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Transforming Engineering Education in India by Seeking Motivations from Bharat

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Abstract : There has been a growing awareness in recent years about the need for transforming engineering education in India that can enhance its effectiveness in serving the social and national goals. The efforts involved in these transformations pertain mainly to increasing the effectiveness of the processes of imparting knowledge, skills and wisdom by a teacher to a learner. However, most of these efforts are inspired by educational processes that are followed in the developed countries of the present. This paper is based on the contention that instead of following the developmental models of other countries if we seek motivations from our own past then we can surely approach our future as a developed nation faster. This is because history reveals that India before the British rule, i.e., Bharat excelled in all aspects of human development including science, engineering and education and enjoyed the status of a developed nation for a long unbroken period. In this paper we attempt a backward journey in time from India to Bharat to seek motivations from our inherent root strengths. We then discuss how these motivations can illuminate our path towards achieving the desired transformations in the present engineering education in India, which can contribute to the resurgence of our glorious past, i.e., our re-emergence as a developed nation.

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1. Introduction

There has been a growing awareness in recent years about the need for transforming engineering education in India so that it can serve its destined purpose of contributing to the development of the society and nation [1-5]. The goals like 'Vision 2020' [6] also generated a lot of interest among countrymen in general, and people involved with education, in particular, about the desired transformations needed in the pursuit of this ambitious goal. But the general perception in this direction has remained largely limited to understanding the educational processes that are followed in today's developed countries with the expectation that we can also achieve the same status in future by following the path they treaded.

However, a country cannot develop if it detaches itself from its cultural roots and blindly imitates other countries. An example of this is our experience of green revolution, which, on one hand, made us a food grain surplus country from a deficit one. But on the other hand, it led to the overall degradation of the fragile agro-ecosystem due to the loss of soil fertility, soil erosion, soil toxicity, pollution of underground water and global warming. It increased the incidence of human and livestock diseases and adversely affected the socioeconomic condition of farmers [7]. We are still fighting to mitigate this deterioration without much of a success. Another example is our experience of the adverse side effects of allopathic treatments that has been leading more and more people to take recourse to alternative medicines.

If we peep into history we find that India enjoyed the glorious status of a developed country in the past for a long unbroken period and started losing it relatively recently during the British rule [8-10]. Our developed past can thus be a better source of inspiration towards our goal than the present of other developed countries. A strong system of indigenous education served as the backbone of our prosperity in the past. Thus instead of emulating the education models of other developed countries if we make a backward journey in time from India to Bharat to understand our own inherent root strengths that ensured our developed status and optimise them, then we can be on a much surer path towards achieving the desired transformation in education in general, and engineering education, in particular. This paper is a comprehensive attempt in this direction.

We first revisit our history to bring to fore our glorious past [(Section 2A] and its deterioration during the British rule [Section 2B]. In Section 3 we trace the roots of the problems plaguing the present engineering education in the changes introduced by the British in our native education system to serve their selfish motives. In section 4 we discuss how this historical retrospection of our past can illuminate our path and provide us motivations towards transforming our present engineering education in a desired way so as to contribute to bringing closer our future as a developed nation by reviving our glorious past.

2A. Bharat as the glorious past of India

Even a casual student of history is aware of the fact that Bharat was known as 'Sone ki Chiriya', i.e., a golden sparrow. Since antiquity, this country had been identified as synonymous to prosperity as it enjoyed a unique distinction of abounding in both wealth and intellect. History is replete with evidences that bear testimony to the glory of Bharat as a developed nation. Table 1 presents a few major evidences.

Several historical evidences suggest that Bharat was the world's largest economy between 1 CE and 1000 CE [8, 9, 14-17]. Figure 1 depicting the historical trends in global distribution of GDP clearly shows the leading position of Bharat during this period. The status of Bharat as a developed nation is also evidenced till as late as the 18th century. In Table 2 we list some relevant observations collected from various sources revealing the glory of Bharat till the British rule.

