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‘So That All May See’: An Interrogation of Knowledge Generation in the Post-colony

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Abstract

Discourses on geopolitics of knowledge have for long focused on distribution of knowledge artifacts as a marker of West’s domination. But following Mignolo and focusing on enunciation, we centre-stage the geo- and body-politics of knowledge- the knower, known and the knowing in the process of displacement of dominance. Through an exploration and interrogation of a surgical invention in ‘stem cell therapy’ in ophthalmology at a clinic-cum-research site in India, we show that only through the mutual imbrication of the socio-economic-cultural sensibility of the geo-historically located innovator surgeon and the immanent scientific logic of stem cells therapy that displacement occurs in geo-politics of knowledge. We argue that mutual imbrication happens through the ‘*location*’ becoming implicated in the known and the knowing thereby equipping the knower in a mutually constitutive manner. Such implication of the ‘local’ can occur only when a knowledge-artifact is yet to be concretised in the Simondonian sense, i.e, is open and still in the making. Dialogic relations between the knower and the known allow locally informed transductive leaps of imagination in an open knowledge artifact.

Key words: Enunciation, Decolonial, Geopolitics of knowledge, Simondon, Knowledge Artifact

*Both authors have contributed equally

‘So That All May See’¹: An Interrogation of Knowledge Generation in the Post-colony

India may have the most number of problems...but it also has the most number of solutions.

Dr. G N Rao, Founder of LVPEI

The discourse on geopolitics of knowledge, often informed by historically constructed dualities such as the North-South, West-and the Rest, centre-periphery or the developed-developing with an implicit undertone of “*first in Europe (West) and then elsewhere*”, maps and remaps nation-states through data on global distribution of the *volume* of knowledge artifacts (KA). In recent years such statistical exercises mapping various markers of national identity on patents and other intellectual property, signal a steady growth in knowledge generation (KG) in natural sciences and engineering from the countries of Asia, Africa and Latin America (WIPO, 2014). Countries like China, South Korea, India and Brazil now appear among the top 20 scientific KG (WIPO, 2014). The international patent office has reported an increase in the number of patents filed from low income countries (WIPO, 2014). The share of science and engineering articles from US/Europe has concurrently declined from 69% in 1995 to 58% in 2009 (NSF, 2012). In the social sciences too, citation analysis has shown an increase in publications from erstwhile colonized regions; Latin America’s share grew by 74% between 1988-97 and 1998-07, while Europe’s increased by 58.4% for the same period (Gingras and Natanson, 2010). These trends have generally been interpreted as evidence of the rise of the Rest, a positive consequence of globalization suggesting that global flows of people, ideas and resources have led to a decline in differences in KG capabilities across the globe (NSF, 2012). The fact that high technology MNCs today locate their R & D centers in countries like India and China is presented as

¹ ‘So That All May See’ is the Vision Statement of the organization on which this study is based.

evidence of the declining gap in KG. Scholars have also reported a dramatic rise in research collaborations (Gazni, et.al, 2012; Leydesdorff, et.al, 2012) suggesting that “*the underlying social organization involved in creating scientific knowledge has been shifting*” (Leydesdorff, et.al, 2012).

Critical scholars like Gingras and Natanson (2010) have argued that globalization has adversely affected peripheral countries, reducing their autonomy and increasing their dependence on the ‘centre’ for KG. A plethora of studies on research collaborations, citation patterns, patent and other IPR filings identify the neglect of domestic work and privileging knowledge from the West (Gazni, et.al, 2012; Prato & Nepelski, 2014; Leydesdorff, et.al, 2014; Gingras and Natanson 2010). Studies of Critical Management Studies (CMS) scholars have also supported these broad patterns. They find that management knowledge has been produced in the West and all the concepts, theories and categories come from and privilege the West (Alatas, 2003; Fougère and Moulettes, 2011; Srinivas, 2008; 2012; Tipton, 2008; Prasad, 2015; Jack, 2015, Jack & Westwood, 2007, Nkomo, 2011).

One feature common to these studies, is their focus on the *enunciated* (Mignolo, 2009) the final artifactual form of KG- whether a patent, a copyright, a journal article, or a textbook instead of the ‘process’ of arriving at the artifact. Since the KG apparatus is no longer contained within nation-states in the manner of ‘national innovation systems’, a sole focus on the final artifact of KG process may be inadequate to map the global topography of knowledge work and the dynamics of domination or its displacement therein. As Warwick Anderson rightly suggests, ‘*even the most local..... should imply a network, suggesting connections with other sites through traffic of persons, practices and objects*’ (Anderson, 2002: 652).

More fundamentally however, following decolonial theorist Walter Mignolo's distinction between *enunciation* (or the act of knowing) and the *enunciated*, to examine the 'enunciation' is to understand the enunciator (or the knower), geo-historically located and socially embedded, in the act of knowing. The enunciated, as the 'known', is free-floating and capable of detaching from the context both of the act of knowing and that of the knower. An attempt to interrogate scientific/technological KG in a post-colony, reduced historically to a site that produced 'culture' and not 'science', a site which at most was a consumer of 'first in Europe and then elsewhere science' (Prakash, 1999) through the 'colonial matrix of power', would need to recover the knower at the locus of knowing. This paper is an attempt to examine 'the enunciation' in scientific KG or the creation of a KA within a dominated field and the dislocation of domination in the process of the creation of this artifact in a post-colony.

In what follows, after a brief review of the literature on geopolitics of KG, we analyze the invention of an ophthalmic stem cell (OSC) therapy in India. We borrow from Simondon's notions of 'concretization' of technical objects to articulate the internal technologic of the artifact-in-making. Our study, through a critical hermeneutic analysis (CHA) of the case exemplar, reveals that dislocation of geopolitical dominance in KG rests on the 'location' implicating both the act of knowing and the imagination of the known, a la Simondonian '*transduction*' through the locally embedded inventor.

Literature Review

Mainstream scholarship studying KG has examined ways by which KG and its codification can be improved. While management research has focused its attention on the dynamics within firm boundaries even as the firm extends beyond geographies (Andersson, et.al, 2015); development

planning and policy research has examined the institutional set-up and collaborations necessary like the Triple Helix model (Etzkowitz, 1993; Etzkowitz and Leydesdorff, 1995) for effective KG and transfer within and between countries and institutions (Molina-Domene & Pietrobelli, 2012; Arocena, et.al, 2015; Audretsch, 2014).

