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Organizational responses to institutional pressures:

Reconfiguration of spaces in nanosciences and nanotechnologies

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Abstract

The literature on organizational responses to institutional pressures describes responses ranging from compliance to resistance via different modes of decoupling. However, although these studies provide a greater understanding of the phenomenon, they tend to consider the different elements separately. Through a comparative case study of six research teams in the area of nanosciences and nanotechnologies, we offer three contributions. Our first is to the decoupling literature by way of a complementary and cohesive framework, which shows that organizations vary in their responses by reconfiguring their physical (policy and materiality), mental (meaning) and social (identity) spaces, and that each space can be reconfigured at the core or periphery, or not be reconfigured. Our second and third contributions are through descriptions of two modes of organizational responses to institutional pressures and two factors explaining the variety of responses.

Keywords

Decoupling, institutional pressures, nanosciences and nanotechnologies, organizational responses, research teams, space

Introduction

Institutional studies show that organizations vary in their responses to institutional pressures (Kraatz & Block, 2008; Oliver, 1991): they may change their practices (Kodeih & Greenwood, 2014), symbolically adopt practices (Bromley, Hwang & Powell, 2012; Bromley & Powell, 2012), decouple formal policies from practices (Boxenbaum & Jonsson, in press; Westphal & Zajac, 2001) or compartmentalize sub-units or identities (Kraatz & Block, 2008; Pratt & Foreman, 2000). Since Meyer and Rowan's (1977) seminal paper, organizational responses to institutional pressures have triggered considerable interest among scholars to understand the role of top management, formal rules (Westphal & Zajac, 2001), practices (Beck & Walgenbach, 2005), and professional norms (Turco, 2012). Other studies have also focused on the extent to which organizations adopt new practices and the extent it is symbolic or substantive (Boxenbaum, 2006; Bromley & Powell, 2012).

However, although these studies provide fruitful information by focusing on various elements, they tend to be disparate and to consider these different elements separately. Indeed, although practices must be understood in relation to material elements (Orlikowski, 2007; Orlikowski & Scott, 2008), cognitive aspects tend to be emphasized (Clegg & Kornberger, 2006; Kornberger & Clegg, 2004). Therefore, by lacking commonality in their dimensions of analysis, the current literature provides only a limited understanding of how organizations respond to institutional pressures.

Based on Hernes (2003, 2004b), we build on the decoupling literature and propose a three-pronged spatial framework to better understand organizational responses to institutional pressures. Hernes (2003, 2004a, 2004b) argues that every organization is constituted of physical, mental and social spaces. First, physical space describes the infrastructure and equipment, formal rules and role structure within the organization, i.e., the formal structure of organizations (Meyer & Rowan, 1977). Second, mental space defines the shared meaning and

the sense that members make of their organization and field (Fiss & Zajac, 2006; George, Chattopadhyay, Sitkin & Barden, 2006). Finally, social space describes the sense of belonging and how identity is constructed in relation to practices (Paulsen, 2003; Pratt, Rockmann & Kaufmann, 2006).

Seeing organizations as a combination of three spaces renews our understanding of organizational responses to institutional pressures. Indeed, 'compliance' (Oliver, 1991) describes reconfiguration of all three spaces, while 'decoupling strategies' (Boxenbaum & Jonsson, in press; Oliver, 1991) describe responses where some spaces are reconfigured and others not. By 'reconfiguration', we mean the integration of expectations related to institutional pressures that leads to a change in the physical, mental or social space. Using this framework, therefore, provides an opportunity to deepen our understanding of decoupling and of how organizations respond to a new institutional pressure by considering the three spaces within the same analysis.

We consider the emergence of nanosciences and nanotechnologies (N&N) as a major institutional pressure. N&N refers to the science and technologies that deal with matter at the nanoscale (one billionth of a meter) to use novel properties and to produce new materials (Bonaccorsi & Thoma, 2007; Bozeman, Laredo & Mangematin, 2007). It not only introduces new technologies and devices, but also changes the ways of performing and organizing science. N&N affects a range of science disciplines and challenges the ways that they have traditionally been organized (Bonaccorsi & Vargas, 2010). As such, N&N has an impact on all three spaces.

Through a comparative case study of six research teams in Ireland, we identified four responses showing that physical, mental and social spaces can be reconfigured at their core or periphery, or not reconfigured at all. First, we observed that all spaces can be reconfigured to integrate N&N into their core, where new shared meaning eases the reappropriation of the

material elements that enable the construction of a new identity. The second and third responses show that reconfiguration of the physical space is not a requirement for peripheral reconfiguration of mental and social spaces to integrate N&N. Finally, we observed that organizations can actively resist N&N by not reconfiguring the three spaces at all.

Our study makes three contributions. The first is to Oliver's (1991) model by showing that organizations do not respond to institutional pressures as a whole; rather physical (material elements and formal rules), mental (meaning) and social (identity) spaces can integrate institutional expectations separately and to varying degrees. Our second contribution is to decoupling studies (Boxenbaum & Jonsson, in press; Fiss & Zajac, 2006; Westphal & Zajac, 2001) by showing the interrelations between physical, mental and social spaces and highlighting different modes of organizational response to institutional pressures. Our third contribution is the description of two factors (unclear institutional pressures; impact of institutional pressures on organizations already embedded in existing disciplines) that enhance understanding of the variety of organizational responses to institutional pressures.

In the following section, we describe the literature on organizational responses to institutional pressures and decoupling, and then the extent to which using a three-pronged spatial framework improves our understanding of the phenomenon. We go on to present our research design, outline the general context in which the study took place, and report on how our data were analysed. We then detail our findings in four sub-sections. Finally, we discuss our contributions to the literature on organizational responses to institutional pressures and decoupling.

Responses to institutional pressures and reconfiguration of spaces

Responses to institutional pressures

A basic principle of better describing organizational responses to institutional pressures is to understand how organizations respond in order to increase their chances of survival, while preserving the efficiency of their practices (DiMaggio & Powell, 1983; Meyer & Rowan, 1977; Oliver, 1991). Organizational responses to institutional pressures vary, ranging from passive acquiescence to active resistance (Kraatz & Block, 2008; Oliver, 1991). At the most passive end of the continuum, organizations comply, more or less consciously, with an institutional pressure by adopting new practices and adapting structure (DiMaggio & Powell, 1983; Oliver, 1991) to fit institutional expectations. Empirical studies show that compliance is more likely to occur when the institutional pressure is coming from actors on which organizations depend for resources, such as funding agencies and professional associations (Greenwood, Hinings & Suddaby, 2002; Ruef & Scott, 1998), and is aligned with the organization's goal (Oliver, 1991). Moreover, compliance is also facilitated when top management is strongly involved in the adoption of the new practices (Fiss & Zajac, 2004). At the other end of the continuum, organizations can ignore or actively resist by rejecting and attempting to take control of the new institutional pressure (Kraatz & Block, 2008; Oliver, 1991). In this case, organizations preserve their core practices by resisting the institutional pressure. Between these two sets of responses, increasing attention has been paid to organizations that decouple their elements both to maintain legitimacy and to preserve efficiency (Boxenbaum & Jonsson, in press; Meyer & Rowan, 1977; Scott, 2008).