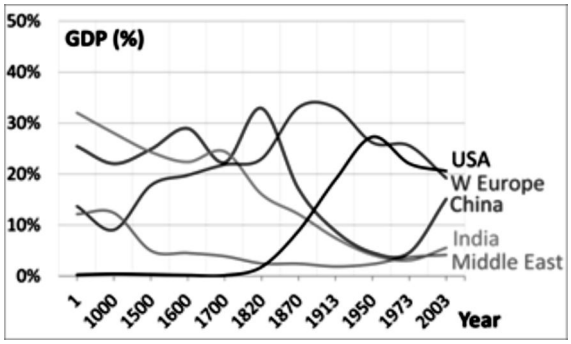

Table 1: Evidences that bear testimony to the glory of Bharat

Historical Evidence	Reference
The excavations of Mohenjo-daro, Harappa, Lothal and Rakhigarhidate revealed how the Indus valley civilization - the first known permanent and predominantly urban settlement - flourished here from 3500 BCE to 1800 BCE.	[11]
The developed economy of Bharat dates back to as early as 800 BCE when Sreni, an ancient form of business organisation was followed, which resembles a lot to the modern corporate business.	[12]
The coin system prevailed in the Mahajanapadas (great realms) during 5-6 centuries BCE giving Bharat a rare distinction of being one of the first countries to develop money-based trade.	[8]
The period from 321 BCE to 187 BCE belonging to the Maurya dynasty witnessed a great economic growth due to improvements in infrastructure, security of trade routes, uniformity in measurements, and use of coins as currency.	[13]

This advanced state of economy was due to the sound base of science and engineering that resulted from an equally sound foundation of education that prevailed in Bharat since ancient times. Table 3 includes a few examples that convey this richness. Table 4 includes a few quotes that convince us of our prosperous past.

Table 2 : Observations revealing the glory of Bharat before the British rule

Observation	Reference
Bharat was a major exporter of textiles, ships, steel, spices and foods such as sugar, oils and butter and accounted for 95% of British imports from Asia. However, it had very little to import from Europe. Thus the trade imbalance was compensated by Europeans through export of large quantities of gold and silver.	19
In 1760, India was the largest economy in the world, constituting 27 per cent of all global economic activity. India was at the very center of the vast Indian Ocean trade, which for centuries d warfed that of Europe. -----	15
India had the largest and most advanced economy for most of the interval between the 1st century and 18th century, the most of any country for a large part of the last two millennia.	8, 16
During the period when the Mughals ruled India, the country's income was 17.5 million Pounds, which was greater than the entire treasury of Great Britain.	17
India was the richest land till the British came here. Whereas Britain's share in world exports before was only 9% as against India's share of 19%.	20

Table 3 : Rich base of Bharat in science, engineering and education [21, 22]

