Pursuit of Innovation in Vedic Studies

: Raise, Rise & Race

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Abstract

Innovation plays a pivotal role in economic development of a nation. Its relevance and examples were there during Vedic period as well. Innovation need to satisfy the criteria of verifiable truth, socially usefulness, and esthetical elegance - satyam, shivam, sundaram. Vedic scriptures have huge amount of knowledge that exhibit the characteristics of holistic approach, classification and measurement. Language is the regenerative storehouse of knowledge. Sanskrit is one of the most ancient languages of the world, which has molded the culture and the thought systems not only of India but also of many other countries in Asia. Notation technique for context free grammar to describe syntax of language is basically inspired by Panini's work. Some linguists suggest renaming BNF to Panini-Backus Naur Form (PBNF). Speech sound architecture is shown in Panini Table in terms of Place of articulation and Manner of articulation. Sanskrit is syntax-free and word-order-free natural language. Sanskrit grammar is prescriptive**,** that takes phoneme as smallest unit with meaning.

Vedic knowledge encompasses large number of disciplines such as linguistics, health, astronomy, physics, chemistry, biology, mathematics, metallurgy, fine and performing arts, etc. Knowledge content therein is of high quality testified over a long period. Many scientists have expressed suitability of Sanskrit as a computer language especially for AI applications. Concept–based Networking Language (CNL) may be developed for knowledge exchange across world languages. Syllable based encoding may

lead to PHONICODE - universal code for world languages. IT and Vedic studies both may benefit from each other. Few projects for Technology Development are suggested. Vedic studies as alternate knowledge framework may be introduced in curricula of technical education. Two knowledge frameworks – Indian and western – may open up new horizons for break-through research and innovations.

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Innovation: aim at "सत्यम् , शिवम् , सुन्दरम् "

There are related terms in vogue such as creativity, innovation, invention, discovery, entrepreneurship. At the core is a new idea or a new concept. *Creativity* involves new ideas/concepts. *Innovation* is successful implementation of creative ideas having impact on economy and society. Innovation may be linked to improvements in efficiency, productivity, quality, competitive positioning, etc. *Invention* is constructing something new out-of-box. *Discovery* is finding something unknown. *Jugaad* , an Indian term, may connote to innovate in non-formal way that may not be explained instantly in structured manner. Such innovation may be even by untrained worker. *Entrepreneur* creates value to convert 'material' into 'resources'; creates new business/service. *Inclusive innovation* may include both structured innovation and jugaad – unstructured/ intuitive innovation.

Science is search for सत्यम् (Truth) . Applied science leads to development of *Technology* for problem solving. Now-a-days there is concern about Integrated Design that is sustainable, beneficial to mankind, and eco-friendly. Aesthetics adds value to it. Thus the engineering solution must ensure aspects of शिवम् and सुन्दरम् as well. Innovation is driven accordingly.

Future prosperity of rich economies will depend both on their *ability to innovate* and on their *capacity to adjust to change*. **Future** innovations will spring from **the base of pyramid - common men** who need to be encouraged to *cooperate for innovations* and *compete for achieving excellence* to suite to local environment.

Inclusive Innovation is key driver of sustainable development. Knowledge – better ways to do things – has always been main source of long term economic growth from agricultural revolution to the present knowledge revolution. World is transforming into networked society. Distances are shrinking. Concept of global village is being propounded. In the multi-cultural world, it is a challenge. Technological culturisation may involve the process of localization that would facilitate faster acceptance of a new technology.

Scientific basis of knowledge is contained in Vedic scriptures. Standard practices were evolved for loss-less transfer of knowledge, through Shruti- an oral tradition; for performing arts through Guru-Shisya parampara - closer interaction between teacher and student; and refinement in knowledge through Shastrarth - discourse. Excellence and collaboration were aimed at. Holistic approach of problem-solving was emphasized at all levels of activities. "Let noble thoughts come from all directions"**,** "Every one can do it", "we hardly harness very small fraction of brain power," There is a Vedic rcha that means "Divine powers are within, become a leader not follower. Based upon own experiences, create base for new invention." Such was motivation to ever encourage and strive for innovation. The Vedic studies have thus great relevance even today.

