The Vedic Inventive Principles

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1. Segmentation
2. Extraction
3. Local Quality
4. Asymmetry
5. Combination
6. Universality
7. ‘Nested Doll’
8. Counterweight
9. Prior Counter-Action
10. Prior Action
11. Prior Cushioning
12. Equi-potentiality
13. ‘The Other Way Round’
14. Spheroidality
15. Dynamics
16. Partial or Excessive Action
17. Another Dimension
18. Mechanical Vibration
19. Periodic Action
20. Continuity of Useful Action

21. Skipping
22. ‘Blessing in Disguise’
23. Feedback
24. Intermediary
25. Self-Service
26. Copying
27. Cheap/Short Living
28. Mechanics Substitution
29. Pneumatics and Hydraulics
30. Flexible Shells/Thin Films
31. Porous Materials
32. Colour Changes
33. Homogeneity
34. Discarding and Recovering
35. Parameter Changes
36. Phase Transitions
37. Thermal Expansion
38. Strong Oxidants
39. Inert Atmosphere
40. Composite Materials
(American) SCAMPER – 7 Directions

Bob Eberle’s concept, Michael Michalko’s ThinkerToys
(European) De Bono – Lateral Thinking Triggers

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De Bono’s Provocation Operator
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- Dominant Idea & Crucial Factors
- Fractionation
- Reversal
- Analogies
- Random Triggers
- Change the sequence of arrival
**Vedic Ganita Sutras**

<table>
<thead>
<tr>
<th>Indian Sutra</th>
<th>Sanskrit Sutra</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aanuroopye Shoonyam Anyat (Suitability/Proportion)</td>
<td>GunitaSamucchaya (the sum of properties)</td>
</tr>
<tr>
<td>Ekaadhikena Poorvena (One more than before)</td>
<td>GunakaSamucchaya (the sum of qualities)</td>
</tr>
<tr>
<td>Nikhilam Navatashcharamam Dashatah (All by nine and the last by ten)</td>
<td>Aanuroopyena</td>
</tr>
<tr>
<td>Paraavartya Yojayet (Turn back, exchange or reverse)</td>
<td>Shishyate Sheshasanjnah</td>
</tr>
<tr>
<td>Oordhvam Tiryagbhyam (Use both vertical and horizontal views)</td>
<td>Aadyamaadyenaantyamantyena</td>
</tr>
<tr>
<td>Sankalana Vyavakalanabhyam (Join and separate)</td>
<td>Kevala Saptakam Gunyaat (There are only seven virtues)</td>
</tr>
<tr>
<td>Chalana Kalanabhyam (Cause movement)</td>
<td>Veshtanam (Surround)</td>
</tr>
<tr>
<td>Yaavadoonam (Whatever is less)</td>
<td>Yaavadoonam Taavadoonam</td>
</tr>
<tr>
<td>Vyashti Samashti (Individual and collective)</td>
<td>Yaavadoonam Taavadoonikrtya Vargamcha Yojayet</td>
</tr>
<tr>
<td>Shesaanyankena Charamena (The sum of whatever is left or unused)</td>
<td>Antyayordashake:pi</td>
</tr>
<tr>
<td>Poorna Apoornaabhyam (Complete and incomplete)</td>
<td>Antyayoreva</td>
</tr>
<tr>
<td>Ekanyoonena Poorvena (One less than before)</td>
<td>SamucchayaGunitah</td>
</tr>
<tr>
<td>Shoonyam Saamyasamucchaye (Similar conclusions equal zero)</td>
<td>Lopanasthaapanabhyam (Destroy and rebuild)</td>
</tr>
<tr>
<td>SopaantyaDvayamAntyam (As you get close to the conclusion, there will be two conclusions)</td>
<td>Vilokanam (observation)</td>
</tr>
<tr>
<td></td>
<td>Gunitasamucchayah Samucchayagunitah</td>
</tr>
</tbody>
</table>
Not really Mathematics!

