Biotechnological Developments, Socio-Technical Processes and Materiality: The Affordances and Constraints of 'Social Innovation'

Abstract

There is a commercial focus to mainstream studies on biotechnology innovation, with little attention paid to the dialogical spaces, material practice and relational networks that serve to afford or constrain the 'social innovations' that support the biotechnological developments. In this, as in other areas of innovation, problems of innovative sustainability as well as innovation acceptance and ultimate integration into its intended end use remain problematic. We suggest these challenges are inherent in the socio-technical processes concomitant to the intended innovative outcome and that they often remain implicit and as a result are largely unsupported. In drawing on data from the Australian biotechnology industry, 'social innovations' - as the socio-technical processes and dynamics associated with the development and uptake of biotechnology innovations - are examined through a qualitative case analysis drawn from the Australian bioindustry. The purpose of this study is twofold: first, to illustrate the importance of socio-technical processes in the emergence of biotechnological innovations and second, to reveal the fundamental importance of materiality in examining the underplayed and understated material dimension to innovation and change.

Keywords:, social innovation, biotechnology, materiality, social networks, narratives, change.

Introduction

There has been surprisingly little written about the socio-technical processes integral to biotechnology innovations within the mainstream organization and management studies

literature. The humanistic focus has tended toward ethical issues, pubic concerns and, of course, commercial imperatives. There is abundant information in which genetically modified crops are either promoted as a panacea for food shortages or as the devil incarnate in playing with the natural order of the world (Jamal, Haque et al. 2010). Media interest engages with volatile public concerns often creating a type of moral panic and yet, scholarly academic research into the other side of the value chain, on the socio-technical dynamics of biotechnology innovation and the insights such studies may offer remain noticeable by their absence. In seeking to address this hiatus, fieldwork conducted into the Australian biotechnology industry is reported here. Our findings are used to highlight the importance of socio-technical processes and their inherent material foundation in shaping biotechnology developments. We argue that 'social innovation' as it is popularly referred to, is in fact more accurately the sociology of innovation (Daniel and Dawson 2011), that is the socio-technical processes shaped by complex social interactions, the materiality of action and practice, and outcome of supporting narratives that enable ideas to be negotiated and formed, accepted, rejected as well as interpreted and redefined across the network of relations involved in the innovation development processes.

We reject approaches that take a purely constructivist position, downplay material affordances or conflate expressions of material constraint with technological determinism. In addition, we advocate the need to counter-balance the prevalence of scientific determinism by recognising it is the materiality of biotechnology along with the complex socio-technical processes in its development, which defines the space within which innovation negotiation in practice occurs. The concept of socio-technical system recognises the importance of balancing social and technical aspects of innovation for maximum integration and efficiency

(Trist and Bamforth 1951). In other words, whilst we fully support the mainstream claims that contextual processes shape technology practice-in-use which can demonstrate unique and domain specific dimensions (for example, that the same technology can be used in different ways in different contexts), we contend that there are in fact constraints on the degrees and variations in use that cannot be solely explained by context and social processes alone. We argue that the creation of knowledge and understanding, through making and giving sense to the materiality of the bio-innovations contributes to the ability of users to recognize and leverage innovative opportunities for the new technologies.

Evidence from the Australian bioindustry cases presented here suggest individual and collective understanding of what biotechnology can or cannot do occurs in a common relational space of the associated biotechnology community as they construe and negotiate a shared interpretive framework that in fact is instrumental in promoting the acceptance of certain innovations over others. We reveal socio-technical processes and the material negotiation of bio-innovations arise within the perceived affordances and constraints of what is possible in terms of the embedded social practices, activities, relationships and routines. In examining this socio-technical-materiality interplay we suggest that whether innovation is examined through a more commercial or technical lens, there remains an inherent interweaving between the social and material that is played out in the socio-technical processes that implicitly shapes understanding and interpretation of the innovation artefact.

The purpose of this study is to illustrate the importance of materiality and socio-technical processes in the emergence of biotechnological innovations, particularly to reveal the fundamental importance of socio-technical processes in interpreting and negotiating the

understated material dimension of the artefact. Consequently in our study that follows, we briefly explore the blurring of boundaries in the spaces and places in which the social and material intermingle and entwine in the acceptance and integration of new biotechnology innovations. Within the temporal context of shifting relations, we identify some of the affordances and constraints that arise from social processes and the materiality of biotechnology. We conclude that the social-relational and material concerns are all played out in a complex co-evolutionary process of knowledge development, technology acceptance and innovation integration. In presenting this the paper is divided into five sections. Following this introduction, the next section explores current literature on the socialness of innovation, the sociology of innovation and socio-technical materiality. The third section presents the methodology of the qualitative study, while the fourth section details the results and discusses the insights gathered from the Australian Bioindustry. In conclusion, we argue that the materiality of relational and material concerns are all played out in this complex co-evolutionary process of knowledge development, technology acceptance and innovation integration.