Knowledge: an engine for economic growth

न हि ज्ञानेन सदृशं पवित्रमिह विद्यते । (गीता 4-38)**.** Knowledge is critical factor in accomplishing any task with excellence. Modern science is developed based on successive observations and analysis. Hypotheses and postulates evolved based on large samples of similar observations, and the conjectures on the basis of inductive logic. Abstraction is dealt with symbolically in mathematical framework. Better understanding of the physical world through science led to innovative techniques and technologies to develop commercialisable products that resulted in wealth generation. Economic growth became primary indicator of how relevant is the technology. Innovation became buzzword on all the sectors of economy especially in the context of globalization. Innovation is reflection of multi-disciplinary frameworks of knowledge. It may be an idea, a technique, an arrangement, or approach. Its relevance is of course tested in the prevailing or the desired

environment. Innovation has become synonym of wealth creation and economic growth.

Knowledge flows from community to community, from generation to generation in both explicit and implicit forms. Language is the regenerative storehouse of knowledge. Language is effective vehicle of communicating knowledge. Language with multiple knowledge frameworks, thus, emerges as resource for innovation.

Sanskrit: applied science of language

Sanskrit is one of the most ancient languages of the world, which has molded the culture and the thought systems not only of India but also of many other countries in Asia. Sanskrit is not a dead language. Sanskrit was for over a millennium, a living spoken language with a considerable literature of its own. Besides works of literary value, there was a long philosophical and grammatical tradition. Sanskrit is still spoken in some Indian families. Even now new literature is being created in Sanskrit. Seventh system of philosophy, ParamarthaDarshan, has been added to SaTDarshan recently by pundit Ramavatar Sharma. Vocabulary of Sanskrit has permeated all Indian languages, and order of alphabet is similar to that of Devanagari, and thus provides continuity with the past of our country. There is renewed interest in learning Sanskrit because of its rich knowledge base in linguistics, philosophy, medicine, mathematics, astronomy, etc. Phonology (study of Speech) and orthography (Study of Spelling) have not been so perfectly described in any natural language as in Sanskrit. Panini's book on Sanskrit Grammar, called Asthtadhyayi, has been considered by eminent American linguist Bloomfield as "one of the greatest monuments of human intelligence". Panini (~ 4 countries BC) was preceded by a long chain of grammarians, and his tradition continued even afterwards. With his 4000 sutras, each of which is usually no more than two or three words, Panini was able to explain how almost all the words used in Sanskrit of his time were formed. It is precursor of today's generative grammar. Notation technique for context free grammar to describe syntax of language is basically inspired by Panini's work. Some linguists suggest renaming BNF to Panini-Backus Naur Form (PBNF). BNF is a notation technique for context-free grammar. Panian Grammar is prescriptive that definesSanskrit.

Panini classified speech sounds on the basis of place of articulation (P) and manner of articulation (M). Speech sounds were divided into two classes of Vowels (स्वर) and Consonants (व्यंजन). Chemistry of speech sounds was studied in detail. There are about 60 books on Pratisaakhya discussing these aspects. Consonant is viewed as body whereas vowel as soul. Every utterance is a syllable and has vowel(s) embedded in. Spoken consonant combines pure consonant and a vowel. अ is the first in the set of primary vowels (अ , इ , ऋ , लृ , उ). Derivative vowels are also produced – दीर्घ by doubling the self, and व्यत्पन्न स्वर (derivative vowels) by combining अ with the

following vowel इ or उ. Derivative consonants are produced by combining a vowel इ , ऋ , ऌ or उ with the following fundamental primary vowel अ . When a pure consonant combines with vowel to generate a speech syllable that is represented by a glyph showing vowel enveloping the consonant with a distinct shape called vowel modifier मात्रा. Script Grammar is also described accordingly. Speech sound architecture is shown as below in पाणिनि सारणी (Panini Table) wherein P denotes place of articulation, and M denotes Manner of articulation.

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Places of Articulation:
P1: Velar कंठ्य P2: Palatal तालव्य P3: Retroflex मूर्धन्य
P4: Dental दंत्य P5: Bi-labial ओष्ठ्य
Manner of Articulation:
M1: - Aspirated & Unvoiced अल्प प्राण – अघोष (अप्र–अघ)
M2: + Aspirated & Unvoiced महा प्राण – अघोष (मप्र–अघ)
M3: - Aspirated & Voiced अल्प प्राण – घोष (अप्र–घ)
M4: + Aspirated & Voiced महा प्राण – घोष (मप्र–घ)
M5: Nasal नासिक्य
M6: Fricative अलिजिह्वा
Vowel: स्वर , Vowel Modifier: मात्रा (at the end of syllable), Consonant: व्यंजन

Each of consonants and vowels may have multiple variants. Hence we may generate a large set of speech sounds, some of which may correspond to distinguishable speech sounds of a living language. Hence encoding of such syllables may lead to universal code PHONICODE. Speech sounds remain similar, but they may be written / transcribed differently in different scripts. To take an example, 'knowledge' is spoken similarly in all languages but it is written differently using respective scripts. In Devanagari, it is written as नॉलेज.

