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Sharing Instrumentation and Valuing Experimental Activities: Inter-organizational Articulation Work Between Two Technological Platforms

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Abstract

This article explores some of the many tensions that emerge from the sharing of scientific instrumentation by focusing on technological platforms—i.e. sociotechnical devices whose aim is to organize the sharing of experimentation devices among several research groups or institutions. It analyzes the case of a merging process between two platforms that belong to the same research and innovation campus with the concept of "articulation work" (Fujimura, 1987). In the present case, the articulation work is produced not only between the three levels that are mentioned by Joan Fujimura (experimental activities, the laboratory, and the social world), but also implies an inter-organizational level. Taking this fourth level into account is particularly useful in order to shed light on the differences of professional and institutional cultures between the various protagonists of both platforms—especially concerning, in the present case study, the way of valuing the pricing and accounting rules.

1. Introduction

In science, it is widely recognized that produced knowledge is a common good. Sharing it through scientific publication is a central value in the normative system of science (Merton, 1973; Evans, 2010). However, sharing becomes more problematic when it concerns scientific instrumentation. When researchers deal with their tools, machines, or instruments, they are not so inclined to allow the use of such a strategic resource by others. Indeed, sharing instrumentation may lead to a set of tensions concerning the organization of scientific work: could a shared experimental technological device be modified for a single experience, even though other users might be affected by these modifications? Should it be used only for routine uses, even if it limits the innovation potential that could emerge from more creative uses? Is it preferable to limit the number of users? Or, should each experimental activity be done by some technical experts, rather than leaving users free to adjust the parameters of their own experience? And, more generally, how should instrumentation sharing be organized, depending on scientific, financial and strategic constraints? In particular, is there an optimal degree of pooling—i.e. a degree of pooling that could preserve both technical resources optimization and respect for the experimental cultures of all the scientific communities concerned?

This article deals with some of the many tensions that could emerge from instrumentation sharing in science. It explores the stakes of technical resource pooling by considering the case of technological platforms—i.e. sociotechnical devices whose main rationale is organizing the sharing of instruments among various scientific groups and institutions. It is based on data produced during more extensive fieldwork in a new research and innovation campus and examines the case of the merging process between two of the many platforms that belong to the campus.[1] It shows that the many dynamics that lead to instrumentation sharing could be usefully analyzed through the concept of "articulation work" (Fujimura, 1987). Several STS scholars have already shown that technological platforms have diverse and contingent organizational models, despite their unique label and the central national programs that, sometimes, promote and support their creation (e.g. Aggeri et al., 2010, in the field of biotechnology; or, Merz & Biniok, 2010, in the field of nanotechnology). They examine how, and to what extent, these models shape scientific practice (Keating & Cambrosio, 2003) and science-industry relationships (Peerbaye & Mangematin, 2005; Merz & Biniok, 2010). Most of these studies consider platforms when they are already built and study their effects on knowledge production.

[1] See boxed text 1 for some methodological information and a brief presentation of both platforms.

In contrast, this article adopts a more processual and relational approach to this kind of scientific organization, in which platforms are considered as the temporary result of many organizing activities. By considering the platform "in the making," its organization is not conceived as a direct consequence of its missions and governance mechanisms nor a set of basic technological resources, but rather as an enduring "organizing work" (De Terssac & Lalande, 2002).

The next section (2) defines what a platform is by comparing it to other types of scientific infrastructures and introduces the concept of articulation work. Section 3 accounts for the case of a merging process between two technological platforms. Section 4 analyzes the results of the case study through the concept of articulation work. Section 5 concludes the article by justifying why focusing on the concept of articulation work was useful to go deeper in the understanding of how such sociotechnical infrastructures can be shared effectively.

