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Ranganathan's Spiral: An Aerial View of Scientific Method

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0 S.R. RANGANATHAN AND RESEARCH

Ranganathan can easily and arguably be criticized for too often treading the alien corns. It looks as whenever he wanted some supporting ideas from any non-library field, instead of looking for the established theories, he tried to formulate his own from *ab initio* thinking. That was also his method of teaching in the classroom. Though not in sync with the cumulative nature of science, I offered an outsider's view. Such occasional forays into alien fields are against Ranganathan's own grain who always believed in relay research to build a pyramid of science. He used to say days of solo research are over. His model of the Spiral of Scientific Method to describe the systematic technique of exploration of new knowledge in any discipline of knowledge is a case in point. It is not a topic of library science. Never the less, Spiral is not any new model, but essentially a simple and spectacular demonstration of the phases through which a research enquiry proceeds. Science is nothing but systematic, evidence based investigation to arrive at the truth, to explore knowledge and solve intellectual problems— to state the trite. P.W. Bridgman (1882-1961), a noble laureate American physicist likes to say that "there is no scientific method as such, but rather only the free and utmost use of intelligence"[1].This exaggeration has only an iota of truth ; indeed to be a researcher you need something more than intelligence or common sense. One needs to know the idioms of the field of research methods—both in theory and practice. The Spiral, though not his area of core research, describes in a simple way the

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genesis and growth of new knowledge and its continuity. It happily does not contradict the universally accepted general and broader view of the research procedure, namely data collection, data collation, analysis and tabulation, inference and findings, and of course reporting and communication. Spiral, it may be said, is Ranganathan's peculiarly simple way of describing a complex subject; otherwise, already many cyclical theories of scientific investigation had been put forward[2].

Morris Cohen and Ernest Nagel in 1934 had already described the method of science essentially circular[3]. Devoid of any novelty Ranganathan's is only a visual on the commonly known course a scientific enquiry takes.

01 RANGANATHAN'S VIEWS ON RESEARCH PROCESS

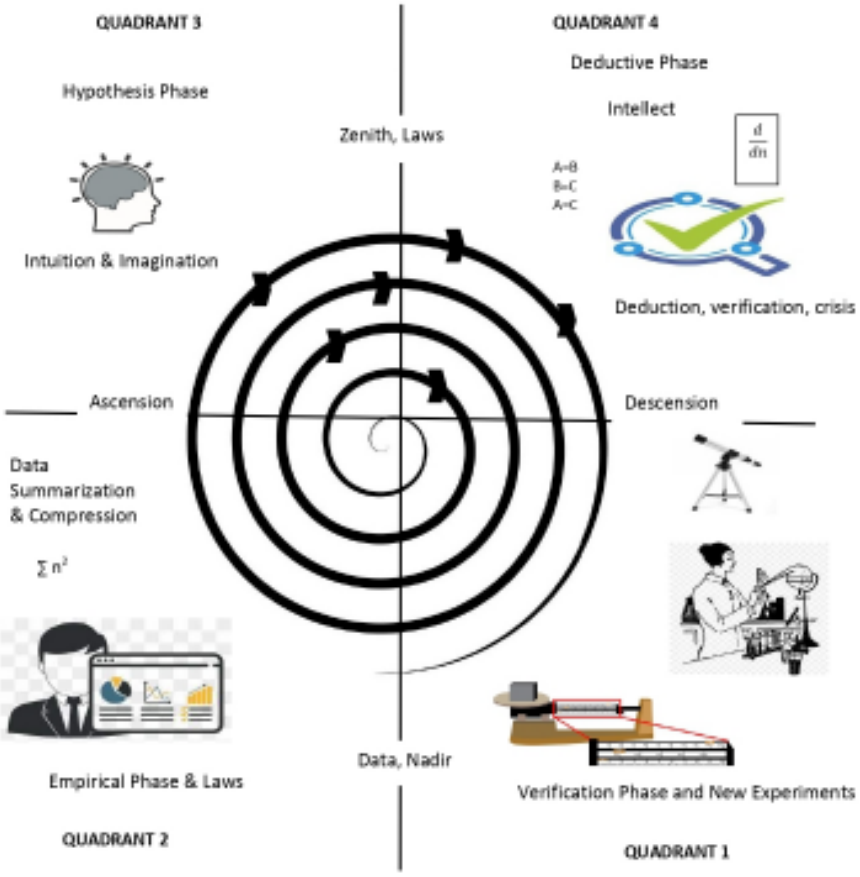
Still it is significant as it throws ample light on Ranganathan's views on research process and to some extent on his own method of conducting research. It is one of his explicit statements on research methodology. Unfortunately, it has not gained much acceptance or has not pervaded the literature on the philosophy or method of science in general. The fault lies with our profession that we, as usual, are not able to sell across our professional ideas and methods beyond our own house. It deserves to be publicised.