Vedic Sanskrit is also available on Unicode, and hence it would be easy to access on web, and display characters without separately downloading the fonts. UNICODE for Vedic Sanskrit includes codes for Devanagari (U+0900 – U+097F), extended Devanagari characters (U+A8E0 – U+1CFF), and Vedic Extension (U+1CD0 – U+A8FF). Vedic extension includes Tonemarks for Samaveda, Satapathbrahmana, Rigveda and Athrvaveda, Signs for Yajurveda, Diacritical Marks for Nasalization, Visarga and Arthavisarga, Cantiliation and Breathing Marks for Samavada. (URL: www.Unicode.org/charts/PDF/U1CD0.pdf).

पाणिनि सारणी (Panini Table)

P = (P1,P2,P3,P4,P5), M = (M1,M2,M3,M4,M5,M6)

		व्यंजन (Consonant)						स्वर (Vowel)					स्वरांत
		अप्र-अघ	मप्र-अघ	अप्र-घ	मप्र-घ	नासि	अलि जिह्वा	व्युत्पन्न	व्युत्पन्न	व्युत्पन्न	मूल	मूल	
		M1	M2	M3	M4	M5	M6	व्यंजन स्वर	दीर्घ स्वर	ह्रस्व स्वर	ह्रस्व स्वर	दीर्घ स्वर	मात्रा
कंठ	P	क	ख	ग	घ	ङ	ह	-	-	-	अ	आ	- ा
तालु	P	च	छ	ज	झ	ञ	श	य (इ+अ	ऐ	ए (अ+इ	इ	ई	ि ी
मूर्ध	P	ट	ट	ड	ढ	ण	ष	र (ऋ+अ	-	-	ऋ	ॠ	ृ ॄ
दंत	P	त	थ	द	ध	न	स	ल (ऌ+अ	-	-	ऌ	ॡ	- -
ओ	P	प	फ	ब	भ	म	-	व (उ+अ	औ	ओ (अ+उ	उ	ऊ	ु ू ो ौ

Sanskrit grammar is **prescriptive,** that takes **phoneme** as smallest unit with meaning. Knowledge representation is deeper and holistic at **sentence-level** with three necessary and sufficient conditions of Expectancy (आकांक्षा), Compatibility (योग्यता), and Proximity (सान्निधि), whereas modern linguistics is **descriptive** and empirical, that takes **morpheme** as the smallest unit with meaning, uses **word-by-word** approach rather than sentence.

Sanskrit is syntax-free and word-order-free natural language. Shastric Sanskrit is the Natural Language with all the desirable properties of formal artificial language, such as natural, expressive, unambiguous and irredundant.

Karakas are important in case role assignment and thus facilitate in semantic extraction. There is equivalence between semantic net [representing tuples of verb, case role, and instance], and sentence analysis in Sanskrit. Knowledge inferencing in Sanskrit is therefore rather complete.

Sanskrit: a language for computer

Rick Briggs, a computer scientist of NASA in USA, published a paper in the Artificial Intelligence Magazine, 1985 on "Knowledge Representation in Sanskrit and Artificial Intelligence". He demonstrates that a natural language can also serve as an artificial language such as Esperanto also, and that much work in Artificial Intelligence has been re-inventing what existed more than two thousand years ago. He establishes parallelism between modern scheme of knowledge representation using semantic nets and Sanskrit Grammarian's unambiguous sentence analysis. Modern knowledge-based computing employ Predicate Logic, Semantic Networks, Conceptual dependency schemes to represent World Knowledge. This may be related to Shabda-Bodha concept dealt with in Nyay, Vyakarna and Mimansa.

This has been amply demonstrated that SANSKRIT is linguistically quite advanced. This has potential of emerging as a suitable language for computers. Moreover it is possible to develop Concept based Networking Language (CNL) based on SANSKRIT.

With the convergence of technologies and consequent emergence of knowledge-based society there is paradigm shift from data to information to knowledge and to wisdom. Knowledge is much more tacit. Interpretation of explicit knowledge is important. The knowledge management is emerging as a discipline of corporate profitability. Knowledge has been deeply and systematically analysed in Ancient India. Sastras deal with Anubhava that is Experience (consciousness), Jnaana that is Knowledge (science), and Kaushala that is Skill (applied science).