Science
1. Mathematics (i) The concept of zero was invented in Bharat. It infiltrated in western thinking in the 12 th Century. (ii) Several results relate d to permutations, combinations, sums of squares and cubes of terms of arithmetic progression, triangles, cyclic quadrilaterals, trapezium, circle s, ?, sine, cosine and tangent series were studied by mathematicians of Bharat before their western counterparts. **2. Physics and Astronomy** (i) The concept of atom was formulated by Kanad in about the 6th century BC. He explained the various observed natural phenomena using theories based on ato ms and their interaction s. (ii) There are references to the study of several physical phenomena related to magnetism, optics, ro tation of the Earth, speed of light, gravity and planetary motion in our scriptures. (iii) Aryabhata correctly insisted that the earth rotates about its axis daily and also explained solar and lunar eclipses. **3. Chemistry** (i) In Bharat, the practice of chemistry was evident through the manufacture of mercury, zinc, copper and their alloys since around 3000 BCE. (ii) References are found in our literature a bout various chemicals, processes and equipments such as caustic alkali, electricity generation in a cell, distillation vessels and explosives. **4. Medical Science** (i) Atharva-veda contains hymns on diseases and their treatments **.** (ii) Charaka described the concepts of digestion, metabolism, and immunity and the cures for diseases related to almost every human body p art using medicines ha ving natural elements. (iii) The first cataract surgery is said to have been performed by Sushruta in 6th century BCE. Sushruta-samhita includes knowledge of Leech therapy (used in US hospitals), intestinal surgery, absorbable ligatures, bladder stone removal , plastic surgery, suturing and several surgical instruments. He defined the function of the heart ahead of H arvey (17th century CE) (iv) Vagbhata brought forth the knowledge of Obstetrics and Paediatrics in 6th century CE.
Engineering
1. Civil Engineering (i) There are rich references to building constructions in the Atharva -veda and other scriptures of Bharat. They include knowledge related to soil testing, making of bricks, mortar and assembling pillars. The bricks so produced were very uniform and durable for thousands of years. (ii) Advances in civil engineering are evidenced in the great temple architecture and town planning of Bharat since ancient times. **2. Irrigation**: (i) Irrigation was developed in the Indus Valley Civilization by around 4500 BCE. (ii) The Grand Anicut, Kallanai, located on Cauvery River in Tamilnadu is the oldest dam in the world that is still in use today [23]. **3. Metallurgy** (i) The history of metallurgy in Bharat began prior to the 3rd millennium BCE and continued well into the British Raj. (ii) Bharat was the first to smelt zinc more than 2,000 years ago through the use of a highly sophisticated pyro–technology. (iii) The world's first iron pillar - the Iron pillar of Delhi - stood without rusting for around 1600 years. [24] (iv) By 200 CE, high quality steel , called as Wootz steel, was produced in Bharat. It was exported throughout much of Asia and Europe and became famous in the Middle East as Damascus steel . It played an important role in the development of modern English, French and Russian metallurgy. **4. Mechanical Engineering** Kautilya's arthashastra describes 32 machines indicating theoretical development of mechanics and sophistication of technology to sustain it. There are also references to the mechanical contrivances which used the links and pulleys in a sophisticated way for several purposes [25].

Education

1. The literacy rate of Bharat in the Upnishad era was 80 % [26].
2. Several centers of higher learning existed in Bharat from 3 rd century to 12 th century that included internationally renowned centers at Taxshila, Nalanda, Somapura, Vikramashila, Odantapuri, Pushpagiri and Valabhi . Students from far countries like Korea, Japan, China, Tibet, Indonesia, Persia and Turkey came here to study knowledge domains such as arts, medicine, mathematics, astronomy, philosophy, politics and war . These centers turned out several scholars that include Aryabhatta, Brahmgupta**,** Bhaskaracharya**,** Susruta, Charak, Chanakya and Pāṇini. [27, 28]
3. Takshashila University was considered to be the world's earliest university in the world.
4. Nalanda University was world's first university to have residential quarters for both students and teachers.
It employed 2000 teachers and housed 10,000 students in a remarkable campus that featured a library nine storeys tall that housed 9 million books [9].

Table 4 : Convincing quotes about our prosperous past

Quote	Reference
"---- Her textile goods – the fine products of her looms, in cotton, wool, linen and silk – were famous over the civilized wor ld; so were her exquisite jewell ery and her precious stones cut in every lovely form; so were her pottery, porcelains, ceramics of every ki nd, quality, colour and beautiful shape; so were her fine works in metal – iron, steel, silver and gold. She had great architecture – equal in beauty to any in the world. She had great engineering works. She had great merchants, great businessmen, great ba nkers and financiers." - **J T Sunderland, the Yorkshire – born American Unitarian minister**	8, 14
"Education is no exotic in India. There is no country where the love of learning had so early an origin or has exercised so lasting and powerful an influence." - **F W Thomas - English Indologist**	29
"If there is a country on earth which can justly claim the honour of having been the cradle of Human race or at least the scene of primitive civilization, the successive developments of which carried into all parts of the ancient world and even beyond, the blessing of knowledge which is the second life of man, that country is assuredly India." - **Friedrich Creuzer (1771- 1858), German philologist and archaeologist**	21
"India was China's teacher in trigonometry, quadratic equations, grammar, phonetics…." - **Mr. Lin Yutang, a Chinese scholar**	
"We owe a lot to Indians, who taught us how to count, without which no worthwhile scientific discovery could have been made. I have made the Gita as the main source of my inspiration and guide for the purpose of scientific investigations and formation of my theories." - **Albert Einstein, Physicist and Nobel Laureate**	
"After the conversations about Indian philosophy , some of the ideas of Quantum Physics that had seemed so crazy, suddenly made much more sense." - **Erwin Schrodinger, Physicist and Nobel Laureate**	

The detailed accounts of the prosperity of Bharat during the period when British had just arrived and didn't establish as rulers yet have been given by Dharampal [30]. Dharampal researched into the authentic references collected by the British themselves and brought to fore the rich prosperity of indigenous science, engineering and education that prevailed before the British rule [31-33]. Table 5 includes a few examples that bring forth this prosperity.