One strand of critical research has focused on citation studies and highlighted continuing domination of the West. According to Gingras & Natanson (2010) for the period 1980 to 2007 in their study of 1162 journals, Europe and North America together contributed 92.6% of the journals and 90.2% of articles between 1980-2007.). Their study also found that central actors in the field tend to concentrate their citations on the central journals and countries, thus neglecting contributions from outside Europe and North America”. The study also describes another trend where North American and European collaborations sought by African, Asian and Latin American authors had more than tripled by 2005 compared to 1980s indicating a greater dependence on the prestige of the ‘centre’ amongst those in the ‘periphery’. This is accompanied by a noticeable decline in peripheral regions citing papers from within their regions. For instance from 1993-95 to 2003-05, regional self-citations for papers from Africa have declined from 22% to 11.7% and for Asia it fell from 6.8% to 1.6%. These trends show that knowledge produced within the periphery is not being valued even within the periphery and only that emanating from the ‘centre’ counts for scholarly prestige and knowledge. Gingras and Natanson conclude with an observation of increasing academic dependency and focus on the ‘centre’ to the neglect of the local. These social science trends have been supported in natural sciences and engineering research too (NSF, 2012).

A second strand within the critically oriented literature has been informed by dependency, postcolonial and decolonial theories and has looked at epistemic domination and subalternisation

of knowledge. Some, following Sandra Harding (1994), have demonstrated the colonial roots of modern Western knowledge. Yet others have focused on resurrecting subalternised epistemologies and knowledge systems in fields as diverse as medicine, technology, agronomy and management. Postcolonial CMS have also revealed domination through modern social science knowledges of management and development (Jammulamadaka, forthcoming; Alcadipani & Faria, 2014; Frenkel and Shenhav, 2006; Alcadipani & Cooke, 2013) and the need to make room for subalternised knowledge systems (Ibarra Colado, 2006; Dussel & Ibarra-Colado 2006; Faria, 2013). Some others have argued that managerial practices of knowledge transfer are essentially colonizing and exploitative and that organizational members engage in subtle forms of resisting such exploitation (Mir, Mir & Upadhyaya, 2003; Mir, Banerjee & Mir, 2008; Prasad & Prasad, 2003).

However, as postcolonial science scholars Seth (2009) and Anderson (2002) suggest, much critical work has assumed an easy binary between the modern/indigenous and the local/global. In claiming a space for indigenous knowledges, critical scholarship has more often than not unproblematically invoked the western/indigenous as a binary. A similar unproblematic invocation of a global or western/local binary can be traced within critiques of technology transfer. While this simplified binary following the logic of *strategic essentialism* (Spivak, 1993) has enabled a clear analytic characterization of the process and technologies of domination and subtle mechanisms of resistance, what remains as yet unknown is the process that materializes a dislocation of domination. The postcolonial and decolonial aspiration of provincializing Europe remains as yet in the realm of imagination. Attempts at deciphering the process of dislocating and unhinging domination will need to recognize that contemporary world

defies any stable identities of global/local, modern/native. The interconnections of the globalized world necessarily frustrate such easy categorization (Appadurai, 1996; Ong, 1999). Anderson (2002) suggests that the older ways of studying science and KG as occurring in closed communities of nation states are not suited “*to explaining the co-production of identities, technologies ... characteristic of an emerging global order.*” (Anderson: 2002:643). By implication, attempts at understanding the geo-politics of KG will have to shift the gaze from KA- the citation, the patent, the IPR, the textbook, the journal article – which resides in a stable identity location embodied in an institutional, geographical and disciplinary affiliation to the process of arriving at the artifact – a process where people, knowledge, ideas, resources all flow between these numerous identity pit-stops. This paper is such an attempt. It seeks to specifically examine the KG process and the dynamics that lead to an unsettling of the dominant forces with an attendant shift in the locus of KG.

Theoretical Framework

The decolonial theorist Walter Mignolo contends that “*because geo-historical and bio-graphic loci of enunciation have been located by and through the making and transformation of the colonial matrix of power...*”(Mignolo, 2009: p.2), shifting the focus to ‘enunciation’ is necessary to understand the nuances of dominance, de-linking and decolonization of knowledges. ‘De-linking’ Mignolo explains occurs by “*...thinking from the absent perspective...*”, that perspective which was silenced and denied existence by modern epistemology which ... “*created the figure of the detached observer, a neutral seeker of trust and objectivity who at the same time controls the disciplinary rules...*” (Mignolo, 2006, p.4).

Building on the notion of ‘situated knowledges’, Mignolo (2006, 2009) argues that the knower, the one who generates knowledge, is always implicated geo and body-politically. Contrasting the

writing and subjectivities of Cervantes' who writes Don Quixote and Waman Puma a native Quechua writer and thinker who writes in broken Spanish "*Nueva coroniza y buengobierno*" both from the sixteenth century, Mignolo argues that the subjectivity of Cervantes who writes during a period of a shift from theology to philosophy in Europe is quite different from that of Puma who is writing during a period of colonial decimation of his peoples. He advocates that any KG process to be truly decolonial has to give room to these differences in subjectivities in the generation of knowledge. Such assessment of the nature and position of subjectivity can only be carried out by asking questions of "*who, when, why and where is knowledge generated (rather than produced, like cars or cell phones)? Asking these questions means to shift the attention from the enunciated to the enunciation*" (Mignolo, 2009: p.2). We draw upon this dictum of Mignolo to focus on and tease out the enunciative process and the enunciator.

To supplement our Mignolian analysis of the enunciative act and provide a handle to the scientific logic of technology (very much like the linguistic rules and logic of literary text) which interacts with the enunciator we draw upon Simondon's (1980) work on transduction and invention elaborated in 'On the Mode of Existence of Technical Objects' where he has theorized about the process of 'becoming' of a technical object. Simondon says that in a 'concrete technical object' there is a certain convergence of structures which attains structural unity and an internal coherence. This coherence makes a technical object stable and reliable in a variety of natural environments and makes it portable as an artifact.