The Inherent Socialness of Innovation

From the early biotechnology ventures in the 1980's, the promise and impact of new technologies has since seen many national and regional governments and agencies seek to invest in centres and networks of expertise to provide and promote relational spaces where innovation can flourish. Whilst the support of collaborative arrangements for technological development seems logical, in practice many collaborations that require external participative resources to offer new perspectives or expertise will ultimately fail for a variety of reasons, for example, in the face of conflicting functions and/or the need to continually balance

insights/conflicts from different groups/organizations (Bessant and Tidd 2007).

Within the biotechnology industry, there is often intense pressure to secure public acceptance, especially where there are high demands for innovation that involve equally high levels of knowledge evolution and redundancy. Under such circumstances, there is increasing emphasis on the importance of appropriate and effective paths of knowledge sharing both within and across organizations. Knowledge in these situations, moves from the level of organisational agendas and industry competition to a complex situation of intra and inter-organizational knowledge sharing where collaboration and the creation of communities of practice become the focus (Miles, Miles et al. 2009). This sharing of knowledge is further complicated by the important role of tacit knowledge in both innovation and scientific activities, (that knowledge which is personally understood and thus difficult to express or document in easily accessible ways) and its role in the interpretation, translation and transformation of specialist knowledge (Duguid 2005). When considering innovation and the new knowledge from which it is generated, it is pertinent to recognize that Nonaka (1994:14) proposes that knowledge creation is in fact the result of 'a continuous dialogue between tacit and explicit knowledge'. We suggest that such recursive knowledge development is the foundation of the socio-technical processes and the interpretative positioning of scientists involved in the generation of bioinnovations (Daniel and Dawson 2011). These social processes are then inherent in the balance of 'know how' (tacit) with 'know what' (explicit) required to enable the effective 'knowledge translation' necessary for innovation consensus and integration so it is clear how this challenge has gained major significance in the modern workplace (Smith 2001; McWilliam, Kothari et al. 2009).

In addition to achieving that balance of the tacit and explicit for knowledge development, there is recognition of the need to develop sustainable knowledge communities where new knowledge in various technological domains can be cultivated, refined and leveraged. The question is then how do such 'communities' establish an environment – a relational space - where knowledge sharing and cultivation can occur broadly and spontaneously? Kerno (2008:77) suggests that communities of practice offer a 'useful and valuable alternative to more traditional knowledge management approaches' largely because of their ability to develop tacit knowledge and promote knowledge sharing; features implicit in the community knowledge base. In considering this we recognize that the broad context within which the bioindustry operates is a result of its diverse industry applications which consequently promotes the engagement of multiple professional groups, the emergence of differing organisational agendas and the collaboration of multiple perspectives of knowledge. Thus the dynamic social processes that occur within that collective underlie the development of new biotechnologies because they are implicit in setting the scene for diverse interactions which enable existing socio-technical practices to be negotiated in which associated new knowledge can be developed and refined.

The idea of broad external interactions and diverse relationships as a mechanism for knowledge sharing and idea generation is consistent with Chesbrough's concept of 'open innovation' (2004). This position is based on the premise that it is the fluidity and dynamism of the relationships and interactions of participants which facilitates learning and knowledge sharing. This relational aspect of learning leads to collective knowledge development, as individuals continually explore and share their personal knowledge, experiences and expertise for their own scientific agendas as well as for organisational advantage. This

engagement in experiential practice draws attention back to materiality in counter-balance to the dominance of narrative in explaining innovation as a social construction. This suggests the importance of a supportive socio-contextual basis for relationships and interactions to contribute to learning and the collective advancement of knowledge and practices of the community or team. Indeed such a conducive socio-technical foundation has been noted as a prerequisite for innovation (Drach-Zahavy and Somech 2001; Handley, Sturdy et al. 2006) and thus the inherent socialness of innovation is established.