Table 5 : Examples of prosperity of indigenous science, engineering and education prevailing in Bharat before the British rule

Science and engineering
(1) Practice of smallpox inoculation long before the British knew about it (2) Use of drill plough (introduced in England in 1730) since time immemorial. (3) Observatory at Varanasi treated as one of the five 'celebrated observatories' of the world by the *Encyclopaedia Britannica* till 1823 (4) Considerable use of surgical techniques in the 18th century, which included removing cataracts, ulcers and cutaneous irruptions of the worst kind (5) Practices of (i) crop rotation, (ii) manuring and (iii) us ing various other implements in irrigation (6) Existence of advanced centers for developing ships, rust resistant steel, high grade mortar, and techniques to make ice

Education

(1) Existence of about 1 lakh village schools in Bengal and Bihar alone arou nd the 1830s (Adam's report) (3) Presence of 11,758 indigenous schools and 740 colleges in Madras in 1826 (as stated in an inquiry cond ucted by Sir Thomas Munro) (4) 1594 scholars receiving education from private tutors in Theology, Law, Astronomy, Metaphysics, Ethics and Medical Science in 1820s (details s ent by collector of Malabar) (5) Better contents, methods, conditions, attendance and teachers in Indian schooling in 1820s compared to that in England during those times (T his system was adopted for educating masses in England; earlier only the children of the nobles were given education there [20].)

2B. How British Rule Contaminated Our Glory

The two centuries of British rule saw a gradual contamination of the glory of Bharat as it was systematically plundered and depleted of its vast wealth and resources for the benefit of Britain. It was a period of our deindustrialization and de-development. Our share of the world economy declined from 24.4% in 1700 to 4.2% in 1950 [8, 34]. Our share of global industrial output reduced from 25% in 1750 to 2% in 1900 [8, 35] and the percentage of village lands that were revenue free decreased from 35-50% to 5 % [20].

This saga of systematic plunder of Bharat by British has been researched by several historians [36-39]. A few of the observations from these studies are listed in Table 6. Dr Manmohan Singh expressed this transition in the words, "There is no doubt that our grievances against the British Empire had a sound basis.--- Indeed, at the beginning of the 20th century, "the brightest jewel in the British Crown" was the poorest country in the world in terms of per capita income" [40].

Table 6 : Observations about the systematic plunder of Bharat by British

Observation	Reference
The British conquest of India was the invasion and destruction of a high civilization by a trading company [the British East India Company] utterly without scruple or principle, careless of art and greedy of gain, over-running with f ire and sword a country temporarily disordered and helpless, bribing and murdering, annexing and stealing, and beginning that career of illegal and 'legal' plunder which has now [1930] gone on ruthlessly for one hundred and seventy three years.	9, 41
The little court disappears – trade languishes – the capital decays – the people are impoverished – the Englishman flourishes, and acts like a sponge, drawing up riches from the banks of the Ganges, and squeezing them down upon the banks of the Thames.'	9, 42
The halcyon days of India are over; she has been drained of a large proportion of the wealth she once possessed, and her energies have been cramped by a sordid system of misrule to which the interests of millions have been sacrificed for the benefit of the few ...	9, 43
During the period 1780–1860 India changed from an exporter of processed goods paid for in bullion to an exporter of raw materials and a buyer of manufactured goods.	8, 44

3. Tracing the problems of present education system to their roots in British Rule

There have been several studies that review our current education system in general [45-48] and engineering education system in particular [49 -51]. Majority of these studies have criticised the rigid examination oriented structures of the current system and expressed needs for reforms. Though we have grown from 20 universities and 500 colleges at the time of independence to 789 universities and 37204 colleges by 2013 [52], we find that the system has failed to fulfil the expectations of our country when we look at the outputs of this system in terms of its contributions to employability, industry, culture and research and thus to the national development.

