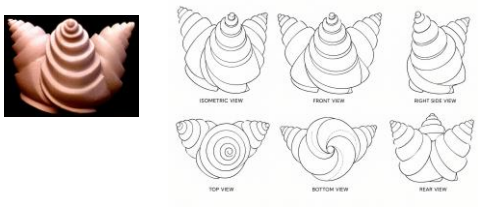
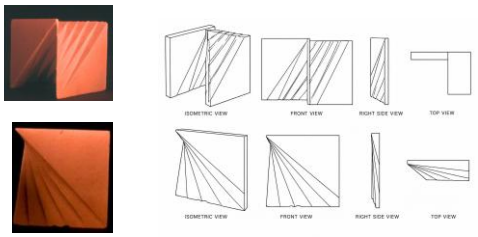
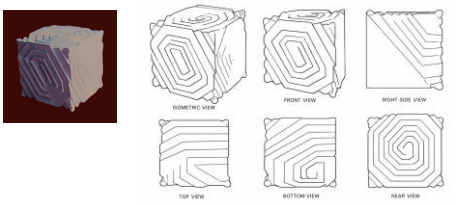
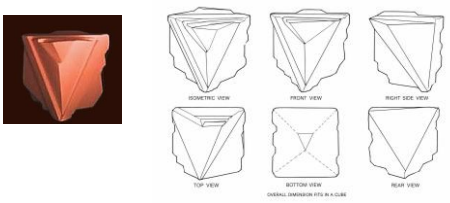
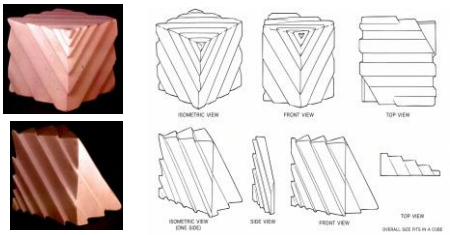
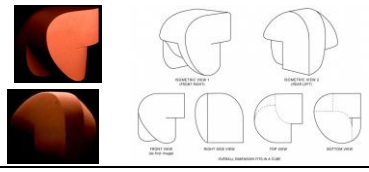
However, Morphological reading a conventional tool in analytical research, remains classificatory. Its pedagogic value is limited to probe the generative patterns.

6.2.2 Level 2 — Visual Strategies and Underlying Form Grammar

As the very purpose of the task was learning 3D Form, we can look at the accompanying visual language and vocabulary of visual operations: part- whole, scale, repetition, continuity, frame, void, edge transition, figure–ground, perceptual completion and ambiguity. These operations are not specific to the spiral in cube problem; they are transferable principles of 3D visual language.

As only photo documentation could be retrieved, Line diagrams using AI were generated for better understanding of the visual strategies behind each solution.

Solution	Visual strategy	Underlying visual-language grammar
1.Shelled Cube: student: not recorded 	The spiral is seen through straight lines and planar transitions rather than a conventional curved spiral, facilitating its blending with the cube. The geometry progressively turns while remaining compatible with the cube.	Curve → straight / planar articulation. Spiral order can remain perceptible even when its conventional curved representation is transformed.
2. Tunnel Squared: student: Aloysius, Gomes 	The spiral is depicted through broken parts. Sides of squares suggest spiral movement in 3D. Hollowness of the cube creates interest. Hollowing is used so that surrounding space visually penetrates the cube. A language for 'Figure and Ground effect' in 3D is created.	Part → whole; visible → implied. Gestalt continuity enables separated parts to be perceptually connected. Mass ↔ void becomes an active visual relation, similar to Figure and Ground in 2D
3.Coiled Cube: student: Rajan Vernekar 	A hollow frame on four sides of the cube permits the spiral within to be seen while the cubic boundary remains perceptible. This gives the advantage of reading 'Outer spiralled cube surface' and 'inner spiral movement' simultaneously	Frame → reveal. Enclosure need not conceal. Two geometric orders can occupy the same spatial field and remain simultaneously visible.
4.Lotus Cube: student: Pradeep Save 	Two sides of the cube are made into a continuous surface through a large radius, allowing them to be seen within a single visual frame. Radii effectively bring softness of lotus petals into Cube geometry. Three adjacent surfaces can be read as a continuous surface event.	Edge → transition → continuity. Radius can transform the perception of adjoining planes from separate faces into a flowing surface and bring out the surface quality of the cube.
5.Cubes in Ascent: student: not recorded 	The cube is broken into **successively displaced/stepped cubic masses.** Repetition preserves cubeness, while positional change introduces movement. Scale is used effectively. The cubes retain their identity as cubes, while changes in scale and placement in 3D space collectively depict spiralness.	Self-similarity + scale transformation + spatial displacement → emergent Fractal order. Transformation occurs through relationships among repeated elements.

