UNIVERSITÉ
DE LORRAINE

SCIENCE & YOU :
DEBATING SCIENCE CULTURE

RETHINKING THE CONVERSATION: 5 VIEWS

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FOREWORD

This seminar is intended to launch a debate on scientific and technological culture issues, but also more generally, on the ways in which science contributes to shape our everyday life. We hope the discussion will carry through to June 2015, for the Science & You event, and reach out beyond the usual framework of exchanges which take place over the span of a few days. Indeed, every day we have to face a chorus of political injunctions, stances, and media discourses, invoking science and the dissemination of science, as well as questions from the whole of civil society. The seminar will afford a time and a place for intense reflection, which we hope will then extend throughout the year and into different places. With this aim, we have called on top-ranking researchers, from Canada, China, France, India, Switzerland and the United Kingdom. Each one will share their own, inevitably different, understanding of what is at stake in science communication. It is precisely this difference which will allow us to shatter the conventional frameworks, often too purpose-built and simplistic, of a common reflection on the dissemination of science. We also want this seminar to create the conditions for interdisciplinary, interprofessional, intercultural and intergenerational sharing and confronting of ideas. It is a question of breaking free from routine ways of thinking which restrict our understanding of ongoing changes, and taking on the debate on science which we intend to observe and promote. I am convinced that this seminar can change us all and fully empower us as actors in the movement we have been caught up in.

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RETHINKING SCIENCE CULTURE AND GOVERNANCE TODAY

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The discourse to promote and raise the status of scientific culture (hereafter PUS) over the last fifty years is structured around four goals:

- transmitting the values and skills on which our modernity has been built;
- preserving the nation's competitive edge;
- grasping the developments in contemporary science as a part of culture; and
- enabling everyone to play a full part in current debates. These goals are periodically updated and reasserted in accordance with the development of social, political and economic isssues. Together, they form the core of the discourse bonding together actors and advocates of PUS.

We can only agree with these arguments. What could we object to them? Who would dare to deny the need for a scientific culture when the impact of science and technology – or to be more precise, the impact of techno-science – on contemporary society is such that we cannot conceive its evolution in their absence? How can we fail to notice their impact on professional activities and on every object, however humble, that fills our daily life? Who would deny that economic growth is closely linked with their development? Who then would object to the acquisition and mastering of scientific and technological skills needed by this integration? There are so many arguments in favour of these goals that it is impossible to challenge their legitimacy. Thus, they seem unsusceptible to credible opposition.

THE QUESTION OF NECESSITY

Under the pretence of promoting the need for PUS, some questions are eliminated out of hand. The main one is the following:

Why has the individual and collective acquisition of scientific knowledge been perceived for over fifty years as a social necessity? One of the reasons is that populations adjusting to a constantly renewed sociotechnical environment implies that they must constantly acquire new skills; and that updating these skills is now the essential requirement for preserving the collective ability to innovate, which is seen as the driving force behind economic and social development. Therefore, it is necessary to regularly update the level of skills and reassert the consensus in order to maintain collective performance.

This is nothing more than the transfer of a constantly evolving knowledge and its applications to the techno-economic sphere. Here, we encounter the spirit of the process described by Schumpeter which constantly revolutionizes the economic structure from within, destroying the old and creating new ones. This process of Creative Destruction is the main dynamic of capitalism[1]. This perpetual revolution in knowledge entails that of its applications and compels support for the process all the more as it is appears as a natural and irresistible phenomenon.

The strategy consists on the one hand in pretending there is a dissociation between the production of scientific knowledge and modes of development – as if science remained an autonomous sphere – on the other hand, in treating the direct link between science and economic development as given.

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[1] Schumpeter, J., ([1943] 1994), *Capitalism, Socialism and Democracy*, London : Routledge.

This is why the issue is less that of the persistence of a line of arguments than the circumstances that motivate its present-day revival. Why, for example, should Universcience, along with others, feel it has to reassert the need for a thirst for "discovery" and "innovation" on the same level as the need for an understanding of the "rapid and complex developments[2]" of techno-science? The issue raised by this revival is all the more pressing since the report published in 2012 by the French *Inspection générale de l'administration de l'éducation nationale et de la recherche* raises the question of the pertinence of the continuing usage of the concept of scientific illiteracy when more than 50% of the university age populaition pursue higher education and more than 32% of the French labour force work in science and technology[3]. What about the worn out disaffection for scientific studies? "Can we speak of disaffection when the number of newly-qualified engineers per year has almost doubled in the last 20 years (from 16 000 to almost 30 000 between 1990 and 2010)?"[4]

In other words, scientific illiteracy is not what is the real issue here. It is the distrust towards science and technology that must be countered. Given the pace of the development of techno-science, Universcience wants to prevent "misunderstading, mental block, or plain rejection". [5]

Yet this anticipated and very much feared distrust has nothing to do any more with the fear of and resistance to science which have been traditionally associated with a state of ignorance. In recent years, a growing ambivalence towards science has been identified amongst the more educated and cultured segments of the European demos. [6]

It seems to us that this ambivalence is born out of strong dissent about the historical and seemingly natural link between social progress, progress in knowledge, and technological and economic progress. This triple link is challenged because it is no longer justifiable to consider social progress as an inevitable outcome of technological and economic progress. At this point, we can speak of a reasoned anxiety in people's minds at "a time when techno-science and its impact on the collectivity, and thus on the public sphere, is increasingly brought into question".[7]

CONTROLLING DISCOURSE

Faced with these doubts, several strategies are mobilized to control both the speech of scientists and of the public. In general, this control works through the de-legitimization of opinions voiced on both side. It is easy to discredit the stands taken by the public by repeatedly measuring levels of scientific knowledge with tests that constantly reveal and construct a useful ignorance. But the repetition of these tests perpetuates the equivalence

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[2] Universcience, (non daté - undated), La culture scientifique et industrielle, un capital éducatif et culturel pour une société de l'innovation, et de la connaissance, www.universcience.fr/cs/(consulté le 30 novembre 2013).

[3] Cervel, Jean-François ; Bresson, Patrice ; Cormier, Béatrice ; Gauthier, Roger-François ; Mazodier, Myriem, (2012), *La diffusion de la culture scientifique : bilan et perspectives*, Rapport, Inspection générale de l'administration de l'éducation nationale et de la recherche, Ministère de l'enseignement supérieur et de la recherche, Ministère de l'éducation nationale, de la jeunesse et de la vie associative, p. 6.

[4] Holland: 38 %, Germany: 36 %, USA: 32 %, UK: 26 % ; EU average: 31 %, idem, p. 6.

[5] Universcience, op. cit.

[6] Bauer, M. W., (2009), *Indicateurs science-société*, Les Cahiers du M.U.R.S., 2ème trimestre, p. 114-115.
In this paper, Bauer states that in the context of the European Union, "the more a country is literate, the more its citizens tend to show scepticism about the benefits of science". (translated from French)

[7] Cervel et al, op. cit, p. 1.

between the assessment of knowledge and the memorization of encyclopaedic and decontextualized statements which in no way account for real knowledge, cognitive processes, or of the ability to deal with complexity that social actors muster on a daily basis. These standardized tests, for example, assess the public's ability to differentiate between the effects of antibiotics on bacteria and on viruses, for the sole purpose of pointing out that a great majority will get them mixed up, ignoring the skills needed to deal with highly complex conceptual and technological environments. These repeated surveys discreetly but faithfully serve the ideological construction of an ignorant public.

Paradoxically, this control also works through the de-legitimization of the position voiced by scientists. The exercise of critical reason, an essential component of the scientific mind since the 18th Century, is no longer of much use. It is even counter-productive within a neoliberal rationale. The Enlightenment no longer contributes to the wealth of nations. Thus, it has become necessary to dissociate the production of knowledge from the questioning of its origin and impact. The aim is to promote the role of the scientist, as producer of new and useful knowledge, against that of the scientist, as critical thinker.

DEMOTING SPEECH

This double de-legitimization takes form through the establishment of different systems of demotion for scientists and for the public.

Demoting the public's speech is achieved through hijacking, underrating and masking.

- Hijacking brings discredit on the public's desires and expectations of well-being and social progress, considered to be secondary to the imperative of solving the global economic crisis. Putting the accent on individualistic reflexes, which is backed by an opportunistic research rhetoric centered on the individual as being solely responsible for his or her own life, reduces the desire for well-being to a state of self-serving concern. Caught in this trap, the social actors who demand well-being involuntarily become the accomplices and agents of their own demotion.

- Underrating consists of calling into question the possibility of developing the means for public awareness and voicing of opinions, or of confining the voicing of opinion to a strict framework in predefined consultation systems, under the pretext that the public would in no way be competent enough to assess the complexity of contemporary issues and have an enlightened opinion on these questions. Purely institutional participative systems thus tend to allow individuals to express themselves on very general questions, above-ground themes, without allowing for of expression on questions claimed as pertinent by highly committed local actors. For example, a Consensus Conference on climate change will be suggested, while a demand for a debate on the construction of a new airport will be severely repressed on the grounds that the actors, though committed, are not aware of priority stakes for which they do not have the necessary expertise[8].
- Masking is carried out by controlling, deleting, or jamming information in order to

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[8] For an in-depth discussion of this aspect, see: Boltanski, L. & Chiapello, E., (1999), *Le nouvel esprit du capitalisme*, Paris: Gallimard.

systematically maintain uncertainties and doubts on the nature and extent of collective stakes, supposed to be scattered across multiple interests and divergent opinions. For example, in the case of climate change, while the scientific community is in agreement about global warming and its anthropic causes, the media, who are supposed to represent the state of awareness and opinions in the public space, constantly maintain doubts and uncertainties which benefit those who have no interest in these stakes appearing as a collective responsibility[9]. Thus, the media contribute either to the concealment of certain real debates or to the artificial fabrication of public controversies[10].

Basically, these procedures aim to reinterpret the meaning of what is doing the rounds, and impose a view derived from the commenting, reformulating or editorializing of numerous statements, whether spontaneous or requested. For example, many evaluation procedures turn the reactions elicited from different audiences into judgements.

What seems important to us is that these processes free up the power of technocratic discourse. Technocratic discourse is set up as an inescapable mediation insofar as it is presented as a coherent, rational, anonymous and collective discourse in a confused and vague social space. It exploits the authority of knowledgeable discourse and short-circuits democratic debate.

Demoting scientific discourse is established by other means.

- The first is the order issued to the scientific community to limit itself to a role of expertise, a role which also happens to be very much in demand and has high visibility. In taking on the role of experts, which gratifies them with a social justification and demonstrates the value of science, researchers get caught up in the play of economic and political interests and become accomplices in their own loss of freedom of speech. We can observe more and more cases of dual roles: researchers offer their services as experts in response to private demand, while setting themselves up as arbiters of the public good by virtue of their role as so-called repositories of scientific knowledge.