Till some decades back, the perilous effects of this system were limited to streams of arts, commerce and science but did not affect engineering because there were only few engineering institutes that maintained requisite standards of a professional degree course. But with the mushroom growth of engineering institutes in the country in recent years engineering education too has been going through the same state of deterioration. This is borne out through the recent statistical data pertaining to poor percentage of accredited engineering programs and poor employability of the engineering graduates in the country. With an exception of premiere institutes such as IITs, IISc and BITS, majority of our engineering institutes are wallowing in mediocrity.

According to the National Employability Report Engineers 2019, the employability of Indian engineers has not changed on aggregate level since 2010 and 80 per cent Indian engineers are not fit for any job in the knowledge economy [53, 54]. The Executive Summary of the report says that only 3.84 % of engineers are employable in software-related jobs at start-ups; around 3% engineers possess new-age skills in areas such as AI, Machine Learning, Data engineering and Mobile technologies and only 40% of engineering graduates end up doing an internship and 36% do any projects beyond coursework.

The last two decades saw a rapid proliferation in the number of engineering colleges in the country with the number increasing from 1511 in 2006 to 3392 in 2014 [55]. But this period also witnessed a rapid deterioration and a concomitant decline in the interest of society in engineering education. This is reflected in the large number of seats in engineering colleges (almost half of the sanctioned intake) remaining vacant in last few years [4, 56]. In December 2017, six states requested AICTE to not approve new colleges as the demand for engineering seats in their respective states was consistently low [57]. With engineering education losing its sheen, science courses have recently started getting preference to engineering courses for UG education [58].

As the crisis in engineering education is becoming more visible, it is becoming clear how the quality of engineering education is playing spoilsport in capitalising our rich youth demographic dividend and impeding our march towards a developed status. Recently AICTE announced measures to curb this deterioration by reducing the number and intake capacity of engineering colleges and increasing the number of accredited engineering programmes in the country. Presently just around 15% programs are accredited [59, 60]. However, such measures alone cannot provide long term solutions to the problems engineering education is facing today and more fundamental solutions need to be sought through a more in depth analysis.

The roots of many of these problems plaguing the current engineering education can be traced to the systematic destruction of the indigenous education system of Bharat and its replacement by a system that would serve the British colonial interests. A little insight into history reveals this. The handful of British rulers found it very difficult to govern a large country like India without the participation of her own people. Thus British rulers wanted people born in India to work for the British. They wanted pupils to become either good clerks (followers of orders from higher authorities) or good civil servants (higher authorities subservient to British). They realised that the strong system of education existing then would not let this happen and thus introduced a new system to serve these motives. Macaulay led these motives by promulgating an education policy in 1835 that denigrated indigenous education and promoted English education through English language. Two quotes by Macaulay included in Table 7 clearly bring out these motives.

Table 7 : Macaulay's quotes revealing motives behind the education system introduced by British

(i) I have travelled across the length and breadth of India and I have not seen one person who is a beggar, who is a thief. Such wealth that I have seen in this country, such high moral values, people of such caliber, that I do not think we would ever conquer this country, unless we break the very backbone of this nation, which is her spiritual and cultural heritage and therefo re, I propose that we replace her old and ancient education system, her culture, for if the Indians think that all that is foreign and English is good and greater than their own, they will lose their self esteem, their native culture and they will become what we want them, a truly dominated nation. (ii) We must at present do our best to form a class who may be interpreters between us and the millions whom we govern; a class of persons, Indian in blood and colour, but English in taste, in opinions, in morals, and in intellect.	[61, 62]

Mahatma Gandhi could discern the destructive potential of this new system very early and expressed it in his address at Chatham House, London, on 20 October, 1931, " ---- I say without fear of my figures being challenged successfully, that today India is more illiterate than it was fifty or a hundred years ago, and so is Burma, because the British administrators, when they came to India, instead of taking hold of things as they were, began to root them out. They scratched the soil and began to look at the root, and left the root like that, and the beautiful tree perished. ---- [33]". The vicious motives of British behind the system of education introduced by them have been brought forth convincingly by several historians [9, 61-64]. Table 8 includes a few observations from these works.