Policy-practice decoupling is defined as being carried out by organizations that 'abide only superficially by institutional pressure and adopt new structures without necessarily implementing the related practices' (Boxenbaum & Jonsson, in press, p. 64). Meyer and Rowan (1977) suggest that to preserve the efficiency of their practices, while complying with

new institutional pressures, organizations decouple their formal policies from their practices: a symbolic adoption. For instance, in their study of stock-repurchase programmes, Westphal and Zajac (2001) show that, when experiencing conflicts with the interests of top executives, organizations tend to symbolically adopt the programmes while decoupling them from practices. If conflicts with top management can lead to policy-practice decoupling, such decoupling is a complex phenomenon that depends on multiple factors, such as stakeholders' expectations (Crilly, Zollo & Hansen, 2012), embeddedness in established rules and norms (Martin, Currie, Weaver, Finn & McDonald, 2016), and acceptance from internal stakeholders (MacLean & Behnam, 2010; Turco, 2012).

To deepen this phenomenon, empirical studies have examined the impact of institutional pressures on practices (Hallett, 2010). For instance, Beck and Walgenbach (2005) show that, if a pressure directly impacts their core activity, small organizations may not implement ISO 9000 standards as this would threaten their flexibility and product customization. Moreover, although they are implemented, expectations related to institutional pressures are also adapted to fit local practices (Ansari, Reinecke & Spaan, 2014; Boxenbaum, 2006). Adding to this perspective, Kodeih and Greenwood (2014) show that identities play an important role in the ways organizations respond to the adoption of global standards for management education. Indeed, they describe how business schools vary in their adoption of global standards – either reshaping their core programmes or keeping their core characteristics and simply adapting them (Kodeih & Greenwood, 2014). Studies on policy-practice decoupling therefore show that organizations can decouple their policies from their practices, but, even when implementing new practices, expectations are subject to local adaptations (Kodeih & Greenwood, 2014; Martin et al., 2016; Turco, 2012) and variations may occur even within the same organization (Binder, 2007).

Although providing a greater understanding of how organizations respond to institutional pressures, Bromley and Powell (2012) argue that policy-practice decoupling is just one form of decoupling that must be completed by means-end decoupling. This perspective suggests that organizations may fully implement a new practice with little to no impact on core practice and efficiency: symbolic implementation (Bromley & Powell, 2012). Bromley et al. (2012) illustrate this form of decoupling by showing that, in the US non-profit sector, some organizations implemented a new managerial tool, strategic planning, but were unable to evaluate whether their organizations were more efficient in conducting their mission (Bromley et al., 2012). Interestingly, Dick (2015) adds to this perspective by showing that, even though part-time working was damaging to the core activity, policy service maintained this practice. Means-end decoupling complements policy-practice decoupling and enriches the understanding of organizational responses to institutional pressures by showing that, despite being implemented, new practices can be more symbolic than substantive.

These various studies on organizational responses to institutional pressures show that organizations respond differently to similar institutional pressures (Fiss & Zajac, 2006; Oliver, 1991) and that responses vary depending both on the organization itself and its characteristics (Beck & Walgenbach, 2005; Binder, 2007), and on the environment (Crilly et al., 2012) and the way it is perceived (George et al., 2006). However, these studies focus on a specific aspect, such as policy-practice (Westphal & Zajac, 2001) and means-policy decoupling (Bromley et al., 2012), or the impact of institutional pressures on practices (Beck & Walgenbach, 2005; Turco, 2012). Thus, they tend to be disparate, meaning that we lack a more cohesive framework to better understand how organizations respond to institutional pressures. We propose describing organizational responses to institutional pressures within a three-pronged spatial framework to fill this gap.

Responses to new institutional pressures through reconfiguration of spaces

The concept of space provides a new way to see and understand organizations (Hernes, 2004b; Katz & Kahn, 1966). Although this perspective has received increased attention in the study of organizations (Clegg & Kornberger, 2006; Hernes, 2004b; van Marrewijk & Yanow, 2010), it has been surprisingly absent from institutional studies. Indeed, the cognitive turn has dematerialized practices (Clegg & Kornberger, 2006), even though they must be understood in their relation to physical space and practices (Orlikowski, 2007). While cognitive elements are fundamental to understanding the integration of new practices (DiMaggio, 1991; Jones, Boxenbaum & Anthony, 2013; Scott, 2008), material elements have been overlooked and tend too often to remain implicit (Orlikowski & Scott, 2008; Pinch, 2008).

Building on Lefebvre's (1991) work, Hernes (2003, 2004a, 2004b) proposes a three-pronged framework, encompassing physical, mental (cognitive) and social spaces of organizations, which facilitates understanding the elements that are reconfigured when an organization responds to a new institutional pressure. Physical space encompasses two elements (Hernes, 2003, 2004a, 2004b). First, it characterizes the structure, i.e., the material entities with which individuals interact, such as buildings and equipment. Material elements are important to institutional studies, as they are instantiations of institutions (Gawer & Phillips, 2013; Gieryn, 2002). Second, physical space includes the policies and formal rules of the organization.

Mental space encompasses how individuals make sense of the pressure, as well as the meanings and symbols that are related to it (Hernes, 2003, 2004a, 2004b). First, pressure can be perceived as an opportunity or a threat (George et al., 2006; Sonenshein, 2007) by top management, leading to different responses (Crilly et al., 2012). Indeed, while an opportunity would be likely to trigger acquiescence, a threat would be likely to trigger decoupling or avoidance (Oliver, 1991). Moreover, if a pressure is too complex or presents inconsistencies, an organization may delay its acquiescence to the pressure (Raaijmakers, Vermeulen, Meeus

& Zietsma, 2015) or even resist it altogether. Second, shared meanings are important, as they provide stability for actions. Moreover, they provide individuals with a repertoire of terms and symbols that enable them to communicate and interact (Scott, 2008). Spaces are not independent of one another, and mental space is related to physical space. Indeed, materiality bears meaning (Kornberger & Clegg, 2004), and a new physical space is not merely walls and facilities. It carries the meaning of what it has been built for, a plan for the practices that will take place in this space, and so on. Physical space is brought into practices through the meanings that it carries.