10 SPIRAL OF SCIENTIFIC METHOD

The spiral was formulated especially to demonstrate the nature and characteristics of science. Since the first edition of *Five Laws of Library Science* was published in 1931, many people including many eminent personalities were skeptical of the scientific status of librarianship[4]. In other words, they were reluctant to admit the validity or even potentiality of the five laws as scientific in character, though as percepts and ideals or even slogans the laws fascinated them. To convince the skeptics, Ranganathan had took to to the primal rout to demonstrate the nature and characteristics of science itself. First, he defined from the elements as to what science is. For him, as other philosopher of science, science is not any demarcated field of study, but a method of study and investigation to know the unknown. More than this any discipline of knowledge can be studied and explored scientifically.

11 STRUCTURE OF THE SPIRAL

Then he described its procedure by an analogy of a never-ending spiral winding horizontally upwards in clockwise direction[5-6].



SPIRAL OF SCIENTIFIC METHOD

The spiral has been divided into four regions called quadrants by two straight axes intersecting each other at right angle at the centre of the spiral. Accordingly, there are four cardinal points:

- Nadir, Ascendant, Zenith, and Descendant.
- The first quadrant is at the right hand bottom area bounded by descendant and the nadir.

- Moving clockwise, the area bounded by the nadir and the ascendant is called the second quadrant.
- The third quadrant is the arch bounded by the ascendant and the zenith, i.e. left hand upper region.
- The fourth quadrant is the right hand upper area between the zenith and the descent.

Thus, in all there are four geometrical quadrants corresponding to four major and distinct phases through which a research enquiry passes to find a solution to aformulated problem or on to its path to discover new and verified knowledge.

12 THE DYNAMIC SPIRAL

Oxford dictionary defines a spiral as something moving in a continuous curve that winds round a central point. Like the spiral, knowledge is always in a dynamic continuum[7]. Thus the spiral is endless, and is never static, though moves invisibly slowly. Knowledge always being fragmentary and dynamic we can begin our investigative study at any point of the spiral. In the first quadrant data is collected by observation, survey, experimentation, harvesting or may be obtained from authentic secondary sources. It could even be outsourced. Manual, participatory means, mechanical and electronic gadgets may be used to aid and angment our primary senses for data collection. Nevertheless, primarydata ultimately comes through the sense organs. A questionnaire is only to elicit and record data so are experimentation or observations. The work involves industry and ceaseless efforts, patience, perseverance, and requires objectivity in collecting, selecting and sampling data.This phase is the bedrock of a research enquiry. Authentic data is vital and sacred for ultimate true findings. Objectivity is the first rule of the game. The nadir is the databank which is the culmination of the work in the first phase.

13 WORK IN THE FOUR QUADRANTS

In the first quadrant, Q1 the progress is from general and abstract to particular to obtain discrete and granular data. In the second quadrant,Q2 data is cleaned, collated, tabulated and may be compressed— latter applies to big-data using compression algorithms. By stepping into the this quadrant movement is from concrete to abstract. It may be reminded that data may be in textual,numerical, graphic or audio form Proper classification of data is essential here which may show some patterns and regularities in the tabulated data . The purpose is to wring out some recurring patterns in the data. It is