Simondon distinguishes between "inventing" and "developing through stages". Simondon suggests that technical objects 'develop through stages' through a physical translation of one or more, often previously unrelated, scientific principles. Since unrelated elements brought together

in the physical system of the technical object are not integrated, they often produce uncalled for secondary effects through reciprocal influence on each other. This creates a region of indeterminacy known as '*disparation*' in the technical object and keeps it 'open'. While the scientific principle is known, the specific information on *disparation* is empirical in nature (the 'meaning' that each element gets in relation to others in their simultaneous working) and cannot be arrived at theoretically. The margin of indeterminacy present in the *disparation* is what is progressively reduced as a technical object '*becomes*' in stages. Routine concretization proceeds through minor adaptations that does not resolve but merely suppresses the uncalled-for secondary effects or '*disparation*'.

On the other hand, in "*inventing*", the initial incompatibility/*disparation* or problem is transfigured into the solution - the means of achievement, by a reworking/rearrangement of internal functional distributions within the elements in the system. Concretization here is effected only because of the 'invention' that *imagines* the problem as solved. Here, elements which make up the technical object must be re-organized in relation to one another by means of an as yet unknown, *imagined* causality whose proof will emerge only once the object has been constituted. This new system of actuality becomes possible only because the system exists together with its '*associated milieu*' which Simondon defines as a definite system of natural elements surrounding the technical object that is linked in a recurrent causal relationship with the elements of the system. The associated milieu is the "invented" technical object's condition of existence. Acts of such invention therefore presuppose the use of an anticipatory functioning, based on a specific unity within the individual-cultural-geographic problematic which is discoverable neither in nature nor in technical objects made up to that time. This involves a conditioning of the present

by the future. The associated milieu, a repository of tendencies and potentialities of all elements in relation to each other provides a background of information and meaning to the inventor to instigate a creative leap of reversed conditioning in time where an *imagined* solution rather than pre-existing fact provides the rationale to concretise the technical object. This process which is neither deductive nor inductive is what Simondon calls '*transductive*'. Simondon's idea of transduction distinguishes the 'creative' inventive act from *mere hypothetico-deductive* work.

METHODOLOGY

This research seeks to uncover the dynamics of KG in a post-colony in creating a KA. A methodology that enables us to foreground simultaneously the process of KG, its author, the authorial process, the context of authorship and the internal logic of concretization of the technology-in-the-making is most important for this study. We have chosen the critical hermeneutic approach (CHA) to organizational analysis (Prasad, 2005; Prasad, 2002; Prasad & Mir, 2002; Phillips & Brown, 1993,) for our study as it allows us to pay specific attention to the historical, socio-economic and organizational context and the complex issue of author intention in decoding the meaning of the text.

This interpretive approach to 'text' draws upon the hermeneutic tradition developed by Gadamer (1975) Ricoeur (1971), Schleiermacher (1985) and others. The critical hermeneutic approach insists that understanding a text involves movement between the text and context - the whole can be understood through its parts and the part through the whole i.e., the hermeneutic circle (Prasad, 2002; Prasad, 2005). Context itself exists in multiple levels of synchronous and/or historical comprehensiveness. It is not given apriori but determined by the researcher pursuant the questions and objectives of study (Prasad, 2002; Prasad, 2005). Understanding the text results from a fusion of the horizons of the text's author and the researcher, through an identification of

the questions which the text answers (Prasad, 2002). Such understanding, while necessarily located in the present and accessible only through the interpreter's own prejudices, goes beyond the intention of the author (Prasad, 2002; Gadamer, 1975). A long standing practice within social sciences treats social and economic phenomena and not just written word as texts (citing Ricouer, 1971, Prasad 2002, Phillips and Brown, 1993). Following Prasad (2002) and Prasad (2005) we draw upon postcolonial theory that is suited to our specific geo-historical location to provide critical self-reflexivity to the process of interpreting the text.

Data and Method of Analysis

The specific 'text' this study analyses is an ophthalmological surgical technique called "Simple Limbal Epithelial Transplant" (SLET) developed by Dr. Virendar Sangwan of L.V. Prasad Eye Institute (LVPEI) of Hyderabad, India to treat one kind of corneal blindness. The 'context' for this study has been identified as a) historical evolution of the technique within LVPEI, b) evolution of and regulation of ophthalmic stem cell (SC) and medical SC research and therapies globally. The study interrogates the enunciator Sangwan enunciating within the LVPEI organization, which itself is located both geographically and temporally within the global SC ophthalmic and medical research.

The data for this study has been obtained from five different sources. A) The first source has been interviews. Interviews were held with 5 doctors and scientific staff at LVPEI, the head of research, the executive chairs at LVPEI. Each interview typically lasted about 75-80 minutes. In addition multiple interviews totaling over 8 hours were held with Sangwan and his scientific team to understand their technique, motivation and processes in treating LSC deficiency (LSCD). B) Over 50 research papers on SC therapies in general and specific ophthalmic applications like

LSCD were consulted. We analyzed the abstracts of all published work of Sangwan between 2001-2015 to understand the nature of problems he was addressing, the kind of data he used etc. We viewed the papers as reports of ‘trials’ or experiments that were made to a global expert peer group to stake a claim to knowledge generation. C) videos (both publicly available and internal to LVPEI) were consulted. D) United States Food and Drug Administration, Indian Department of Biotechnology and European standards and regulations of SC research and therapies were consulted. E) Websites and publication lists of 6 key investigator groups in ophthalmic SC research were consulted.

The interview data was first transcribed and treated on par with other data. Unlike grounded theory, CHA does not involve a fine-grained coding of textual data with the generation of themes and categories. CHA is characterized by a continuous and sympathetic interrogation of the text, a historical and contextual analysis (Prasad, 2005) in order to identify the deeper meanings it carries. We therefore continuously traced the histories and contextual interactions of the “SLET” text and debated amongst ourselves and also with Sangwan and his team to improve and confirm our understanding. The writing of the paper began only after saturation had been achieved in the identification of the enunciation process as posed by the research question. The final written paper was also shared with Sangwan to clarify our understanding. This was done in the spirit of the fusion of hermeneutic horizons of the author of the text and the researcher-interpreters. Thus the specific steps adopted in the method were

- a. Identifying the historical trajectory of the evolution of SLET in treating LSCD
- b. Identifying the specific steps and stages through which Sangwan’s team developed the SLET at LVPEI

- c. Identifying the specific constraints, opportunities, inspirations, insights, that enabled and supported Sangwan's work on SLET. Locating the work of Sangwan at LVPEI within the broader regulatory context in India
- d. Locating Sangwan's work of evolving SLET within the broader context of global ophthalmic SC therapeutic research
- e. Comparing the different trajectories and outcomes of Sangwan's SLET and other global ophthalmic SC research groups.