A Sociology of Innovation

This perspective of the social creation, leverage and acceptance of initiative and knowledge supports the view of Keeble and Wilkinson (1999) who suggest that innovation is a process of knowledge development involving learning and sharing of both explicit and tacit knowledge. Specifically, it confirms the importance of unique socio-technical processes (social interactive and inherently technically[1] focused) of entrepreneurial knowledge acceptance that contribute to innovative outcomes. As such the development of innovations in the Australian bioindustry as examined in this research, provides an opportunity for the exposition that such uniquely situated knowledge (that is, a shared socio-technical perspective) is an essential intangible infrastructure for the development and sustainability of a vibrant bioindustry.

The sociology of innovation (Daniel and Dawson 2011) provides a tool which explains the fundamental role of both social capital and socio-technical processes in leveraging intellectual resources and entrepreneurial capabilities in innovative environments. The

[1] "Technical" is considered here as an understanding of the skills, knowledge, tools or expertise to leverage outcomes in a particular field.

professional variety and inter-organisational complexity of the contemporary bioindustry means biotechnology stakeholders tend to operate as multi-dimensional negotiators interacting opportunistically to leverage their technological applications to commercial success (Kale, Singh et al. 2000). The catalytic relational networks the social capital of the bioindustry is able to provide 'social resources' (e.g. access to information and knowledge, quality relationships, mentoring, informal mechanisms for coordination and control such as reciprocity) and 'relational wealth' (e.g. mutual trust, commitment, support, shared experience, understanding and a common bond) (Daniel and Dawson 2011). As a result, the social capital of the bioindustry is undoubtedly an inherent factor in the activities of professionals that contributes to the acceptance of new biotechnologies (Daniel 2006; Maurer and Ebers 2006).

The Notion of a Socio-Technical Materiality

These relational spaces within which knowledge communities develop are not only shaped by social processes but also by the materiality of the technology and its practical implications that links with their area of expertise. For example in discussing knowledge in organizations, Seely Brown and Duguid note that: 'what individuals learn, always and inevitably reflects (both) the *social* context in which they learn it and in which they put it into *practice'* (2001:201). On this issue, Karen Barad (2003) argues that there has been a tendency for every 'thing' to be represented through images, culture and language. From her perspective 'Language has been granted too much power…There is an important sense in which the only thing that does not seem to matter anymore is matter' (Barad 2003: 801). She argues for a shift from representationalism in which too much power is given to language in determining what is 'real' to 'performativity' that would focus attention on matters of practice, doing

things and actions. This would counterbalance the dominance of narrative descriptions of reality that she claims tend to mirror and exclude some of the more subtle entwining of the social and material. She suggests that the notion of diffraction rather than reflection is useful in illuminating the relationship between the 'social' and 'scientific' (Barad 2003: 803). In explaining the mutual entailment between the material and discursive social narrative she notes that:

> Materiality is discursive (i.e., material phenomena are inseparable from the apparatuses of bodily production: matter emerges out of and includes as part of its being the ongoing reconfiguring of boundaries), just as discursive practices are always already material (that is,, they are ongoing material (re)configurations of the world). Discursive practices and material phenomena do not stand in a relationship of externality to one another; rather, the material and the discursive are mutually implicated in the dynamics of intra-activity. But nor are they reducible to one another. The relationship between the material and the discursive is one of mutual entailment. Neither is articulated/articulable in the absence of the other; matter and meaning are mutually articulated. Neither discursive practices nor material phenomena are ontologically or epistemologically prior. Neither can be explained in terms of the other. Neither has privileged status in determining the other (Barad 2003: 822).

Similarly, in her development of the concept of 'sociomaterial practices' that advocates 'the constitutive entanglement of the social and the material in everyday life' Orlikowski argues that there has been a tendency to ignore materiality (Orlikowski 2007: 1435). She contends that materiality has been under-theorised and often overlooked in workplace studies on

organizing even though materiality is evident through the machines, clothes, buildings, pens, computers, phones and other common objects used in daily work practices, as well as in the less visible aspects associated with software, data networks and so on. In studies that have examined particular technologies - in this she refers to her own work (Orlikowski 1992), as well as the work of Barley (1988) and Zuboff (1988) – she argues that the materiality of technology is often viewed as a specific incidence, as intermittent rather than as an integral ongoing element of daily work practice. Furthermore, she highlights the difficulties with studies that take either a human-centred or techno-centric perspective. The former, whilst taking a more contextual approach in examining the way people interact and make sense and use of technology in particular situations, nevertheless tend to lose sight of technology in over-emphasising the social; whereas the latter, tends to view technology as clearly definable, exogenous and stable and in reifying technology falls into various forms of analysis that could be labelled as technological determinist (Orlikowski 2007: 1436-1437).