Solution	Visual strategy	Underlying visual-language grammar
6. Cube Kamala: student: Milind Tamhane 	Four related elements merge toward the base and grow toward four corners. Flat surfaces progressively become curved, while repetition and rotation establish the larger order. Gestalt principle of repetition for emphasis is successfully used to relate part and whole.	Repetition + rotation + surface transformation. Several related elements can collectively generate spiral order while retaining individual identity.
7. Spiral Within: student: Girish Nalavade 	Parts — straight-line elements — depict the whole spiral. The choice of cuts in the cube and the orientation of serrations make the spiral perceptually available without explicitly depicting it. Gestalt principle of Simple Good Form, is effectively used to depict spiral within the cube through fragmented serrations	Part → whole through orientation. Selected fragments can imply an absent whole; direction and sequence enable perceptual completion.
8. Spiral Surround : student: Ravindra Rajhans 	Continuity of three surface spirals is brought out through tetrahedral elements at the edges of the cube, allowing movement to cross from one plane to another and creating a three-dimensional figure–ground effect.	Surface → edge → adjoining surface. The edge acts as a connector rather than a boundary. Cube and spiral can alternately operate as figure and ground.
9. Tetra Cube Spiral: student: not recorded 	The tetrahedron is depicted as part of the cube through stepped spirals. Curved spiral character is translated into **faceted triangular/planar transitions.** Spiral order mediates between the two geometric systems.	Cube ↔ stepped transitional order ↔ tetrahedron. Repetition and stepping establish perceptual continuity between distinct geometries.
10. Vortex Folds: student: not recorded 	The cube appears transformed through **folding and progressive directional changes of broad surfaces.** A tetrahedron-to-cube perceptual relation is achieved through an Escher-like figure–ground effect, allowing perception to shift between the two implied geometries.	Figure ↔ ground reversal in 3D. A single configuration can sustain more than one geometric reading; perceptual ambiguity becomes a formal resource. **Changing surface orientation generates visual flow**
11. Endless Cubed: student: Nagarajan.G 	A continuous endless surface builds a three-dimensional cube perceptually, with repeated turns, folds and returns, making beginning/end—and at places inside/outside—ambiguous rather than through six conventional enclosing faces.	Surface → implied volume. Continuous surface, void and changing orientation allow the observer to perceptually complete the cubic volume.

- Cubes in Ascent offers a particularly revealing example. The cube remains an invariant geometric identity while scale and spatial position change. The solution can be read as an intuitive manifestation of self-similarity not only an order occurring deeply in Nature and articulated explicitly in fractal geometry (7) but also found in Hindu Temple Architecture. (8).

It becomes a significant observation in the Arūpa framework, where cultural exposures may be leading to manifestation of underlying order that was tacit in the creator's mind.

6.2.3 Level 3 — Metaphoric Source/ Generative Lead

Can students take leads from larger metaphoric source available currently? Seeing the underlying order and connecting will be an important learning in metaphoric imagination. Skill in searching and connection making also can be acquired during a studio task. Few examples are discussed in this context

- In **Tunnel square** the analysis in the chart:
  'Hollowing is used so that surrounding space visually penetrates the cube.
  A language for 'Figure and Ground effect' in 3D is created'
  indicates a visual strategy and Innovation. A framework for looking at visual examples in Nature which have such order would be possible. A picture below taken from the Annexure is indicative of such visual search.

- **Cubes in Ascent** suggests another kind of lead.

  Visual analysis: The cube is broken into successively displaced/stepped cubic masses.
  Repetition preserves cubeness, while positional change introduces movement.
  Self-similarity + scale transformation + spatial displacement → emergent Fractal order,
  is noticed.
  . An image from another rich source of nature seen through a specialist angle, namely minerals and crystals, can act as an invigorating input.