Rationale for selection of SLET

The nature of the research question necessitated that we examine the process of arriving at a KA in a dominated field of knowledge; only then could we examine the enunciative processes involved in dislocating domination. We therefore examined the statistics on patent filings. Generally USA along with Europe and Japan, have been the leaders in patent filings. India filed 43,031 patents in 2013 but 75.2% of these were by non-residents² indicating an externally driven KG. Patent data showed that the top three fields of research in USA during 2010-12 were computer technology, medical technology and pharmaceuticals (WIPO, 2014). However, WIPO specialization index which adjusts for country size showed India fared better than USA in computer technology³ and pharmaceuticals. Since a context of domination could not clearly be established in the above two fields, we chose our study exemplar from medical technology where USA and broadly the West⁴ clearly had dominance. Within medical technology, we focused on SC technology. SC medicine forms part of the emerging field of personalized medicine

² Non-resident patent filing means the first author filing for patent lives outside the country.

³ The WIPO specialization index for pharmaceuticals India 0.621, USA, 0.184 Computer technology India 0.427, USA 0.192. USA has been taken as the reference for this comparison because it has historically been one of the highest patent filing countries. In 2013, it fell to second place after China.

⁴ The top countries in declining order in medical technology patent filings are Israel, Australia, USA, Switzerland, Russian Federation, Netherlands, Sweden, and UK as per specialization index WIPO (2014)

(Takahashi & Yamanaka, 2013). Around 50% of the work on SCs is happening in the field of regenerative medicine (Barfoot, et.al, 2013). SC technology started developing in the late 1980s, one could therefore possibly argue for the existence of a notional level playing field outside the historical effects of colonization. Thus, focusing on SC technology for our study makes it possible to look at contemporary dynamics of enunciation under domination in the '*emerging global order of scientific KG*' (Andersen, 2002). SC technology witnessed rapid growth upto mid 1990s and settled down to around 200 patents per year towards the end of 1990s (Bergman & Graff, 2007). USA has the highest 21% share of patent filings in this technology followed by EU (14%) (Bergman & Graff, 2007). Within SC technology, SC transplantation is one of the top areas of research (Li, et.al, 2009). We therefore chose to focus on SC transplantation research. For our research site, we chose LV Prasad Eye Institute (LVPEI) which is recognized as a global leader in SC transplantation surgery of the eye and a WHO Centre of Excellence in eye care clinical services and research (www.lvpei.org). LVPEI was established in 1987 by a corneal surgeon Dr. G N Rao in Hyderabad in India. Dr. Rao was driven by a desire to provide excellent eye care to the people of his native state and therefore he had come back from Rochester. One of the corneal surgeons at LVPEI, Sangwan developed SLET surgical technique for treating blindness caused by damage to the eye's corneal SCs. This surgical protocol is now practiced globally as a highly effective line of treatment.

Findings:

Overview of treating LSC Deficiency

In certain genetic and other pathologic conditions of the eye, alkali and acid burn accidents the limbal SCs (LSCs)⁵ which ensure constant regeneration of the transparent avascular corneal epithelia is damaged. The LSCs are those cells which progressively differentiate and migrate to give rise to the corneal epithelial cells that are found in a healthy cornea. The partial or complete destruction of LSCs leads to varying degrees of LSCD. As a result, the surrounding conjunctival epithelium invades into the cornea which is unable to regenerate itself. This invasion fills the otherwise transparent cornea with blood capillaries making it opaque leading to loss of vision. Conjunctival invasion can be prevented by limbal restoration through surgical transplantation of LSC grafts. Till 1989, the entire cornea (a circular disc like transparent part in the front of the eye) from cadaveric donors was being transplanted. Clinical outcomes of corneal transplantation were poor and patients also needed costly immunosuppression. In 1989, the presence and location in limbal region⁶ of LSCs was established conclusively (Kenyon & Tseng, 1989) through the surgical innovation by Dr. Tseng in the US which involved grafting 10-20 mm pieces of limbal epithelium with SCs from a living donor eye (including one's own good eye) on to the limbus of the damaged eye. This technique known as CLAu (conjunctival-limbal autografting) had good clinical outcomes for the recipient eye but ran a high risk of LSCD and vision loss in the donor eye due to extraction of large pieces of tissue. Therefore researchers developed CLET (cultivated limbal epithelial transplantation), reported between 1997 and 2000, where very small

⁵ A small population of basal cells in the limbal area, a narrow area located between the cornea and conjunctiva

⁶Limbal region is the transition zone in the eye where the conjunctiva ends and the cornea begins.

portions of LSC tissue (about 2 mm) were taken from healthy donor eye and SCs were cultivated into a multilayered (3-4 layers) differentiated corneal tissue in the lab using artificially derived and/or non-human media, growth factors and feeder cells. This cultivated corneal multilayer was then transplanted into the damaged eye. CLET had good clinical outcomes for recipient eye and ensured safety for donor eye but had two important downsides a) safety risk due to non-human biological (*xeno*) media in the culture technique and b) extremely expensive time consuming procedure requiring sophisticated lab.

Sangwan's work at LVPEI

Sangwan had joined LVPEI almost two decades earlier. He had pursued his fellowship in corneal surgery at LVPEI and had subsequently joined as a corneal surgery faculty at the institute.

LVPEI a tertiary referral centre for people within India and outside practiced as a founding value '*providing the best patient care and treatment irrespective of the patient's ability to pay*'.

