

The Vedic Inventive Principles

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Abstract

The Principles of Vedic Mathematics are a set of aphorisms recommended to be applied to solve mathematical problems. A deeper look into the principles reveals that these principles are generic in nature and provide directions of thought effective in solving all types of problems. This paper extracts sixteen generic principles and consolidates them into seven broad directions of thought – Observation, Division (Segmentation), Equation (Comparison), Addition, Subtraction, Variation and Rotation. The principles can be used stand-alone or in combinations to provide a rich set of triggers or thought directions. These triggers are suitable to be used during all stages of the problem resolution cycle right from understanding a problem to creation of ideas and solutions.

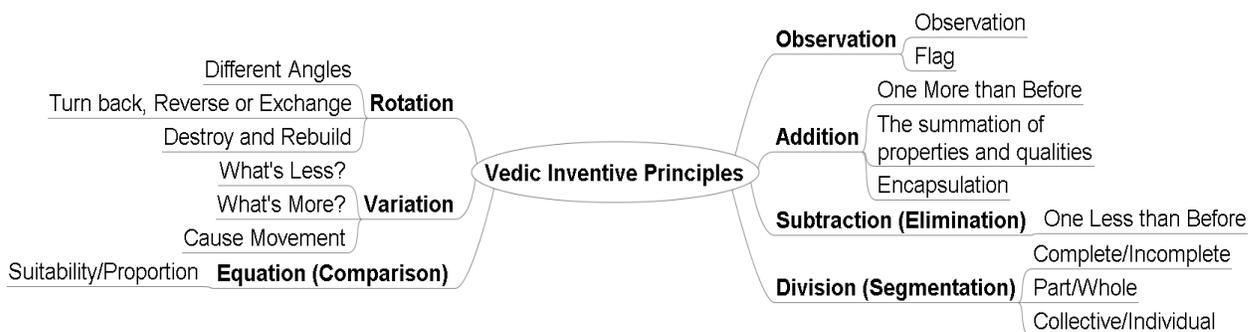
1. Background

The Principles of Vedic Mathematics [6] or “Ganita Sutras” (as they are called in Sanskrit) were published in the early 1960’s. The Sutras were claimed to be a set of Mathematical principles rediscovered from ancient Hindu texts of knowledge (the Vedas). This was a controversial assertion – many believe that these principles are neither Vedic nor related to Mathematics [8]. In the course of this paper, we will not attempt to delve into the origins of the principles. We continue to call them Vedic purely from a commonly accepted usage perspective.

The use of inventive principles or triggers to stimulate creativity is widely accepted. Edward De Bono has proposed the use of random words as triggers to generate new directions of thought [3]. The 40 inventive principles of TRIZ [4] are widely used as triggers to generate new ideas when resolving specific types of contradictions. The seven SCAMPER principles [7] are also useful in the context of brainstorming and ideation. In this context, it is interesting to look at the Vedic Mathematics principles from an “inventive triggers” lens. At the outset, it does seem that the Vedic Principles mirror the simple techniques the human brain uses to get to solutions in a systematic manner [9]. Experiments with these principles in live brainstorming and ideation sessions have proved fruitful.

2. The Vedic Inventive Principles

There are a total of 16 principles and 13 corollaries [Appendix A]. Some of them do not convey any apparent meaning while some are ambiguous. A few principles are very specifically mathematical and are therefore unsuitable for general use. The remaining 16 principles (that are simple and unambiguous) have been clustered into 7 directions of thought for simplicity of understanding and use:



2.1 Observation

[Open up multiple avenues for exploration]

Observation

"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.

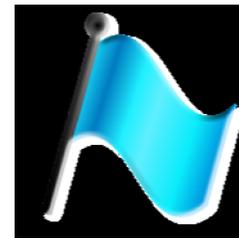
- Focused observation can facilitate broader understanding and prevent narrow views.
- Observation (go see yourself) is one of the one of the key principles of Toyota's "Lean Thinking [5]".
- "Pure observation" or "White Hat" thinking is usually the first step in a Six Thinking Hats [2] brainstorming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



Flag

"Dhvajam – Flag"

- 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.



2.2 Division (Segmentation)

[Slice a scenario in multiple ways]

Part and Whole

"Vyashti Samashti" – Part and whole

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

Collective and Individual

"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



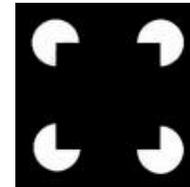
Individuality

- § 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

Complete and Incomplete

"Poorna Apoornabhyam" – Complete and incomplete

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".