Finally, social space is related to human bonding, i.e., identity both within the organization and a community (Hernes, 2003, 2004a, 2004b). As identity is constructed in practices, such practices that exist at the group level play an important role in identity construction (Hernes, 2003; Katz & Kahn, 1966). Identity construction creates not only a sense of belonging to the organization, but also a sense of difference from other communities or groups (Paulsen, 2003; Pratt et al., 2006). Social space is related to physical space, as materiality impacts behaviours through practices (de Vaujany & Mitev, 2013; Hernes, 2004b). Therefore, a modification of the structure in response to a new pressure impacts identity construction. Moreover, identity in relation to how pressures are perceived – mental space – is an important concept in understanding how the organization responds to new pressures (Kraatz & Block, 2008) as identity, especially when perceived to be under threat, affects organizational responses to institutional pressures (Kodeih & Greenwood, 2014; Randel, Jaussi, & Standifird, 2009).

Building on contributions from the organizational responses to institutional pressures and decoupling literatures, the three-pronged spatial framework provides an opportunity to study the variety of organizational responses through a cohesive framework. Indeed, although it provides a greater understanding of this phenomenon, the current literature remains disparate by studying the elements related to the three spaces separately. Describing how organizations

respond to institutional pressures by reconfiguring their three spaces (physical, mental, and social), the three-pronged spatial framework explains the range of full, partial or no change in practices.

Methodology

Research setting: N&N in the Republic of Ireland

N&N has triggered an interest in studying collaborations in science (Lavie & Drori, 2012), identity construction (Wry, Lounsbury & Glynn, 2011), and market strategies (Granqvist, Grodal, & Woolley, 2013). For this study, N&N presents two interesting characteristics to explore how organizations respond to institutional pressures. First, N&N requires significant investment, leading to more interactions between scientists and policy-makers (Roco, 2005). However, as scientists have become more and more dependent on external funding (Laudel, 2006), scientific organizations are constrained in their willingness to resist the pressures from policy-makers. Second, N&N is characterized by an important level of multidisciplinarity, a characteristic that has been fostered by policy-makers (Bonaccorsi, 2008; Bonaccorsi & Thoma, 2007). N&N represents, therefore, a change in practices that requires reconfiguration of physical, mental and social spaces.

National and European funding for N&N has changed the scientific landscape in the Republic of Ireland (referred to as 'Ireland' hereafter). Though a latecomer to N&N, funding – used for facilities, equipment and scholarships – is now in line with that of leading European countries, such as Germany (Forfás, 2011) and, in terms of publications and patent rankings, Ireland is among the main European countries to produce N&N outcomes (Heinze, 2004).

Research design and cases

We adopted a comparative case study research design (Eisenhardt, 1989; Yin, 2009) to study how organizations respond to new institutional pressures. We chose to examine teams in order to answer our research question, as it is at this level that we can observe practice variations at play in organizational responses (Bromley & Powell, 2012; Hallett & Ventresca, 2006). We focused on qualitative data, as these are relevant to theory-building (Durand & Jourdan, 2012), which enabled us to identify both the similarities and dissimilarities between cases to enrich the theoretical construction (Eisenhardt, 1989).

Table 1 describes the six cases we examined, which were anonymized as 'Alpha', 'Beta', 'Gamma', 'Delta', 'Epsilon' and 'Omega'. Teams comprise one team leader (or two, in the case of Alpha), postdoctoral researchers (except for Delta for funding reasons) and PhD students. Only the team leader is permanently funded by the university, while the other members are funded by external sources. These external sources are also mobilized to support buildings, scientific equipment and consumables.

The six teams conduct research in the areas of materials science, and nanotechnologies and biological systems. While we acknowledge that the cases do not cover all N&N sub-disciplines, they represent two large sectors actively fostered in Ireland. The teams at Alpha and Beta are the most multidisciplinary, as they include scientists with backgrounds in all three disciplines of physics, chemistry and biology. The multidisciplinarity derives from the fact that making nanoparticles relates to chemistry, identifying their character relates to physics, and studying their effects on biological systems relates to biology. The other teams are less multidisciplinary, as their areas of research are related only to physics and chemistry. All team leaders hold PhDs in physics, except the leader of Alpha, whose PhD is in theoretical chemistry.

< Please insert Table 1 about here >

Data collection

Data collection comprised two stages. The first stage entailed interviewing key informants (Miles & Huberman, 1994), along with collecting internal documents. Thus, the first author interviewed each team leader to collect information about: the team's research specialty (Chubin, 1976) and purpose; the team's members; how and why the team was created; how the team obtained its funding; how the team sustained its activities; journals targeted and conferences attended by the team; and funding agencies to which the team has submitted applications. Information gathered in the team leader interviews was triangulated with the second-stage interviews with team members and documentary sources.

The second stage consisted of interviewing team members (postdoctoral researchers and PhD students), and policy and funding agencies to obtain a more thorough description of the teams, of the various aspects of their activities, and of the different stakeholders that were directly or indirectly involved. Team members were interviewed about their career paths, sense of N&N, their view of the funding environment, and conferences and journals. Interviewees' CVs were used to objectivize their career paths (see Table 2 for case data).

< Please insert Table 2 about here >

As concerns policy and funding agencies, the first author collected documents and conducted interviews with key people related to science-and-technology policies, particularly N&N (see Table 3 for policy and funding agency data).

< Please insert Table 3 about here>

Our second data-collection stage was rounded out with a follow-up series of team leader interviews, designed to clarify the dataset, obtain more information about the teams and answer any relevant additional questions.

Data analysis

The data analysis comprised three main steps. First, we wrote thick descriptions of the global context of the national science-and-technology policy, the development of N&N, the research activity and space reconfiguration of each team, and the political and scientific environment in which the teams operated.

Second, we identified the extent to which teams reconfigure their physical, social and mental spaces, drawing on five codes derived from the literature (Hernes, 2003, 2004b). Physical space was coded along two dimensions, which we refer to as: (1) the rationale for the construction of the infrastructure that hosts the team and equipment, and the pressure that enabled or constrained this construction; and (2) the formal rules of the organization. Mental space was coded along one dimension, referred to as: (3) the extent to which organizational members make sense of N&N, and the meanings and symbols that are related to it. Social space was coded along two dimensions, which we refer to as the sense of belonging of team members: (4) within their organization; and (5) in relation to a scientific community.

In the last step, we focused on theorizing and building contributions by discussing our findings in relation to the literature on organizational responses to institutional pressures and decoupling. Given the idiosyncrasies of the teams, we first conducted a within-case analysis

(Eisenhardt, 1989; Yin, 2009) and then a cross-case analysis to describe both the similarities and dissimilarities across cases (Eisenhardt, 1989).

Findings

Based on our empirical study, we identified four organizational responses to the N&N institutional pressure: (1) core reconfiguration of physical, mental and social spaces; (2) core reconfiguration of physical space, with peripheral reconfiguration of social and mental spaces; (3) absence of reconfiguration of physical space, with peripheral reconfiguration of social and mental spaces; and (4) resistance to reconfiguring physical, social and mental spaces.