Consequently patients came from all walks of life and economic strata and patient and disease load was heavy. Sangwan was often concerned that while they could waive charges for clinical treatment to poor patients, they ultimately had to pay for medication after discharge. He knew that the poor could not afford expensive immunosuppression drugs which often followed corneal transplantation surgery. Sangwan was particularly sensitive to immunological issues and cost of treatment after his encounter with the condition of a poor woman whose eye was affected with an auto-immune condition during his fellowship days. Sangwan's concerns vexed him.

Developing Monolayer CLET and a *xeno*-free culture medium

Sangwan routinely performed corneal surgeries on patients blind due to LSCD. He kept himself abreast of trials and new procedures for treating LSCD proposed by different research groups

across the world and brought them to his patients. He had practiced both CLAU and amniotic membrane transplants (another technique proposed in mid-1990s by Tseng's group).

Abreast as he was, bringing CLET to his patients was a problem for Sangwan. LVPEI did not have a developed SC laboratory for growing a SC multilayer; nor was he formally trained in SC biology. Yet, he tried. He collaborated with a cell biologist at his institute and used the institute's seed funding for research. In absence of air-lift equipment, a standard technique of growing SC in US and Europe where after growing SCs for three weeks in a medium, the medium level is lowered to provide an air-liquid interface that promotes stratification of epithelial cells for another week, Sangwan and his team cultivated monolayer epithelium in submerged conditions. Microscopic analysis of their monolayer sample showed varying stratification along different parts of submerged culture which led them to hypothesize that there was an inherent property of SCs to stratify. Even though they found evidence of stratification and a high percentage of surviving SCs in their technique, they could not actually produce a multilayer tissue in the lab. This handicap was interfering with Sangwan's ability to treat his patients. He therefore approached LVPEI's institutional review board (IRB) for permission to transplant a monolayer instead of the multilayer used in a conventional CLET procedure. IRB did not agree initially but was eventually persuaded with lab data on inherent stratification propensity of SCs. Invoking the principle of 'informed consent of patient' IRB members personally ensured that Sangwan had explained risks to patients by participating in patient briefings. Finally Sangwan got a grant for 20 trials from Department of Biotechnology (DBT), Government of India and he began performing monolayer CLETs. In routine post-operative reviews he found that the cornea did indeed grow normally and that even the feeder cells (whose behavior was not yet understood by science) had integrated normally into the cornea. Thus Sangwan learnt that their hypothesis

about the inherent disposition of the SCs to stratify was not completely incorrect. The early results were published in *Investigative Ophthalmology* and *Bioscience Reports*. After exhausting the DBT grant, armed with clinical and lab evidence, he approached Dr. Rao. He requested LVPEI to fund further treatments using monolayer CLET as per usual processes at LVPEI. Dr. Rao, a data and evidence driven leader and surgeon found the clinical outcomes satisfactory and assured financial and moral support to Sangwan and his team. Once it became established that in-vivo stratification was occurring in a satisfactory manner and vision was being attained by patients, the efforts of Sangwan's team were focused on characterizing the clinical indications and prophylactic protocol for a variety of LSCD patients to improve treatment outcomes. Simultaneously, Sangwan's team also worked on standardizing and removing the animal based ingredients (xeno-free) in the culture medium. First they excluded feeder-cell layer, then replaced fetal bovine⁷ serum with 10% autologous serum (serum from the same person). There was no difference in growth pattern with both these changes. Sangwan's team finally standardized the culture process all along bearing in mind the affordability of the process. Finally they made their new knowledge of an inexpensive cultivation technique available free to the world in the form of a *Nature Protocols* paper in 2010.

This entire approach contrasted significantly with the logic deployed by the original developers of the 1997 CLET procedure, the Pellegrini group of Italy. Pellegrini group's Holoclar, became the first trademarked LSC therapy with pre-marketing approval in Europe. Working closely with a pharmaceutical firm that invested in creating a cGMP compliant central manufacturing facility, Pellegrini group worked actively to standardize their culture medium using fetal bovine serum

⁷ Fetal bovine serum is an animal product and is considered 'xeno' or alien to the human body. Such xeno biological materials are considered high risk for human therapies.

and other associated markers⁸. The Pellegrini group contended that it was necessary to identify and predict the exact number and growth rate of donor SC tissue and developed markers for the same. Pellegrini et.al (2014) contending with Sangwan's approach argued that as *“variability ... due to individual genetic background (due to using human autologous serum) could be detrimental for the reproducibility of the culture...reduce the reliability of the in process controls, and hamper the definition [of]... quality criteria FCS (Fetal bovine serum) ...would accomplish strict safety ... provide the manufacture process with precise, highly reproducible quality controls, product specifications, and release parameters.”*(Pellegrini et.al. 2014).

Sangwan's group defended its approach against Pellegrini's (2014) attack, *“Although an attractive theory⁹, other groups have neither replicated such claims nor ...controlled for the confounding effect of clinical severity... [which affects] clinical outcome”* (Sangwan, et.al. 2014). Sangwan's group firmly puts its faith in the clinical approach. The clinical approach took into extensive account the individual condition and lifestyle of the patient - his/her eye, its micro environment, its disease history and its ability to respond to intervention and fabricated an intervention around these inputs. It prioritized personalized clinical assessment over standardized arms-length product based therapy that discounted individual variation. Their research regularly provided published updates about clinical outcomes including failures (vital information for a clinician's decision making), patient indications and line of treatment; something which no other SC research group in the world was doing. Their idea was to contribute towards the development of robust surgical protocol for treating different kinds of LSCD and participate fully in a global 'trial of ideas'.

⁸ Markers chemically evaluated the number of SCs in a donor tissue.

⁹Of the necessity of predicting the number and growth rate of SCs.