generalization. It mostlyinvolves the work of normal equations which mathematically summarizes a large number of observations. Very useful is inductive logic, which is bottom-up reasoning to formulate empirical laws from enormous, even tangled mounds of data. These laws which, at best, are conclusions, are only highly probable. To repeat, it is the work of the intellect and mathematical calculations. Now computers come very handy in compressing, collating and finding patterns or regularities in the data. Big data can only be handled with computers. Ascendant represents the formulated empirical laws. Empirical laws based on facts, not any theory, show relations between variables. Thus a huge mass of data is mutated into a few regularities. In the third quadrant, Q3 the work is of trans-intellectual nature. Only with the help of intuition the empirical probabilities are further boiled down to a few fundamental laws which also latently subsumes all the empirical laws. Zenith, embodying normative laws, is the highest abstraction of the empirical laws which represents the topmost and the highly fruitful but rarely reached phase of the enquiry. Every research is not supposed to reach the zenith. Ranganathan was a gifted master intuitionist. He had a very exalted view of intuition which he believed as trans–sensory trans intellectual perception (*divya indriya*) by which a person envisions the whole 'thing-in-itself' in a momentary flash of ideas suggesting itself as the solution to the long lingering problem. Intuition is spontaneous and sudden and opens the flood gates of ideas which sustains the intellect for a considerable time. It is achieved through spiritual exercise and *tapas*[8]. It is a known fact Ranganathan was a *karamyogi*, a *tapsvi* who thought of library science day in, dayout, sleeping, waking and waking to the exclusion of all the worldly chores and family responsibilities. Thus he was made for intuition. Hans Wellisch once wrote that "Ranganathan would resort to meditation when other methods to strike at a solution failed"[9].Similarly his research assistant, later professor at the DRTC, M A Gopinath revealed, "His spiritualism flowered when he divorced himself from the mass of details which were incubating in his mind…The integral nature of Ranganathan's theory emerged from occasional intuition ; and his intellect strove to make it more explicit to the rational mind of the scientific worker"[10]

14 VERIFICATION PHASE

Thereafter, we move onto the fourth quadrant Q4, wherein the fundamental laws are verified by deductive logic and on ground realities, and through their numerous indirect applications. Deduced laws are empirically true. The movement here is from abstract to concrete; general to particular. The descendant represents the deduced laws which are far more numerous than the empirical laws, but considerably less than the basic laws. These are in the

form of corollaries and principles got by particularization of the normative principle. Thus again here we move from abstraction to particularization. Verification is always indirect and time taking process as in social science you cannot put the reagents in the test-tube, titrate and see the results on the spot.

15 THE CRISIS

Only at the stage of verification we testify the functionality and utility of laws. Sometime later in time or with new discoveries some new facts or phenomenon may not be explainable with the prevailing normative principles. Certain new facts which do not fit in the theory usher the scientific world into a state of conflict and to beginning of new knowledge. Exception tests the rules. At this moment of crisis having collected more facts we again return to the nadir; and thus the cycle starts again. The spiral is endless or open-ended. When it reaches again the same point, there is a qualitative difference between the two points. These two points being in different planes, one can never jump from one point to another such point on the same axis without going through full circle. Arriving at the same point in the next circle may take even centuries—say bit less in this age of information revolution. Now the information is exponentially multiplying at never before tremendous rate. In about 1900 it took a century for doubling the existing knowledge. According to reliable sources now it is doubling every 13 months[11].But we never come to the same point again in the sense we do not cross the same river twice. Distance between the two points is paradigmatic change which Ranganathan terms boundary conditions.The movement is always clockwise.

Ranganathan warns that "The Quadrants 1, 3 and 4 and the Nadir and the Zenith are danger spots in the cycle—that is, spots of possible errors. These three quadrants correspond to the play of pure intellectual work and the senses. The chief tools are language, logic, and mathematics; the other tools are unaided primary senses, the instruments and the mental set established by racially anthropological habits and social practices"[12].These are generally held pre-conceived notions and deeply entrenched cultural beliefs and taboos.

2 GENERALISED VIEW OF SCIENTIFIC METHOD

The four phases constitute a blanket description—mere skeleton without mass—of the mazy and thorny way of research. The spiral is rather a mechanical or a bit facile way of describing research; otherwise the research process in reality is bit recondite and an elusive one. It has been presented here as if all the steps are an easy walk. At the first instance, one may argue that Ranganathan unconsiciously talks of higher paradigm changing science, not

of the individual research process. It is neither any manual of research methods instructing novices on the intricacies of research methods. That is true as nowhere Ranganathan takes into consideration any individual case. Nor in his entire body of writing he has ever described any small but real research inquiry passing through the spiral, except of library classification, which he believes, has reached the level of abstraction[13]. The spiral everywhere has been presented as sheer abstract thought without any tangible case study. Yet at the same time, we hold the spiral valid at the lower levels of research by the virtue of hierarchic principle by which ontogeny recapitulates phylogeny. It simply means that the individuals repeat the development of the group.