- One more than before
- One less than before
- Reverse or exchange
- Part and Whole

Are these sutras really “mathematical”? Are these sutras purely “mathematical”? What do they “literally” mean?
Logical Clusters

Vedic Inventive Principles

Observation

- Observation
- Flag
- One More than Before
- The summation of properties and qualities
- Encapsulation

Addition

- One Less than Before
- Complete/Incomplete
- Part/Whole
- Collective/Individual

Subtraction (Elimination)

- Different Angles
  - Turn back, Reverse or Exchange
  - Destroy and Rebuild
  - What's Less?
  - What's More?
  - Cause Movement

Variation

Equation (Comparison)

Rotation
Observation
[Open up multiple avenues for exploration]

Vilokanam
[Observation]

Pure observation, without judgment, is probably the most critical first step in any problem-solving effort. Opening the mind to become receptive to data is of utmost importance.

Focused observation can facilitate broader understanding and prevent narrow views. Observation (go see yourself) is one of the key principles of Toyota’s “Lean Thinking [5]”. “Pure observation” or “White Hat” thinking is usually the first step in a Six Thinking Hats [2] brainstorming session as espoused by Edward De Bono.
Observation
[Open up multiple avenues for exploration]

Points of change –
By observation, one can identify key points where change occurs. It is important to create mechanisms to “flag” these points or provide indications or signals of change.

Points of importance –
During the course of problem solving, while allowing the mind to diverge and work in a broad area, it is important to “flag” or mark key points along the way. For instance, parking a promising idea and returning to explore further is a way of marking a key breakthrough. Effective “flagging” can ensure that nothing of promise is inadvertently forgotten in the attempt to explore wider avenues of problems and solutions.
Division (Segmentation)
[Slice a scenario in multiple ways]

Constituents
- Divide an object into constituent parts
- Divide a transaction into constituent actions
- Divide a scenario into objects, people and actions
- Divide a day into hours
- Divide a context into facts and perceptions

Super-system
- The 10,000 – 20,000 – 50,000 Feet views
- The whole is greater than the sum of parts – look at system behavior which is manifested only in the whole and not in the parts
  - The molecular strength of Carbon-60
  - Foraging behavior of ants
- The whole is also a part of a greater whole
Division (Segmentation)
[Slice a scenario in multiple ways]

Vyashti Samashti
[Collective and Individual]

Collective
View objects as a collective rather than as individual units
- The utility of cars in general as opposed to the utility of a specific vehicle
- Market trends
Evaluate collective behavior
- Teaming strategy
- Mob mentality

Individuality
Focus on one object as an individual entity and evaluate its interactions with everything around it
Focus on one perspective individually at a time – Six Thinking Hats
Associate actions with a specific person rather than with a generic profile
- Jim likes to eat chocolate vs. Boys like to eat chocolate
Division (Segmentation)
[Slice a scenario in multiple ways]

The human brain reduces complexity by forming patterns. Over time, some patterns become fixed or rigid. Grey gets sorted into either the black or the white box.

The tendency of the brain is to “complete” the pattern quickly.

Since this happens subconsciously, it can be difficult to identify when this happens. While forming patterns, the brain compensates for both missing data as well as extra data. Any data that doesn’t “fit in” can get subconsciously discarded.

It is important therefore to take a deeper look to identify the difference between perception and reality of what is “complete” and what is “incomplete”.