Developing SLET

In the continuing efforts at refining protocols, Sangwan's team started working with Prof. Sheila McNeil of Sheffield University, UK, to develop a suitable biomaterial that could be a substitute for the currently used human amniotic membrane. Only a licensed tissue bank could store amniotic membranes. An 'off the shelf' biomaterial would expand access since surgeons without access to a tissue bank could also perform the surgery. In one of their skype calls, Sheila inquired with Sangwan about the possibility of a 'tea bag' approach where the donor tissue was cut into smaller pieces (as is done for lab based culture) but instead of growing in the lab is directly put into the recipient eye and allowed to grow there. This approach completely bypassed the lab. Sangwan pounced on the suggestion and quickly implemented it in the form of a surgical innovation (Simple Limbal Epithelial Transplant). Finally, around 2010, Sangwan developed the SLET (simple limbal epithelial transplantation) surgical technique where the need for external lab cultivation was done away with. SLET led to safe and cost-effective treatment for LSCD. The clinical outcomes of SLET were extremely encouraging. This was reported first in 2012 in the British Journal of Ophthalmology paper "*Simple Limbal Epithelial Transplantation: A novel Surgical Technique for the treatment of LSC Deficiency*". Initially, Sangwan's group was a little apprehensive as their transplant included a thin underlying slice of stromal cells which could have rendered the cornea opaque. Rather surprisingly they found that stromal cells "*almost completely disappeared by 6 months*". Once again their clinical practice informed a hypothesis. They explained the stromal disappearance as "*we hypothesize that, as the epithelial cells grow out ...the stromal element undergoes remodelling and is gradually incorporated into the underlying cornea by 6 months.*" (Sangwan et.al. 2012) SLET was safe. It reduced the cost to patient since the patient now had to visit the hospital only once. In one sitting,

tissue was extracted from donor eye and also transplanted into the recipient eye. It did not require a lab. His team also organized several workshops to train surgeons in SLET, thereby expanding access.

All through these years, Sangwan and his team had been in continuous dialogue with research fraternity across the globe - presenting papers in conferences, publishing articles, bidding for research grants, defending their findings and building legitimacy for their practices. Through the years, they had also had their share of '*being told what to do because you are from India*'. A few years ago in a competitive grant bid, a reviewer had commented on Sangwan's proposal that being from India, he was better off focusing on malaria and not cutting edge SC work. On another occasion, investigators from the developed world preferred to appropriate the lead on research. Yet, Sangwan's persistence had prevailed. They continued with their stated objectives of making intervention xeno-free, safe, less costly, affordable and accessible to all. The development of the modified culture method, monolayer CLET and the novel surgical technique of SLET by Sangwan and his team constitute the three departures that we take up as exemplars for deeper analysis in the next section.

Critical Interpretation

To interpret the enunciative politics in the KG process described above, we locate the three KAs (monolayer CLET, novel culture medium and SLET) generated during the departures effected in the enunciative process of Sangwan, within the state of knowledge on LSCD, technologies of regenerative cell therapy at respective points in time, i.e. 2000 and 2010 and the industrial/institutional regulatory regime in vogue. Through this we identify the Simondonian processes of invention and transduction in the enunciation.

State of science

Regenerative therapy based on SC transplantation seeks to insert a ‘living SC’ into the human system. To achieve the regenerative function this cell must continue working within the recipient microenvironment. The interplay between SCs and the surrounding microenvironment create complex recurrent causalities between different elements, thus cell growth is governed by a complex process. One popular research approach - cell biology based approach elucidates these complex interactions before designing therapies through tissue engineering to mimic in vivo biochemical and biophysical microenvironment (Pellegrini, 2014). Existing scientific knowledge on complex cell interactions enables the design of a concrete and closed therapy in the form of a standard product in which many of the indeterminations and variabilities of the process are absorbed and suppressed through a step-wise resolution of small Simondonian ‘*disparations*’. This has been the strategy adopted by Pellegrini group, Tseng group and others in making Holoclar (Pellegirni group) and amniotic membrane based product (Tseng group). Such productization enables easy commercialization of the therapy.

It also enables the creation of a revenue and profit stream in the form of a patented or trademarked product – a concrete portable technical object- leading to recovery of research costs. A patient seeking treatment through Holoclar has to necessarily get hooked into the central SC manufacturing facility of the firm to produce transplant tissue, the patient also has to rely on immunosuppression, in the process creating a circuit of commerce through which Holoclar could travel. This concrete portable technical object leads to technological determinism (Simondon, 1980p.) in the Simondonian sense because it incites the need for a whole supporting infrastructure, which and only which will enable the ‘concrete portable technical object’ to

perform healing. Due to these revenue possibilities, cell biology research often attracts funding. It also operates within a strict regulatory regime designed to protect the patient against the risk of variation and commercial exploitation.

Another research approach, the clinical research approach, often advances novel therapeutic propositions (such as surgical techniques) picking on different leads provided by cell biology research and prior clinical trials. Clinical observation of proposed techniques (through trials) in turn leads to generation of new information. The open nature of this approach to technology, in a Simondonian sense, makes proposing design of experiments and generating data important in taking forward a research track to stake a claim in KG. For instance, while limbal location of corneal SCs was hypothesized both through animal model and cell marker studies, it was the clinical success of Kenyon and Tseng's CLAu surgical procedure that provided a strong indirect evidence for the hypothesis. This clinical invention, not only proposed novel treatment for LSCD, it contributed to further cell biology knowledge of limbal cells. Surgical interventions thus were invented with incomplete knowledge and their clinical outcomes supplied the necessary hypothesis. Yet CLAu's associated risk of donor eye LSCD created a *disparation* between the requirements thrown up by recipient and donor eyes. CLET provided a solution to donor eye risk. In addition it marked an advance in cell biology lab practice, a demonstration of the lab's ability to mimic in-vivo condition.

Sangwan's Location and his Transductive Leaps

In Sangwan's case, his unbearable helplessness (of profound import in a society which treats doctors as Gods exemplified in the Sanskrit adage "*Vaidyo Narayano Harihi*") in producing a