BIOTECHNOLOGY INNOVATIONS: THE CASE OF AUSTRLIA

We adopt an interpretive sociological perspective in our empirical investigation of innovation processes in the Australian biotechnology industry. Qualitative data were collected in four case studies through a series of semi-structured interviews with key bioindustry stakeholders. This data was analysed to reveal the materiality of change and the social frameworks that support the acceptance and integration of new biotechnologies. Each case presents a different context comprising: an agricultural research organization; a human therapeutics research laboratory; a medical diagnostics company; and a wider industry group of bioindustry stakeholders.

Research Methodology

Qualitative data were collected through a series of semi-structured interviews with key bioindustry stakeholders. This data was analysed to reveal possible social frameworks supporting the acceptance and integration of new biotechnologies. The move towards interpretive philosophies as a method for grounding research in a sociological perspective is well established in management studies (Zammuto 1984; Alvesson and Deetz 2000) and has been used to understand the relational interactions and the hermeneutics of humanistic factors in the analysis of organizational issues (Robson and Rawnsley 2001; Prasad 2002). Interpretive methodologies provide a critical extension to qualitative methods by ensuring context and dynamics are recognized as significant contingent factors in the empirical field (Denzin 2001; Matthyssens and Vandenbempt 2003).

In exploring frameworks of sense-making and in particular, processes of social acceptance and integration of biotechnology innovations, four case studies were undertaken. The versatility and relevance of case study analysis for theory building in contemporary and pre-paradigmatic research fields was a fundamental rationale for using this methodology (Perry 1998). Each case presented a different context of biotechnology research in Australia. These were: an agricultural research organization; a human therapeutics research laboratory; a medical diagnostics company; and a wider industry group of bioindustry stakeholders. Purposeful case selection was undertaken to enable dissimilar examples to contribute to theoretical development as well as to the transferability, generalisability and empirical soundness of the empirical research beyond what is possible with a homogenous sample (Eisenhardt 1989). Following individual case analysis, a cross-case analysis enabled the examination of the collective evidence to reveal empirical parallels across the cases and

congruence across the bioindustry sectors.

Empirically, a multiple participant approach was adopted to provide a research methodology that makes sense of more than the observed reality of the bioindustry environment. Alvesson and Deetz (2000) note a multiple participant approach is not new in organization studies and is achieved by extending interpretation through multiple 'dialogues' (Denzin and Lincoln 2000) which grounds the research outcomes in the experienced realities of stakeholders. These multiple dialogues provide a robust depiction of stakeholders' social interactions through the identification and subsequent exploration of dominant ideas and significant themes (Numagami 1998). In doing so, this approach enables holistic theory development across diverse stakeholder perspectives and positions, as equal voices, so avoiding preconceived pattern seeking which may suppress understanding of complex social systems (Stacey 1995; Moss 2001).

The empirical evidence for this research involved interviews with representatives from different positions in the bioindustry; all involved in biotechnology innovation. This was a multi-level analysis of stakeholders from various roles and hierarchical positions within each of the case studies to ensure representation of the perspectives of diverse participants in these innovation activities. Interviews were conducted across multiple bioindustry stakeholder groups including industry (MNC's, publicly listed companies, spin-outs, et cetera), research (public, private, corporate and government), government (local, state and federal) and business professionals (financial/accounting, venture capital, entrepreneurs, marketers and so forth). In-depth semi-structured interviews provided over 50 hours of qualitative data which revealed significant insights into the relational experiences of stakeholders in the process of

biotechnology innovation acceptance and integration. This multi-level research provides a critical view of these interactions and experiences by recognizing that biotechnology stakeholders interact in a heuristic process of innovation acceptance and integration beyond the common commercialisation agenda. This critical approach is gaining greater acceptance as organizational research seeks to understand the co-evolutionary influences of complex environments and multiple stakeholders (Lewin and Koza 2001). Moreover, it is useful here as it enables heterogeneous knowledge inputs of stakeholders to be recognized as contributions and contingencies to their interactions in the development of bio-innovation acceptance and integration frameworks.