- The second system is direct censorship, that is to say the ban on communicating information likely to inform public debates, and thus on taking part in them. For example, the Harper Government in Canada has forbidden federal scientists to speak directly to the public or to answer questions journalists could ask them on themes which are heavily dependent on science (water pollution, the environmental impact of certain technologies, etc.). Any request for information they receive is to be passed on to the public relations department of the relevant ministry[11].

- The third system has to do with the management of research. On the one hand, we can note the generalization of management techniques in research: the generalization of financing through calls for tender, benchmarking, the obsession with labels of excellence, the integration of techniques for anticipating outcomes and disseminating

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[9] We cannot remain silent about the now well-established fact that the media have their own interests, independently of democratic or scientific stakes; nor can we disregard the fact, also well-established, that they are at times subject to attempts at manipulation.

[10] See: Oreskes, N. & Conway, E. M., (2011), *Merchants of Doubt*, New York: Bloomsbury Press.

[11] The policy adopted by the Harper Government has attracted very strong reactions. Even a superficial search of the media on the Internet will give an idea of its extent.

them, multiple evaluations at every stage of research and in every production unit (individuals, teams, networks, universities, laboratories, etc.) On the other hand, research is required to be anchored in economic processes, whether it be at the stage of obtaining funding for projects, which is granted in preference to consortiums of researchers and economic agents, rather than for the significance of the knowledge produced. Following this rationale, the knowledge value of what is produced is over-determined by potential economic worth. There is almost a direct correspondence between the value of knowledge production and the production of innovations having market value. Scientific invention today tends only to achieve full potential in innovation, which excludes numerous systems of knowledge.

These processes contribute to a growing heteronomy in the field of science. Contrary to the movement towards autonomy which characterized the development of science up till the 1980s, and whose institutional form was defined in 1945 by Vannevar Bush[12], a brutal reversal of trend can be observed from the 1980s on. All of the processes which had ensured the autonomy of the field have been called into question in the context of massive reforms of the organization of higher education and research in Europe, the USA and Canada. For example: peer review is no longer enough, it has to be coupled with multiple administrative assessments; the research timescale is considered ineffective compared with that needed by innovation[13]; the rendering of accounts to various authorities is now an integral part of research; etc. Moreover, it is now inconceivable that research organizations and universities can live without the contribution of a high number of engineers and agencies for management, promotion, evaluation, and communication which now frame the activities of teaching and research. What researchers say about the conditions of the production of knowledge is no longer taken into account in the organization of research activities. The rhythms and timeframes imposed on researchers dispossess them in part of the specificity of scientific activity. Thus, this ebbs away and takes refuge on the fringes of the organizations: it is to be found in seminars or classrooms, all of them places for the sociability and temporality suited to scientific creation, sometimes on personal time and in relative clandestinity.

PUS MANAGEMENT

It is worth remembering that the 1980s were also characterized by both the assertion of the need for scientific culture, and by the support provided by the State, which included it in its priorities, and gave every encouragement to actors in scientific circles to take initiatives and engage in activities promoting science as a culture and the circulation of knowledge from the scientific community towards the general public. Thus, from 1982 onwards, following the Chevènement Conference in France[14], disseminating the results of research to the public became one of the missions of researchers and teacher-researchers, who are civil servants. In the same way, many centres for scientific and technical culture and associations involved in PUS received support. In any case, the state did not think it necessary to provide a framework for these activities, actors being free to decide on objectives and the means to achieve them. Established knowledge (advances in science) was to be made accessible to the largest public possible on the

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[12] See: Bush, V., (1945), *Science The Endless Frontier*, A Report to the President by Vannevar Bush, Director of the Office of Scientific Research and Development.

[13] Thus, in France the time allotted for PhDs has been reduced to three years.

[14] Colloque national sur la recherche et la technologie, organised by the Minister, Jean-Pierre Chevènement, in 1982.

basis of an implicit, consensual and pragmatic model.

For thirty years, promoting and raising the status of scientific culture have remained a concern, but only one amongst many others. The State, without backing out of its commitment, has not considered PUS important enough to continue playing a role, satisfying itself with lending support. Having ardently advocated the convergence of science and society, the State soft-pedalled on the mission, at a moment when the interdependence of science, technology and society was growing.

This discretion on the part of the State is paradoxical. In fact, the space of science and its impact in social discourse is greater than ever: many actors no longer subscribe to the dissemination model, which is still very much predominant, and consider science as a subject of debate. Furthemore, criticism of science, which had been intense in the seventies, has been reactivated by a series of major crises concerning health and the environment, which highlight the collusion between techno-science and certain economic actors who care little about the public good. Just for the record, we can quote the Chernobyl disaster in 1986, which inaugurated an unbroken string of widely publicised health and environmental scandals.

This intense questioning poses a challenge to the model of economic development through continuous growth supported by innovation. For example, the alter-globalization movement born against the 1999 Seattle WTO conference[15] directly challenges the role assigned to science in this model, and thus takes part in what is now known under the generally accepted term of citizen science.

At the same time, Internet is becoming a part of daily life and brings great changes in the practices of social communication and forms of sociability. Thus, the advent of a digital and networking market creates a crisis in institutional and media communication which destabilizes the powers-that-be. Digital technology undermines traditional modes of communication and the hierarchies that underpin them; imposes the reorganization of scientific, educational and cultural practices; redraws the boundaries of social areas (as with universities); pervades the systems and procedures for validating knowledge. As a result, a plethora of actors, from both public and private spheres, are using new communication technologies to take part in dissemination and discussion activities. These new practices are obviously transforming contemporary forms of disseminating scientific culture, and weakening the traditional forms.

Moreover, taking advantage of the technologization of the social sciences, the growth of the managerial model gives rise to the development and application of tools for the management of activities and social productions (project management, evaluation, anticipation, quantification, communication, etc.). This managerial push can be seen as a counterpoint to the growth of the critical movement of citizen engagement, which promotes self-organization and advocates action on a local scale.

Finally, another major trend can be observed: the development of the steering of general policies at the supra-national level since the 1970s, with set slogans and agendas for states to adapt and adjust to. So there is a sort of reversal in meaning regarding the action of States, which is increasingly understood in terms of being centred on

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[15] See also: Wintrebert, R., (2007), Attac, la politique autrement ?, Paris : La Découverte.

global issues and so inevitably less open to the aspirations and actions of their own population. A particular example as far as we are concerned is the role played by the OECD (Organization for Economic Co-operation and Development). The OECD, founded in 1961, incites its member states, on the one hand to adopt a science policy, and on the other hand to invest in research in order to tackle the new scientific and technological challenges and improve their economic competitive edge. In the 1963 report *Science, Economic Growth, and Government Policy*, the OECD in particular recommends the development of national science policies, a recommendation to be followed by a majority of states involving the creation of ministries for research, responsible for setting up a national policy. In 1971, a second report, *Science, Growth, and Society*, after recording that most member States had implemented measures for the coordination of the national scientific effort, insists on the fact that science and technology form an integral part of economic and social development and that this implies a much closer link than in the past between science and technology policies and every field of socio-economic concern and government responsibility[16]. In a word, the OECD takes due note of the growing integration of science and society, and of the structuring effect of this integration. The OECD concludes, then, that the development of present-day society cannot be conceived without that of science and technology, and as a corollary, that the idea of economic and social progress is so closely connected with that of the development of science and technology that the two tend to merge. The OECD came back again in 1981 with *La politique scientifique et technologique pour les années 80*, when the economic context had changed and a structural crisis followed the period of rapid growth which characterized the post-war period. In this new context, the need to adapt the workforce to technological change becomes an overriding necessity for governments. "Perhaps", states the report, "a high level of scientific and mathematical culture across the whole population may be a prerequisite for the nation to have a workforce capable of responding to the demand for the higher level of professional qualifications entailed by the rapid implementation of new technologies in the national economy"[17].

Echoing rather belatedly the words of the House of Lords, which stated that society's relationship with science is in a critical phase[18], and consequently recommended a series of measures to remedy the situation, the European Union first endorsed this analysis and then recommended a general science policy, to be adapted by each State, with the explicit aim of making the European Community the first world economic power in its most recent Framework Programme[19].

Supra-national authorities like the OECD or the European Commission are, then, acting on several levels. They make possible a dialogue between nations which weakens the spectrum of specifically national regulations, particularly with the models for creating ministries for research; they highlight the integration of scientific policies and models of economic growth through innovation; they prescribe mobilizing populations through simultaneously training up a new generation of scientists who have internalized a new professional identity, a new work force, which is both competent and adaptable, and the

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16 OECD, 1971: 107. (free translation from French).

17 OECD, 1981: 100. (translated from French).

18 House of Lords, (2000), Select Committee on Science and Technology, Third Report, Science and Society, 23 February 2000.

19 To get an idea of how the European Union's philosophy has evolved, see the site dedicated to European research and innovation: ec.europa.eu/research/horizon2020/index_en.cfm, (consulted December 1, 2013).

conditions necessary for populations to accept the rhythms of change in their everyday life and professional surroundings. For example, Horizon 2020, the EU Framework Programme for Research and Innovation, is swarming with recommendations about communication, dissemination and involvement, around the top priorities of the research policy: excellence, societal challenges and industrial pre-eminence.

PUS GOVERNANCE

Faced with these multiple convergences, at the moment we can observe a resurgence of political interest in science culture. Contrary to what happened in the 1980s, the undertaking now consists in framing the organizations and actors active in PUS for the sake of coherence and efficiency. Hence, the need for a governance that integrates the production of knowledge, its anchoring to economic development, and the involvement of populations. The expected new role of science communication is to ensure the adherence of the populations. Scientific communication is no longer destined to be an autonomous and relatively heterogeneous sector in which the actors are free to pursue their activities as they feel. It is now called for in the framework of an overall policy which intends to coordinate and integrate the actions undertaken. Indeed, it is now impossible to keep up with the changes made necessary by the model of economic development supported by constant innovation without ensuring the convinced involvement of populations who are unceasingly mobilised and caught up in a process of constantly accelerating change[20].

And so it seems this new effort in favour of PUS basically aims to convince that the accelerating speed of social transformations brought on by the development in techno-science is legitimate. The whole thing is similar to a work of ideological persuasion aiming at rallying the population around the idea that the rhythm of progress in knowledge can only speed up; and that the outcomes of this knowledge, materialized in technology and objects, will lead to transient frameworks of existence, forever imposing adaptation to new surroundings, themselves subject to constant reconstruction; and that controlling risk through science and technology is possible in a post-industrial society[21]. It is a question of assuaging doubts aroused by the economic, social and societal consequences of the acceleration of techno-science.

