Scientific temper: An arena of contestation in a globalised world

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Abstract

The notion of a 'scientific temper' embedded in the political discourse in India, transcends boundaries of 'science'. It is rooted in ideas promoted by the European Enlightenment, and is generally expressed as a secular value system. In the course of introducing the notion of a 'scientific temper' to the Indian population bitter debates ensued around issues of 'science and society' by the budding scientific community. This notion was to serve as a catalyst for social change and eventually resulted in the articulation of a national goal termed as 'scientific temper'. It is argued that the objective of all science communication programmes is aimed to create a scientifically tempered society. Spreading a 'scientific temper' is a socio-political project that aims to create an

alternative dynamic worldview. It heavily impinges on social and cultural practices, facilitates renegotiation processes and has as its objective democratically shared social ideals. In course of time it is becoming clear that conflict arises between science and extra-science and the present paper probes the complexity of mediation between these two conceptual worldviews in a globalised world order. The paper also presents a policy perspective to science communication in India and the dynamics of some important outreach initiatives.

Introduction

At the outset we will stipulate three conditions to guide this conversation. Firstly, this presentation is not aimed to provide a solution to several questions and concerns repeatedly raised by the community of scholars in the area of Public Understanding of Science (PUS) over the past 30 years. We argue that all science communication activities should aim at developing a 'scientifically tempered society'.

Secondly, this presentation builds on the keynote address delivered at the International Conference on Science Communication, Nancy, France, 2012 , and two editorials published in the Journal of Scientific Temper. Thirdly, the presentation draws heavily on the Indian experience and history; therefore, any generalisation requires careful scrutiny to ensure local applicability.

Background and Ideological basis of scientific revolution

All revolutions have a past, present and, if successful, a future too. This is true also of scientific revolution. Recent work in the history of the European Enlightenment tells us it was not a one-off event[i]. David C Lindberg acknowledges that 'the rationalism of the Greeks was one of the greatest achievements of antiquity' and he asserts that 'with the living traditions' (after Christianity spread to Europe) 'philosophy was becoming progressively more like religion, based on inspired authorities, with mystical illumination and personal salvation'[ii]. He further notes that the ideals of rationality and objectivity through the ages to a limited extent continue to be 'available and influential'. Science in this regard was perceived as the 'handmaiden of theology' and its role was limited to the 'interpretation of Holy Scripture'[iii]. The fortification around scientific investigation

started to develop cracks by the 12th century. Grant (1986:52) argues that 'Thus were the seeds of science–theology confrontation planted, the bitter fruits of which would grow to mature in the thirteenth century following upon the introduction of Aristotle's scientific works, which formed the crucial core of the new Greco-Arab science that entered the Western Europe'.

The 'confrontation planted' was not a sufficient condition for scientific revolution to take place in Europe. During the previous century two competing theories gained acceptance among scholars[iv]. Firstly, it was suggested that the application of mathematics to 'natural philosophy' cleared the deck. 'A revolution in science resulted, therefore, when Copernicus, Galileo and other early modern scholars united the two enterprises, thereby creating genuine mathematical physics and setting science (or the physical sciences at least) on the road to modernity.'(Op. cit. p360). The other group of scholars proposed that the application of the method of science and experimentation eventually resulted in a paradigm shift in favour of the sciences (op. cit. p 362). Even if we assume that there was disconnect between natural philosophy and mathematics (which, evidence shows, is obviously erroneous) in Europe, the first hypothesis could easily be rejected. Evidence shows that in India, China and Arabia, mathematics was always an integral part of scientific investigations. The second theory cannot be accepted because philosophers through the ages systematically performed controlled experiments often using instruments, but could not produce a scientific revolution[v].

Lindberg shows that the revolutionary catalytic agent in the sixteenth and seventeenth century was metaphysical and cosmological rather than methodological (op. cit. p364). It was the advocates of a 'mechanistic universe of lifeless, indivisible atoms moving in an infinite void', that struck the final blow. In the fearsome clash of ideas, 'the organic universe of medieval metaphysics and cosmology had been routed by the lifeless machinery of the atomists' (op. cit. 365).