Natural language has its own knowledge representational and inferential mechanisms, which are dramatically different from any existing automated reasoning and knowledge representation system. Natural language understanding is essentially the process of acquiring knowledge conveyed by natural language utterances and updating hearer's existing knowledge with this new knowledge. This hypothesis calls for revision of some standard modern linguistic notions. The notion of 'speaker-only' based concept of meaning extractions should be changed to 'speaker & hearer-based' concept, situated in a context.

Natural language analysis may consider objects (नाम) and processes (भाव) and their role relationship सत्त्वप्रधानानि भाव प्रधानानि आख्यातानि according to Yask. This model may substitute NP-VP representation at syntactic level.

Roger Schank's conceptual dependency graph for representing knowledge in a natural language considers the attributes which may rather be rationalised on the basis of Yask's Sat bhav Vikar—six states of a process. These are: अस्ति, जायते, वर्धते, विपरिणमते, अपक्षीयते, म्रियते (is, being born, growing, transiting, diminishing, extinct), Panchatanmatras- five sense acts include; श्रवण, दर्शन, स्पर्श, स्वाद, गंध (hear, see, touch, taste, smell). Two more attributes may be 'do' & 'any other'. Hence 13 attributes will suffice. Sanskrit studies will help in logically arriving at various parameters needed to analyse and design cognitive systems.

Vedic Scriptures: Knowledge in multiple perspective

Knowledge is dealt with in Apara Vidya Sastras which are classified into four Vedas (scriptures), six Vedanga-s (Vedic Auxiliary Science that deal with phonetics) and four Upanga-s (supplementary subjects).

Rg Veda had 27 Sakhas, Yajur Veda had (sukla: 15) & Krsna: (86) Shakhas, Sama Veda had 1000 Shakhas and Atharva Veda 9 Shakhas. Every Vedic Scripture has 4 types of texts: Samhita, Brahmana, Aranyaka and Upanishad. There are special Vedic grammar rules for each Shakha known as Pratisakhya and phonetic rules known as Shiksha.

There are four Upangas: Mimansa Sutras describe rules for interpretation of Vedic text, Nyaya & Vaisesika sutra-s (deal with logical aspects, ontological classification, process of human understanding), Purana-s are narrations of messages and teachings of Veda-s, Dharma Sastra-s describe code of conduct for universal harmony.

There are 26 parameters for each Vedic syllabic definition.

Western (Cartesian) logic has its own limitations. Further, cognitive studies look towards oriental systems of knowledge representation, reasoning, inferencing and interpretation. Vedic scriptures and sutra-s contain proper documentation and classification of knowledge.

This would necessitate digitization of Vedic Knowledge and building up Jnana-Nidhi (Knowledge base or digital library), and development of software environment for knowledge-representation, understanding, inferencing and interpretation. The technologies thus developed will enable design to futuristic wearable information appliances.

Sanskrit is linguistically advanced and rich in content in literature, philosophy, astrology, science and technology. Ayurveda is the medial science which finds growing relevance in the modern society. Metallurgy was advanced. There is description of aeronautics in the form of Pushpak Vimaan. Fundamental contribution in Mathematics is known to all. Concept of zero, basis of 10, multiplicative principle, larger and smaller numbers, Sutras – 16 main sutras and few sub-sutras - that contain instances of addition, subtraction, multiplication, division, squaring of fraction, etc.

Measurement of time covers very wide spectrum. Kalpa is in terms of light years; yuga in terms of thousands of year, whereas ghatika is a fraction of a second. Upanishads describe very wide spectrum of measurement ... Vedic mathematics computes from either left to right or right to left; computes at distances 0, 1, 2 ... $n/2, \left(n/2 - 1\right)$, ... 2, 1, 0 and combines them to get the result. There is symmetry in operation. This gives us short cuts and new ways of encryption. Scientific developments had followed holistic approach that takes into consideration multiple knowledge frameworks.

Innovation: a holistic approach

Multiplicity of knowledge frameworks and linguistic tools of inferencing facilitate innovation. On the basis of this hypothesis, Vedic studies in SANSKRIT language have greater potential for stimulating innovation with holistic viewpoint.