Core reconfiguration of physical, social and mental spaces

The first response is the most important in terms of reconfiguration, as all three spaces are reconfigured to comply with the N&N institutional pressure. Our findings show that the new physical space, and the N&N meanings related to it, influenced the core reconfiguration of the social space. Data also suggest that although the three spaces were reconfigured at their cores, this led to tensions with established scientific disciplines. These tensions can mainly be observed within the social space, where identity is constructed within the organization and through belonging to a community. Table 4 summarizes these findings. Alpha and Beta are illustrative of this organizational response.

Alpha responded to N&N by creating a physical space, financed by national and supranational funding dedicated to N&N, to which the meanings related to N&N were attached. While Alpha's team leader started the N&N activities before the creation of the new infrastructure, Alpha seized the financial opportunity promoted by policy-makers to develop this stream of research and create a new physical space:

> These are really the biggest investments, buildings and space and so on. So obviously, there was quite a lot of competition for what gets selected to go in, and obviously [the university] realized that this was an area of strategic growth that they wanted to be involved in. (Alpha, postdoc 1)

The new infrastructure includes the term 'nano' in its name. Along with the reconfiguration of 'walls' came the reappropriation of material resources, and the symbolic attachment of equipment to N&N. Indeed, although the equipment used by the scientists comes mainly from the established discipline of physics, it is considered typical N&N equipment. Within this new physical space, the formal rules were that multidisciplinary N&N research – understanding of nanoparticle behaviours and interactions with biological systems – must take place. As N&N was new at the time, Alpha created a PhD programme that integrated these core characteristics and trained new members in the basics of all three disciplines: '*We do all the chain synthesis, characterization, interaction with proteins and interaction with biology, because that is the only way. Because we're interdisciplinary, it means that you have to convince biologists to learn physical chemistry, and vice versa*' (Alpha, postdoc 2).

The creation of a physical space and the related meanings enabled the construction of an identity where N&N was at the core. This social space, constructed in interactions with other members and through practising a new way of conducting experiments, enabled Alpha's members to distinguish themselves from established scientific disciplines: '*I am not either chemist or biologist. If there would be a degree in nanotechnology, I would be the best person because none of the chemists are biologists and none of the biologists are chemists*' (Alpha, postdoc 4). This awareness of being distinct from other disciplines emerged early on in the group's existence. Indeed, Alpha was created before construction of the building was complete and was hosted in another department, where Alpha's first members started research at the nanoscale. As the temporary host centre was dedicated to another team, the creation of Alpha with its own name and stated purpose enabled Alpha's members to distinguish

themselves from the members of the host centre: '*I don't know how to define it in the sense of, like, this department is the Department of Molecular Biology. For example, we are doing something strange with respect to them*' (Alpha, postdoc 3).

The core reconfiguration of physical, mental and social spaces produced tensions in interactions with scientific communities. Indeed, core reconfiguration is difficult to achieve as only a few journals provide space to publish multidisciplinary research. As N&N is not institutionalized, scientists face the barrier of publication. Indeed, most of the scientific journals have broadened their scope to N&N research, but only a few – such as *Nature* and *Nature Nano* – publish multidisciplinary studies:

> I'm studying how nanoparticles are travelling inside the cell. So, I read literature on people studying how to move inside the cell, but none of those papers are doing what I'm doing, so to say. They are not using the kind of methods, they are not using the kind of analysis that I am doing, which is what, I think, is novel and interesting. (Alpha, postdoc 4)

We found similar findings – core reconfiguration of all three spaces – in Beta. As with Alpha, research at the nanoscale started before the actual creation of the new physical space. This previous research enabled Beta's team leader to apply for national funding to create a physical space that complies with pressure from policy-makers: '*the area that has the biggest change because of nanotechnology is the bio, bio-medicine, technology, toxicology, pharmacy. I think they're* [policy-makers] *targeting the funds because they really see the potential benefits*' (Beta, team leader 1). Although the 'walls' existed already, winning a competitive national call for funding enabled Beta to finance N&N-dedicated equipment, and to rename this reconfigured area of the building to include the term 'nano'. In line with the expectations of policy-makers, multidisciplinarity was core to the formal rules. Projects, especially at doctorate level, were multidisciplinary: '*My PhD would be physics, but the project itself, you*

can't really describe it as pure physics. It's everything. I mean it's predominantly biology. It's toxicology basically. It's toxicology and materials science' (Beta, PhD 1).

This physical space and its reappropriation – enabled by the meanings related to N&N – in turn enabled the construction of a social space that would be distinctive from other organizations: '*Beta's research is quite unique because we're not focusing on making nanomaterials. We're focusing on the application of nanomaterials and how that's going to affect consumers down the line*' (Beta, PhD 1). This multidisciplinary practice was core to Beta's social space and enabled Beta's members to distinguish themselves from the established scientific disciplines: '*A biologist wouldn't probably be able to understand.* […] *Biologists have their systems*' (Beta, PhD 2).

In line with Alpha, the core reconfiguration of physical, mental and social spaces led to tensions with the established scientific disciplines. Although there are N&N-dedicated conferences, where multidisciplinary work is presented, scientists face more difficulties when it comes to getting their research published in journals. Indeed, as only a few journals publish multidisciplinary studies, Beta's members have to adapt their multidisciplinary research to the established disciplines: '*It is more or less like publishing articles from chemistry, physics and biology, and merging these in terms of biophysical, biochemistry – something like that*' (Alpha, postdoc 1). These practices, which fit Beta's reconfigured spaces, can face a further barrier to getting published: established disciplines have not been transformed to comply with N&N pressure:

> [A PhD Student] is writing a paper now. We have no idea where we are going to put this. Because her project is the tyre particles project, we have to sit down and decide where we're going to submit that. It's quite a different study, and we don't know where to put it. (Alpha, postdoc 2)

This first response describes core reconfiguration of physical, mental and social spaces, where meaning played an important role in the reappropriation of the physical space and in the core

construction of identity. As we now move on to discuss, other teams reconfigured their spaces to a lesser extent.

Core reconfiguration of physical space, with peripheral reconfiguration of social and mental spaces

The second response describes reconfiguration of the physical space to integrate N&N into its core, but with only peripheral integration of the institutional pressure into mental and social spaces. Here, the structure has an impact on practices, but to a lesser extent than in the previous response. We found that embeddedness in an established discipline with only peripheral integration decreased the tension with scientific communities. Table 4 summarizes these findings. Gamma is illustrative of this organizational response.

Gamma reconfigured the physical space at its core to comply with the N&N pressure by joining one of the biggest research centres dedicated to nanomaterials. Although the purpose of the centre is research at the nanoscale, Gamma's team leader was opportunistic in this reconfiguration; indeed, the pressure from policy-makers to fund N&N was seen as an opportunity to get funding from both national and supranational agencies. The use of the term 'nano' described more a symbolic adoption of the pressure than a core modification of practices: '*We're now keeping an eye on energy, because of course there's a big emerging field* […]. *In the sense of we're still talking about nano, so it's actually kind of nanoscience that's related to energy application*' (Gamma, team leader).