How, in this context, can we imagine a possible autonomy of PUS as a research field? True, today it is not possible to consider it as an emanation of the discourse of scientists themselves, nor of the media, nor as a result of a social demand coming from the public. On the other hand, we need to take into account the role we intend it to play in an integrated governance of science policies, economic priorities and the implication of populations, together with the place it will occupy in a whole cluster of other trends, such as the rise in what is termed "citizen science" and the transformations of social communications. It is certainly not a question of putting forward an umpteenth normative model, following on from a perpetually updated succession (deficit model, contextual model, dialogic model, etc.). The challenge and the difficulty are in escaping the temptation to put forward a new normative model. It is more a case of trying, despite all, to construct the object on the basis of all these apparently contradictory trends, independently of the determinations borne in the very idea of governance.

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[20] Rosa, H., (2013), *Accélération : une critique sociale du temps*, Paris : La Découverte.

[21] For a critical discussion of the questions of risk in post-industrial society, see: Beck, U., (1986), *La société du risque*, Paris : Aubier.

We are convinced that thinking PUS today is forcing ourselves to think of different processes and objects in constant interaction with each other, and in the same movement, trying to connect them together. We need to remain mindful of public aspirations and in particular of the sturdy demand for a strong link between attitudes to science and democratic functioning. This strong link implies that we take into account the questions directed at researchers and politicians, even if that means re-thinking operating processes that are already well-integrated (decision-making upstream of projects, discussing economic development models, etc.), and respect the public's persistent confidence in science. We must also continue to pay close attention to the discourse and aspirations of scientists themselves, both in the research they conduct and in the debates they feel are needed and in which they are prepared to get involved (as in the case of global warming or the protection of biodiversity). Finally, we must develop a critical vigilance with regard to the power of persuasion of systems of governance and their numerous channels of communication.

With this in view, it is obvious that the issues in scientific communication do not concern a purely empirical or technical approach. They concern democratic requirements.

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SCIENTIFIC TEMPER: AN ARENA OF CONTESTATION IN A GLOBALISED WORLD

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INTRODUCTION

At the outset I will stipulate three conditions to guide this conversation. Firstly, this presentation is not an effort to provide a solution to the questions and concerns that have been repeatedly raised by the community of scholars who have worked in the area of Public Understanding of Science (PUS) over the past 30 years. The presentation tries to argue that all science communication activities should aim at developing a "scientifically tempered society".

Secondly, this presentation is a continuation of the keynote address presented at the International Conference on Science Communication, Nancy, France, 2012[1], 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, have a future too. Such was the case of the scientific revolution. The recent work in the history of the European Enlightenment tells us it was not a one-off event[2]. 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"[3]. 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 became perceived as the "handmaiden of theology" and its role was limited to the "interpretation of Holy Scripture"[4]. 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 the scientific revolution to take place in Europe. During the previous century two competing theories gained acceptance among scholars[5]. 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. p. 360). 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

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[1] Raza, G., (2012), *Scientific Temper and Indian Democracy*, in P. Baranger, & B. Schiele, (ed.), *Science communication Today, International perspectives, issues and strategies*, CNRS Editions, 59-72.

[2] O'Brien, P., (2013), *Historical Foundation for a Global Perspective on the Emergence of a Western European Regime for the Discovery, Development and Diffusion of useful and Reliable Knowledge*, Working papers No 176/13.

[3] Lindberg, D. C., (1986), Science and Early Church, in D.C. Lindberg & R. L. Numbers, (eds.), *God and nature: historical essays on the encounter between Christianity and science*, Berkeley: University of California Press, 21.

[4] Grant, E., (1986), in D. C. Lindberg & R. L. Numbers, (eds.), op. cit, p. 50.

[5] Lindberg, D. C., (2007), *The beginnings of Western Science: the European Scientific Tradition in Philosophy, Religion and Institutional Context, Prehistory to AD. 1450*, The University of Chicago Press, 360-365.

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[6].

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. p. 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 the 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 the 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[7]. 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

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[6] Sarma, K. V. & Shukla, K. S., (2000), (ed.), *History of Astronomy in India*, Indian National Science Academy.

[7] Grayling, A. C., (2008), *Introduction, The Enlightenment, in The Britannica Guide to the ideas that made the modern world, the people, philosophy, and history of the Enlightenment*, p. ix-xxix.

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[8], gained momentum during its second half[9]. Phrases like "Modern Knowledge", "Scientific Method", "Western Models of investigation", "Liberal and Enlightened System" and "Scientific Spirit" became part of the intellectual discourse[10]. Though, initially, this debate was limited in its reach, by the turn of the century the emerging scientific community, social reformers, media, educationists and 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*, introduced the somewhat hazy idea of "scientific temper"[11]. 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[12]. 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[13]. 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[14]. 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

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

[8] Venkateswaran, T. V., (2013), Negotiating Secular School Textbooks in Colonial Madras Presidency, *Journal of Scientific Temper*, 1(3-4): 143-197.

[9] Report on the Administration of the Madras Presidency 1866, the number of schools aided by the British Government increased in the southern part of India a critical number of proponents of secular education also increases, http://archive.org/stream/reportonadminis01statgoog/reportonadminis01statgoog_djvu.txt, (consulted November 6, 2013).

[10] Mahanti, S., (2013), Perspective on Scientific Temper in India, *Journal of Scientific Temper*, 1(1-2): 46-63.

[11] Nehru, J., ([1946] 1994), *The discovery of India*, centenary edition, Oxford University Press, 509-512.

[12] Scientific Policy Resolution 1958, http://www.dst.gov.in/stsysindia/spr1958.htm, (consulted November 6, 2013), and Science, Technology and Innovation Policy, 2013, http://dst.gov.in/sti-policy-eng.pdf, (consulted November 6, 2013).

[13] Nanda, M., (2013) The Battle for Scientific Temper in India's New Social Movements, in *Prophets Facing Backward: Postmodern Critiques of Science and Hindu Nationalism in India*, New Brunswick (NJ): Rutgers University Press, 207-224.

[14] Nandi, A., (1984) Cultural frames for social Intervention: A Personal Credo, *Indian Philosophical Quarterly*, XI(4): 411-421. Ashish Nandi, Claud Alwares and Shiv Visvanathan joined the debate in the nineteen seventies, and produced a very strong critique of 'Scientific temper' from the point of view of 'anti-modernist' position.

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.

SCIENCE VERSUS 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**. 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.

The public understanding of science surveys carried out in India suggest that the migration of people from rural areas to urban centres causes a cognitive void[15]. In a rural cultural milieu, traditional belief systems, and in turn religious worldviews, are transmitted to new generations through strong interpersonal interaction[16]. 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***.

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, 1996)[17] or, to 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

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** For example the theory of creation in Semitic religions are very different from the theory in the Hindu religion or Buddhist cosmology.

*** 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.

15 Raza, G.; Singh, S.; Dutt, B., (2005), Channels of information and public understanding of science, *Indian Journal of Science Communication*, 4(2): 26-28.

16 Raza, G.; Singh, S., (2007), Science and Public: Study Report based on survey conducted during Ardh-kumbh 2007 at Allahabad, *NISTADS Report*, 2007.

17 Kuhn, T.S., (1996), *The Structure of Scientific Revolution*, Third edition, The University Chicago Press.

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, I have argued elsewhere, 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[18].

The project of "spreading scientific temper", which is a constitutional duty of the citizens in India, is a quite complex one. Spreading scientific awareness is only a precondition for the creation of a 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)[19].

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.

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[18] Supervisions and Belief of Indian Space Scientist, *Times of India,* November 8, 2013.

[19] Greene, B., (1999), *The Elegant Universe: Superstrings, Hidden Dimensions, and the Quest for the Ultimate Theory,* Vintage.

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.

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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INTRODUCTION

I will formulate my present argument as work in progress with a series of linked statements. Rather than fully elaborated theses, I see them as contributions to an ongoing discussion.

On the distinction between 'scientific culture' and 'science culture' we find an analogous discussion in organisational analysis. In a classic paper on that topic Smircich (1983) argued that the concept of 'culture' has a double use. On the one hand 'culture' refers to the manners of constituting a productive unit, its values and taken for granted norms, the internal organisation of its modus operandi. In this sense it is the outcome or the dependent variable of a managerial intervention. Managers are cultural workers comparable to artists. On the other hand, productive industry must respond everywhere to the cultural context of the locality in order to succeed. Thus, culture is the context of managerial designs. This context is beyond the immediate control as is the weather and the climate of a place. Here 'culture' is the independent variable that requires strategic adaptation to be sustainable; industrial activity is the fact of external relations internalised.

1. THE NOTION OF *SCIENTIFIC CULTURE* (I.E. SCIENTIA FACERE) SHOULD BE KEPT DISTINCT FROM THAT OF *SCIENCE CULTURE*

What looks like a minor difference in suffix, might be a useful index of a key distinction. *Scientific culture*, the conduct of science and research is now pretty much a global affair. Research laboratories all over the world operate on the same materials, with the same procedures and similar equipment, with the same theoretical tools and mathematical formalisms, with global mobility of expertise, and communicating to a global peer review process performed by the leading academic journals in each field.

1.1 Global scientific culture retains diversity of managerial and epistemic styles.

An example of discerning operational style is a recent magazine reportage on CERN, the large scale super-collider installations of subatomic physics near Geneva, as a 'democratic republic of science' (*CH-Tages Anzeiger* 26 Oct 2013). We can see that this diversity of organisational operations remains within a global framework that is recognised and understood everywhere in the human universe. However, notions of difference in the operations of science continue to be of interest and are detailed in the following sources:

- On thinking styles and thinking communities (Fleck, 1979 [1935]) as revealed by laboratory studies (Latour & Woolgar, 1979);
- The six styles of European science (Crombie, 1994);
- Life styles of science personified by Newton, Goethe & Napoleon (Fuller, 2010);
- Romantic and rationalist science according to Luria (1993)

The global nature of scientific science is mapped by sets of sciento-metric indicators. Input and output variables are reported in standard formats as defined by manuals from FRASCATI to OSLO and beyond. Such reporting is undertaken by national and international agencies who anxiously monitor a global competition over rankings on these intangible assets. The investment in R&D (GERD, BERD, HERD) of the country or in % of sales on the corporate level, the manpower involved in research per million population, the numbers of international patents generated, the number of research documents produced in % of global output, the numbers of citations received, or the balance-sheet of Hi-tech exports and imports are regularly reported. Most of these indicators are inspired by an economic rationale to ascertain science exclusively as a productive factor (Godin, 2005). While happy to acknowledge an operative 'scientific culture', most scientists and their advocates would not like to see science in the remit of culture politics jointly with Sports, Museums, and Opera. Advocates are anxious to see science funding as a key economic policy. Actors close to policy making are therefore rather reluctant to talk of 'scientific culture' as it prejudices the ministerial responsibility. 'Scientific culture' is therefore very much an academic pursuit.