2.3 Addition

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

One More

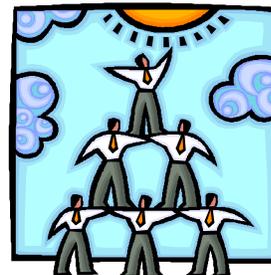
"Ekaadhikena Poorvena" – One more than before

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)

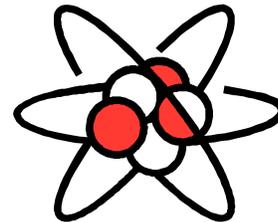
Summation of Properties and Qualities

"GunitaSamucchaya – The sum of properties"

"GunakaSamucchaya – The sum of qualities"

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.



"SamucchayaGunitah – The property of the sum or whole"

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

Encapsulation

"Veshtanam – Surround, cover or enclose"

- 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



2.4 Subtraction

[Remove, eliminate, reduce or decrease]

One Less

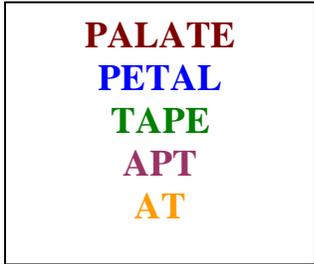
"Ekanyoonena Poorvena" – One less than before

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



2.5 Variation

[Observe and create change]

What's more?

"Sheshaankyena Charamena" – The sum of what's left over

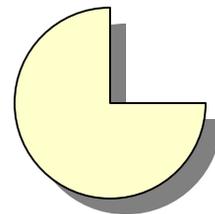
- Identify things that are extra or in excess – why are these in excess?
- Identify things that are unutilized – how can they be used?
- Identify things that are left over or are by-products – how can this be re-used?
- Identify points of improvements in performance – what is causing the variation?



What's less?

"Yaavadoonam" – By whatever 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?



Cause Movement

"Chalana Kalanaabhyaam – Set in motion or 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

2.6 Rotation

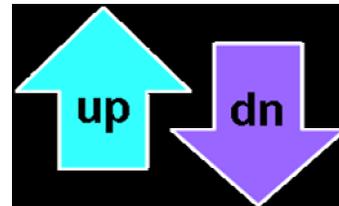
[Reorient to create new perspectives]

Turn Back, Exchange or Reverse

"Paraavartya Yojayet" – Turn back, exchange or reverse

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.

Different Angles

"OordhvaTiryagbhyaamam" – Vertically and horizontally

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

Destroy and Rebuild

"LopanaSthaapanaabhyaam – Destroy and Rebuild"

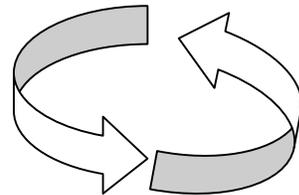
Often, to break out of a dead-end of repetitive patterns, it is important to destroy the existing patterns, clear the mind and rebuild from scratch. The same approach can be used while designing systems where first-cut designs can be dismantled and rebuilt from scratch. Sometimes, rather than continue 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.



2.7 Equation (Comparison)

[Match, compare and choose]

Suitability/proportion

"Aanuroopye Shoonyam Anyat" – Everything else, other than what is in proportion or is suitable, is zero or absent.

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!)

3. Summary

The use of triggers to stimulate new thoughts is a well-documented beneficial practice. Triggers can be random and infinite (use of any word), as suggested by Edward De Bono [3] or specific and finite as proposed in the TRIZ methodology (40 Inventive Principles [4]) or SCAMPER [7]. The Vedic Inventive principles also offer triggers or thought directions in similar contexts of ideation, brainstorming and problem solving. Sixteen of these triggers have been consolidated in this paper into seven broad directions of thought. Observation is critical to create a broad perspective and open up multiple avenues for exploration. Division (Segmentation) helps slice a scenario in multiple ways. Addition looks at adding, merging or combining elements to create something new. Subtraction looks at a perspective of removing or eliminating parts of the system in question. Variation talks about observing and causing change. Rotation looks at ways to re-orient the problem to create new perspectives. Equation (Comparison) enables the ability to match, compare and choose.

4. References

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About the Author

Karthikeyan Iyer is an Innovation Consultant guiding teams in the use of creativity and innovation techniques to solve problems related to technology, business processes and strategy at Wipro Technologies, a global IT services company. His current work touches key large scale innovation initiatives aimed at business growth and several technology-focused centers of excellence within the organization. He has more than 8 years of experience in the IT services industry. He holds a Bachelor's degree in Computer Science from Ramrao Adik Institute of Technology, Mumbai University, India.