multilayer transplant tissue to help his ever-present patient load provided him the necessary ‘instigation for a Simondonian transductive creative leap’ where the ‘absent multilayer’ became ‘surviving SC monolayer’. Historically, every SC cultivating scientist knew that in a submerged culture a monolayer could be grown and that many more undifferentiated SCs survived in this process. However, the lab standard had veered towards cultivating multilayer using ‘air-lift’ technique, the SCs survival itself being regarded as inconsequential. The specific location of Sangwan as a patient-centric clinician working with a large throughput of LSCD disease load in a context deprived of costly lab infrastructure but endowed with a surfeit of clinical data, saw the promise incipient in the surviving SCs. He could ‘re-imagine the lab’ in the ‘recipient eye’ as the site of proliferation and stratification. This imagination gathered momentum from his routine observation of the natural healing process aided by the eye’s tears and nutrient supply. From frequent use in surgery, he also knew of amniotic membrane’s excellent anti-inflammatory and other beneficial properties. In imagining the possibility of a monolayer transplant, Sangwan implicitly brought together all these incomplete bits of information and reimagined the microenvironment of recipient eye to stratify the epithelia as the ‘lab in the eye’. Sangwan visualized surgery as a tight coupling of ‘transplant tissue-recipient eye’ - the technical object and its *associated milieu*. Unlike other groups for whom the eye was a neutral void that needed filling up, the recipient eye was a necessary condition of existence for Sangwan’s technique. For him the eye did not just have LSCD, it also had nutrients! He did not believe animal models were necessary because according to the state of scientific knowledge his departure was only from the multilayer (already proven to work) to a monolayer transplant. Sangwan freely borrowed ideas from every part of the world and preferred learning from it instead of *reinventing the wheel*, testifying to the ‘traffic in ideas between identity pit-stops’ that Andersen (2002) alludes to. The

fact that regulatory regime in India was in a nascent stage also put extra responsibility on the IRB but gave them more freedom to act in the patient's best interest following the Helsinki protocol of informed consent for a novel therapy. Clinical outcomes after monolayer CLET trials showed that his imagination was indeed correct. In one transductive leap he had managed to convert the '*disparation*' of the 'failed multilayer generation' to a solution - the monolayer transplant along with its 'associated milieu' in the 'recipient eye' became the complete system. Now that he knew his technique worked, he utilized LVPEI's policy and value system to provide this treatment to all needy patients. Monolayer transplantation for Sangwan was not simply a KG endeavor (which would have been the case had he stopped trials with the exhaustion of DBT grant) but a patient well-being endeavour. KG for him was incidental to the process of providing succor to his patients. Eventually they had treated over 700 patients with 70% success after one year follow up - a case load (with the accompanying privilege of generating a surfeit of clinical information) and success rate unmatched by any other group in the world.

That Sangwan's journey continued into the production of a xeno-free autologous culture medium which could be easily and cost-effectively prepared once again attests to his desire to ensure that treatment remains accessible and affordable to people from all walks of life. This journey of providing relief to the patient who was sometimes a young woman of marriageable age suffering from an acid attack by a jilted lover, on another occasion a factory worker who lost an eye in an industrial burn accident constantly drew Sangwan's attention to thinking of cost - not just as surgical cost but as the cost of treatment for the patient even after he/she went home. He had seen many a patient who could not afford immunosuppressant medication for long periods of time and hence had focused on using the person's own cells and media for treatment. Like other

researchers around the world he could have easily developed the medium into a proprietary formulation and turned it into a revenue stream. However, he and his team chose to disseminate their knowledge widely in the form a protocol so that all those who needed it could easily use it. Explaining the motivation behind the leap to SLET, Sangwan et.al (2012) writes, “*Currently, opinion is divided about which of the two existing techniques ...is a better ... Both techniques are effective in the long-term ... and the surgeon’s preference is often limited by economic and logistic factors. Proponents of CLAu consider ex-vivo cultivation unnecessary and expensive, while proponents of CLET consider autografting technically challenging and risky.*” Sangwan and his team had practiced both CLAu and CLET for a decade and were informed by the strengths and weaknesses of both methods. The novel simplified SLET, combines the benefits of both CLET and CLAu while avoiding the difficulties of either. The SLET imagination was triggered by a chance conversation with a foreigner Sheila and her experience of growing skin cells. Sangwan again tilted towards the recipient eye’s microenvironment to trigger the healing process. His reported clinical objective was “*...to address the challenge of determining how little of the limbus can be clinically effective given a suitable underlying substrate...*” (Sangwan et.al.2012) and the unstated but ever present human objective was to expand access (evident in the frequent appearance of the word ‘cost’ in his writings and the absence of the same in the papers from other research groups). In making SLET’s *transductive* imaginary leap, he was drawing upon the very same amniotic membrane properties but, there was an uncertainty, which could only be resolved, given the nature of *transductive* moves, through generation of empirical information from the proposed system’s working.

In a 2014 review paper in Indian Journal of Ophthalmology titled “Transforming ocular surface SC research into successful clinical practice”, he wrote: [*T*]he authors' group has had the unique

opportunity of exploring all the techniques of SC-based therapy for ocular surface reconstruction This unique experience has given the authors an enviable perspective on the subject that no other group in the world can currently claim. Through this article the authors have tried to share their vast experience and clinical perspective on this subject and make recommendations based on rigorous scientific evidence.”

At every step, the socio-economic-cultural– institutional characteristic of Sangwan’s location translated either into a scientific objective or a *disparation* for Sangwan and his team. It translated as cost of treatment, cost of production, circumvention of animal models, ease of practice, ease of dissemination, expansion of access, lack of infrastructure and so on. Similarly the *transductive* leaps of imagination which invented the technical objects became possible because he viewed the recipient eye not as a passive, neutral or empty site waiting to be filled up but as a site of healing potential, an eye of a poor person living in a village who did not care to know what the state of knowledge was but needed relief as soon as possible. It also moved beyond the boundaries of nation-states or the ‘national innovation system’ and dialogued with ease with fellow researchers around the world and did not hesitate to draw upon and give back to this collective heritage of human endeavor.

DISCUSSION

Our exploration and interrogation of the evolution of a technical object through interplay of the socio-economic and cultural sensibility of a geo-historically located innovator surgeon and the logic immanent in the technical object in its evolutionary formation brings us to the issue of geopolitics of knowledge. Mignolo (2009:2) has categorically stated that “*geo-politics of knowledge goes hand –in-hand with geo-politics of knowing*”. Western epistemology has

generally assumed that the “...*knowing subject in the disciplines is transparent, disincorporated from the known and untouched by the geo-political configuration ...*” (2009:1). From this neutral point of observation also called the ‘*hubris of the zero point*’ (Castro-Gomez, 2007) “*knowing subject maps the world and its problems*” (Mignolo, 2009:1). Nowhere is this assumption more central than in the natural sciences for modern science has been conceived as a universal knowledge governed by objective laws that are beyond the assault of history and location. As a corollary, scientific KG too has been seen as history and locus neutral. The linearity concealed in the implicit first mover advantage of West’s stock of scientific knowledge has often provided the impetus for interventions to develop the third world scientifically through institution building for science and technology in a diffusionist mode with progress being measured in the number of KAs – patents and like, generated by such institutions.