1.2 The duality of science - technological systems and metaphysical speculation – is today unified in 'techno-science'.

A theory put forward by Dorn (1991) purports that science has a dual origin determined by geographical-climatic conditions. Where rainfall is frequent and thus there is no water shortage through the annual cycle, these regions saw historically the emergence of science as a metaphysical pursuit. There will be a cosmogony, i.e. speculative theory of the cosmos and its origin. The classical example here is ancient Greek science of observation and speculation, of which we know the authors. In world regions where water was sparse, collective efforts were required to develop and maintain supplies all through the year with elaborate irrigation systems. These collective efforts of construction and maintenance bring forward a science that is focused on technological-practical efforts and the scientific contributions remain mainly anonymous. The archetype of this type of science is Mesopotamia and Ancient Egypt, where astronomers predicted the rising water levels of Euphrates, Tigris and Nile by making calendars. Who remembers any scientists involved in those efforts?

We might argue that modern 'big science' such as the Manhattan Project which brought about the nuclear bomb in the 1940s, was a project that bridged the metaphysical and the technological quest. Undertakings of similar scope of resource mobilisation are nowadays known as 'techno-science' as in the Genome Project or the recent Brain project. This is scientific research at the frontiers of knowledge, where the engineering element cannot be separated neatly from that of scientific thinking.

2. WE DEFINE 'SCIENCE CULTURE' AS THE SYMBOLIC CONTEXT OF MAKING SCIENCE.

Apparently, philosophy of science is as useful to the conduct of science as ornithology is to the life of birds (a saying attributed to Richard Feynman). Nevertheless, many scientists cultivate their preferred self-presentation with the help of authoritative philosophical accounts of what it means 'to do science'. This includes the demarcation of science from pseudo-science and non-science, the formalisation of hypothetic-deductive reasoning and the logic of modelling. However, all these accounts do not exhaust nor constrain the proliferation of representations of science in the wider culture. We seek to map empirically that whole variety of representations of science under the term 'science culture'.

2.1 While scientific culture is global, science culture remains local.

The science culture, the way everyday people think of, imagine and value and contest science and scientific knowledge in their everyday life continues to vary with the world's cultural diversity. We expect that the public imagination and the conversations about science, of what science is, does and what we can expect from it, i.e. the social representation of science, varies widely along traditional boundaries of 'deep culture', with geography, across generations and levels of education and different historical mentalities of longue duree. Longue duree is likely to dominate the culture of science across the globe for some time to come. Deep currents of mentalities are not shifting very quickly. In Africa, India or China, we find ways of speaking such as 'Capitalism with Islamic, Chinese, African or Indian characteristics', this might by analogy also apply to the social representations of science: Can we ascertain the image of science with Chinese, Arabic, African or Indian characteristics? This intuition is already reflected to some extent in discussions regarding the public understanding of science. What in China is predominantly referenced as 'literacy' (Wang et al, 2012), is in India the 'scientific temper' (Kumar, 2011) and in Africa the local knowledge or 'African philosophy' (Du Plessis, 2012).

On a theoretical plane, we might ask: what determines the variety of the culture of science? The thesis of 'multiple modernities' argues that the process of modernisation does not follow the one-way-only pattern that Weber described with the 'rationalisation' of social affairs and the progressive 'disenchantment' of Nature. Weber's idea might be framed ethnocentrically by European and Protestant-spiritual notions of development (see Carroll, 2011). Different paths to modernity, incorporating elements of rationality and retaining elements of enchantment of Nature might give rise to different science cultures, in particular with respect to the tolerance or intolerance of scientific and numinous entities in everyday life.

Maybe Dorn's (1991) conjecture of the dual origins of science, rainfall and irrigation, while no longer holding true for the production of knowledge, continues to keep its grip on the culture of science through the appreciation or dismissal of the metaphysical quest for knowledge. Thus we must recognise that the image and the imagination of science is fuelled by local resources (Doorman, 1989), either as a matter of milieu specific worldviews (as in social representations) or in relation to particular grievances and mobilisations (as in civic epistemologies).

2.2 Mapping the culture of science in comparison and longitudinally

The culture of science needs to be mapped in empirical research, and we might do this either as an investigation of cultural stocks and resources or in the performance of culture. Social representations theory (see Bauer & Gaskell, 1999; Bauer, 2014) and the idea of civic epistemologies (Jasanoff, 2005) are useful concepts to compare the culture of science; each of these two concepts offers a slightly different framing of the issue. Social representation focuses on the cultural stock of symbolic resources and anchors diversity in the specific worldview of different milieus and communities and their system of communication, this manifests itself in competition to alternatives. Civic epistemology looks at the performance of culture and shows diversity in the political mobilisations around particular grievances and in conflict with dominant powers. This is exemplified in the controversies over civic nuclear power and genetic engineering for agriculture and human health care.

This agenda of mapping the science culture must be addressed by considering several issues separately and jointly:

- Creating viable indicators of this local 'Science Culture';
- Moving this exercise beyond 'performance races' towards a typology of functional equivalences. An example of this might be the Science Culture Index (SCI);

- To mobilize and encourage the construction of a global database that enables more comparative research (we have outlined this agenda in Bauer, 2012 and Bauer, Shukla & Allum, 2012).

The basic idea is to conduct comparative research with a view of reconstructing cultural trajectories including the comparative segmentation of the public of science in different contexts. This exercise needs to learn from previous attempts in the same direction which failed to galvanise international collaborations by exclusively focussing on a limited number of survey type indicators. The effort requires renewed reflections on what are the key dimensions of such metrics, however, without throwing away the metrics which we are already familiar with such as knowledge, utilitarian attitudes, interest and engagement with science.

3. RECONSIDERING COMMON SENSE AND SCIENCE

The notion of science culture overlaps with the older practice of common sense (CS). In the ancient double sense of 'sensus communis', the term refers to the capacity of bridging different sensory perceptions and conflicting public concern into a synthetic judgement. CS highlights the everyday need to judge on the basis of a diversity of considerations. However, the relations between common sense and science are historically controversial. This relation can be seen in various ways.

First, common sense serves as the 'other' against which science is to be demarcated. Progress of science means getting away from, overcoming and getting rid of CS. Here CS is often synonymous to superstition, irrational belief, and popular delusions that will have to be debunked. This is consistent with a notion of an elite group of virtuosi who know and the people that are ignorant ('oligo poloi' versus 'hoi poloi', the elected few versus the many). Here we are facing a long tradition of polemics against stocks of harmful beliefs. And this chimes with many other distinctions where a clear hierarchy is drawn such as episteme and doxa, knowledge and opinion/belief.

Second, science is considered the continuation of CS with other means; it is an elaboration of CS ('The whole of science is nothing more than a refinement of everyday thinking', A. Einstein in *Physics & Reality*, 1936). Sociologists of science have observed: there is very little difference between everyday living and life in a laboratory, and this becomes clear once you follow researchers in their footsteps.

Thirdly, CS is a source of knowledge which science has a yet to fully explore, either through logical explications of its assertions or through mobilisation of its value and moral competences. Here, one might think of the recent dignification of traditional and local knowledge for purposes of developing new synthetic drugs through genetic engineering with the help of indigenous ethno-botany or a general folk-biology (see Balick & Cox, 1996). The flipside of this endeavour includes modern forms of phyto-piracy.

Fourthly, common sense notions of health and illness are increasingly recognised to be part of the solution to health issues. The way people perceive and construe their health predicaments is no longer ignored as part of the problem, but understood as part of the solution. Representations of health and illness motivate the healing process and guide the coping with illness (Petrie & Weinman, 1997). This logic of understanding common sense notions might well apply to other walks of life.

Our discussions and research on science culture invites a reconsideration of the relationship between global science and local science culture as common sense. This might be particularly fruitful when we consider that past discussions of CS remain very much within the European intellectual traditions (Gautier & Laugier, 2009; VanHolthoon & Olson, 1987). How and to what extent is the notion of common sense, or any pragmatic equivalent, present in other cultures? We ask: What makes the appeal to a 'common sense' possible; is this a universal possibility or an ethno-centric niche particular to the Graeco-Roman tradition of longue duree? The international nature of this seminar is a fitting occasion to at least raise the question.

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DIGITAL HUMANITIES RAISE QUESTIONS FOR HUMANITIES AND FOR SCIENCE IN GENERAL

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Something is happening in the humanities, which could be characteristic of what is going on in science in general and in the relationship between science and society today. This change raises questions which researchers and other actors in society need to discuss.

What is happening is at the conjunction of various ongoing transformations. Some of them come from the actions of decision-makers regarding scientific and innovation policies. They introduce new practices, institutions and management in order to better connect research and innovation, to increase scientific entrepreneurship and academic capitalism, to create markets for knowledge and to introduce a new public management with evaluation and contracting agencies. They also express performance and accountability requirements and put pressure on public budgets. They press for an increasing conditionality of public funding, which leads to a search for private financing, to organizational streamlining effort and to increased competition between institutions and between disciplines regarding public funding.

Ongoing transformation in science also comes from changes regarding research methods, scientific instruments and research questions. This is very clear regarding high-energy physics, genomics, neuroscience and astrophysics, but it also concerns human and social sciences with their libraries, research infrastructures for large social science surveys, databases in the humanities, etc. These changes open up new possibilities for researchers who are envolving their methods and research questions. Research practices also change because of epistemic transformations related to the identification of new scientific challenges, new approaches and new problems in the public agenda (e.g. global warming or an aging population).

In the case of the spring of the *digital humanities* (DH) since the beginning of 2000, we observe such combined transformations. Regarding the access to new information technologies, digital humanities appear to be a turning point for "humanities computing" or "humanities and computing". But this emergence has also to do with institutional changes. In the US, the humanities are confronted with a crisis marked by budget cuts (Paxson, 2013), a decline in colleges and universities (Clooney, 2013), domination of "hard sciences" considered as the only legitimate and valid source of knowledge, and attacks against human sciences (the humanities would lack scientific or economic relevance). In this context, the extensive use of information science and technology is presented as a way to save the humanities (Shapiro, 2013): "*a more digital focus could help save the 'dying humanities'*", says Alexander Huang (Spogmay, 2013). Researchers, professors and public institutions such as the *Office of the digital humanities* from the *U.S. National Endowment of the Humanities* (NEH), see in the use of new technologies the way to renew students' and the public's interest in the humanities, making them more accessible to the public. The NEH presents itself as constructing the new frontier of human sciences; it sets up programs to generate scientific and technological breakthroughs in these disciplines (Kolowitch, 2011). The application of computer sciences to history, languages, cultures and social interaction would engage the humanities and social sciences in a new endeavour, and should bridge the gap between the two scientific cultures.