The old ideologies, though over a long period of time, lost the battle for control and dominance and the institutional structures based on these ideologies crumbled. There was no prime cause required to understand nature, any more. As the power of the prime mover, the God, weakened, the authority of the church and royalty was also challenged. It is therefore safe to assume that scientific revolution was an event on the trajectory of

human civilization when old, outmoded ideas collided fiercely with the newly emerging paradigm of secular thought. This clash of paradigms did not take place in an ideological vacuum. The 'ideologically rich historical foundation' of a secular modern science inspired the masses as well as the emerging bourgeois class, who became its vanguard.

The ideas get transformed

The next centuries witnessed two important processes. Firstly, as the political power balance changed in Europe, the ideas of Enlightenment went through a transformation in European societies. Secondly, these ideas travelled through cultural spaces across the globe, encountered varying consciousness levels and went through transformative phases before being absorbed within the various cultural thought-structures of societies.

For example: Grayling argues that in eighteenth-century France, aggressive anti-clericalism was a form of secularism[vi]. As the 'intrusive and oppressive priestcraft' withered away from the west, both content and the form of secularism changed. It assumed a neutral meaning that is embedded in the 'separation of church and state'; a significantly less 'hostile' notion. As these secular ideas travelled to other parts of the world, the word 'church' was replaced by 'religion', especially when they encountered multi-religious societies. In the process the 'hostility' was further diluted.

The notion of 'secularism' transmuted in content and form in Europe over the past three centuries. However, it was always closely linked to the idea of scientific enquiry, scientific method and scientific rationality. In India it went through a transformation when it encountered a social structure that was fractured along religious, caste, linguistic and regional identities. Secularism in the Indian context did not mean 'separation of church and state' rather, it was understood as 'The State shall not discriminate against any citizen on grounds only of religion, race, caste, sex, place of birth or any of them' (Article 15, Constitution of India). This understanding was arrived at over a period of more than a hundred and fifty years of political debate and freedom struggle.

Secular Values and scientific temper

The debate on the importance of modern science, science education, science popularisation and science-society relationships had started in India during the early 19th century[vii], gained momentum during its second half[viii]. Phrases like 'Modern Knowledge', 'Scientific Method', 'Western Models of investigation', 'Liberal and Enlightened System' and 'Scientific Spirit' became part of the intellectual discourse[ix]. Though, initially, this debate was limited in its reach, by the turn of the century the emerging scientific community, social reformers, media, educationists and the leaders of resistance movement had started using these terms frequently. Gradually, these ideas seeped through the osmotic membranes of caste, class and language, and became part of the cognitive structure of the people.

As the debate matured over the next fifty years, Pt. Jawaharlal Nehru, probably, realising that the notion of secularism has been reduced to Hindu-Muslim Unity[1], introduced the somewhat hazy idea of 'scientific temper'[x]. Over the next fifty years, in an independent India, some of the tenets of scientific temper have crystallised into a more focussed understanding of this term[xi]. Though it can be argued that the Indian populace of today is more scientifically tempered compared to the days of the British Raj, building a scientifically tempered society still remains a distant dream[xii]. The 'cynical' may argue that constructing an ideal scientifically tempered society is a utopian dream. The 'romantics' may reject the idea of constructing such a society altogether[xiii]. Others may continue to trace the roots of dynamic and robust democratic structures within a science-society relationship.

The term 'scientific temper' might be a fuzzy notion; it does not mean that, at any given point of time, the distinct features that characterise this term cannot be identified. Both science and society continually evolve and therefore the relationship between the two is dynamic, nonlinear, complex and ever changing vis-à-vis a social structure. Consequently, the contours of the science-society linkage also change as it encounters different socio-cultural structures.

[1] In order to rule the Indian subcontinent, the British master had actively incited large-scale violence between Hindus and Muslims.

Science verses Extra-Science

As opposed to a continuous progress within the scientific-knowledge-complex, in other structures of configuring the cosmos and its reality, the ultimate truth remains frozen in time. These structures of thought could collectively be termed as extra-scientific. Across cultures which subscribe to extra-science, perceptions about the ultimate truth may change radically, but within a specific thought structure, compared to science, perceptions do not change with time[2]. The rigidity, inherent in such thought structures, does not allow any radical change. This renders the propagation of extra-scientific messages easy; the repeatability ensures inelastic crystallization of perceptions within the thought structure of a common citizen. Extra-scientific ideas are transmitted through repeated messages, symbols, social conversation, literature, folklores and religious practices, from one generation to another.