Jacques Delor report of UNESCO (1998) on higher education mentions importance of innovation, "Owing to the scope and pace of change, society has become increasingly knowledge-based so that higher learning and research now act as essential components of cultural, scoio-economic and environmentally sustainable development of individuals, communities and nations". But the report does not focus on holistic perspective of education as envisioned by Swami Vivekanand, "we want that education by which character is formed, strength of mind is increased, the intellect is expanded and by which one can stand on one's feet. Education is manifestation of the perfection already in man". This ensures necessary conditions of focused approach, refraining from distractions, strength of mind, expanded horizon of intertwined concepts.

Howard Gardner suggests Multiple Intelligences. Daniel Goleman proposes schooling the emotions and testing EQ (Emotional Quotient). Sanskrit scholars had emphatically mentioned need of the qualities crisply as follows: यम, नियम, आसन, प्राणायाम, प्रत्याहार, धारणा, ध्यान, समाधि. Yama refers to the ability of self-restraining; Niyama refers to judicious behavior with external world. Sound mind in sound body, so, Asanas and Pranayam are important. MNCS like Microsoft teach mediation for higher productivity & quality of employees. Microsoft certified Yoga classes are held in US companies.

Collaborative learning was promoted as expressed in the following: सहनाभवतु सहनौ भुनक्तु सहवीर्य करवाहै । Kapila, Vyasa, Patanjali and indeed all philosophers of India, applied the scientific methods of observation and analysis in coming to their respective discoveries. Kapila was the great psychologist, and the founder of the Sankhya system. We get truths from both the microcosm (internal) and macrocosm (external). Microcosm must bear testimony to the macrocosm and vice-versa. The whole universe is built upon the same plan as one little being. In Isaavasya Upanishad, पूर्णस्य पूर्णमादाय पूर्णमेवाशिष्यते connotes this idea. In Indian mysticism, the concept of

infinity and zero are very closely linked. In Sanskrit "Poornam" means both full and zero. Indian mathematician knew that division by zero gave them infinity. The symbol for infinity (∞), that is horizontal 8, is called lemniscates. English mathematician John Wallis introduced this symbol in 1655. The symbol is that of Anant, the great Adisesha of infinity and eternity, which is represented as coiled up serpent. The concept of infinity has always remained an enigma. The Taittriya Upanishad says; यथो वचो निवर्तन्ते**,** अप्राप्य मनस सह **-** where mind and speech return (being) unable to comprehend. Anant is the symbol of non-thought.

Prakriti is the cause of all manifestations, which we call thought, intellect, reason, love, hatred, touch and taste.

Triplet is the minimal set for stability, completeness and expressing a natural system.

The Prakriti consists of triplet of Sattva, Rajas and Tamas. In the beginning of evolution, these are in equilibrium. The Chitta (mind-stuff) has three fold functions of buddhi (intellect), ahamkara (consciousness) and manas (mind). This gives us clue that a physical system can better be represented by a tri-state system. Modern science also supports this. Any color can be represented by three basic colors—R. G. B. Blood cells are of three types—RBC, WBC & Platelets; Atom consists of Neutron, Proton and Electron. Diagnosis of human illness is based on tridosha of Vaata, Pitta and Kapha.

Innovation and leadership go together. Quality of innovation is inspired by the holistic perspective, integrated approach, and aptitude for achieving excellence.
Gita explains various paths of Yoga: Knowledge, Action, Devotion, etc.- all aiming at the Absolute. Gita assets the essence of Yoga in Action: योग**:** कर्मसु कौशलम् This plurality motivates for innovation in our living.

Vedic Studies: stream of innovations

Innovation had been core of thinking process. An idea used to be discussed, argued logically, and new ideas and explanations were made from time to time. Thus there had been continuous process of innovation. Some of the Scientific & Technological innovations which are contained in Sanskrit are given below in the following chronological table:

Period	**S & T Innovation in Ancient India**
1500 B.C.	*Rigveda* : concept of natural law (rta): 1028 hymns & 10,462 rchas
1000 B.C.	*Samveda :* book of melodies

Yajurveda : the book of Sacrificial formulas, the whole series of 27 or 28 naksatras. Number names up to 10^{12}.

Atharveda : astronomical knowledge, more detailed medical Knowledge.

1000 B.C.-500 B.C. *Brahmanas, Aranyakas* and *Upanishads* doctrine of punchabhutas; ***Codification*** of medical knowledge into *Ayuveda*

Sub-sturas: beginning of geometry, irrational number

Early ideas of *Vaisheshika, Samkhya & Mimamsa;* of *Bauddha, Jain* and *Charaka darshanas*

Physical concepts: atomism, space, time, motion and sound Astronomical ideas: mathematical series (AP & GP), Agricultural practices to increase soil fertility.