What is going on at the researchers' level? What are they doing? How are they defining themselves? How are they shaping groups, including and excluding types of work or people? The quest for a definition of digital humanities has been present since the emergence of the DH label and still is hot topic. The question has been the subject of many discussions over the last 10 years. Claire Warwick (2010) proposed the following definition: "*Digital Humanities is an important multidisciplinary field, undertaking research at the intersection of digital technologies and humanities. It aims to produce applications and models that make possible new kinds of research, both in the humanities disciplines and in computer science and its allied technologies. It also studies the impact of these techniques on cultural heritage, memory institutions, libraries, archives and digital culture*". This definition underlines the multidisciplinary character of the field, but also points its specificity, which is the design of new tools (models and applications) allowing opening new avenues for research in the involved disciplines.

One prominent scientific figure who could illustrate such potential of DH is Franco Moretti, mapping the historical circulation of novels and of words throughout Europe, and thus describing the relations between literature and geography (Moretti, 1998). He was appropriating and using existing tools (principal component analysis, clustering technics, style quantification, network theory) in order to interpret its corpus. While doing such analysis he was shaping a new literary critique which he re-examined in order to reconstruct his intellectual trajectory in terms of models (evolutionary model, geo-cultural domination model) (Moretti, 2005) and of "distant reading" (Moretti, 2013). He was not so much designing new tools but their possible use and adaptation for the humanities.

As such, DH appear to open new opportunities for humanities, to allow the use of new tools and maybe to raise new research questions. This starts changing the way scholars think about their work and draws the attention of human scientists, making them reflect on their new tools and what this would change in terms of research practices, methods and epistemic referents. This is what seems to be an evident change for humanities.

However, a question which may be more important comes from the definition of DH. As we could see in our quote of Claire Warwick, DH is not defined as the use of information technologies for human sciences. If we look in a handbook like *Digital Humanities* (Burdick et al., 2012), we also find similar restrictions: "*The mere use of digital tools for the purpose of humanistic research and communication does not qualify as Digital Humanities*" (Burdick et al., 2012: 122). The book includes "case studies" of digital humanities production. All are about building original tools or archives; none are examples of analysis using existing computational tools. The authors also emphasize design, interfaces, database structures, codes for data treatment and new forms of public engagement. In this restrictive definition, maybe Franco Moretti would not be recognised as a DHer.

Such definitons and restrictions are not consensual. The debate engaged by David Golumbia (2013) reveals that some DHers issue warnings about the potential damage to the field by such restrictive definition. Other DHers gave a broader definition like: "*a relatively focused field that utilized computers for organizing, displaying and searching for patterns within digitized texts*" (Vaner, 2013). However, the design of new tools seems to be the new criterion, which makes the greatness of a DHer. A real DHer would be someone putting hands into the code.

Going back to the institutional impetus given to DH and to the funding priorities of the granting institutions, we could also note the humanities are invited to do science like real science, which means setting up mega-scientific international and interdisciplinary networks to face big challenges like the programme "*Digging into Data*", which associates the *National Endowment for the Humanities* (NEH, US), the *National Science Fondation* (NSF, USA), the *Institute of Museum and Library Services* (USA), the *Joint Information Systems Committee* (JISC, UK), the *Arts and Humanities Research Council* (UK), the *Economic and Social Research Council* (UK), the *Social Sciences and Humanities Research Council* (SSHRC, Canada), and the *Netherlands Organisation for Scientific Research*. The challenge is to answer questions like: "*What do you do with a million books? Or a million pages of newspaper? Or a million photographs of artwork?*". Information technologies would allow humanities to become real sciences, using objective and quantitative approaches. The priority in terms of research grants is then on the design of new tools, more then on the use of existing and already disseminated tools.

In fact, challenging experiences are developing, like the *Venice Time Machine*[1], a 10 year programme aiming to design a historical and geographical simulation of the city based on digitization of one thousand years of well-documented archives, modelling, visualisation and interactive devices. Such experiments are not new. The first experiment was more than sixty years ago, when Jesuit Father Roberto Busa managed to win the support of one of the founders of the IBM company to establish a computer concordance of the works of St. Thomas of Aquinas. The experiment, which began on punch card machines and lasted for more than twenty years, led to new research practices and opened the field of linguistic computing. During the 1960s-1980s, historians developed quantitative history, around the Annales School in France among others, and designed new tools to work on new types of sources, such as censuses or account books, which are of serial nature, and to perform statistics on quantitative series. This led Emmanuel Le Roy Ladurie (1968) to say: «The historian of the future will be a programmer or will be no longer» Then, in 1987, researchers defined a computer encoding standard for texts, the TEI[2], in order to help librarians, publishers and researchers to describe and encode digital documents, thus facilitating the edition of texts and search operations in these texts. Then, when disseminated through the World Wide Web, flagship projects made human scientists aware of the potential of such tools. In history, Edward Ayers'[3] project *The Valley of the Shadow* is seen as a precursor. Since 1991, Ayers wanted to develop a comparative story with both the North and the South regarding the US Civil War. He gathered heterogeneous documents, such as letters, diaries, church records, battle reports, and newspapers in order to give an account of the life in the two communities during war. Using the capacities of digitization and databases, and then the web in 1996, the project was at the foundation of the *Institute for Advanced Technology in the Humanities* (IATH), which is dedicated to the use of information technologies for humanities research. This project was a demonstration, for IBM, regarding what can be done with computing and large and heterogeneous archives. It is a pioneer regarding the design of on-line archives and interactive devices. Today, new kind of tools are still designed like the on-line travel service for the Roman Empire (ORBIS - *The Stanford Geospatial Network Model of the Roman World*)[4], which allows to calculate journeys (time and expenses) and to trace routes for travelling through this complex communication network, shaped by political and military domination, economic exchange, and transportation technologies (ox cart, horse relay, loaded mules, navigable rivers, coastal sea or open sea boats and routes, rapid military march, etc.). The tool allows you to take into account the environmental and seasonal constraints, and costs, as determinant of connectivity, which classical maps failed to do. All these projects and prototypes opened new avenues for humanities.

This focus on the design of new tools does not reflect the everyday practices of human scientists. Even if they almost all use PCs, most make little use of existing capacities of the new tools or are not even aware of their existence. Some researchers call for awareness-raising among Master students in human sciences regarding, for instance, the existence and possibilities of lexicometry and XML-TEI encoding[5]. The digital humanities orientation toward big challenges and tool design contrasts with the ordinary practices

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[1] http://dhlab.epfl.ch/page-91073-en.html

[2] Text Encoding Initiative (TEI), cf. http://www.tei-c.org/

[3] Ayers, E., The Story Behind the Valley Project, http://valley.lib.virginia.edu/VoS/usingvalley/valleystory.html, (consulted November 24, 2013).

[4] http://orbis.stanford.edu/

[5] http://www.boiteaoutils.info/2011/09/les-historiens-seront-ils-finalement.html

of human scientists. The first are called DHers; the second simple human scientists, even if they use PCs, databases, Internet search, word processing software, publication workflow, machine translation, blog, web site design, social network, tweets, and Geographic

Information Systems, or even specialized tools as in linguistic computing. So, using digital tools for humanities is not the criterion for being recognized as a DHer.

A consequence of such explicit or tacit definition of the DH leads to demoting the use of digital tools, at least from the DH community's (researchers and granting institutions) point of view. If such definition disseminates into the academic milieu with the promotion of DH, there would also be a risk for the evaluation and career of scholars. Instead of valuing analytical results and their use among the human science community, the design and building of challenging tools would be the new criterion for academic promotion. Till now, however, this is not the case. Either for digital history or for linguistics computing, building things is not a distinctive criterion. There is no distinction between building and using tools. Designing and building prototype tools versus using existing tools is not what matters in academic disciplines in human sciences. But for the DHers, this seems to be the criterion of greatness inside the community. Thus there seems to be a diverging definition of what matters, depending on whether we refer to digital humanities or to humanities (not only pencil or paper humanities but also computer supported humanities).

This also means that when a tool has proved its usefulness for humanities and is adopted by many scholars, or, worse, by laypeople, it goes out of DH and starts to be disqualified. As long as scholars have to use boring programming languages or models (like HTML, RDF, etc.), this is part of DH. But, when Graphic User Interfaces (GUIs) or friendly blog or database design tools disseminate, and are used to produce a lot of interesting results for humanities, they no longer characterize a DHer. The consequence is that the successful adoption and use of a tool will lead to it being cut off from DH, exactly like what we can observe in engineering research. When a new technological concept has proved its usefulness and is transferred to users (mainly industry, markets and public services), it ceases to be a part of research. This analogy would then lead to the assimilation of DH to engineering sciences, rather than to humanities, which would become the equivalent of a business (picking inventions off the DH shelf in order to make common consumer products) and consumption. Thus this raises the question of the real salvation impact of IT for humanities if IT use is devalued, and if this will serve yet unborn humanists (taking into account the long process required to translate an invention into a disseminated innovation).

In Warwick's definition, DH were defined as a multidisciplinary field, undertaking research at the intersection of digital technologies and humanities. What we observe is the fact that the dynamics of the domain leads to a specific style of science, a type of engineering, around new challenges and the production of methods, tools and applications, supposed to make possible new kinds of research. DH international conferences are interesting to characterize from this point of view. There we observe a growing importance given to "demos". The "demos" consist in public demonstrations of a technology or in slide shows about the proof of a technological concept. These "demos" play various roles (Rosental, 2009) in terms of proof and persuasion, as an observatory of technological possibilities, as a transactional instrument between communities (IT and Humanities), as a project management tool (for granting institutions), and as a capitalizing device (integration of previous technologies and connexion to other projects through Internet). The "demos" play a role in the dynamics of the scientific communities, contributing also to shaping their identities and differences and defining the new epistemological criterion of what is a relevant scientific result. Scientific proof tends to be brought by the production of "demos" and an epistemology of doing. This raises the question of the future of humanities, beyond the technological proof of the public and commercial relevance of the research. This question is not specific to DH. Other scientific communities (in physics and biology among others) already face these new expectations concerning science and its regime of objectivity (Daston & Galison, 2007).

DH focus on the design and building of new tools and develop knowledge and a way to work similar to engineering. However, building realizations like the travel service for the Roman Empire, leads the DHer to also move from the production of analytical, critical or interpretative knowledge toward integrative knowledge. Building a visual representation, for instance, involves completely different kinds of knowledge and enforces the internal coherence of the representation as a new requirement. Lack of information, uncertain data and incoherent models lead to problems which are much more evident in such visual or interactive representations than in a book or an article. The situation appears to be similar to what happens to mechanical designers who need to fully define the artefact they design.