3 UPPER AND LOWER LAYERED SPIRAL

As another proposed interpretation, the spiral can be postulated as consisting of two congruous layers moving at different speeds. The lower one moves hyper slowly even completing one circle in centuries in some cases. Coming of its full circle heralds scientific revolution or what the American philosopher of science Thomas Kuhn(1922-1996) calls creation of new paradigms.[14] Ranganathan terms it boundary conditions only within which the laws hold their sway.[15]It simply means laws are not eternal, even universal. Events of discoveries or the milieu which impart motive force to thelower cycle are few and far between. What constitutes the supreme motive force is the scientific temper of the age. This hypothesis also explains those sciences which have not taken even full circle of the spiral, and are still at the natural history or empirical stages. It means that notwithstanding the name these disciplines are not yet fully grown sciences. For example, psychology is still at a stage where biology was a century ago. This stage lies in the second quadrant, i.e. empirical phase. Yet these are sciences as the data is collected objectively to formulate some empirical laws by induction or mathematical statistics. Library science has taken one full circle by virtue of the foundation of the Five laws. It is only exceptional that an emerging discipline like library science should complete the full circle at so early a stage of its emergence. However, some still believe library science to be at the empirical stage of its development. Formulation of norms in any social science is avery long and arduous process which takes even centuries of constant observations. Ranganathan formulated them at a stroke through interplay of strong intuition without much labour pangs though through prolonged conscious efforts. On the other hand, their formulationis something sudden from the blue. The seemingly easy discovery and unexpected enunciation in so simple words has made some people to discount their gravity

and full potentialvalue. But basic laws are always simple and axiomatic. No matter all the great theories have their skeptics in the waiting. This partially explains not so much popularity of the Five laws in the western world. Anyhow, this is beside the issue.

4 INTUITION DEPENDENT

The slow movement of the spiral is on two accounts. Collection of data in social sciences is very slow and comes with an inbuilt bias; human calculus is not amenable to quantify sentient human behaviour and to easily draw any empirical laws. Needed strong flash of intuition also retards the process to reach the zenith. Intuition is not objective and subject to rules, so it is not a reliable tool. Nature of intuition is inexplicable, rather mysterious. Being sudden and spontaneous it occurs at odd and unexpected times and places. No researcher, however great, can sit and wait the intuition to show up. But to whom intuition occurs become great. No researcher can halt the research till intuition strikes. The lower layer of the spiral grinds out laws of the highest order, and they are more than logical. But these are rare. In fact, no scholar consciously goes on to an expedition to fish for them. Most of the research enquiries end at the data collecting stage, trying to interpret the data in the framework of the paradigm or the prevailing boundary conditions. Ambition is to conform to the prevailing common place norms and fill a small gap in knowledge. These fillips are transitory. Unconsciously, the basic laws are the product of relay research as they require observation and trials for centuries. Spadework has to be done by illustrious predecessors, for science is cumulativein nature. For example, in astronomy, Kepler used the data assiduously collected by Tycho Brahe and formulated his laws of celestial dynamics. When Ranganathan was making a study tour of British libraries during 1924-25, he never knew he was doing research. Observed facts got deposited in his mindand yet this was a research which later aided the formulation of the Five Laws.

41 RUN-OF-THE–MILL RESEARCH

Upper layer of the spiral may be said to represent the research at the intellectual level. Such a type of research does not produce normative principles but answers only small research questions or explains a phenomena. This type of a research, as already said, remains confined to the boundary limits already

set by the lower layer. It is an evidence based description and explanation of a phenomenon or situation. Here, we have to replace intuition by imagination in the third quadrant. Imagination is a quality required of every researcher[16]. Considering imagination as a tool only for literary persons or artists, it is generally misconceived that not much of it is required in scientific research. In fact, no worthwhile research has ever been done without it. Every researcher must be imaginative, if not intuitive in thinking and working. "Imagination is more important than knowledge. Knowledge is limited. Imagination encircles the world", Albert Einstein (1879-1955) said to have said it.