Poorna Apoornabhyam
[Complete and Incomplete]
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Poorna Apoornabhyam
[Complete and Incomplete]
Addition
[Add, merge, combine or increase to create something new]

Ekaadhikena Poorvena
[One more than the previous]

- **Add** an object/ **Combine** objects
  - Swiss knife
  - Tooth-brush with tongue cleaner on the back surface
  - Cell-phone with camera
  - Vacuum-cleaner with dustbin
- **Merge** functions so that you don’t need a separate object
  - Board for chopping, grating, dicing vegetables
  - Car battery charges while the car is running
  - Pollination happens while the bee collects nectar
- **One more way** to achieve a function
  - Pen – pencil – chalk
  - Toothbrush – chewing gum
  - Sweater – central heating
- **Increase** (one-to-many or less-to-more)
  - Knife – scissor – tri-blade razor – rotary-blade electric shaver
  - Pin – brooch – zipper – Velcro fastener
- **Increase beneficial effects**
  - Number of pores in a sponge for better absorption/ storage
    (also applicable to Integrated Circuits using semiconductors)
Addition

[Add, merge, combine or increase to create something new]

Identify all the properties and qualities of the system for e.g. length, strength, color, efficiency, cost etc. Rather than looking at one property in isolation, look at the summation of the properties say length and color, or strength, efficiency and cost.

• As Lean Thinking suggests, measure higher rather than lower. E.g. measuring the “wear” of a tyre combines the measurement of material strength, distance traveled, road conditions, average speed and frequency of rotation.
• Improve multiple parameters at once rather than one at the cost of other or arriving at middle ground. E.g. decrease weight + increase strength + decrease cost.

The whole is greater than the sum of parts – look at system behavior which is manifested only in the whole and not in the parts

• The molecular strength of Carbon-60
• Foraging behavior of ants
• Volume is created only when length, breadth and width combine
Addition
[Add, merge, combine or increase to create something new]

Veshtanam
[Encapsulation/Surround]

• Add a layer to hide the details of the system
• Add a protective layer or substance
• Create a layer of abstraction
• Convert part of the system into a black box
Subtraction

[Remove, eliminate, reduce or decrease]

Ekanyoonena Poorvena

[One less than the previous]

Remove a resource
How would you construct a building in one less day
How would you row a boat with one less person

Remove a constraint
If cost is not a problem, will the solution be different?
If the lock does not have a key, how will the function be achieved – number lock

Decrease/reduce (many-to-one or more-to-less)
Decrease the number of objects performing the same function
Table with 4 legs – table with three legs – two broader legs – one cylindrical leg?
Number of redundant keys on the keyboard

Remove/reduce objects with overlapping functions
Ceiling fans in a well-ventilated space

Reduce harmful effects
How to decrease the rate of deflation of a punctured tyre – leading to tubeless tyres.

Eliminate an object that is not contributing to function
Appendix in the human body

<table>
<thead>
<tr>
<th>PALATE</th>
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<tbody>
<tr>
<td>PETAL</td>
</tr>
<tr>
<td>TAPE</td>
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<tr>
<td>APT</td>
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<tr>
<td>AT</td>
</tr>
</tbody>
</table>
Variation
[Observe and create change]

Sheshaankyena Charamena
[The sum total of what’s left over]

Identify things that are extra or in excess – why are these in excess?
Identify things that are unutilized – how can they be used?
Identify things that are left over or are by-products – how can this be re-used?
Identify points of improvements in performance – what is causing the variation?
Variation
[Observe and create change]

drafting innovation together

Yaavadoonam
[By Whatever or how much ever is less]

• Identify things that are not available in adequate quantity – gaps in the system.
• Identify dips in performance – what is causing a variation?
• Identify things that are borrowed from other parts of the system – what is missing in this part of the system that has to be covered by other parts?
• Identify delays – what is causing inadequacy of time?
• Identify points of stress or duress – what is missing that causes this stress?
Variation
[Observe and create change]

Chalana Kalanaabhyam
[Set in motion/cause change]

- Create movement in anything stationary – objects, parameters, thoughts
- If movement is the norm, try becoming stationary
- Change anything that is constant
  - Engines rotating at constant speed – drive at different speeds
  - Processes that are unchanged over a long period of time – introduce continuous variations
- Personal habits, say exercise, use different combinations everyday
- Random changes by choice – genetic algorithm
Rotation
[Reorient to create new perspectives]