The observation of another typical form of scientific meeting in the DH community enforces this conclusion. *THATCamps* (*The Humanities and Technology Camps*) are "unconferences" where sessions are proposed and scheduled by the attendees on site and through social network tools (notably Twitter). They often participate in the sessions both orally and virtually using at least one or two digital devices (PCs, smart phones), so that we can observe a kind of duplication of parallel discussions with sometimes surprising interferences between them. The focus of these unconferences is on skills. They organize hands-on training for tools. Attendees share information, methods, tips and tricks regarding tools. The unofficial slogan we can hear in or around these unconferences is "less yack, more hack." They sometimes engage in in situ collaborative creation or start projects. The dynamics here are similar to what could be observed in other dynamics where a scientific and technical community is emerging and structuring itself around the design and the mastery of new scientific instruments. Such an instrumental community (Mody, 2011) or research-technology (Shinn, 2007) develops around the transversality of instrumentation (multipurpose devices) in the face of scientific specialization, thanks to genericity in instrument design. Such an instrumental community tends to break down established scientific boundaries, to reduce hierarchical control, to be grounded on voluntary participation and to coordinate transversally, including with industry. Participants voluntarily share information about skills and techniques and set up their own meetings, like THATCamps. They build themselves as a distinct community, encouraging its growth through the encouragement of newcomers to adopt and invest in the new techniques. The instrumental community also reflects on its identity and sets up its own rules of thumb about who is considered as a real member (in DH, who is a real DHer) and where the boundaries are. This influences the formulation of members' research directions. This dynamic could also lead to the development of a distinct scientific space and autonomy regarding established disciplines, if the double membership of the DH and of an established discipline, and internal divergences about identity do not lead to its disaggregation.

DH design and produce a lot of prototypes, experimental realizations and digital resources. Some of these prototypes and creations could be adopted and improved and be largely disseminated and used. They will then split off from DH. But the prototypes which do not meet with such success, what would their future be? Are they condemned to enrich a cemetery of prototypes? Beyond the proof of the concept, what would be the future of these prototypes? Sustainability and future-proofing seem not to be major preoccupations inside the DH community, despite the significant investments in creating digital tools and resources. This is very similar to research in engineering, about which Callon (1988) showed that a lot is "Not Applicable Applied Research".

For many DH projects, sustainability is a challenge. At least the earlier projects were not "future-proofed". Some of them became entirely inaccessible; others are not more easily available, have lost some functionalities or contents, or were not up-dated and became obsolete, frozen in their past. In *Sustaining Our Digital Future*, Nancy Maron, Jason Yun & Sarah Pickle (2013) remember that a review of UK Digitisation Projects, funded during 1999-2004, showed that, in 2009, 16% have unavailable URLs, 25% have no known URL, 53% have to up-dated their website since the launch. Some projects are thinking about their future, as in the case of ORBIS, in terms of intensification of the project through: the addition of detailed information (about roads, rivers and sea ports, winds and currents) allowing simulations for regional case studies and analysis of the network properties; the provision of layers that contextualize routes and expenses; the spatial extension to the Red Sea and the Indian Ocean allowing connections to caravan routes in the Arabian peninsula and the inclusion of southern Mesopotamia. Researchers involved are also thinking about the possible extension of their model of sea routes over the entire planet and other periods of history; thus they call upon colleagues who would seize this opportunity. They would also expand the simulation considering probabilities regarding evolution and response to environmental and other constraints (integration of given data and dynamic processes), but also through the connexion to other existing databases of spatial information or emerging applications such as Google Ancient Places. The future of this realisation (its accessibility and evolution) depends on the existence of a research group, of a supporting institution and/or of a scientific or users community. Contrary to a book or to public archives, such a future is not so certain and this raises major questions regarding the dynamics of DH and similar sciences.

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SOCIAL CONTEXT OF SCIENCE COMMUNICATION: LOCAL SCIENCE COMMUNICATION STRATEGY

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1. THE SOCIAL CONTEXT OF SCIENCE COMMUNICATION

1.1 An interpretation of the social context of science communication

(a) Discussions of the concept of "context of situation"

The concept of "context of situation" is originally applied in linguistic research. It means an associated complex of all the factors required to determine the meaning of a word, sentence or text. The Polish anthropologist Malinowski first used the term “context of situation“. He believed that people’s words are to be considered in the context of the prevailing situation if one wants to understand his words correctly. G. Frege took the context as a principle so as to claim that the meaning of a word or sentence must be interpreted in its specific context, namely understood in a specific context of situation (Wei Yidong, 2000).

The development of *context* research has gone through two stages, which are the traditional context research stage and the cognitive context stage (Huang Huaxin, 2004). The stage of traditional context research emphasizes regarding the context as an objective background to describe and focuses on connotation, classification, function, and structure. It was widely accepted that similar objective contextual features are certain to cause similar linguistic performance and meaning during this stage. In the stage of cognitive context research, linguists pointed out the insufficiency of subject research in traditional context research and criticized research based on the nature and function of language only in terms of human society and environment. Instead, they advocated increased research into the role of human psychological cognition, which makes up for and enriches the insufficiency of traditional context to some extent.

(b) Social context in the sociology of science

The development of context research has gradually spread beyond research in the linguistic domain. Thus it extends to be a kind of research on social context with unique social ideology. Hu Zhuanglin (2010) argued that the study of context has presented the trend “from linguistic (linguistic context) idealization (linguistic context and non-linguistic context), triple (linguistic context, physical context and common knowledge), towards diversification (world knowledge, collective knowledge, specific knowledge, participant, degree of formality, media, etc.)“. Guo Guichun (2002) put forward that the extension of context cannot only mean the previous and the following sentence, and text or a specific text, but also an interpretative theory, normal form, a specific historical period, historical background, and even covers all social, historical, cultural, scientific, political, and psychological factors and all interrelated and interactive factors. In a word, its connotation is determining a certain specific context of situation for the meaning.

At present, the concept of context of situation is widely applied in the philosophy of science and technology, the history of science and technology and the sociology of science and gradually becomes a kind of contextual analysis method. In the research perspective of the sociology of science, the contextual analysis method takes science as “text“, looking for its meaning and essence in a specific “context of situation“ and advocates interpreting science in correlation with multiple social factors (Zhang Yu, 2011).

(c) Social context in science communication

Science communication, as a complex of various disciplines, emerges with scientific development and social progress. The social context of science communication has as an inevitable result the extension of social context to the domain of science (Su Guoxun, 2004). Huang Huaxin (2004) put forward that “the social context of science communication“ has two types of structural patterns. The one that we call background context – meaning political context, economic context, historical context and cultural context – indirectly influences science communication through background penetration. The other is context of situation – meaning text context, occasion context, purpose context and psychological context – directly integrated into the situation of science communication.

This paper is based on a study of hierarchical relationships between context, social context and science communication context. The social context of science communication can be divided into the external and the internal context of science communication. Science communication, as a sub-system of society, is bound to be influenced by all social factors. We consider the interactions in the external social context, including factors like economy, culture, politics, history and science communication, as the external context of science communication.

All subjects are involved in the science communication sub-system and the communication ecological system formed by these subjects can be regarded as the internal context of science communication. Hence, this article considers that the social context is the external environment for science communication, which is also the basic starting point of the present research.

1.2 The changing social context of science communication

The Social Context of science communication is not considered immutable. The development of globalization brings change to social structure and inevitably affects science communication at all levels so as to have a profound influence on it. Thus it follows that we find there are several changes taking place in the social context of science communication around the world.

(a) The relationship between science and society is closer

Modern science is influencing the intelligence of the whole society on an unprecedented scale and with such tremendous power that its social status and the function of science and technology improve rapidly, which is the new feature of the science and society relationship in this new century. Science and society have built an increasingly close and diversified relationship. Science is becoming an important part of society while the process of society "scientization" and science "socialization is developing rapidly. As a result, modern science has become a powerful lever of social progress.

Science and technology development has become the basic driving force of the economy and society, and the strength of science and technology has become an important indicator in measuring overall national strength. Meanwhile, the framework of world competition is decided by capacity for scientific and technological innovation. Most countries set up science and technology innovation plans as the core driving force to promote national and regional development then carry out strategic implementation. Therefore, science and technology input is gradually increased. It is estimated that Horizon 2020 will receive € 70.2 billion for 7 years from 2014 onwards (see EU2020). There is a comprehensive increasing demand for science communication aimed at society followed by a constant improvement of scale and speed in science and technology creation, communication and application.

(b) The relationship between science and the public is getting closer

The interpenetration of science and society is getting deeper, which brings technicalization into the social environment and daily life. In daily life, public dependence on S&T is increasing. However, there are more and more problems brought by the development and application of science and technology, and the public become anxious about these problems. In that case, many scientific and technological problems also become public social issues. Appropriate consciousness of the public in the development, application and decision-making of science and technology is improving constantly and the public's right to know, right to expression and right to participate and debate are constantly improved. The formulation of S&T policies and the input of major science and technology projects encounter greater pressure from the public. Improper handling of the relationship between science and the public causes the public to misunderstand and even gives rise to social public incidents. The dispute that arose in the process of the approval of the PX project in China proved to be a typical case. New developments in the relationship between science and the public highlight the importance of science and technology communication.

(c) The rapid spread of modern media technology

The rapid development of modern information technology has provoked the appearance of media applications in a new media era. The commercialization of internet, which has symbolized the birth of the new media era since 1992, it arose from the birth and socialization applications of internet. It is the transition from media forms featuring deconstructive property, which substantially opens up media expression as well as a new era of science communication.

With the development of new media technology, new media technology represented by Internet and the mobile web begins to manifest its strong spread of influence. Along with the gradual expansion of the scope of its application, the new media turns into a dominant social media to a certain degree, and breaks away from the traditional communication structure so as to form a new communication ecology. Science communication contains new features in the new media ecology. For instance, the public can obtain science and technology information through new media conveniently, or spread and express their own wishes and viewpoints, thus influencing government science and technology policy-making and behavior. New media technology provides new platforms, new approaches and new means for science communication. The public can achieve self-obtaining and ubiquitous learning of science and technology information.