400 B.C.-400 A.D. *Ayurvedic treatises*- Charaka and Sustruta Samhitas; Tridosha theory; extension of the dictrine of 5 elements, space, time and sound

Arthashastra of Kautilya, Pingala's Chandah-sutra: Permutation, combinations and Binomial ideas.

500 A.D.-1500 A.D. *Nyaya Bhashya* of Vatsyayana: extension of atomic ideas, vision, sound, inpetus theory; classification of animals and plats

Padartha dharmasamgraha of Prasastapada: atomism, space, time, motion, sound

Aryabhatta: theory of rotation of earth, epicycle theory of planetary motions, values of pie & sine, square & cube, roots, indeterminate equation of the first order.

Panchasidhantika of Varahamihira

Ganitasarasamgraha

Amarakosa: classification and synonyms of plants and animals, minerals and metals.

Authoritative compilation of Ayurvedic knowledge, urine and pulse examination, Siddha system of medicine.

polytechnics; alchemical ideas, iron-casting, paper-makin

1600 A.D.-1900 A.D. (Foreign influence)

Use of mercurial and non-mercurial compositions as internal medicines

synchronization of astronomial and mathematicsl knowledge with India's Jantar Mantar at Delhi

Translation of Arabic literature/knowledge; country's map

DC Ray's work on murderous compounds and rare Indian minerals JC Bose's work on polarization of electric waves by double refraction; on generality of molecular phenomena produced by electricity by living and non-living substances. [*Influence of Indian philosophy on science*]

Setting up Engineering Colleges, and institutions of basic learning

To summarize, there is Basic Structure of Indian Knowledge System: अष्टादश विद्या – ४ वेद, ४ उपवेद (आयुर्वेद, धनुर्वेद, गान्धर्व वेद, स्थापत्य आदि), ६ वेदांग (शिक्षा, कल्प, निरुक्त, व्याकरण, ज्योतिष, छंद), ४ उपाङ्ग (धर्म शास्त्र, मीमांसा, पुराण, तर्कशास्त्र). Philosophical Tradition (सर्व दर्शन) include न्याय, वैशेषिक, सांख्य, योग, मीमांसा, वेदांत, चार्वाक, जैन, बौद्ध; Indian Linguistic Tradition entails Phonology, morphology, syntax and semantics; Indian Artistic Tradition encompass चित्रकला, मूर्तिकला, वास्तुकला, स्थापत्य, संगीत, नृत्य एवं साहित्य

There is proper classification, standardization, methodology of argumentation, logical system and documentation in Sanskrit.

Re-look at Curricula of Sanskrit Universities

Sanskrit Universities need to be encouraged to introduce mandatory credit course on "Fundamentals of Knowledge Technology for Sanskrit" with the objective of raising quality of Sanskrit education and research to excel globally. Knowledge Technology will augment creativity and critical thinking of Sanskrit learners. There is need to design skill intensive PG Diploma / B (Voc) course on "Sanskrit Informatics or संस्कृत संज्ञानिकी" with provision of internship in appropriate industry or on industry-based problem to solve in-house under supervision.

Present Sanskrit studies and research are still largely confined to Interpretation phase. There is need to spur **innovation** in Sanskrit Universities with induction of basic sciences and Knowledge Technology or ICT as productivity enhancing tool.

Re-look at Curricula of Professional Disciplines

Professional courses are intended to impart sound knowledge of core discipline, interdisciplinary project exposure, societal sensitivity, entrepreneurship and life-long learning. Curricular revisions in India are normally based on the recommendations of the western premiere universities or western professional bodies. In many universities curricula are old. There is need to revisit the curricula and integrate Indian

knowledge framework in order to make learning of relevance in addition of quality. We may introduce Sanskrit as language of concepts generation, creative ideas and ethics.

With the neglect of Sanskrit language, we are getting farther away from our own communities speaking Indian languages. English as interface language distorts pronunciation of the native words and turns the semantically-regenerative word entity into a jargon. This in turn would necessitate learning and memorizing even larger vocabulary. With the explosion of information and its faster access on web, ability of memorizing vocabulary is getting reduced. This is again reflected in lesser discerning ability and appreciation for a variety of semantically closer concepts. We may predict that people's knowledge level will drastically decline in the emerging knowledge-based society. A paradox indeed!

At the instance of Ministry of HRD, IIT Kanpur organized Sanskrit Studies Curriculum workshop in September 2001, which proposed introduction of courses in Sanskrit language and specialized knowledge resource in Sanskrit for IIT students. But there was no follow up.