- Another rich cultural resource to experience the fractal order in use would be ancient Hindu Temples.

- Cube Kamala provides a third example. Spiral order is generated collectively by several related elements.

  The visual strategy observed in visual analysis;

  Four related elements merge toward the base and grow toward four corners. Flat surfaces progressively become curved, while repetition and rotation establish the larger order.

  Gestalt principle of repetition for emphasis is successfully used to relate part and whole.

These examples suggest a new preparedness for the pedagogue: a bank of visual resources from Nature and culture, not as alternative Rūpas to be offered to the learner, but as possible metaphoric leads toward underlying orders. The learner must still make the abstraction and arrive at an unforeseen Rūpa.

An LLM search by a student is not likely to lead to images in the right visual diretion, as AI searches currently remain strongly mediated through statistically based language associations. Pedagogic mediation therefore remains essential for quality education.

- Feedback from the student Milind suggests that he actually started with a 'shankh' and multiplied the elements to fit into cube order. Fusion of central symmetry and repetitive order of Gestalt Principle seemed to have happened intuitively. However, some of the images selected as Metaphoric Source would be of interest for a discussion with students. A Pedagogue can prepare a bank of images as Metaphoric Source.

- D'Arcy Thompson becomes relevant here at a deeper methodological level. His contribution to the original exercise went beyond introducing shells, gnomonic growth and logarithmic spirals; through these examples, students could perceive 'Arupa' as the implied geometric and transformational order through which form emerges.

In the present retrospective reading, the same attitude can help the pedagogue move from a manifested student Rūpa to implied orders in Nature and return these to the studio as generative leads.

A Visual bank of metaphoric resource, specially prepared during inquiry is provided as a sample in the accompanying Annexure

6.3 Implications for New Age Foundation Pedagogy

The original Spirals in a Cube exercise depended on a carefully framed problem, material engagement, teacher–student dialogue and a conducive IDC learning ecosystem to nurture 'Inner Order' of the student and 'teacher'. These conditions enabled intense involvement creating a ground for 'Active Silence'. They remain relevant. Current challenge is the scale of contemporary teaching and the information environment in which learning takes place, students' learning behaviour and 'expected role of Pedagogue'

With AI at the disposal of pedagogues and learners, information, images, analogies and formal statistic-based alternatives can be produced almost instantly. The pedagogic problem is therefore no longer simply one of access to possibilities. But to extract 'Meaning as a new Visual order' from the resource. The metaphoric resource can act, sometimes as 'Rupa Inspiration' and sometimes as the indicator to the underlying order in abstraction, in this context.

The three levels discussed above offer possible leads. Morphological reading helps the pedagogue locate the territory in which an emerging solution is operating. Visual-language reading helps recognize how the Rūpa is working perceptually and what visual strategies are

available. Metaphoric/generative leads can then reopen imagination by directing attention toward implied orders in Nature without supplying another design solution.

Pedagogue can deploy AI to enlarge the search for metaphoric leads. However, AI is handicapped in its own direct visual perception. The images suggested by AI need to be carefully vetted to reduce the overlaps due to the language-based selections. This preparatory work for pedagogy thus would become a special skill in the 'New age Foundation'. Often, a student, may get carried away by a ready-made image he/she finds with AI assistance, as a personal discovery of a smart, quick answer. The visual metaphoric bank can become an asset for the Pedagogue, as a backup, to deal with a student in such situations.

7.0 From Manifested Form to Further Inquiry

Traditionally, foundation programmes starting from Bauhaus, HfG Ulm to NID have been syntactics-based exercises in basic design. IDC at IIT Bombay followed the same route. In eighties, I started experimenting with Semantic based tasks in basic design. A presentation on 'Semantics in Basic Design' was made in 'Arthaya', an international seminar organised by IDC in 1987. (9) Prof. Sugiura Kohei, who was present, appreciated my work and encouraged me to pursue further. These tasks are now being examined in the framework of 'Arupa, the Implicate Order'.

Learning of 'Visual language' being the main concern in basic design, multi-sensory Learning got peripheral importance. Attention to 'Semantics – meanings' brings in a new potential and positioning for multi-sensory perception as well as language which links them. Arupa framework draws its strength from HTO (Human Thought Order), based on symbolic language, a natural human ability.