Surveys on public understanding of science carried out in India suggest that the migration of people from rural areas to urban centres causes a cognitive void[xiv]. In a rural cultural milieu, traditional belief systems, and in turn religious worldviews, are transmitted to new generations through strong interpersonal interaction[xv]. Due to changes in cultural settings, in urban areas the interpersonal communication between generations is reduced considerably and thus the process of transmission of traditional ideas gets disrupted. However, the robust interpersonal channel of the rural areas is replaced by even more efficacious electronic channels of communication, which thrive on repeatability of messages. This characteristic of the modern media makes it mellifluous to transmit extra-scientific messages[3].

Ever changing scientific information causes cognitive dissonance

Scientific information is often counter-intuitive and changes regularly, and at times, radically. In other words, it creates paradigm shifts (Kuhn T S, 1996)[xvi] or, to

[2] For example the theory of creation in Semitic religions is very different from the theory in the Hindu religion or Buddhist cosmology.

[3] In India as well as in many other developing countries there is no science TV channel, but there are many religious channels. In India 10 religious channels operate on 24X7 basis. Many news or entertainment channels reserve time slots for transmission of religious discourse.

borrow a phrase from dialectical materialism, goes through a phase transformation of 'quantitative to qualitative change'. When a change comes about in the scientific-knowledge-complex, it is not a function of variation in cultural spaces. Firstly, the shifts materialise on a timeline, and initially, dominate the spaces of consciousness that a scientific community holds. Usually, after the validation and broad acceptance of a new piece of information or a new scientific theory by the scientific community, the new ideas seep through the national, regional, cultural, linguistic and even religious boundaries and tend to occupy thought complexes of the non-expert populace over a period of long time. Conversely, in extra-science different religious-cultural spaces offer different 'truths' but within a group the ideas once accepted do not change with time. This difference makes the task of propagating scientific information, idea, laws and consciousness, and thereby creating a scientifically tempered society, increasingly difficult.

At the micro level, Gauhar has argued elsewhere, that the cognitive structure of a common citizen contains spaces which are secular, materialistic and scientifically shaped (Raza, et al 1999). It also consists of extra-scientific ideas. These two diametrically opposite and contradictory spaces continue to co-exist peacefully. A common citizen invokes one or the other, depending upon the nature of the problem that s/he encounters during quotidian life through an assessment of what option will furnish her/him with the desired results.

Science communicators strive to propagate secular facts and scientific tenets aimed at enlarging the scientific cognitive space and presume that it will reduce the extra-scientific space. Evidence, however, indicates an increase in scientific information does not necessarily result in reduction of extra-scientific beliefs[xvii]. The project of 'spreading scientific temper', which is a constitutional duty of the citizens in India, is quite a complex one. Spreading scientific awareness is only a precondition for the creation of scientific temper. It follows that science popularisation cannot be an end in itself. The multi-dimensionality and non-linearity of processes involved in science communication forbid a direct causal linkage. Let me borrow a notion from physics; there are always a few social and cultural dimensions which are 'curled up', and remain hidden from the observer's eyes, any small perturbation in those dimensions may cause a butterfly effect, and all prediction may prove to be wrong (Greene, 1999)[xviii].

Carefully chalked out strategies for communicating science, may often not yield the desired results. For example, national surveys carried out in the western countries have repeatedly reported inconsequential increase in scientific literacy. The NSF and Eurobarometer reports published over the last 20 years show how worrisome the situation has remained. Scholars repeatedly question the indicators and methodologies followed by researchers who carry out these studies. However, the broad conclusions reflect the primary concern of science communicators that their efforts have not made any significant change.

Culture as the arena of contestation and Globalisation

Culture is the arena of contestation where ideas collide, transform, renegotiate and get assimilated to form new structures of thought. If we consider the two domains of culture, the scientific and extra-scientific, consistently negotiating and re-negotiating with all other domains, the processes could be understood better. For example, statistical tools have influenced economics, politics, literature, judiciary, media, production processes and even religious discourse. The scientific idea that patterns exist in seemingly disordered processes was not accepted without contestation. Many more examples could be cited. This negotiation and re-negotiation between science and extra-science has become increasingly difficult to understand during the past few decades.