Appendix A: Sutras – the complete list

1. Aanuroopye Shoonyam Anyat (Suitability/ Proportion)	Aanuroopye – conformity, suitability Shoonyam – Zero, nothing Anyat – Everything else, other things
2. Ekaadhikena Poorvena (One more than before)	Ek – one Adhik – More Poorva – what was before
3. Nikhilam Navatashcharamam Dashatah (All by nine and the last by ten)	Nikhilam – All, complete , whole, entire Navatah – Nine Charama – the last, final, outermost Dashatah - Ten
4. Paraavartya Yojayet (Turn back, exchange or reverse)	Paraavara – distant and near, earlier and later, highest and lowest, cause and effect, the whole extent of an idea Paraavartya – turned back, exchanged or reversed Yojayet – connect, join or choose, make use of
5. Oordhvam Tiryagbhyaamam (Use both vertical and horizontal views)	Oordhvam – vertically Tiryag – horizontally Bhyaamam – use both
6. Sankalana Vyavakalanabhyaam (Join and separate)	Sankalana – Join, add, hold together Vyavakalana-Separation, subtraction, deduction Bhyaam – Use both
7. Chalana Kalanaabhyaam (Cause movement)	Chalana – Moving, movable, shaking, vibrating, any motion or movement Kalana-causing, effecting, inciting Bhyaam – Use both
8. Yaavadoonam (Whatever is less)	Yaavad – as large as, as much as, as many, as frequent, as long as, as old as Oonam - less
9. Vyashti Samashti (Individual and collective)	Vyashti - singleness , individuality , a separated aggregate (such as man , viewed as a part of a whole [e.g. of the Universal Soul] while himself composed of individual parts the state of individuality and totality regarding (a group of objects) singly or individually Samashti - collective existence , collectiveness , an aggregate , totality the regarding a group of objects collectively
10. Sheshaanyankena Charamena (The sum of whatever is left or unused)	Shesha – remainder, whats left Anya – other Ank – connect, join Charama – the last, final, outermost
11. Poorna Apoornaabhyaam (Complete and incomplete)	Poorna – complete Apoorna – incomplete Bhyaam – Use both
12. Ekanyoonena Poorvena (One less than before)	Ek – One Anya - other Oonena – Less Poorvena – What used to be before
13. Shoonyam Saamyasamucchaye (Similar conclusions equal zero)	Samucchayam – aggregation, collection, accumulation, conclusion, final result Saama – same, similar, equal Shoonyam – Zero, nothing
14. SopaantyaDvayamAntyam (As you get close to the conclusion,	Sa - with Upa – near

there will be two conclusions)	Antya – the last, the one after Dvayam – two, two-fold, dual, double, couple, pair Antyam – the last, the end, final thing, the one after
15. GunitaSamucchaya (the sum of properties)	Gunita – property, functionality, basic substance
16. GunakaSamucchaya (the sum of qualities)	Gunaka – quality, multiplier
17. Aanuroopyena	By conformity or suitability, according to
18. Shishyate Sheshasanjanah	
19. Aadyamaadyenaantyamantyena	First by first and last by last
20. Kevalaih Saptakam Gunyaat (There are only seven virtues)	Keval – only Saptakam – seven Gunya – properties, qualities or virtues
21. Veshtanam (Surround)	The act of surrounding, covering, encompassing or enclosing, wind or twist around,
22. Yaavadoonam Taavadoonam	How much ever is less, that much is less
23. Yaavadoonam Taavadoonikrtya Vargamcha Yojayet	Whatever is less, reduce further by the same amount and then use this to sort or arrange in groups.
24. Antyayordashake:pi	
25. Antyayoreva	
26. SamucchayaGunitah	The properties or qualities of the whole
27. Lopanaasthaapanaabhyaam (Destroy and rebuild)	Lopana-violate, destroy, injure, interrupt, omit Sthaapana-maintain, preserve, support, establish, make stable
28. Vilokanam (observation)	the act of looking or seeing looking at , regarding , observing , contemplating looking for , finding out perceiving , noticing , becoming aware of paying attention to , studying.
29. Gunitasamucchayah Samucchayagunitah	The sum (totality, final result) of properties or qualities is the property or quality of the sum (totality or final result)