The retrospective examination of *Spirals in a Cube* suggests that past student work can be read not only as documented Rūpa, but as a source for recovering morphological, perceptual and generative orders relevant to contemporary pedagogy. Such reading can make aspects of the tacit dimension more explicit and contribute to the pedagogue's own Inner Order.

In this context, a significant question arises: Can language itself—through Naming, Narrative and Poetry, which were not explicit instruments in the original pedagogy of spirals in cube task, help reveal and further generate implicate orders embedded in 'Form'?

This question is taken up in a subsequent article, where Naming, Narrative, Poetry and AI-assisted linguistic exploration, is examined as means for extending metaphoric imagination in design pedagogy.

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2.D'Arcy Thompson, Form and growth, MIT Press

3. Rao, A. G (2024), Arupa Foundation5: Cube as laboratory, Retrieved from https://www.agrao.in/articles-papers-and-talks/172-arupa-foundation5-cube-as-laboratory

4.Rao, A. G (2024). Arupa for Foundation 1: Clay Task- Akshara Devata. Retrieved from http://www.agrao.in/articles-papers-and-talks/158-arupa-for-foundation1clay-task-aksharadevata

5. Schön, D. A. (1992). *Designing as reflective conversation with the materials of a design situation*. **Knowledge-Based Systems, 5**(1), 3–14. https://doi.org/10.1016/0950-7051(92)90020-G
6. Wertheimer, M. (1923/1938). “Laws of Organization in Perceptual Forms.” In W. D. Ellis (Ed.), *A Source Book of Gestalt Psychology*, pp. 71–88. London: Routledge & Kegan Paul
7. Mandelbrot, B. B. (1982). *The Fractal Geometry of Nature*. San Francisco: W. H. Freeman.
8.Kirti Trivedi (1989) — Hindu temples: Models of a fractal universe, The Visual Computer, 5, 243–258, DOI 10.1007/BF02153753
9. Rao, A.G (1987).Semantics in basic Design. Retrieved from http://www.agrao.in/articles-papers-and-talks/16-semantics-in-basic-design-with-bb pictures

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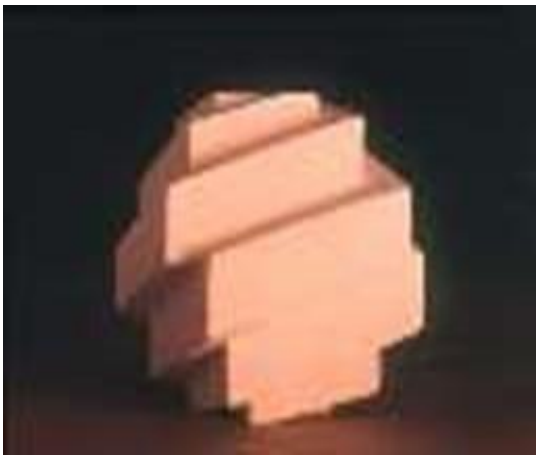
ANNEXURE to Arupa Foundation 7
Visual Resources for Metaphoric / Generative Leads