'Globalisation' along with its baggage of finance capital and market economy has put most societies under tremendous torsional stress. It has exponentially increased the pace of cross-cultural mediation. The clash of ideas, which, during the last century, took place in real time and space, is now is taking place in cyber space and is affecting societies profoundly. There is an upsurge in cross-country and cross-continental migrant labour. They act as carriers of their cultures and implant ideas, both scientific and extra-scientific, into the recipient culture. These processes have put traditional societies under great stress and even Europe, for the first time after WWII is feeling the heat of ethnic friction. Science communicators cannot afford to keep their eyes closed regarding these developments.

The robust policy setting in India as an essential enabler to mainstream scientific temper

Scientific temper is a desired trait of persona to think and behave rationally preferably in sync with modern scientific knowledge. It is essential for sustainable development and peaceful living that most of the countries are striving to foster it among their citizens. India did not lag behind at the level of policy and directives. She created a robust mix of appropriate infrastructure, implementing programmes and an activity further recognizing the fact that scientific temper is not uniform in all people and is determined as a part of their persona. The following presents the issue of fostering scientific temper from the policy and directive perspective.

India issued a 'Scientific Policy Resolution (SPR)' in 1958,approved by the Indian parliament, articulating the importance of science and technology for its development. It resolved 'tofoster, promote, and sustain, by all appropriate means the cultivation of science, and scientific research in all its aspects - pure applied and educational' and further state 'to encourage individual initiative for acquisition and dissemination of knowledge (GOI, SPR, 1958)'. The dissemination of scientific knowledge entails its popularisation, S&T communication through engagement of the people. These are echoed in all subsequent policy and directive documents too such as Technology Policy Statements-1983, Science and Technology Policy- 2003 and Science, Technology and Innovation Policy-2013. So much so that the 43rdamendment to the Indian Constitution was introduced ' to develop scientific temper, humanism and the spirit of enquiry and reform' under fundamental duties for citizens (Bedi et al 2000).

The Role of the NCSTC in fostering scientific temper

As promotion and nurture of scientific temper is an constitutionl mandate there are number of agencies that have been establihsed under the ageis of the Government to nurture scientific temper and communicate science to the public. The National Council for Science and Technology Communication (NCSTC) of the Department of Science and Technology, National Institute for Science Communication and Research (NISCAIR), Vigyan Prasar and National Council for Science Museum are the four major national level agencies involved in the task of spreading sceintific temper.

The National Council for Science and Technology Communication (NCSTC) recognizes that science and technology have emerged as key determinants of of social transformation in India. Initiatives of the NCSTC emphasize the fact that science is a body of rational knowledge, universal in nature, and can be reproduced through experimentation. Well, laid out steps that signify the 'method of Science' are equally important for the authenticity of knowledge it generates.

The implementation of S&T policies facilitated setting up of four major institutions for popularisation of Science and Technology. The National Council for Science and Technology Communication (NCSTC) was set up within Central Government to coordinate and orchestrate the science popularisation efforts in the country; the National Council for Science Museums (NCSM) was set up under Ministry of Culture as an autonomous body to conceive, conceptualise, implement and maintain S&T museums, science centres and science cities across the country. The VigyanPrasar (VP) was setup to generate S&T communication resources- print and electronic- and National Institute for Science Communication and Research (NISCAR) for research in this emerging field. The S&T Councils and departments in each state promotes and popularises science and technology at the local level. Numerous science and technology based Non-Government Organisations (NGO) actively participate in this process.

The NCSTC was setup in 1982 and launched a major outreach initiative, 'Bharat Jan VigyanJatha (BJVJ)' in 1987 that represented massive mobilisation and direct contact with citizens. It involved 26 NGOs, travelled 25,000 kms, with 500 halts at various locations. The whole country was divided into five regions for administrative convenience. Regional languages were used as a means for communication. The whole event was organised around such focal themes as self-reliance and national integration through S&T. After five years, a similar exercise was undertaken during 1992, Bharat Jan GyanVigyanJatha (BJGVJ). The Ministry of Human Resources Development (MHRD) also participated in it. The experience gained by the MHRD become precursor for launching 'Indian Literacy Mission'.