Interestingly, Gamma tackled the computational side of materials science by modelling the electronic properties of nanoparticles through computer simulation. Therefore, their core techniques do not carry the meanings specifically related to N&N, such as multidisciplinarity. This generic instrument is not an N&N-specific practice, and scientists are not therefore bound to N&N through the specific practices of an instrument and the meanings related to it: '*Nano* […] *is very small, very small systems. They're in the range of* 10^{-9} *metres and – unlike*

the experimentalists – nano is just for us changing numbers' (Gamma, postdoc 3). So, even though Gamma is conducting research at the nanoscale within dedicated facilities, the mental space was reconfigured only peripherally. The multidisciplinary aspect of N&N is seen here as an issue, as the activity is based on techniques and capabilities drawn from physics. As such, this makes the term 'nano' more difficult to use when writing for publication: '*It could encompass any number of different disciplines.* […] *The only way you can use the word "nanotechnology" is as a buzzword*' (Gamma, postdoc 4).

This lack of attached meaning and the generic characteristics of the core practices triggered (as in the mental space) peripheral reconfiguration of the social space. Gamma's core practice is an established discipline of physics, and it falls (given the objects studied) into N&N: '*Most of the things people do in condensed matter these days are somehow related to looking at very small things. So everything is by definition nano*' (Gamma, postdoc 2). Moreover, even though Gamma's members acknowledge that N&N has a lot of potential in terms of application by bringing disciplines together, they saw the multidisciplinarity that was core to Alpha's and Beta's core practices as being too broad for theirs. Gamma's members do not distinguish themselves from established disciplines, but argue how their discipline and practices fit into N&N:

> I happened to choose computation of condensed matter partly because I also worked in a condensed-matter lab as an experimentalist. So I had a little bit more exposure to, let's say, nanotechnology in this sense, because I was actually working on my master's thesis. I worked in an experimental lab growing thin films, OK this is highly technical. But I mean that could be classified as […] that would come under the, let's say, classification, you know, of nanotechnology, (Gamma, postdoc 2)

This second response shows that, although the physical space was reconfigured at its core, reconfiguration of the mental and social spaces was only peripheral. This lack of meaning related to N&N and the generic purpose of the core practices led to a peripheral construction

of identity, and enabled Gamma to adapt its research and find applications for its work in newly funded areas if this improves the sustainability of the team. As we now turn to address the third organizational response, the peripheral reconfiguration of the mental and social spaces also occurred without reconfiguration of the physical space.

Absence of reconfiguration of physical space, with peripheral reconfiguration of social and mental spaces

This third response shows that even when the physical space was not reconfigured, the institutional pressure was nonetheless integrated at the periphery of the mental and social spaces. Here, even though research falls in both cases into N&N, team leaders did not attempt to reconfigure the physical space or the meaning attached to it by, for instance, changing the names of the organizations. Although the names of the two teams do not include the term 'nano', N&N is integrated at the periphery of the mental and social spaces. These findings are of interest as they show that the reconfiguration of the physical space is not necessary for peripheral integration into the mental and social spaces. Table 4 summarizes these findings. Delta and Epsilon are illustrative of this organizational response.

Delta's team leader did not reconfigure the physical space of the organization by creating new, or even improving the current, space. Even though N&N is supported by the national agencies that fund Delta, the team leader does not see its activity as entirely fitting this area. Indeed, multidisciplinarity, which is often emphasized in these calls for funding, is perceived more as a constraint than an opportunity:

> We should be looking for the kind of interdisciplinary stuff where the background of the people would be, you know, an advantage, rather than potentially a disadvantage. […] When talking to the bio people, they seem to think that, well, it could be a problem – like, you know, you will fall short in one regard either way. (Delta, team leader)

Therefore, both the structure and the equipment did not carry the meaning related to N&N and supported by policy-makers. Not entirely absent from Delta's practices, N&N was integrated at the periphery of the mental space. The bandwagon that surrounds N&N establishes a distance between the expectations that can be related to a new technology and the practices of scientific work:

> People hear 'nanotechnology'; they hear all sorts of wonderful things that might happen in the future. My work is, I don't know, [...] a lot of the techniques I do are quite simple to implement. It's just a practice, and it's the knowledge of the technique that allows me to do what I can at the moment. (Delta, PhD 3)

However, Delta's members highlight the incremental aspects of N&N and the importance of N&N in the scientific activity: '*None of my work would be revolutionary; it would be evolutionary stuff. You use nano-structured materials to get an improvement that is, in some sense, the continuation of a story*' (Delta, team leader).

Interestingly, without reconfiguration of the physical space and with only peripheral integration of N&N within the mental space, N&N was also integrated at the periphery of the social space. The embeddedness of Delta in an established discipline made core reconfiguration of the social space difficult. Indeed, although the meanings related to N&N and promoted by policy-makers (such as multidisciplinarity) are absent or even rejected, N&N is used as a unit of measurement or as a description of the material structure the scientists are growing: '*I would be looking at semiconductor research first, because that's kind of the overall view of mine. And then, the nano factor has to be a factor of that anyway. It's kind of the two go together really*' (Delta, PhD 1).

Epsilon presents similar findings, with the physical space again not being reconfigured, and N&N being integrated into the mental and social spaces only at the periphery. Epsilon's team leader justifies the decision of not reconfiguring the physical space by the fact that the group

lacks the criteria promoted by policy-makers. Having missed this opportunity, largely promoted by policy-makers, Epsilon faced difficulties in sustaining its activity in terms of financial resources. Although other team leaders appeared more skilful in adapting their activity and production of scientific outcomes, the adaptation is now a priority at Epsilon in order to find funding for both equipment and scholarships:

> My biggest issue, I mean the biggest problem I have, is that I have three students, graduate students, graduating down, within the next nine months. I mean, one of them is going right after Christmas and the other two should be finished by July or August next year. And then, at that stage, I will only have one graduate student left. Ok. So my real funding issue at the moment is to find funding for new graduate students. (Epsilon, team leader)

Even though Epsilon was a latecomer, financial constraints are forcing it to comply with N&N, which fosters projects held by multiple teams and fits the research priorities promoted by the government: '*What I'm hoping is, over the next year, we can, between our contacts in Dublin, Liverpool and Marseille – we all have different contacts in Europe – start looking at some sort of Framework Seven applications, and try and get funding*' (Epsilon, team leader). However, even though the physical space was not reconfigured, N&N was integrated at the periphery of the mental space. Indeed, N&N is just one aspect of the activity, as the research is conducted at the nanoscale. Epsilon's members make sense of N&N as being scientifically relevant, but not enough to be core to the description of their activity: '*Technically, we are surface science, where we are analysing these metal surfaces and we have just put an extra layer of nano-material on the surfaces*' (Epsilon, PhD 1).