Table 8 : Observations that bring forth the British motives behind the education system introduced by them

Observation	Reference
Under the British, the universities remained largely examinations conducting bodies ---- The colleges like the British schools in India, heavily emphasized rote learning, the regurgitation of which was what the examinations tested. The British higher education system did littl e to promote analytic capacity or creative thinking and certainly no independence of mind. Indians educated under this system, observed a senior civil servant in 1913, ' become a sort of hybrid. This is due to their English masters, who are obsessed with t he idea that the only way to "educate" anyone is to turn him into a plaster Englishman.'	9
Education in India under the British Government was first ignored, then violently and successfully opposed, then conducted on a system now universally admitte d to be erroneous and finally placed on its present footing.	63
--- that the great object of the British Government ought to be the promotion of European literature and science among the natives of India; and that all the funds appropriated for the purpose of education would be best employed on English education alone . (first order passed in the resolution by Lord William Bentick's Government in 1835)	64

The observations in Table 8 convince us how the changes introduced by the British moved us away from our native and natural structures of learning for knowledge, skills and wisdom to the artificial and alien structures of learning for marks, grades and degrees. They were intended to produce followers instead of leaders; they discouraged original and independent thinking and encouraged slavish notions. We are suffering from the ill effects of Maculayism even today as we are still following more or less the same system even after seven decades of independence. Today also the products of our education system look down upon anything that is remotely related to Bharat and neglect the huge and magnificent reservoir of our ancient knowledge and wisdom. The artificial exam oriented structures have made the system vulnerable to dilution and deterioration to a great extent [65, 66]. We are conditioning millions of our students to think and grow only through the language of marks, grades and degrees suppressing their natural creative instincts and talents.

When we discuss our education in the post independence era, several attempts to improve our education system from time to time at governmental and nongovernmental levels are cited as examples of reforms. But a closer look reveals that majority of these reforms were changes that accepted and maintained the fundamentals of the system the same as the one that the British handed over to us, i.e., they eluded a fundamental overhaul of the system. Many initiatives are cited by the engineering education researchers as efforts to overcome the lacunae of our present system [3, 67, 68]. However, they are either like the blue oceans in the vast red oceans of marks, grades and degrees [69] or cannot bloom to their full glory as they often get suffocated and smothered by the rigid constraints of our education. For example, accreditation agencies like NBA follow the principles and guidelines of OBE (outcome based education) that is useful for improving the teaching learning processes in engineering institutes but the CO–PO attainments are mostly calculated using the marks scored by students, which cannot always be the correct and only yardsticks of student's learning [70].

4. Transforming the Present Engineering Education with Motivations from Bharat

It is a common experience that the discussions and debates pertaining to the desirable transformation in the present engineering education generally end with a pessimistic conclusion that we cannot change our system. This is the reflection of the deep roots of Maculayism in our country. We seldom realise that it is not our system. It was an alien system introduced by the British to serve their primary interest to rule us. If we can bring this thought into mainstream, we can easily usher an era of transformation. Such a transformation should thus envisage resurgence of the education system of Bharat by externalising the alien system introduced by British and internalising our original, innate system that served us so long successfully. This may not be as difficult as it looks as going to one's roots should be natural to us. Moreover, our overwhelmingly long periods of success spanning thousands of years should also motivate us to overcome the ills which crept in our system only in last few centuries. In table 9 we enlist a few steps that can facilitate our natural progress in this direction.