In our study, we have questioned this assumption of time and space neutral science and scientist. By focusing on enunciation, we centre-stage the geo- and body- politics of knowledge,- the knower, known and the knowing. Our inventor Sangwan is a patient centric surgeon who works in an institution that privileges patient care over all else. He works in a place with very high disease load. He is also a Third World surgeon, a site that has historically been a consumer of knowledge rather than a locus of invention where the act of carrying out experiments on hypothesis not already validated in the ‘West’ is seen as fraught with risks. KG for this inventor is simply a tool by which he can bring relief to his patients. This geo-historically located inventor’s sensibility swiftly translates into his research and scientific pursuits as a preoccupation with costs, affordability and access. These preoccupations are in addition to the routine disciplinary focus on safety and efficacy. If the scientific objective on the one hand has borne

the imprint of the locus, so has the ‘known’ in terms of the ‘eye’. The eye on which Sangwan and his team worked too has been racially implicated as the eye of the poor man/woman who cannot afford to lose a livelihood due to blindness. The fellow ‘surgeons’ whom he trains too do not have access to massive infrastructure that a CLET would need; hence the ‘known’ had to work in their specific circumstances.

Sangwan’s invention and knowing has been possible only by an ‘epistemic disobedience’, (Mignolo, 2009) the rejection of being told ‘*what we are*’, that only a multilayer should be transplanted, multilayer should be lab grown in fetal bovine serum etc., resorting to *transductive* leaps of imagination to ‘de-link’ from these racialised sedimented regulatory and disciplinary practices and proposing trials/experiments based on alternate hypothesis. Sangwan’s invention has been possible because the location equipped¹⁰ him by providing him a socio-cultural sensibility, a scientific objective, clinical data, institutional and regulatory support to engage in ‘de-colonial options’ to intervene through surgical experimentation operating “*from the principle that the regeneration of life shall prevail over primacy of the production and reproduction of goods at the cost of life...*” (Mignolo, 2009:3).

As our exemplar shows, the enunciator is able to engage in such epistemic disobedience and de-linking with the attendant generation of new knowledge only because the technological space in which Sangwan is participating is itself still open. Stem cell research is still a developing field and disciplinary positions and cannons are as yet unspecified. There is a wide recognition within the field of the unknown leaving many possible trajectories of pursuit open to an enunciator. This openness enables the enunciator Sangwan to approach the concretization process from his

¹⁰ We are thankful to Kamalika Chakrabarty for providing this phrase.

specific location. Because the technological field is open, KAs are still in the process of becoming, leaving several *disparations* open for resolution. Sangwan is able to tackle the *disparations* in the ophthalmic SC therapy i.e, technical object presented by his specific location in a much more locally embedded and informed way. Thus the scope for the enunciator to see and tackle a *disparation* makes invention possible. The *disparation* in the technical object allows for the technological possibility of an alternate *transductive* leap of imagination informed by the local cultural and socio-economic sensibility of the geo-historically located knower.

Conclusion

In recent times, CMS (critical management studies) has been increasingly concerned with the geo-politics of knowledge and the continuing domination of the ‘centre’. These concerns have been informed by an analysis of uneven distribution of KAs and have been accompanied by calls for the development of diverse and plural knowledges (Escobar, 2006; Alatas, 2001; Mignolo, 2011a, 2011b; Prasad 2015; Jack, 2015). Our study animated as it is with the postcolonial imagination of provincializing Europe, responds to some of these concerns and adds to an understanding of the dynamics of dislocating dominance in knowledge geo and body politics. By following Mignolo’s call for interrogating the enunciator, we fill a major gap in literature. We do this by simultaneously drawing upon Mignolo and Simondon and show how the cultural logic of Sangwan’s sensibility transforms into the technical logic of ophthalmic SC therapy. Our study lends support to the long standing belief among postcolonial scholars “of cultures as knowledge systems and an awareness that, throughout history, all cultures have always produced knowledge” (Prasad, 2015:190).

Much literature has accumulated on the mechanisms of knowledge transfer from the centre to the periphery and how the periphery can build competence. Critics have rightly pointed out the neo-colonial character of this project. Our study strengthens the critique of knowledge transfer, by showing that a necessary condition for invention is the facility for an enunciator to dialogue with a *disparation* and thereby produce an invention through the dialogic process. For a dislocation of centre's dominance in KG and a move to plurality of knowledges, it is necessary that the enunciator develops and defines his/her search in a manner informed by his/her life and contextual experiences. It is the *transductive* nature of the invention that allows for the techno-logic and the cultural logic to be mutually imbricated in the act of knowing. Inhabiting in and operating in a local world of the post-colony the enunciator is able to draw upon the specific resources of his/her location to *transductively* propose novel hypothesis and carry out trials and experiments to further a track of technology/scientific development. Even when it generates large volumes of KAs, conventional hypothetico-deductive scientific work, whose logic can only test, not question nor reinterpret existing canons of knowledge (Jack, 2015), in contrast, does not afford the possibility for an embedded knower to disrupt the techno-logic.

The transmission of a concrete closed technical object from the West, which is what most projects of technology transfers envisage, impedes such interrogation due to the attendant technological determinism. Knowledge transfer in the form of concrete KAs which come with their attendant infrastructures of functional performance essentially deny the importing location the privilege to dialogue with a *disparation*. Thus, invention becomes impossible. The importing locations remain consuming locations. Further, consumption is ineffective as both KAs and their attendant infrastructures remain alien to importing location. As Simondon says, the associated

milieu is the “invented” technical object's condition of existence. When concrete technical objects travel from the ‘centre’ to ‘periphery’ as KAs, they cause disadaptation because the conditions which seeded the invention are very dissimilar to the new locations to which the artifact travels. The artifact, concretised as it is, is therefore not free to evolve in the new location and thus becomes subject to a fatal disadaptation often felt culturally as ‘lack of access’ or ‘prohibitive costs’ in resource and infrastructure poor but otherwise variously endowed societies of the post-colony.

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