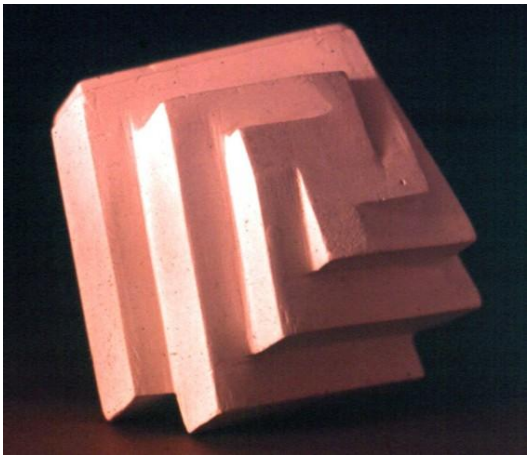
A. G. Rao

5.1 Shelled Cube

Student: not recorded



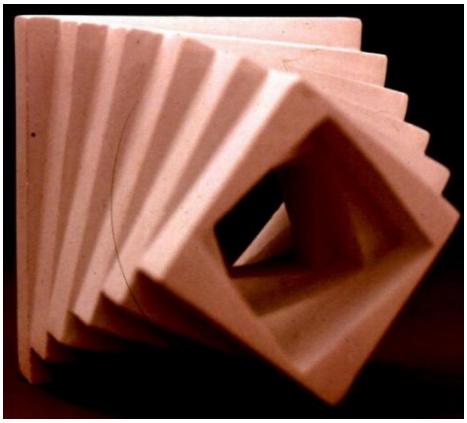
5.1.1



5.1.2

5.2 Tunnel Squared

Student: **Lincon, Aloysius, Gomes**

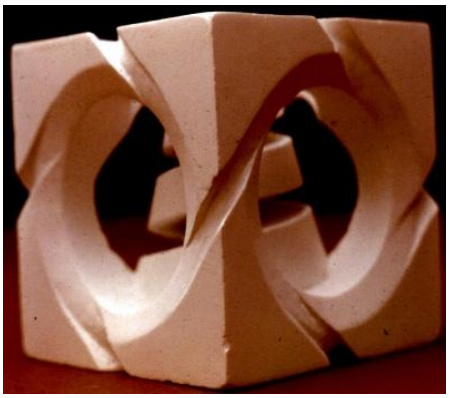


5.2.1

5.2.2

5.3 Coiled Cube

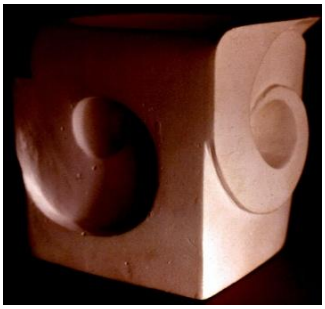
Student: **Rajan Vernekar**



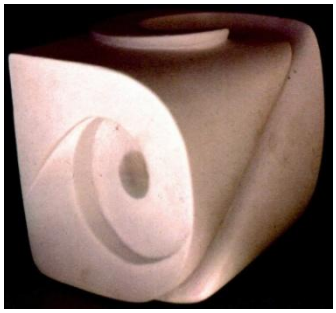
5.3.1

5.4 Lotus Cube

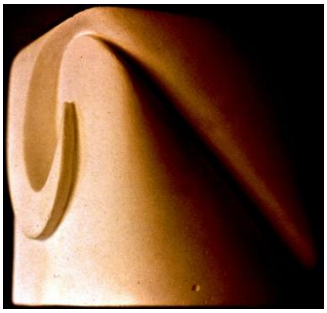
Student: **Pradeep Save**



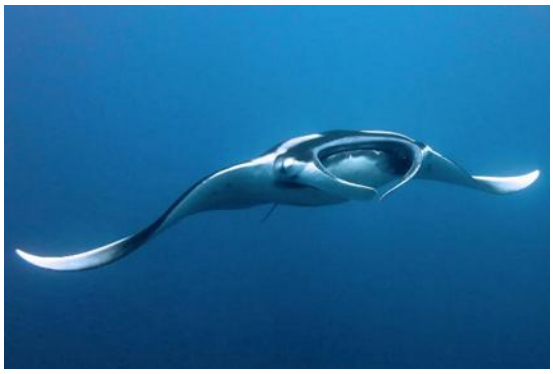
5.4.1



5.4.2

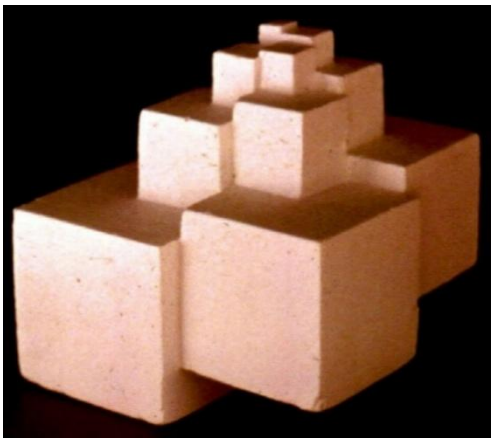


5.4.3



5.5 Cubes in Ascent

Student: not recorded



5.5.1

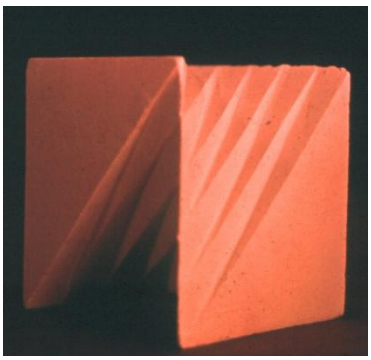
5.6 Cube Kamala

Student: **Milind Tamhane**

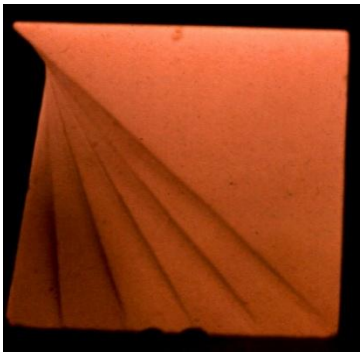
5.6.1

5.7 Spiral Within

Student: **Girish Nalavade**



5.7.1

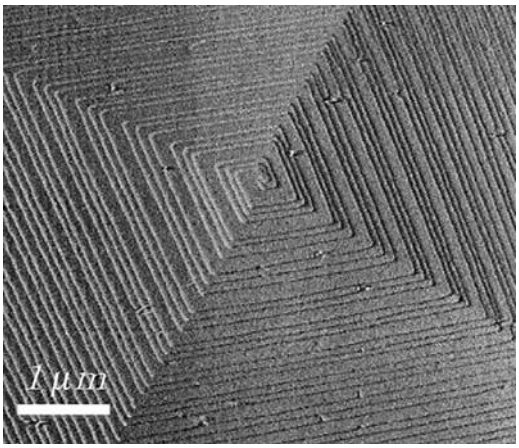