We may revisit curricula at school level, college level, Civil Services level, etc. At school level is the foundation of knowledge. Children have most efficient memorizing and retention ability. School children need to be good in pronunciation, concept regeneration and ethical behavior. More over prescriptive knowledge as encapsulated in Sanskrit shlokas in poetic form is easier to remember and retain compared to narrative descriptive knowledge as in vogue. Ethical values are founded in childhood. Sanskrit literary culture has a long and deep tradition of scholarship. Sanskrit literature is of a sufficiently high standard to apply growing canon of poetic rules.

At college level, learner is expected to attain ability to interconnect concepts within and across various frameworks, and the ability to view a problem holistically. Ethical values are amply described through sukti, subhashita, stories and case studies in Sanskrit. Technical education may introduce courses on "Science of Language", and "Innovations in ancient Science and Technology". Yoga for Innovation, and Darshan (philosophy) may be introduced as part of Research Methodology in M Phil, MTech and PhD programs.

Upon discussion with AICTE, two courses, each of 3 credits, have also been designed on "Essence of Indian Knowledge Tradition". Bharatiya Vidya Bhavan prepared the course material in the form of two text books, namely, Bharati Vidya Saar part-1, and part-2 – भारतीय विद्या सार -1 & 2 originally authored by subject experts in Hindi. The presentation is easy to comprehend. Part 1 contains introduction to our treasure of knowledge - Veda, Vedangas; ancient advances in Science and Technology: Yoga and Holistic Health Care. Whereas Bharatiya Vidya Saar part 2 focuses on our philosophical system, science of language, literature and Art forms. These text books may be translated in other Indian languages also so that the

knowledge contained therein is easily accessible across the country. But it has not caught attraction in regular BTech, MTech, MBBS and similar professional programs. Hence there is need to design courses to facilitate integrating modern science and technology with traditional knowledge. Research dissertations may be required to have survey of Indian traditional experiential knowledge also, and try to look for similarities and identify knowledge gaps.

Traditional knowledge in India is in coded documents that need contextual interpretation. These need to be experimented and tested for evidence. Amalgamation of Traditional knowledge that is basically in Sanskrit, with modern experimental Science and Technology may pave way to break-through research.

Moreover our youths will be better empowered with both modern and ancient knowledge frameworks that may help in out-of-the-box thinking and creative ideas paving a path towards evolution of "New India".

This necessitates to **Raise** Sanskrit Institutions by empowering with Knowledge Technology. Simultaneously Professional Education System needs to **Rise** up with introduction of basics of Sanskrit and exposure to Scientific Achievements in Sanskrit scriptures. "New India" will **Race** upon amalgamation of Sanskrit and modern science and technology. Raise, Rise & Race.

Vedic Studies & Knowledge Technology: a win-win case

Ray Kurzweil, technology futurist, predicts that technologies will miniaturize to disappearance, they will become part of skin and clothes; wearable technologies will become exponentially fast to bring true Artificial Intelligence and human immortality; fantastic nanotechnology capabilities will be available in a decade; pico-technology will grow; technology will build AI to engineer human brain by 2029. Most of his predictions have come true.

Neuroscience will give us what we have sought for decades: computers that think like we do. There are major initiatives like BRAIN in US and Human Brain Project in Europe. With systematic data collection and deep insight into the brain, it may perhaps be possible to create a truly thinking machine. Brain has massively parallel networks of neurons. The brain has ability to communicate with other brains too.

Information revolution set in during mid 1970s with the advent of Computer, digital communication, microchips and rapid reduction in cost of storage and transmitting of information. Industrial revolution raised concerns of productivity and quality which were addressed with information technology. During 1990s, need was felt for Knowledge Management that is processing interlinked information.

Knowledge is residue of thinking. It is created at the boundary of old. Knowledge flows from community to community spatially and temporally. Knowledge links to network of ideas, memory, predictions, procedures, beliefs, cultural expressions and experiences.

Sanskrit scriptures have rich treasure of linguistic, philosophical, cultural, scientific and technological knowledge. In order to capture, analyze, integrate and disseminate vast knowledge in Sanskrit, far and wide, it is imperative to use knowledge technology. India can immensely benefit upon connect up with such heritage knowledge.

Rick Briggs (Scientist at NASA Ames Research Center, Moffat Field, California) published a paper in 1986 on **"Knowledge Representation in Sanskrit and Artificial Intelligence".** But we have not yet harnessed the potential of Sanskrit methodologies and knowledge systems.