Table 9 : A few steps to facilitate our natural progress in the direction of revival of our past as our future

1. This land had been known as B harat since antiquity. It means 'one who is engaged in search for knowledge' – a synonym for what is today called a "knowledge society". The word India that the British gave us does not imply the same power and prestige as Bharat connotes. Thus the word Bharat should be used instead of India, wherever possible, to retain the pride and self esteem associated with it.
2. Many of the problems being faced in today's education, in general, and engineering education in particular, are due to the barriers of language in understanding various subjects taught through English medium . It is a well known fact the assimilation of any knowledge is optimum through one's own native language. This is borne out by a clear research that children learn best in th eir own mother tongues and by the tremendous progress achieved by nations, which have adopted their native languages as media of instruction [71].
3. We should not view Universities as the only islands of kno wledge in the sea of ignorance. This view dominated for the past 3 -4 centuries from the beginning of colonization of much of the people of the world since the birth of modern science in Europe . The dominant viewpoint for resurgent Bharat has to be 'Knowledge in Society' (Lokavidya) according to which knowledge is produced and incessantly renewed as living knowledge by human societies, communities and peoples through their productive, cultural and social existence [72]. Examples of Lokavidya include everyday activities of the peasant, or the weaver, or the metal worker or the Baiga iron smelter.

In our journey of transformation the first point that needs to be noted is that today's educational institutes running a system based primarily on marks and degrees are weak translations of what existed and suited Bharat the best. Education in Bharat was considered a sacred process closely linked to life and thus served to fulfil the economic and cultural needs of the country. This system looked upon education as the holistic development of body, mind, intellect and soul because it believed that only a small fraction of knowledge can be expressed in words or scripts and this fraction alone cannot complete the main aim of education. It believed that objectives of education are not different than objectives of life [73]. Thus the teaching learning process of this system differed drastically from today's system in several respects. A few of these are included in Table 10. With the system introduced by British, education got divorced and delinked from life (life of an individual, society and nation).

The close links that existed in past between the education we provided and the prosperity we enjoyed can be great motivations for improving our present education. They can guide initiatives which can liberate our present education from the artificial constraints introduced by British and make it a more open and flexible system, which is conducive to learning and can cater to our vast youth demography. We call these initiatives as 'learning initiatives' (LIs). These initiatives need not be considered as some new and external set of reforms that need to be experimented before institutionalising in the present education. On the other hand, they need to be understood as reforms from within the existing system to eradicate the contaminations introduced in our original system by the British and to resurrect the beautiful tree of education that once existed and flourished in Bharat. They just embody a paradigm shift of focus of learning to knowledge, skills and wisdom from its pre

Table 10 : Teaching learning system of education system of Bharat [73, 74]

(i) Teachers enjoyed complete autonomy in matters s uch as number of students and subjects taught (no centralised syllabus). (ii) There was freedom of lengthening or shortening the learning period in accordance with the intellectual abilities and dedication of the student in question. The student was not allowed to proceed to the next unit unless one unit was mastered completely. (iii) Examinations were not considered part of the requirements to complete one's studies. (iv) No convocations were held and no written degrees were awarded, since it was believed that knowledge was its own reward. (v) Student's intensity of motivation for earning knowledge was tested for admission . If the motivation was lacking students were given time and called for admission at a later date. Pursuit of knowledge was the only basis of education.

From this perspective many existing initiatives that address the objectives of overcoming the lacunae of our present system such as OBE, project based learning, learning by doing, business incubator and knowledge center initiative [3, 67, 68] also become the examples of LIs provided they are not governed by the constraints of the present system. Thus projects completed in the current system as routine requirements for obtaining degrees are not examples of LI. But projects completed with learning that is adequate enough to enable students in getting placed in their cherished companies or in starting their own ventures are examples of LI. Such projects lose the relevance of the question how many marks they fetched.

The knowledge center initiative taken by us has been developing as a strong example of LI in recent years. The initiative has been discussed in details in our earlier papers [1,4,5,75]. These details include the premises of the initiative, methodology of its implementation and the case studies based on the implementation. The initiative addresses how the natural learning based on the ignorance and curiosity of learners can be facilitated through a cafeteria approach that promises them the benefits of enjoyment, employment, empowerment and enlightenment.

In Table 11 we discuss how LIs promise to bring about the desired transformations in the present engineering education by overcoming its fundamental flaws. Table 12 shows how LIs can be launched on a large number of platforms and can attract youth due to their inherent freedom and flexibility.sent focus on syllabi, exams, marks and degrees.