Inductive theory building from the case data through thematic analysis and cross-case examination enabled the complexity and dynamism of stakeholder interactions in the bioindustry to be acknowledged by revealing common themes that emerged across the many interviewed groups. In this way, the grounded themes extend the existing knowledge paradigm of stakeholders interacting in the bioindustry through theory development, by comparison of observable elements with the theoretically known (Webb 1995).

DIALOGICAL SPACES, MATERIAL PRACTICE AND RELATIONAL NETWORKS

Interviews with participants in the Australian biotechnology industry were consolidated in a cross case analysis to reveal consistencies and differences in socio-technical processes and attitudes to the materiality of biotechnologies. In addition, the affordances and constraints on that materiality as informed by the complex relational interactions and discursive narratives that formed, developed and refined within the associated dialogical spaces is illustrated.

Interviewees from the bioindustry discussed biotechnology in all its material manifestations that is, as a tool, as a research technique, and as a process they were developing for future application. What was apparent was that across all four cases there was a clear appreciation of the affordances of biotechnology as a research technique on the basis of its manifest qualities, as the following three quotations reveal. '*Most of the techniques that we use today are biotechnological... They're the most specific, rapid and cost effective tests and that's why we choose them.' 'I guess that's what attracted me to a lot of the techniques…is that you can get good results quite quickly with powerful techniques.' 'Where we can we try to choose biotechnology, it's usually better consistency and reproducibility...I suppose it's also stability.'*

In addition to the inherent material benefits of the technology, there was also evidence that there were parallel constraints in using the technologies which arose as a consequence the molecular nature of the research agendas and the fundamental platform technologies that facilitate those investigations. For example: '*Basically the stuff we do is biotechnologically driven so there is really no choice in choosing techniques.'* And *'...you're constrained by the technology platform that you're using.'*

Another aspect of the biotechnological techniques was consideration about the impact of its material affordances to the user. That is: '*...I wouldn't use a technology, like just get something new in to solve an immediate short term problem if it wasn't going to be useful down the track.' 'It's the path of least resistance within the context of the regulatory bodies, and the funding bodies and also to a certain extent the peer group as well.' 'It's important to*

look at what the community is going to gain from the product or technology.'

This view of the materiality of biotechnology reveals the social aspect of its development. It was clear the social aspect in the emergence of the various biotechnologies was more than consideration of its long term role, use or application as indicated in the quotes above but also as evident in the socio-technical processes inherent in its development through scientific negotiations and collaborative activities. For example: '*Biotech is nearly at the stage where Physics is: oh you can't do anything by yourself; you can't do anything unless you've got a group of twenty people, thirty people, fifty people...' 'If we identify something new which would be beneficial ...we (the research group) will discuss it as a group and then we weigh the risks.'*

There was evidence that a particular biotechnological approach or technique which had been sanctioned by other scientists particularly through practice was likely to be accepted more readily than those requiring independent assessment: '*I mean sometimes we use things because everyone uses them and you just do it.'* Or *'...if there is a group that's using technology successfully and they're happy and you have a good relationship with them or you feel confident and you know that they feel happy then you're more likely to go and try and perhaps learn how to use that technology.'* Or *'I think the peer group of scientists that I work with largely determine the things that I do from a couple of points of view. One is that many of them might already be using the technique…or have…strong views about how they are used and perhaps where they are used and so on.'* Clearly the social-relational dynamics and material interpretations are played out in a complex co-evolutionary process of knowledge sharing, innovation acceptance and technology integration.

In this way the interviews revealed how unique socio-technical processes of biotechnology development and integration were informed both by the materiality of the technology and the affordances and constraints associated with it, as well as by the recursive social interactions that were integral to knowledge development and innovative outcomes. The following quotations illustrate the process of reflection on the material in the social negotiation of the technologies together with recognition of the malleability of the different technologies: '*It's all entirely peer group and what other people are doing and what works basically.' ' It has to work, I have to see a demonstration of it working and in the hands of someone I respect as a scientist otherwise, I'm not interested in it.'* And *'There's always lots of different approaches to the same thing so I'm sure that what they're doing is just as legitimate. I don't feel ours is more.'* The practical capabilities of the material artefact are clearly an affordance to the social negotiation of its acceptance and integration.