5.7.2

5.8 Spiral Surround

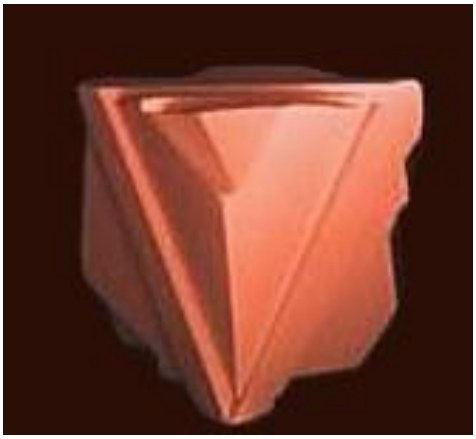
Student: **Ravindra Rajhans**

5.8.1



5.9 Tetra cube Spiral

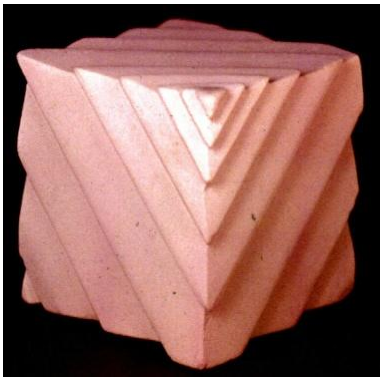
Student: not recorded



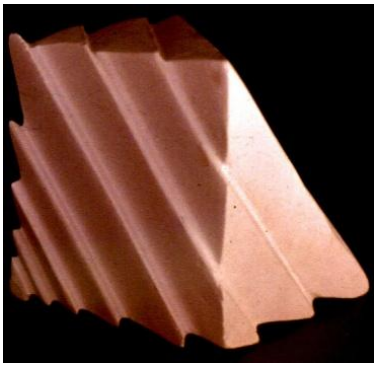
5.9.1

5.10 Vortex Folds

Student: Student: not recorded



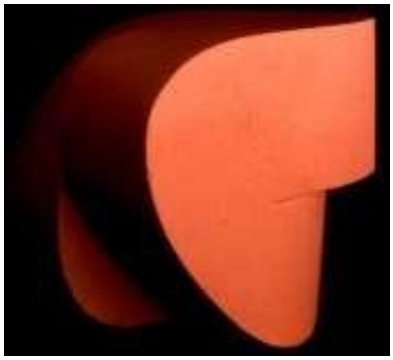
5.10.1



5.10.2

5.11 Endless Cubed
Student: **Nagarajan, G**

5.11.1



5.11.2

Image References and Acknowledgements

Student-work photographs are from the author's/IDC archival documentation of the 1985-87 Foundation exercise; student authors are identified wherever records are available. The metaphoric-source images were assembled retrospectively as visual analogies. Where the exact original image source has been verified, it is given below. Where it has not yet been recovered with confidence, this is stated explicitly rather than inferred.