Table 11 : LIs for transforming the present engineering education

Flaws in the Present System	How LIs Promise to Overcome them
In the present system a teacher teaches a class of students to prepare them for a particular syllabus and a particular exam. The system thus speaks only in the parlance of marks, grades and degrees.	In L Is experts guide and facilitate learners to pursue th eir motivations to accomplish the set goals. LIs thus speak in the parlance such as 'learning motivations', 'learning goals', 'learning processes' and 'learning outcomes'.
The present system of education is based on 'one size fits all' approach - a system that compels every student to follow the same syllabus, same examination pattern and same evaluation procedures despite wide variations in their natural ignorance and competence, pace and style of learning.	LIs are based on the premise that learning can be optimised if it is in resonance with one's natural propensities. They will thus enable everyone to follow an independent learning curve. This will help overcome the 'one size fits all' approach by personalizing and customizing the education to the propensities and needs of individual learners.
Exams conducted in the university affiliated colleges have lost much of their meaning in recent years and the marks scored in these exams are no longer considered as effective yardsticks for testing the knowledge and skills of students. Most of the employers and institutes of higher learning don't believe in the se marks and conduct their own exams to find out the knowledge and skill based competence of students. These exams, on the other hand, are conducted to filter out a majority of students because of t he limited available opportunities. The employability based on the present education has thus become an issue of major concern as students face a harsh reality that the marks that earned them a degree have little or no relation with the knowledge and skill based competence desired by their prospective employers.	In L I either there are no exams or exams are held only for the purpose of assessing the learning outc omes, i.e., for assessing the knowledge and skills of learners rather than their ignorance. Thus exams are used not for awarding marks to learners (and declaring them pass or fail) but for knowing about their progress towards the accomplishment of the ir learning goals so that the necessary compensatory steps can be taken to com plete the requisite learning. This can definitely improve the employability as it avoids the 'beating about the bush ' syndrome followed in the present system of first acquiring a degree with an aim of getting a job and then finding that the degree lacked the knowledge and skills required to fetch a job. Like driving schools in which a learner enters with a specific aim of learning driving and exits after completing the required learning, L Is facilitate acquiring specific knowledge and skills demanded by a particular job to get that job.

Table 12 : Different platforms on which LIs can be launched

Educational Institutes	Industries / Organisations
LI may be developed as a grass root initiative in any educational institute as a compensatory mechanism to overcome the lacunae of the present system. In this way LI can serve as a natural platform to plan and prepare for goals like accreditation and autonomy of the institute.	LIs can be started in different industries and organizations to facilitate acquiring relevant knowledge and skills . A convincing example of how L Is can be started for achieving societal goals is the Hathkargha project launched by Mahakavi Pandit Bhuramal social cooperative center, Dongargarh (MP), with the inspiration of Jain Aacharya Shree Vidyasagarji Maharaj [76].

The administrative bodies like UGC and AICTE can encourage institutes to develop LIs through appropriate policy reforms, strategies and support . This will enable these bodies to introduce the intended reforms in education in a smoother way. An independent program may be launched to introduce such initiatives within and beyond the educational institutes across the country.

Tables 11 and 12 bring forth how LIs promise to provide long term solutions to the problems faced by the present engineering education in the country. They show us better ways to arrest the present state of deterioration than just increasing or decreasing the number of engineering colleges. With LIs as integral parts more colleges is not a problem as they can serve our growing human resource needs arising due to our developmental aspirations. On the other hand LIs also help us to go beyond the present short term solution of decreasing the number of colleges on the basis of uniform accreditation criteria for evaluating all colleges. LIs that can be launched on a variety of platforms will bring forth how deregulation and de-bureaucratisation of the accreditation procedures can help us in accommodating such initiatives in our system and thus enriching it.

Such LIs can harness our rich natural, indigenous and tacit knowledge, skills and wisdom and open their floodgates to our demographically favourable young population. Thus they promise the development of a career thesaurus out of the knowledge and skills thesaurus to match the plural and diverse interests of our youth to create a win-win situation. This can lead to a resonant matching between the interest spectrum of our youth and the development demands of our country. This, in turn, can provide us the confidence and determination to re-emerge as a developed nation in future not by emulating some other developed country but by revisiting our own history and reliving our own glorious past.

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