Language technologies and tools have been developed *under the TDIL program* of Min. of Electronics & IT, Government of India to process information in Indian Languages, and *a few technologies for Sanskrit too*.

There are still technological issues relating to input, parsing, word processing, annotated corpora, dictionaries, knowledge representation, encoding with Vedic symbols, digitization of manuscripts, Sanskrit WordNet, translation memories, expert systems, Authoring system, spelling check, grammar check, searchable Sanskrit dictionaries, content creation, e-learning resources, etc. Requisite tools need to be developed. Natural Language Processing Tools to develop may include Sanskrit Word Processor, Knowledge Representation Tools, inferencing and Interpretation mechanisms, Optical Character Recognition system for Vedic overlay, Vedic fonts, schemes for Sama Veda data entry, Spell-checkers and Grammar Checker, Web authoring tool, content digitization etc. Auto-Ontology Builder may also be developed for Sabskrit

There is scope of further *research in the field of speech processing* using phonetic rules as prescribed in Prati-sakhya of Shiksha Shastra, metre study as in Chhand shastra. Translation domains of text-to-speech, speech-to-text, speech-to-speech open up new avenues for research and development.

Concept based processing. A word in Sanskrit may connote wider context that interlinks other contextual concepts. For instance, there are several words for Lotus, water, etc. referring to different concepts in Sanskrit. It is possible to develop *Concept based Networking Language (CNL)* that may become Universal Networking Language (UNL) and that may be useful in interlingual machine translation and knowledge representation for Cross Lingual Information Retrieval.

Semantic web, cognitive computing, brain simulation, building consciousness are *emerging research areas* wherein Sanskrit studies

may help. Pattern-based Computer Architecture and Parallel Multipliers based on Vedic Mathematics may also be attempted. Cognitive aspects as discussed in Mimansa, Nyay and Vaisheshik may help in building Thinking Machines.

Capacity building. There is need to identify tools and resources for developing e-learning resources in open domain (MOOCs), language laboratory software, library and school management software, lesson Authoring System, etc. There is need to develop curricula integrating ICT in Sanskrit Studies and Research in Sanskrit Universities. Also there is need to develop curriculum and textbooks for introducing an elective credit based course on Mining Traditional Knowledge in Sanskrit and integrating with modern science and technology. Technical institutions may be identified to mentor each Sanskrit educational institutions to set up Sanskrit Language Labs, and Knowledge Systems Projects Lab.

Standards need to be evolved for input mechanism with direct keying in facility of Sanskrit text, Easy access to diacritical marks for Romanization of Sanskrit text, Devanagari script-grammar, language grammar, transcription / transliteration tables, phonetic table etc. Phonicode may be developed that would be useful for most of the languages. *Standard for Devanagari based Indian Phonetic Alphabet (IPA)* may be developed that will greatly be useful in speech processing and Linguistic studies of world languages, especially Indian Languages. Standard of *Concept based Networking Language (CNL)* may be useful in machine translation among world languages. Use of XML needs to be promoted for content creation.

Synergistic collaboration between Government, Academia and Industry would be required to accomplish the desired objectives. In order to promote Sanskrit based studies worldwide, all the technologies and tools developed through Governmental support and initiatives need be available in open source for use by all. At least twenty quality Open type fonts must be made available free to use by all commercial agencies.

To sum up

Innovation is key driver for socio-economic development. Holistic approach is emphasized in developing engineering solutions. Scientific basis is necessary to ease modularity, interoperability, reusability and scalability. Aesthetics is value addition. Sustainability and ethics are also important. Innovation must therefore aim at "सत्यम्, शिवम्, सुन्दरम्". Vedic knowledge encompasses large number of disciplines such as linguistics, health, astronomy, physics, chemistry, biology, mathematics, metallurgy, fine and performing arts, etc.. Most of the documentation is in Sanskrit that specifies language architecture and application. Knowledge content therein is of high quality testified over a long period. Many scientists have

expressed suitability of Sanskrit as a computer language especially for AI applications. Concept–based Networking Language (CNL) may be developed for knowledge exchange across world languages. IT and Vedic studies both may benefit from each other. Few projects for Technology Development are suggested. Pursuit of innovation had been in our culture. Few examples are cited. There is need to introduce Sanskrit as science of language and Vedic studies as alternate knowledge framework in curricula of technical education. In the emerging knowledge based society, acquisition of multiple skills is essential pursuit. Sanskrit will help in building up innovation-conducive aptitude.

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