Reverse
Rather than looking at how to make it work look at how to make it fail
Cup - half empty or half full?
Instead of jogging fast jog slowly
Move the bell rather than the gong
Road runs backward instead of you running forward – treadmill, escalator
Toothpaste - lid at the bottom
Water faucet - tap mouth upwards rather than downwards
Code first - design later - iteratively

Exchange, Substitute, Replace
Manager and subordinate exchange roles for a week to understand each other's job pressures.
Eat first, brush later
Enter digits first, dial and connect later
Replace expensive items with inexpensive objects achieving the same function

Paraavartya Yojayet
[Turn back, exchange or reverse]
Rotation
[Reorient to create new perspectives]

Change the perspective
- Depth-first rather than breadth-first and vice-versa
- Bottom-up rather than top-down and vice-versa
- Town-planning – rather than viewing it at ground-level, how would an aerial view look like?
- How about a different cultural perspective?
- Approach a problem from the end rather than the start (or from the middle?)
- Look at things you don’t usually look at – how does a car look from below?
- Look at things from the side – neutrally or passively

Consider a new dimension
- Linear – planar – 3D
- Space – time
- Lines – curves
- Degree of freedom – robotic arm, Japanese martial art segmented stick
- Analog – Digital
- Sound – Light – Heat

Oordhva Tiryagbhyamam
[Vertically and horizontally]
Often, to break out of a dead-end of repetitive patterns, it is important to destroy the existing patterns, clear the mind and rebuild from scratch. The same approach can be used while designing systems where first-cut designs can be dismantled and rebuilt from scratch. Sometimes, rather than continue to improve existing systems through patchwork solutions, it might be better to rebuild from scratch.

**Destroy, disrupt, interrupt**

Systematically destroying a system can be a good way to detect faults (and strengths) in the system (subversion analysis).

Interrupting a system can help identify points of inertia.

Ideas to break existing systems often lead to the most innovative ideas to improve or create new systems.

Routine random disruptions help systems evolve mechanisms to recover and thereby become more robust.

**Destroy and Rebuild**

Re-factoring of systems involves the systematic destruction and rebuilding of systems on a part-by-part basis.

This phenomenon is also seen regularly as part of natural processes – the cycles of death and birth of systems including living organisms e.g. evaporation - rainfall, forest fires – fertile soil etc.
Equation (Comparison)
[Match, compare and choose]

Last by last and first by first
Compare apples with apples and oranges with oranges.
Nail and hammer, screw and screwdriver.
Cotton in summer, wool for winter.
For efficiency of operation, tailor generic processes so that they become suitable for use in specific contexts.

In Proportion
Increase in temperature - ice-cream sales
Number of snakes – number of rodents – crop volumes

Comparison/ Equation
Compare with something similar
Compare with something dissimilar
Draw parallels/equate

Inertia of familiarity
Interestingly, the principle also points out that the human brain actively looks for suitability or proportion – familiar patterns. When encountering a problem, one can be hemmed in by a pet solution which blanks out all other possibilities. In this way, this principle is also a warning to actively avoid the familiarity trap. (This perspective can be generated by applying the “Reverse” principle on this principle itself!)
Application

Apply all triggers in both cycles:
1. Problem Definition / Opportunity Identification
2. Solution Conceptualization / Ideation

Vedic Inventive Principles

- Rotation
  - Different Angles
  - Turn back, Reverse or Exchange
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  - What’s Less?
  - What’s More?
  - Cause Movement

- Variation
  - Suitability / Proportion
  - Equation (Comparison)

Converge
Diverge

Observation
- Observation Flag
  - One More than Before
  - The summation of properties and qualities
  - Encapsulation

Addition
- The summation of properties and qualities
- Complete / Incomplete

Subtraction (Elimination)
- One Less than Before
- Complete / Incomplete

Division (Segmentation)
- Part / Whole
- Collective / Individual
References

8. Math Inspired Systematic Inventive Thinking (MISIT), A. Brostow, March 2008
Thank You

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