5 LIMITATIONS

Spiral is simply conceptual and theoretical. Research process may be cyclical, but in actual practice, the axes, which are merely imaginary, dividing the spiral into quadrants, are not very distinct. Quadrants are not water tight. At times, one may not be sure of the quadrant in which one is working. A researcher may have to often hop to and fro from one quadrant to another. Productive ideas do not flow forward like a stream. Therefore, these quadrants are more or less of theoretical nature. Conceptually, these may be true; geographically these may not have sharply demarcated boundaries.

51 COMMUNICATING RESEARCH

As a point of another criticism, there is no place given to the concluding phase of communicating the results of research. By every account writing is an integral part of any research inquiry and project. Even Ranganathan admits it[17]. Knowledge is social in character; any new discovery or research cannot form the corpus of knowledge till it has been successfully and effectively communicated. There can be no knowledge without a knower or a conveyer. Knowledge is commonly defined as justified true belief (JTB). How it can be believed if is not communicated and scrutinized formally or informally. In a formal system it is scrutinized both at pre- and post publication stages. At the pre-publication stage it is rigorously reviewed by peers. At the post publication level it is open to the public for comments, use and pointing aberrations if any. Bringing the work in the public domain is most crucial for the author. You may be rewarded, suffer brickbats or even be arraigned for research misconducts[18].Only after communicating knowledge to the community concerned its validity is tested and accepted or rejected. (Now we have sites like Pubpeer.com[19] which reviews post publication articles and has been instrumental in bringing to the notice of the science community many research

misconducts and frauds). After undergoing that entire fire ordeal it becomes knowledge. Knowledge after all is defined as justified true belief. Moreover, only when the research results are written a researcher comes to know of any inner contradiction or gaps in research. Writing completes as well as supplements the research process. It is strange that well appraised of the vital importance of writing research, Ranganathan gave no place to it in the spiral. No doubt, it could be given place in the fourth quadrant where the laws are verified.

52 RESEARCH PROCESS SIMPLIFIED

As another criticism, it is felt that Ranganathan has presented very broad or too facile a view of research. Details are missing; it appears no more than an aerial overview of the A/Y of the research process— Z communication is missing. Nor is there any mention of numerous and unforeseen difficulties invariably encountered by every researcher, even in ordinary routine research. Data collection, which is the very basis of true research, is prone to many hazards, pitfalls and biases—both of the researchers and the respondents. Devil lies in data collection and selection. At best, the spiral is the way of "Big" science. No ordinary researcher, has gone this way,or ever conducted research in this manner.

6 CONCLUSION

Nevertheless, it is a novel contribution to the literature on research methods. It provides a practical model to teach the theory of research process. At the same time also depicts the difference between science and humanities or between the maturity of various sciences. Spiral emphasizes that science is a mode of study and investigation, rather any fixed area of knowledge. Not only this a discipline must get into the cycle of the spiral to get the status of a science. A non-science of yesterday may become science today only by moving into the spiral scientific method to develop new knowledge, test the earlier prevailing notions, and letting go the baseless presumptions. It is not necessary to complete the circle. Most of the researches windup in the second quadrant. It is not expected of them to move further. Spiral vividly demarcates the line between sciences and non-sciences. Ranganathan was a positivist in research. Tough in personal life he was orthodox, even superstitions informs his son T. Ranganathan Yogeswar (1932-2016) with many anecdotes.[20] Positivism philosophy regards social sciences methodologically equivalent to natural sciences. Rather the line between social sciences and natural sciences is unwarranted. Difference is only of stages and objects of study. Further the

spiral graphically delineates the structure of the research process and the way it progresses on its path; and the mode in which the different stages of the research enquiry are inter-linked. Ranganathan also applied the spiral in the creation and perpetuation of what he called 'thought energy'[21]. Endlessness of the spiral shows the knowledge to be ever fragmentary, so ever growing. In brief, the spiral is an abstract model to concretely show the path a researcher has to wade through and the possible points of danger and bottle-necks on the way. It is Ranganathan's uncanny imagination to put the complex process of research in so easy a format.

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