The NCSTC was eager to put all means of communication such as TV and Radio to use. It developed 13 episode serials 'Bharat Ki Chhap' depicting S&T contribution of Indian sub-continent. 'Evolution of Man' was another 144 episode Radio serial

broadcasted from 80 radio stations and in 18 regional languages. Currently ' Community Radio (CR)' is expanding very fast. It is being used to popularise health issues – particularly reproductive among female adolescents in deprived localities. A serial on Mathematics-' Ankokekhilari' is also on at 117 radio stations and in19 languages. VP and All India Radio are other collaborators.Theseserials were/are huge success.

The Total Solar Eclipse (TSE) provided an opportunity in 1995 and 1999 for massive engagement with the people. In India there are many myths and superstitions associated with celestial events and NCSTC decided to demystify it and explain the science of TSE to the people (Kamble,1999). TV, Radio, NGOs, state science and technology councils and departments, academic institutions and volunteers were mobilised to engage with the people. A lot of popular resources such as solar filter kit, information brochure, booklets, greeting cards, wall charts, activity kits etc were generated and distributed widely and freely.

The method of science is as important as the knowledge generated. Sensitisation of students about scientific method is an investments in the future. NCSTC conceptualised and is implementing a programme for past 20 years 'National Children Science Congress (NCSC) ' for students in the age range of 10-17. The students are expected to work in team of five students under guidance of a teacher, around a focal research topic chosen nationally. The screening takes place at the school , district , state and national level. A few selected awardees have the opportunity of visiting national and international laboratories, participation in International Science and Engineering Fair (ISEF) at USA. A few selected students are provided opportunity of interaction with the front ranking scientists in the annual session of Indian Science Congress Association. Our collaborators hails from School systems, State Councils, NGOs, Academic institutions and S&T establishments. Around one million students participate every year. In addition to this, there are programmes tofoster innovation among students as well.

Exhibitions and demonstrations are very effective tools to take science and technology to the people. NCSTC support such endeavours of NGOs and academic sectors for fabricating and exhibiting static as well as mobile exhibitions. It had launched 16 coach ac train in collaboration with Max Planck Society, Germany in 2007 exhibiting the S&T exhibits of 'Science tunnel' for four tours across the country. Currently the

'Science Express' is carrying the exhibits packaging Indian Biodiversity and its conservation in collaboration with Ministry of Environment and Forest. It has been visited by more than a million people. Some sets of exhibitions loaded on buses move place to place particularly to schools demonstrating basic principles of science. Our collaborators are supported through grant-in- aid to mount static exhibitions at the places which are in easy access to the people eg. religious fairs and gatherings.

Celebrations involving the students and people are another effective way to engage students and people with S&T. NCSTC helps observe the 'National Science Day (NSD)' every Feb 28 to celebrate excellence in discovery science. It is the day discovery of 'Raman effect' was accepted by the scientific community and Raman was awarded the Nobel prize later in 1930. The occasion is celebrated to inspire the students and kids to develop positive inclination for the science. Similarly 'National Mathematics Day (NMD)' on Dec 22 and 'National Technology Day (NTD) on May 11 are celebrated to emphasise the importance of science, mathematics and technology. The celebrations entails open houses by national laboratories, debates on S&T issues, quizzes, exhibitions, essay and paintings competitions etc. A focal theme is selected for celebration of NSD- the focal theme for 2014 was fostering the scientific temper keeping the125th birth anniversary of Pandit Jawaharlal Nehru in view- an ardent votary of science and scientific temper (Nehru 1943).

A pool of quality manpower- science communicators- are essential to carry out any programme across the nation. NCSTC organises training programmes to hone skills and run certificate, diploma and degree courses in select universities. NCSTC has instituted scholarships for aspiring science communicators. They are expected to work on a project preferably in the media house to learn and practice S&T communication. A vast programme on 'Water' is developing and linkages are being thrashed out among local community, students and Panchayati Raj system. There are individuals contributing in generating scientific temper through various medium. NCSTC has constituted Awards and recognition systems for out- standing contributors and bestow these awards on the occasion of NSD.

A typology of science communication interventions

It is in this context we wish to highlight a typology of science communication interventions in India. The typology centres on a variety of principal objectives twinned with the mutually reinforcing objective of fostering scientific temper. These approaches embed socio – cultural and economic imperatives in some cases and learning objectives as the case may be.