2. THE SITUATION OF DIVERSIFICATION IN SCIENCE COMMUNICATION BROUGHT ON BY CHINA'S SOCIAL CONTEXT

2.1 Some characteristics of China's social context may affect science communication

Compared to other countries, the Chinese social context is characterized by extreme localness, these local features being embodied in society, economy, culture, science and technology, history and other aspects. China's science communication is not only faced with common social context changes which is the same as the rest of the world, but is also faced with another layer of challenge, which is brought by China's distinctive social context with localized characteristics. Through the comprehensive consideration of China's social context, the author thinks that the following two aspects of China's social context characteristics directly influence science communication:

(a) Unbalanced regional development brought about by geopolitical structure

China covers a wide geographic area with extensive longitude and latitude, and a complicated and varied landscape. The terrain basically varies from high-altitude in the west to low-lying in the east. China is adjacent to Eurasia, the largest continent in the world, and on the edge of the Pacific Ocean, the most extensive ocean in the world, where a monsoon climate prevails. Climate resources are distributed unevenly and most resources are located in the subtropical zone and the temperate zone, with only a small part of resources located in the tropical zone. Rainfall decreases progressively from southeast to northwest (Chen Yue, 2005). For instance, coastal areas of Southeast China have a monsoon climate and abundant water and heat resources. The northwest area is of temperate grassland and temperate desert climate and short of water resources. Eastern China is the coastal area of the continental shelf and has abundant oil resources, there is abundant oil, gas, and coal nearby. The coastal areas of Southeast China are a foreign opening area at the initial stage of the reform and opening up, with flourishing foreign trade. The northwest areas have abundant biological resources, such as wool, high-quality dairy farming, etc. Coastal cities have superior geographical conditions and large ports. Parts of coastal areas have famous scenic spots or developed heavy industry. Alternatively, these areas have abundant marine resources and developed tertiary industry. At the same time, the difference in state support for different regions is also the reason that causes the imbalance of economic development in different regions in China.

Geopolitical features not only have an impact on social and economic development, but also form cultural environments with geopolitical characteristics. Relevant research shows that China's coastal areas absorb advanced culture and technology in the world, as the window communicating with the world. The cultural development is of openness and compatibility, hence the cultural industry is of various types. With developed achievements of the emerging cultural industry combining with culture, the development of S&T is prominent in coastal areas with high technology and an accumulation of professional talents. The coastal areas consist of flat terrains and extensive sandy beach areas, which are suitable for cultural activities related to the ocean and thus to the development of cultural industries such as sports, leisure, tourism, etc. The inland areas are populated areas of the minorities. Due to land formation and people's awareness, most nationalities maintain primitiveness, non-sophistication and uniqueness. It is this national culture with characteristic styles that make for abundant folk culture, folk arts, and folktales of the minorities, so that it becomes the important part of cultural resources. Eastern coastal areas have been flourishing in culture and economy since ancient times. Priority is given to economic and cultural development and the rate of development exceeds that of some inland cities. Many mountains, basins and plateaus in inland areas of the west make transport inconvenient and limit exchanges between the area and the outside world to a great degree, therefore causing the poor circulation of resources. People's tendency to reject new things greatly reduces domestic demand. It not only limits cultural communication and diffusion, as well as the development of a cultural industry in the area, but also limits understanding of the outside world for the culture of inland areas and economic and cultural development.

The characteristics of geopolitical structure cause an unbalanced objective social context of regional development in Chinese society. Data from a report on China's Human Development Index by Renmin University (2012) showed that the regional difference of comprehensive development level of China's society and economy is escalating since 2005 (Yuan Wei, 2012). The regional difference of index of people's living standards is high and increasing year by year, thus causing the regional difference in the overall development level of society and the economy to increase gradually, and the imbalance in regional development to be remarkable.

(b) The characteristics of localness in the Chinese population structure

Data from the National Bureau of Statistics of China showed that Chinese citizen's structure possesses significant features of localness in natural structure, social structure and consumption structure. In terms of the overall natural structure of Chinese citizens, the proportion of Chinese urban and rural residents is close to 1:1, with Han nationality accounting for 91.5% and minorities accounting for 8.5%. The sex ratio is 1.05:1. The old-age dependency ratio of Chinese citizens was 12.3% in 2011 and the natural structure of citizens tends to be aging obviously (National Bureau of Statistics of China, 2010).

In terms of the social structure of the Chinese population, although the educational level of Chinese citizens has improved significantly, as in 2011 Chinese citizen's per capita years spent in education was 8.5 years, the new labor force's average years of schooling was over 10 years, both of these figures were above the world average (see People's Daily Online, 2013). The general education level of the Chinese population is still low. Data from the sixth (2010) census showed that people receiving higher education and above accounted for 8.9% in 100 thousand people and people receiving secondary education accounted for 53%. In addition, people receiving primary education accounted for 27% and the illiteracy rate was 4.1%.

In terms of Chinese citizens' consumption structure, the consumption of China's urban and rural households is obviously differentiated, and the consumption of a Chinese family is drastically differentiated from the consumption level of developed countries. In 2011, the per capita disposable income of China's urban households is 19,109.4 Yuan and that of China's rural households is 5,919.0 Yuan, which is differentiated significantly. It is worth noting that the annual per capita service consumption of culture, education and entertainment of urban households is 1627.6 Yuan and that of rural households is 366.7 Yuan in cash. As for cash outlay for culture, education and entertainment, that of China is very much lower than that of the major developed countries in the world. According to the relevant report, 1/5 of per capita income is used for leisure and entertainment in the US.

Moreover, the structure of the Chinese population is in a phase of fast flow and change. The crowds of "new urban residents" who come to work in cities and are settled in cities are increasing sharply. The Report on the Development of the Floating Population in China in 2013 issued by the National Health and Family Planning Commission in

September 2013 showed that there was a 236 million floating population in China in 2012, namely, there was one floating person in 6 people. The floating population tends to be younger in recent years. The average age of the floating population was about 28 years old in 2012 and the majority of the floating population of labor age was born after 1980. Compared with the last generation of "new urban residents", the new floating population of leaver age was 7 years ahead of schedule. It was written in the report: "The distance of the flow was longer and the reason for the flow was diversified, and they tend to be settled in work places and prefer large cities."

To sum up, under the vision of the globalization of science communication, social context is experiencing the changing relationship between science and society, science and the public are in an increasingly close relationship, and new information technology is booming. In the localized perspective, science communication also needs to deal with China's local social context characterized by urban-rural imbalance, a regional development imbalance and the diversity of population structure. This composite overlay of various factors in the Chinese social context creates the trend towards complication in science communication development, and brings about the diversity of public demand for science communication.

2.2 The diversity of Chinese citizens' demands for science communication

The social context of science communication in China presents both common features of globalization, and distinct local characteristics. Its influence is highlighted in the imbalance between the development of Chinese civic scientific literacy and the diversified demand of the Chinese public for science communication.

(a) Imbalance in the development of Chinese civic scientific literacy

China's geopolitical structure causes the unbalanced development of economy and culture, as well as urban and rural differences in population structure, which is also the root factor of the imbalance in the development of Chinese civic scientific literacy. Scientific literacy levels of Chinese citizens are significantly differentiated in gender and nationality according to the 8th Civic Scientific Literacy Survey in China, which was carried out in 2010. The proportion of male citizens with basic scientific literacy was 3.7% (the average level was 3.27%) and that of female citizens was 2.6%. The proportion of Han citizens with basic scientific literacy was 3.3% and that of minorities was 1.9% (Ren Fujun, 2011).

Scientific literacy levels of Chinese citizens are significantly differentiated between urban and rural areas. With the gap of 3.1 percent points, the proportion of urban citizens with scientific literacy among Chinese citizens is 4.9% and that of rural residents with scientific literacy is 1.8%.The development gap between regions is also prominent, residents with scientific literacy living in the east account for 4.6%, which is obviously higher than that in the central areas and west areas. While the difference between central areas and west areas are not obvious, respectively 2.6% for the central areas and 2.3% for the west areas.

Scientific literacy level is also influenced by age and education level. The proportion of citizens with basic scientific literacy decreases with increasing age, while it increases with improvement of the level of education. The scientific literacy level among citizens undertaking different professions is also different. The professional technicians have the highest scientific literacy level and production personnel in agriculture, forestry, animal husbandry, fishery and water conservancy and domestic workers have the lowest scientific literacy level. Scientific literacy level has a high correlation with people's interests, attitude and engagement with science and technology issues. The imbalance of scientific literacy status among the Chinese public is bound to bring more complexity to public demands on science communication.

(b) Diversified demand of the Chinese public for science communication

Along with the increasing relationships between science and society, science and the public, the public shows more interest and increasing demands on science and technology-related information. The Chinese civic scientific literacy level has improved significantly. The proportion of adult citizens with basic scientific literacy has increased from 2.25% in 2007 to 3.27% in 2010. Due to the diversity of China's population structure, along with the gradual increase of public attention to science and technology, the Chinese people's demand for science communication is diversified in growth. Findings from the eighth civic scientific literacy survey showed that Chinese public interests in science and technology topics are different. Male citizens, Han citizens and citizens with higher educational levels are more interested in scientific and technological information. Different groups show different interests in new discoveries in science, invention and technology, and medical progress.

As for the response to "the most interesting information on science development for you", the Chinese public's responses present different clustering characteristics among various social groups. For instance, the groups which are most interested in medicine and health are the female and the elderly. Female urban residents showed higher interests in information about environmental science and pollution abatement. The youth group is more interested in computer and network information.

The diversity of public demand for science communication is also reflected in the selection of science communication channels. According to the survey result, channels used by different groups to obtain scientific and technological information are obviously different. Urban residents make more use of newspapers, Internet and books to obtain scientific and technological information than rural residents. In terms of regional difference, there are more residents in the east who make use of newspapers and Internet than those in the central and west areas. The proportion of young citizens obtaining scientific and technological information with Internet, scientific journals and books is the highest. Citizens who are 30-49 years old tend to obtain scientific and technological information through newspapers. Citizens over 50 years old prefer to obtain scientific and technological information through television, radio and talking with people.

Citizens' participation in science communication activities is obviously different in cities and villages. The survey data show that urban residents participating in large science popularization activities such as science and technology week, science and technology festival and science and technology day account for 28.9% and rural residents account for 19.9%.The proportion of rural residents participating in science and technology consultation (35.1%) and science and technology training (42.3%) is higher than that of urban residents (29%, 30%). However, the proportion of urban residents attending science and technology exhibitions and science and technology lectures is higher than that of rural residents.

People's utilization of science communication facilities is obviously different in urban and rural areas. The average proportion of people visiting science and technology venues is 27%. The proportion of urban residents who have visited is 41.5% and only 20.2% of rural residents have visited relevant science and technology venues. 64% of urban residents have used public libraries or reading rooms and 42.5% of rural residents have done this. As for the reason for not going to science and technology museums, 28.2% of urban residents' response was "no facilities locally", while 44% of rural residents' response was the same. The proportion of urban residents who replied there was "no natural history museum locally" accounts for 33.6% and 48.3% of rural residents. The difference in behavior patterns among in Chinese citizens' engagement in science communication activities illustrates the diversity of public demand on science communication infrastructure distribution and service coverage.