As with Delta, even though the physical was not reconfigured and the mental space was reconfigured peripherally, N&N was integrated at the periphery of the social space. In that sense, N&N is not core to the practices, but still has an influence on them. Epsilon does not reject N&N; rather, it integrates it as a scientific argument for its work: '*I know people, like I have loads of people using nanotechnology where maybe they are not really justified, but, no,*

ours are definitely like nano-mesh and nano-network-like structures' (Epsilon, PhD 3). As Epsilon is embedded in an established discipline, the core of Epsilon's identity is surface science. This is reinforced by the nature of the research conducted, which is more monodisciplinary than multidisciplinary, as promoted by policy-makers: '*Our research is basic research, and publications are just very, very basic, fundamental research-type publications*' (Epsilon, team leader).

This third organizational response is of interest, as even though the physical space was not reconfigured, N&N was still found at the periphery of the mental and social spaces. Although we did not observe in our data a core integration of N&N into the social and mental spaces without integration into the physical spaces, this finding suggests that the social space is constructed in practices, and in relation to the meaning attached to the physical space.

Resistance to reconfiguring physical, social and mental spaces

This last organizational response describes an active resistance regarding the reconfiguration of physical, mental and social spaces. This case was important to the findings, as it completed the range of possible responses to a new pressure. Here, the organization resists the institutional pressure by not reconfiguring any of the three spaces. Table 4 describes these findings. Omega is illustrative of this response.

Although funding was available and Omega had the capabilities to apply for it, Omega's team leader did not engage in the reconfiguration of the physical space. While its equipment is used for research at the nanoscale, it did not try to renew this to improve its facilities. However, due to the fuzziness and the 'trendy' aspect of the N&N pressure, Omega differs from Delta and Epsilon as it actively resists N&N by claiming that being N&N specialists would represent opportunistic, rather than scientific, behaviour: '*There's a lot of misinformation with nano – and almost playing that card as a way of trying to appear modern and appear cohesive. We haven't done that*' (Omega, team leader). This differs from the previous

organizational response as, in this case, the non-reconfiguration was related to a rejection of N&N. Therefore, Omega tends to use the term 'nano' only rarely. While doing so would be scientifically accurate, the group's scientists do not use it in their publications: '*The term that we use, we refer to thin films. So, they are within the – like – nanometre scale of something – let's say, one-, two-, three-, four-, five-nanometre films – which we just refer to as thin films*' (Omega, postdoc). In the different meanings that are attached to the N&N pressure, none can be related to the research activity of Omega's members: '*I am not sure whether that would be the conventional idea of nanotechnology, because I think people normally think it is in, it's in the structure dimension. But that's not the way we think of it*' (Omega, postdoc).

With no reconfiguration of the physical and mental spaces, the social space was not reconfigured either. Omega's members, especially Omega's team leader, have stronger views on N&N, excluding it from their identity. They consider themselves as doing basic science: '*We don't really do any fancy nanotechnology. We do very basic surface science*' (Omega, PhD 2). For them, N&N involves building material from molecules, whereas they are studying the basic aspects of materials science. This vision is shared by the postdoctoral researcher and PhD students, who see themselves as working in an area that is very relevant:

> I don't care if people do not think I am a nanotechnologist, because the area we work in – thin film and interfaces – is of critical importance in so many areas. In particular, the area that I work in, which is the semiconductor and how devices work, is dictated by the interactions between surfaces. And essentially, the layers we look at are of the nanometre dimension and range. (Omega, team leader)

Omega's identity is forged around the techniques and the molecules it is using while N&N is not a feature it uses even to differentiate itself from other teams or disciplines. Omega is deeply embedded in the established scientific community of surface science.

This final response describes a non-integration of N&N into Omega's physical, social and mental spaces. This non-reconfiguration of the spaces is characterized by the team defining its research as basic and N&N as application-oriented. We note here that the physical, social and mental spaces remain embedded in the established discipline of surface science. Although resistance is made possible because of alternative sources of funding, it reduces the range of funding opportunities, and triggers other conflicts, such as sustaining the activity.

< Please insert Table 4 about here >

Discussion

To better understand how organizations respond to institutional pressures, we extend the three-pronged spatial framework to describe how organizations respond differently to a similar institutional pressure by varying the extent to which they reconfigure their physical, mental and social spaces. Through a comparative case study (Eisenhardt & Graebner, 2007; Yin, 2009), we have identified four responses. The first response describes how organizations respond to N&N by reconfiguring the core of their physical, mental and social spaces. While core reconfiguration of the mental space provides meaning for the reappropriation of the physical space, these two actions enable the construction of a new social space, i.e., a new identity. The second response shows that even though the physical space was reconfigured at its core to integrate N&N expectations, the mental and social spaces were reconfigured only at the periphery. The third response complements the second by showing that peripheral reconfiguration of the mental and social spaces is possible even when the physical space is not reconfigured at all. The fourth and last response shows that organizations can respond to N&N by active resistance, rather than reconfiguring the three spaces. Based on these findings,

our study makes three contributions: (1) it provides a complementary and cohesive framework for organizational responses to institutional pressures; (2) it sheds light on modes of organizational responses to institutional pressures; and (3) it identifies two factors that explain the variety of responses to institutional pressures.

Complementary and cohesive framework to organizational responses to institutional pressures

The literature on organizational responses to institutional pressures and decoupling (Boxenbaum & Jonsson, in press; Oliver, 1991) shows that organizations can adopt or even symbolically implement new practices (Bromley et al., 2012; Westphal & Zajac, 2001), and that practices can be more or less impacted (Kodeih & Greenwood, 2014). Even though these studies are fruitful in enabling a better understanding of this phenomenon, they tend to be disparate and to consider the different elements separately. The three-pronged spatial framework is more cohesive as it includes policies and formal rules (Bromley & Powell, 2012; Oliver, 1991) within the physical space and also considers the sense that it is made of institutional pressures (George et al., 2006) in the mental space. It then integrates a complementary perspective on practices by looking at them through identity in the social space.

By providing a cohesive framework, our first contribution is to Oliver's (1991) model and to policy-practice and means-end decoupling (Boxenbaum & Jonsson, in press; Bromley & Powell, 2012) by showing that organizations do not respond to institutional pressures as a whole; rather, physical (material elements and formal rules), mental (meaning) and social (identity) spaces can integrate institutional expectations separately and to varying degrees. Indeed, practices and changes in practices must be studied in relation to the physical space (Orlikowski, 2007) and their related meaning (Kornberger & Clegg, 2004; van Marrewijk & Yanow, 2010), and to identity construction (Paulsen, 2003). This completes our understanding

of decoupling as it sheds light on these different elements within the same framework. This is relevant to the organizational-response and decoupling literature as, while we observed coupling responses when spaces are reconfigured at their core, or not at all, we also saw that some spaces can be reconfigured while others are not.