It was particularly interesting to note that technologies with discreet material attributes which emerged into the biotech' industry were often promoted by supportive scientists to peers and colleagues for incorporation to alternative applications. This process of non-deterministic appropriation of new technologies is strong evidence for the socio-material voluntaristic approach in biotechnology development. There is clearly evidence of the socio-technical dynamics in the initial development, use and appropriation of new biotechnologies as users interpret and negotiate purpose on the basis of the technologies material affordances and constraints. For example: '*If it's a brand new technology, we would hope that once we had passed the proof of principle we can have good results to promote it and get other people to find new applications for the technology.'* Or *'I think just the fact that we can bounce ideas*

off each other and sometimes you can incorporate technologies from the other areas into your own area to help with problem solving.' Or *'Oh you've got to promote the technology, if I believe in a particular technology I've got to go out there and promote it to the rest of the company and get everyone behind it definitely before its able to make progress.'*

CONCLUSION

The implication of a dynamic social capital and extensive socio-technical networking among scientific professionals in the development and of an emerging industry is apparent in the evidence of this research. These results suggest that the highly dynamic environment of the emerging bioindustry was sufficiently malleable for initiating entrepreneurs to undertake interactions, such as, convincing, motivating and engaging necessary professionals and potential collaborators and with those socio-technical mechanisms, establish a foundation of social capital for future developments in the bioindustry. It is apparent that the relational dynamics of the initiating entrepreneurs created an environment for leveraging biotechnologies by creating a recognised platform of participation based on their common socio-technical mechanisms, that is, interactions focused on leveraging their technological goals

Our study also reveals how the intrinsic social interactions of bioindustry relationships, together with their innovation intentions and the materiality of the technologies they are developing can be better understood as a dynamic socio-material process. The sociology of innovation here reveals that a socially malleable interpretive frame comes into play in the early development of new biotechnology based innovations, where knowledge, sense-making activities, preferences, agendas and materiality will have both explicit and implicit influences

on what and how the emerging innovation evolves. We illustrate how participants in the development of biotechnology draw on reflective interpretations of the material affordances and constraints of biotechnologies together with the social capital of other participating stakeholders, rather than solely focussing on the outcomes of technology. Innovation leverage is subsequently achieved by the relational interplay that occurs in context and over time, and is influenced by the materiality of the artefact and the socio-technical negotiations at the individual and group level. As such, social engagement in what we term discursive spaces facilitates common interpretations and agreements. This approach and indeed this case, illustrates how an understanding the sociology of innovation addresses some of the inadequacies of previous research on decision-making and innovation. It enables a more holistic recognition of the interplay between social, contextual and material environments and the stakeholder's interpretations and activities in relation to the innovation that is being introduced. In this way, innovation acceptance and integration can be seen to involve the constant adaptation and renegotiation of activities and expectations by stakeholders to enable its inclusion into an established system.

The materiality of relational and material concerns are all played out in this complex co-evolutionary process of knowledge development, technology acceptance and innovation integration. The social capital that is established over time through formal working relationships and practical engagement in the materiality of biotechnology innovations are also informed by more informal relationships that shape processes of socio-material sense-making and sense-giving in promoting, reinforcing, rejecting and redefining collective interpretations (as evident in the ready uptake of previously accepted technologies). This study thereby illustrates how the research and development capabilities for biotechnology

innovations can be recognised as a widely dispersed, complex and interactive nexus of knowledge and how within this, there are intricate relationships and interdependencies. A further and important contribution of this paper is the revelation that these interactions are often informal (as opposed to being directive) and evolve as the social and the material entwine in a process of making sense and giving sense to biotechnology innovations. These practical engagements and relational exchanges across peers, colleagues, scientists and other bioindustry participants appear central in enabling stakeholders to coordinate and adapt biotechnological practice and biotechnological interpretations.

In conclusion, we argue that practical engagement, the sharing of experiences across networks, and the transfer of knowledge and understanding through relational associations of bioindustry stakeholders, all contribute to leveraging biotechnological opportunities as well as being integral to the interpretation and negotiation of a shared framework that supports acceptance and integration of the material affordances of these innovations. In other words, social innovations cannot be separated from the materiality of biotechnology but are entwined and emergent in the practices, interpretations and interactions that occur. Whilst complex associations and the discursive spaces in which sense-giving and sense-making occurs generates shared understanding, these are in turn shaped by the materiality of biotechnology development, configuration and practice engagement. As such, our work advances previous research by revealing that the complex social processes associated with acceptance and integration of innovations by stakeholders are not separable from the material, as the perceptions of affordances and constraints arise within the dynamics and change of dialogical spaces, material practice and relational networks. This highlights the need for a sociology of innovation perspective for analysing and making sense of innovation processes within

biotechnology and other similar high technology industries.

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