2.3 Booming new media intensify the complexity of science communication

The modern information technology revolution opened up a new era of media and new media products. The Internet is gradually replacing traditional media and becoming the major means for Chinese citizens to obtain scientific and technological information. Recently, new media technology represented by mobile terminals has brought revolutionary development to science communication. The CNNIC survey report shows that the scale of China's instant message netizens has reached 497 million by the end of June in 2013 (CNNIC, 2013). Interactivity and multi-directionality of communication, fragmentation language have become core characteristics at the early stage of the new media era. The birth of new media has changed the traditional media work habits and system of expression.

With the rapid development of digital technology and the change in mass media function and role, new media represented by network media has not only changed human beings' means of communication, but also has a tremendous impact on people's words and deeds, and a revolutionary impact on social structure. Combined with the communication function of special linguistic symbols of the new media, the unified science communication context, jointly structured by internal and external factors, form a unique domain of the information age, namely, the science communication context in a digital media communication environment.

The change in social context brought on by new media increases the complexity of science communication relationships. People's cognition patterns, communication models, and habits in obtaining information have changed drastically. Firstly, a lot of people have developed the cognition habit of shallow reading and fragmentary interaction. User groups using spur-of-the-moment instant communication platforms, such as Weibo, WeChat, is the best demonstration in China. Secondly, the traditional linear unidirectional mass media are marginalized and fade. According to a recent DICC report, TV ratings dropped 13% in 2011 in China. There were 40 million Chinese people saying that they would no longer watch television, including more than 65% of young people.

New media have brought new challenges to China's science communication including the following aspects. The gradual decline and marginalization in public perception of the traditional paradigm of science communication could lead to public alienation from science. Major bodies in Chinese science communication are under pressure and weakening, and some new little-known science communication organizations may obtain a central position in people's science life. Therefore, the question of how to approach the Chinese public accustomed to new media communication and learning must be considered when formulating China's Science Communication strategies.

3. LOCALIZED SCIENCE COMMUNICATION STRATEGY

3.1 The policy system of science communication in China

(a) The Strategy of China's science communication policy

The science communication policy system in China is driven by national demand and the requirements of the public. It not only has to adapt to China's unique social context, but also satisfy the diversified demand from the public in science communication.

These policies are promoted by government sectors after introduction and mobilize the participation of various social organizations. Government and social organizations jointly build various activity platforms so as to enable the public to participate in science communication events. The feedback and new demand of the public are formed in the process of participating in science communication activities as well as becoming the impetus for the introduction of new policies.

To fully mobilize the power of social participation, China adopts the practice pattern of *large scale unites and cooperates* across the whole country. At present, there are over 20 national ministries and commissions, research institutions, non-governmental organizations, such as Ministry of Science and Technology, Ministry of Finance, Ministry of Agriculture, Ministry of Education, Chinese Academy of Sciences, China Association for Science and Technology, etc., which have participated in the social undertaking and played a dominant and impelling role. Many large social works of science communication have been launched by one or several of them with assistance from other relevant organizations. At the same time, these organizations mobilize other social agencies to set up a broad platform for the public to participate in science communication.

(b) A science communication strategy applicable to different target groups

In order to adapt demand from different groups in science communication, current science communication policy in China has formed approaches to implementation on the basis of five action plans for scientific literacy improvement in target groups, and five foundation projects of science communication capacity construction. The five target groups include minors, farmers, the urban workforce, leading cadres and civil servants, and community residents. Minors are receiving basic education in the process of the construction of scientific literacy and will grow up in the future. Farmers are laborers, who make up the major portion of the population in China, the builders of a new socialist countryside and the group with less educational opportunities. The urban workforce population are the main practitioners and creators of modern life and modern production. Leading cadres and civil servants are the main practitioners in providing public service, while community residents are emerging urban subjects formed in the process of the accelerating period of China's urbanization at present. Science communication modes and plans are respectively designed with regard to five target groups to meet differentiated demands in science communication in different groups.

The demand of science communication from farmers not only embodies the diversified character of China's demand for science communication, but also reflect its unbalanced situation. Therefore, science communication targeted at farmers pays more attention to the construction of rural science and technology training systems, the implementation of rural science and technology communication activities, rural science and technology service channel development, the promotion of rural science and technology demonstration projects (science and technology training, science communication activity, science and technology service and demonstration sector establishments) to improve the scientific production and quality of life of farmers. Science communication to farmers should not only attach importance to improving the level of farmers' practical technology, but also encourage them to constantly enhance capacity in undertaking non-agricultural industries. For example, the "science popularization plan for benefiting farmers and prospering villages" is a large science communication project jointly implemented by the China Association for Science and Technology and the Ministry of Finance, targeted at farmers, agriculture and villages. This project replaces the subsidy method of reward and evaluates mechanisms, screens and commends a batch of advanced groups and individuals with outstanding contribution in publicity of S&T and in villages, as well as with strong regional demonstration functions and strong activity in their local area. This project stimulates farmers to publicize and popularize science and technology via a "model demonstration" pattern. The target of the "science promotion popularization plan for benefiting farmers and prospering villages" project is to enhance more and more farmers' interest, awareness and consciousness in studying and applying science and technology, and lead them to improve their scientific literacy and capacity to cast off poverty, develop production, protect the environment and improve their quality of life. It will lead farmers to set up scientific, civilized and healthy production modes and lifestyles, and boost rural development in economy and society.

3.2 The multi-level infrastructure system of science communication in China

"Science communication infrastructure" is the important entity underpinning the science and technology popularization enterprise. It is also the material support platform for providing science communication services to the public, the crucial component of the national public cultural service system and the construction of national science communication capability. Compared with the rest of world and according to the reality of public demands in China, China's science popularization infrastructure still has a long way to go, specifically in terms of the total amount, uneven regional distribution, shortage of funds, insufficient exhibition and education resources, and lack of professionals. Mainly with regard to the insufficient amount and uneven regional distribution of the science communication infrastructure, China's science communication services have not yet benefited all citizens. As data from the 8th Chinese civic science literacy survey indicates, there is still a considerable proportion of the public who *did not visit science communication facilities* last year either because *there were none locally* or because they *did not know where the facilities were located*. The problem of uneven regional development has not been fundamentally resolved, and the amount of science communication infrastructure remains relatively small in economically backward areas where there is a scarcity of science education resources. In terms of the distribution of China's existing science popularization infrastructure, there is a clear difference between the eastern and the western and central regions, and between developed and less developed areas. Science and technology museums and popular science education bases in the 11 eastern provinces and municipalities account for half of the country's total, while there is a severe shortage of science popularization infrastructure in the western and central regions, which lag behind in constructing such infrastructure.

In order to counter the imbalance in regional development and meet the challenge brought by new media technology, the construction of China's science communication infrastructure should adopt the strategy of different levels, various kinds and gradual development. Existing science popularization facilities in China are characterized by various types and different forms, including science and technology museum mainly serving large and medium-size cities, science popularization education bases[1] relying on collaboration with other agencies and science popularization facilities targeted at grass-root areas. The science communication infrastructure in China also covers both permanent infrastructures set up in fixed places and the mobile facilities of science popularization caravans moving about in urban and rural areas. It also includes online science communication facilities such as Internet-based science communication websites and digital science and technology museums.

In recent years, construction of science communication infrastructure in China has made great progress. To begin with, a fairly large number of science popularization infrastructure facilities have come into existence in China. At present, there are more than 600 large-scale science and technology museums, including science museums, natural history museums and engineering museums. There are medium-size or large science and technology museums in almost all municipalities and provincial capitals, and even many prefecture-level cities boast such museums. There are now as many as 20,000-odd accredited popular science education bases in China, of which 650 have been designated as national popular science education bases,1390 have been designated by provincial science and technology associations, and 26,000 have been designated by science and technology associations at prefecture and county levels. Included are youth science and technology education bases and rural popular science demonstration bases, as well as popular science education bases for many industries. Statistics indicate that now in China, there are 1500 mobile science popularization facilities, including more than 380 science popularization caravans dispensed by the China Association for Science and Technology, 200-odd science popularization vehicles allocated by local science and technology associations, and over 900 such vehicles from other departments.

Secondly, the science communication infrastructure in China has undergone noticeable improvement in terms of content and service capability, its distribution has been becoming increasingly reasonable, and its construction has been accelerating continuously. As part of science communication infrastructure, exhibition and education

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[1] The Science Popularization Education Base is a Chinese localization sort of science communication organizations. The Science popularization education base refers to science communication sectors relying on various science agencies such as teaching sectors, R&D institutions, High-tech production sectors and science service sectors. The Science Popularization Education Base is open to the social public and provides relevant science communication services. (Ren Fujun & Li Zhaohui, 2011)

resources have reached a sizable amount, and with it educational exhibits are no longer merely specimens, pictures, and material objects. Instead, more and more interactive, experiential exhibits have been appearing in science communication infrastructure. Such science communication activities as themed exhibitions, temporary exhibitions, travelling exhibitions and popular science lectures are on the increase. Up to now, the number of the beneficiaries of science and technology museums in China has reached tens of millions and the opportunity for the public to utilize the science communication infrastructure has evidently increased. According to data from the 8th Chinese civic science literacy survey in 2010, 27% of Chinese citizens have visited science and technology museums, up 17.7 % over 2005 figures (Ren Fujun & Zhai Jiequan, 2012).

In light of the social context of diversification of the public's demand for science communication in China and unbalanced regional development, China attaches importance to the development of science communication infrastructures to build a "Chinese modern science and technology museums system". The Chinese modern science and technology museum system includes various science and technology museums (permanent science and technology museums, mobile science and technology museums, science communication caravans and network science and technology museum) as a platform, makes overall planning, develops harmoniously, makes a world-class public cultural service system conforming to China's social context, satisfies the science communication demands of different regions and different groups, provides scientific education for the public as well as providing services.

4. DISCUSSIONS

The authors include research on the social context of science communication in the research on science communication. International counterparts are required to pay attention to the following discussions:

Firstly, researchers should attach more importance to the study of the social context of science communication, and discuss its shaping and impact on science communication modes, frameworks and system models. The effort should be made to bring social context into the research on science communication modes so that it can theoretically enrich the research on diversified science communication modes under different social contexts across continents. In terms of practical application, the analysis of the social context of science communication provides strong support for regional science and technology decision-making.

Secondly, how to describe the social context of science communication? Which dimensions in the social context of science communication are required for reflection? How to establish the framework of indicators for the social context of science communication?

Finally, if the impact of social context on science communication is obvious and profound, is there any meaning in conducting international comparisons on science communication practice? Is there any possibility and feasibility for international comparison? How to carry out comparative studies taking into account a variety of local characteristics? These are issues which require in-depth exploration by science communication researchers

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RETHINKING THE CONVERSATION: 5 VIEWS

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