First, elements from institutional pressures can be integrated at the core of physical, mental and social spaces, which relates to a substantial adoption of a new structure and practices. Here, we observed a coupled response, with the creation of a new physical space and related meanings, and the construction of a new identity. Although the literature describes the adoption of new practices as passive (Oliver, 1991), our study shows that team leaders were active and seized an opportunity to build or reshape their organizations (George et al., 2006). The active characteristics of the core integration are observed in the construction of dedicated physical spaces with meanings attached to them. Moreover, the reappropriation of the equipment enabled the construction of a new identity. Passivity in adopting new practices would suggest that organizations do not have a choice in this adoption, as this would lead to legal sanctions. However, it is important to consider that although the agency of organizations can be reduced, it cannot be totally constrained – except in rare cases – as alternatives exist (Durand & Jourdan, 2012). Thus, we complement the organizational responses to institutional pressures literature (Oliver, 1991) by describing the elements that are reconfigured in the situation of complying with institutional pressures. Moreover, core reconfiguration is an active reconfiguration of spaces by top managers who see an institutional pressure as an opportunity to increase their chances of survival.

Second, elements from institutional pressures can be integrated at the periphery of physical, mental and social spaces. Here, policies and formal rules are not changed and the institutional pressure is complementary. Moreover, identity is only altered. This relates to symbolic adoption and symbolic implementation. It was in these cases that we observed decoupling

responses. We complete Bromley and Powell's (2012) concept of decoupling. Indeed, when a pressure is integrated only peripherally as it is complementary to extant practices. It is thus difficult to evaluate the extent to which adopting the elements of the pressure impacts practice, as in means-ends decoupling for symbolic implementation (Bromley & Powell, 2012). Even policy-practice decoupling can be viewed instead as peripheral integration, since policies are not fundamentally changed, as is the case in symbolic adoption (Fiss & Zajac, 2006). The physical space encompasses both material elements and formal rules, and studies suggest that decoupling is difficult to sustain over time (Dick, 2015; Tilcsik, 2010). Moreover, peripheral reconfiguration is also an active reconfiguration by top managers who, in this case, see an institutional pressure as complementary to their practices.

Third, elements from institutional pressures can end up not being integrated in physical, mental and social spaces. In this case, we also observe a coupling response to institutional pressures, as all spaces are actively preserved from pressures. We note that this response mirrors the first, as the physical space, the meanings related to it, and the social space are a source of active resistance to institutional pressures. The new pressure is categorized as irrelevant to the activity as a threat (George et al., 2006), and is therefore not integrated (Beck & Walgenbach, 2005). Meanings play an important role of source of resistance, as materiality is deeply attached to extant norms, and this makes reappropriation of the physical space more difficult. This must be differentiated from passive non-response, which suggests that policies have 'missed their target'.

This cohesive framework adds to the literature (Bromley & Powell, 2012; Oliver, 1991) by describing the elements of an organization that can and cannot be decoupled. We further our understanding of policy-practice decoupling (Boxenbaum & Jonsson, in press) and means-ends decoupling (Bromley & Powell, 2012) by linking them within the same framework. Moreover, the framework also furthers the rather binary understanding of symbolic (Westphal

& Zajac, 2001) versus substantive (Kodeih & Greenwood, 2014) changes in practices by introducing the extent to which spaces of organizations are reconfigured: core, periphery or absence of reconfiguration.

Modes of organizational responses to institutional pressures

Our study contributes to decoupling studies (Boxenbaum & Jonsson, in press; Fiss & Zajac, 2006; Westphal & Zajac, 2001) by showing the interrelations between physical, mental and social spaces and highlighting different modes of organizational responses to institutional pressures. First, core reconfiguration of physical space is not a necessary condition for peripheral reconfiguration of mental and social spaces. While the literature tends to focus on integration into the structure, and to look at the adoption of practices from the structure, our study shows that other elements of organizations can be impacted, even when the structure is not. Practices, especially in professional fields, are embedded into norms and identity (Turco, 2012) that have an important impact on how they evolve. They can therefore be a source of resistance or change with or without reconfiguration of the structure. However, we did not observe a case where physical space had been reconfigured at its core, and mental and social spaces had not. This suggests that a complete decoupling between policies and practices (Boxenbaum & Jonsson, in press) is difficult to achieve, and that, as practices occur within the physical space, the latter has an influence on the former over time (Hernes, 2004b; Tilcsik, 2010).

Second, reconfiguration of mental space is a necessary but not sufficient condition for the adoption of new practices. Our study shows that the meaning attached to physical space – facilities and equipment – as well as the sense that is made of an institutional pressure, matters for the adoption of new practices. This point is important for institutional studies, as it brings back the material aspects of organizations and of institutions and their related meanings (Kornberger & Clegg, 2004) to understand their impacts on practices (Jones et al., 2013).

Indeed, relabeling strategies (Granqvist et al., 2013) play an important role in the reappropriation of materiality. They enable organizations to build spaces dedicated to new practices (Gieryn, 2002). In line with the decoupling literature, building can integrate a new pressure without greatly influencing practices. Organizational members, especially top executives, can be opportunistic and can modify physical spaces to comply with new pressures without being willing to change core practices. It is important to note that the reappropriation of technology faces the resistance of social and mental spaces, as equipment is embedded in extant disciplines that involve specific practices, methods and professional identity. Thus, meanings attached to an institutional pressure are also sources for resistance when new pressures threaten extant practices.

Factors explaining the variety of organizational responses to institutional pressures

Finally, the third contribution is the description of two factors that enhance understanding of the variety of organizational responses to institutional pressures (Martin et al., 2016). First, institutional pressures are not always clear, even sometimes conflicting (Heese, Krishnan & Moers, 2016), which allows organizations to vary in their interpretations (George et al., 2006) and to adopt different strategies to position themselves regarding the institutional pressure (Granqvist et al., 2013; Granqvist & Ritvala, 2016). Moreover, the presence of alternative possibilities, such as another funding provider (Durand & Jourdan, 2012), may also favour resisting responses.

Second, institutional pressures impact organizations already embedded in existing disciplines that provide ways of thinking and practices that tend to be stable over time (Lakatos, 1970; Popper, 1970). Organizations that are centrally embedded in a single discipline do not reconfigure their spaces as the institutional pressure represents a threat to their practices. However, those at the periphery of a discipline and engaged in multidisciplinary research comply with the institutional pressure as it provides sense to their practices. Moreover,

meanings attached to physical space also play a role in organizational responses to institutional pressure. Organizations that are centrally embedded in a single discipline have more stable meanings related to physical space. Moreover, older organizations have more consolidated formal rules, meanings and identities, which may increase the source of resistance to the institutional pressure. However, organizations at the periphery of a discipline are more likely to reconfigure their physical, mental and social spaces at their core, as they are less constrained by meanings related to an established discipline. Moreover, as multidisciplinarity is less established, organizations are more likely to reconfigure their physical, mental and social spaces at their core.