A typical case in point is the initiatives of the Kerala Shastra Sahitya Parishad(KSSP). During the 90s the KSSP aimed to tackle multiple impacts created by the emrgent of large multinational detergent / soap industry on the local economy in the State of Kerala. KSSP perceived that people in State were made to wrongly believe that larger quantum of lather generated by soaps indicated high quality of the cleansing agent. This had implications also on the quantum of water used to generate lather and hence proportionate waste of the limited water resource. This in turn would generate pollution that was imminently avoidable and promote wasteful water consumption practices. A well designed information campaign was launched to help citizens blow the myth linking lather and quality. Citizens were educated also on soap making to avoid purchase of the implicated soap and in this process also promote a cottage industry to meet livelihood needs. Preventive environmental management themes were aligned with economic imperatives, to help citizens base transitions on principles of science.

Ramanathapuram district in the State of Tamilnadu witnessed a economic upliftment scheme targeting single mother families deprived of livelihood opportunities. This scheme provided milch cows to the single mothers so that they could meet their livelihood needs by selling milk derived from cattle. While this was a well intended intervention, it suffered because the recipients sold the cattle away in a short while. The reason was that the women did not know anything about management of diseases that afflicted cattle in their possession. They thought it prudent to sell the cattle off than to tackle the disease, about which they knew niothing. In the traditional social order while women were the usual caretakers of the milch cows and were intensely involved in cleanliness of the animal and shed, they were not purview to the diseases that afflict cattle. These knowledge domain was restricted to males of the community through subtle gender barriers. When the single mothers had to tackle the health issues of the cattle

they felt overwhelmed and preferred to sell the cattle. The concerted capaing that was launched by the People's science movement reached out not only the 'target' women but every women in the community with the knowledge information on common diseases that afflict the cattle. The campaign was sensitive to the local knowledge and the medicalised diagnosis preferred by the modern veterinary sciences. The campaign also provided skills and knowledge regarding the home remedies and thus enabled agency of the women tending the cattle. Science communication campaign couplled with the appropriate managerial arrangement helped women overcome fetters of tradtion and work towards uplift their socio – economic profiles.

The initiatives of Ekalavya represent the case of infusing scientific outlook through experiential learning. This was for the specific benefit of children in schools in remote and far flung areas in the State of Madhya Pradesh. Locally available and appropriate materials were used to constrct doable science experiments without which the education would have largely remained one way sermons. From 'hands-on' science experiments, to socially relavent projects the Eklavya experiment endeavoured to create a critical science literacy. In socially stratifed communities such as rural India it is but natural that education is seen primarily as a road out of poverty for an individual. However, Eklavya also believes that they must help thier students to improve their lives (and the conditions which frame those lives), regardless of whether they move out of poverty or not.

The brief snapshots of empowerment advocacies presented above are premised upon the possibility for human growth and even transcendence. They inspire action by painting a picture of an imperfect world that can be repaired through collective human action. Critical science literacy provide an opportunity for us to critically reflect upon ourselves and our assumptions, enabling in the long-run voluntary transformation. And most importantly, they create deep affinity by acknowledging that human beings who can be something more than selfish machines seeking status, sex, comfort and convenience.

It is important to recognise that the scope to enhance the spread and depth of these outreach initiatives is significantly large in India. The scope for synergies across institution engaged in science and technology communication to coalesce efforts is also equally large duly recognizing the heterogeneous landscapes she offers to these

institutions. The overarching responsibility to recognize and practice scientific temper as embedded in her Constitution creates the necessary impetus to establish such synergies in a focused manner.

Conclusion

Scientific temper refers to a broad set of values that are rooted in the European ideas of the 'Enlightenment'. These values touch areas of human cognition and actions beyond the boundaries of science and impinge upon the domain of extra-science. Therefore, when these values encounter different cultural groups or sub-groups on a time-cultural space map, it is important to trace the spaces occupied by extra-science. Subsequently, from the broad set of values, it becomes imperative to draw a list of elements that will assist in claiming larger spaces during the struggle for creating a scientifically tempered society.

The project of 'spreading scientific temper' demands continuous research that should probe social, cultural, religious, economic, political (the list by no means is exhaustive) realities that contribute to the propagation of scientific temper or impede it. There is a need to continually revisit the nebulous notion that scientific temper is.

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