5.1a https://saveourgreen.org/allpost/beautiful-spiral-aloe/

5.1b Stepped green mineral/crystal. Source not yet identified.

5.1c L-cystine crystal-growth spiral, AFM image and geometric construction. Shtukenberg, A. G., Zhu, Z., An, Z., Bhandari, M., Song, P., Kahr, B. & Ward, M. D. (2013). "Illusory spirals and loops in crystal growth." Proceedings of the National Academy of Sciences, 110(43), 17195-17198. DOI: 10.1073/pnas.1311637110. Fig. 1. VERIFIED.

5.2a Leaf/silk enclosure. Source not yet identified.

5.2b Ant-colony structure with complex tunnels and chambers. Source: Vecteezy, *Ant House Architecture* photo collection.

5.3a Quatrefoil opening/frame in layered masonry. Source not yet identified.

5.3b Fiddlehead fern. Embedded description in the working file reads: "Fiddlehead fern - Photo via Soulstice." Exact original page/photographer not yet identified.

5.3c Sectioned Nautilus shell. Subject identified; exact image source not yet identified.

5.4a White curled/calla-like floral form. Source not yet identified.

5.4b Manta ray. Subject identified; exact image source not yet identified.

5.4c Shell spiral close-up. Source not yet identified.

5.4d Fern unfurling/fiddlehead. Source not yet identified.

5.4e Pink spiralled flower bud. Source not yet identified.

5.5a Temple shikhara/tower showing stepped/recursive massing. Exact image source not yet identified.

5.5b Temple complex with repeated scaled architectural units. Exact image source not yet identified.

5.5c Temple tower with clustered subsidiary forms/hierarchical ascent. Exact image source not yet identified.

5.5d White stepped crystal/mineral. Source not yet identified.

5.5e Succulent with repeated scaled units. Source not yet identified.

5.5f Plant stem with repeated modular leaf growth. Source not yet identified.

5.6a Fern fiddleheads (*Matteuccia struthiopteris*). Photo: David Fuller; University of Maine Cooperative Extension.

5.6b Green curling plant form. Source to be identified.

5.6c Common octopus (*Octopus vulgaris*), curled arms. Source: ABC Ciencia.

5.7a Spiralled biological/plant form. Working-file metadata points to the RSI article "La bellezza animale, vera e propria strategia evolutiva"; exact individual-image credit still to be confirmed.

5.7b Sectioned Nautilus shell. Subject identified; exact image source not yet identified.

5.7c Artichoke cross-section. Davies and Starr, Getty Images / DigitalVision, Creative ID 200266925-001.

5.8a Microscopic/lamellar angular spiral pattern. Source not yet identified.

5.8b Turtle carapace, top view. Source not yet identified.

5.8c Tortoise shell, side view. Source not yet identified.

5.8d Turtle with layered/segmented shell. Source not yet identified.

5.9a Tetrahedrite crystals on pale matrix. Source: Le Comptoir Géologique, “Tetrahedrite – Encyclopedia.” Photograph: Rémi Bornet.

Light-coloured crystalline mineral cluster. Source not yet identified.

5.9b Galena crystal cluster (PbS), showing cubic / modified cubic growth. Exact image source not yet identified.

5.10a Baryte (barite) crystal cluster, showing tabular/bladed crystalline growth. Exact image source not yet identified.

5.10b Pill woodlouse / roly-poly isopod in defensive conglobation. Exact image source not yet identified.

5.10c Pangolin curled into a protective ball. Exact image source not yet identified.

5.11a White Calla lily / continuous curled surface. Embedded description: “Calla Lily Abstract.” Exact photographer/source not yet identified.

5.11b Max Bill, Endless Ribbon, granite, Janet and Alan Wurtzburger Sculpture Garden, Baltimore Museum of Art. Photograph: I. Peterson; The Mathematical Tourist, “Endless Twist,” 10 January 2017.