Limitations and future research

We identify three main limitations to our study. First, as concerns the variety of responses through the three-pronged spatial framework, we did not consider the dynamics of the different spaces over time. Indeed, as suggested by the literature, spaces are not a product but a process that changes over time (Hernes, 2004b; Lefebvre, 1991). Moreover, decoupling studies show that decoupling is difficult to sustain over time (Tilcsik, 2010) and requires acceptance from the organization's members (Turco, 2012). Therefore, engaging in a longitudinal study would shed light on the relationships between the different organizational responses to institutional pressures and would deepen the influence between the different spaces.

Second, although the cases were similar – team leader, postdoctoral researchers and PhD students – we did not consider the organizational and structural differences between the cases in depth. Indeed, the cases do not have the same dependence in terms of technologies employed. Thus, for example, as computers used for modelling are a more generic technology than physics equipment, meanings attached to computers might be easier to transform so as to

comply with new institutional expectations. Also, science disciplines differ in terms of norms, which may have an impact on how organizations respond to institutional pressures. Therefore, considering the organizational and structural differences may provide a better understanding of how these factors influence the reconfiguration of organizations' physical, mental and social spaces.

Third, the structure of the field may influence the ways in which organizations respond to institutional pressures. Indeed, the organization of science in Ireland is entrepreneurial (Whitley, 2007), as it is in countries such as the UK and US. This makes organizations more dependent on external funding, resources and actors (Oliver, 1991; Ruef & Scott, 1998). However, although policy-makers tend to be more involved in scientific activity, and science tends to be more entrepreneurial, countries such as France provide scientists with more recurrent funding. Comparing the situations in different countries would provide a richer perspective on how organizations respond to institutional pressures, depending on the characteristics of the field within which they evolve.

Conclusion

Our study addressed how organizations respond to institutional pressures. Based on a comparative case study of research teams in N&N, and using a three-pronged spatial framework, we identified four organizational responses to institutional pressures that are defined by the extent to which organizations respond to institutional pressures to reconfigure their physical, mental and social spaces. This study contributes to institutional studies by providing a complementary and cohesive framework describing how organizations respond to institutional pressures. It complements the policy-practice and means-decoupling literature by showing that the physical, mental and social spaces of organizations are reconfigured to varying degrees in response to institutional pressures.

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Table 1: Description of the cases

	ALPHA	BETA	GAMMA	DELTA	EPSILON	OMEGA
Areas of activity	Nanobiology, nanosafety, nanotoxicology	Nanotoxicology, pharmacology	Computational physics	Materials science	Surface science	Surface science
Purpose of team	Nanoparticle behaviours, and interactions with biological systems for medical purposes	Toxicity and behaviours of nanoparticles in mammalian and fish cells, and algae, using spectroscopy techniques	Electromagnetic properties of nanoparticles through computational simulation	Growth of semiconductors and nanostructures, using multiple characterization techniques	Electronic, chemical and structural properties of semiconductor surfaces, using radiation sources	Chemical interactions on semiconductor surfaces to improve electrical properties
Type of research	Multidisciplinary	Multidisciplinary	Monodisciplinary	Monodisciplinary	Monodisciplinary	Monodisciplinary
Core technique	Characterization and spectroscopy techniques	Characterization and spectroscopy techniques	Computer modelling	Characterization and spectroscopy techniques	Scanning tunnelling microscope (STM)	X-ray photoelectron spectroscopy (XPS)
Type of research	Experimental	Experimental	Simulation and theoretical work	Experimental	Experimental	Experimental
Year established	2007	2008	2006	1999	1999	1999
PhD of the team leader(s) (year)	Theoretical chemistry (1984)	Experimental physics (1989)	Theoretical physics (1999)	Solid-state physics (1996)	Solid-state physics (1985)	Surface physics (1983)
	Chemistry (2002)	Experimental physics (2001)				

Table 2: Description of the case data

	Alpha	**Beta**	**Gamma**	**Delta**	**Epsilon**	**Omega**
Team leaders*	25 (1)	150 (2)	30 (1)	30 (1)	30 (1)	35 (1)
Postdoctoral researchers*	90 (5)	45 (2)	130 (6)	None	15 (1)	10 (1)
PhD students*	20 (1)	95 (5)	35 (3)	60 (4)	40 (3)	35 (2)
Documents**	100	280	100	30	25	25
Date	2010 to 2011	2010 to 2011	2010 to 2011	2011	2011	2011
Total**	**235 (7)**	**570 (9)**	**295 (10)**	**120 (5)**	**110(5)**	**105 (4)**

* Single-spaced pages (number of scientists interviewed)

** Approximate number of pages

Table 3: Description of the science-and-technology policy data

	Forfás	**Science Foundation Ireland**	**Enterprise Ireland**	**Seventh Framework Programme**	**Environmental Protection Agency**
Mission	Advises the Department of Jobs, Enterprise and Innovation	Funds basic research	Develops Irish companies through funding applied research	Funds projects in the N&N field	Funds projects directly related to protecting the environment
Interview*	70 (3)	15 (1)	30 (2)**		-
Documents***	1350	470	400	450	160
Date	2010 to 2011	2011	2011		-
Total***	**1420**	**485**	**415**	**465**	**160**

*Single-spaced pages (number of individuals interviewed)

**These managers in Enterprise Ireland are also the contact points for the Seventh Framework Programme (FP7); they have therefore been interviewed in respect of both roles.

*** Approximate number of pages

Table 4: Organizational responses to institutional pressures

	Core reconfiguration of physical, mental and social spaces	**Core reconfiguration of physical space, with peripheral reconfiguration of social and mental spaces**	**Absence of reconfiguration of physical space, with peripheral reconfiguration of social and mental spaces**	**Resistance to reconfiguring physical, social and mental spaces**
Physical space	• Creation of a new physical space • Reappropriation of materiality	• Materiality as relevant but not core to practices	• Absence of reconfiguration	• Absence of reconfiguration • Dissociation of the materiality
Mental space	• New pressure as an opportunity • Core to the shared meanings	• New pressure as complementary • Peripheral to shared meanings	• New pressure as complementary • Peripheral to shared meanings	• New pressure as a threat • Exclusion from shared meanings
Social space	• Integration into practices • Construction of new identity	• Embeddedness into extant practices • Alteration of extant identity	• Embeddedness into extant practices • Alteration of extant identity	• Embeddedness into extant practices • Resistance of new identity