2. Articulation Work Between Technological Platforms

2.1. Platforms and Other Scientific Infrastructures

A platform is a sociotechnical device that enables several laboratories to pool their scientific instrumentation by opening it up to users that belong to other scientific groups or institutions. Platforms can include "large scale research facilities" (Peerbaye & Mangematin, 2005), as well as telescopes, particle accelerators (synchrotrons), fusion reactors (tokamaks) (Hackett et al., 2004), or the many large digital databases that support scientific research. However, at least three characteristic features may distinguish platforms from other scientific infrastructures.

First, a platform is a collection of generic medium-sized instruments that offer a variety of services and experimental activities to heterogeneous user groups. As well as third generation synchrotrons (Simoulin, 2012) or some digital databases (Bowker, 2000), a platform organizes access for some communities of users that come from different disciplines and specialities. By doing so, it differs from other infrastructures such as CERN, which supports the activity of a single research community. Some platforms also aim to open up academic instrumentation to industrial users in order to foster science-industry cooperation (Peerbaye & Mangematin, 2005; Merz & Biniok, 2010). In that sense, platforms fit as much in the world of "research-technology communities" (Shinn, 2002) as that of "big science" (Galison & Hevly, 1992).

Second, platforms may be distinguished from other scientific infrastructures by the logic of rationalization (of scientific work) that justifies its creation and shapes its daily management. During the last twenty years, scientific institutions have launched platforms to optimize the use of technology whose cost and complexity were increasing—which means an increasing set of associated services for the maintenance and the expert use of the machines, purchase management, and other elements. Beyond the pooling of instruments and competences inside a single organization, the largest platforms introduce some logistics and management techniques (that generally come from industry) in order to rationalize the flow of experimental samples.

Third, a platform is a modular organizational unit that may be geographically dispersed. Contrary to many experimental systems, an instrument may easily be added or removed from the platform without calling into question its existence and its identity. Consequently, platforms are more flexible than many other scientific infrastructures: whereas the latters maintain the same operating principle when upgrading (despite successive and gradual improvements), in a platform, a lithography machine may be replaced by a Chemical Vapor Deposition machine without changing the mission of the platform.

As we will see in the case study, these three distinctive features of platforms (the diversity of users thanks to technological genericity, the rationalization of scientific work, and some blurred material boundaries combined with a fuzzy technical identity) are particularly questioned during a merging process. First, the merging process questions the number and identity of the users' groups: each platform has to take into account the potentially different expectations and routines that the users of the other platform may have. Second, the logic of rationalization may falter when faced with the harmonization of functioning rules that takes place during the merging process. Third, if the platform had no clear technical and material identity and boundaries, the merging process between both platforms would not be a problem; it should only be another step toward an increased resource pooling. To understand this paradox between, on the one hand, two scientific infrastructures that are supposed to be open and flexible, and, on the other, the concrete difficulties that emerge during the merging process, it is useful to introduce the concept of articulation work.

2.2. Articulation Work

The concept of "articulation work" was introduced by the interactionist sociologist Anselm Strauss to highlight a specific part of the general organizational process: "the specific details of putting together tasks, task sequences, task clusters, and even the work done in aligning larger units such as subprojects, in order to accomplish the work" (Strauss, 1988, p. 174-175). It aims to conceptualize the organization in terms of process (organizing) and the division of labor in terms of work (Strauss, 1985).

In Science and Technology Studies, the concept of "articulation work" was used by Joan Fujimura to analyze "scientists' efforts to construct 'do-able' research problems;" it is defined as a set of coordination and planning activities that are necessary to "align tasks to three levels of work organization:" experimentation, laboratory and social world (Fujimura, 1987, p.257). It shows that the feasibility of a research problem does not only depend on scientific or technological constraints, but also depends on a specific "organizing work" (De Terssac& Lalande, 2002). Thus, it sheds light on a set of activities that have often been ignored or neglected by laboratory studies.

In the rest of the text, I will use the concept of "articulation work" as it is defined by Joan Fujimura in order to show how articulation work between two platforms concretely occurs. However, contrary to Joan Fujimura's case study, in the present case study, articulation work does not only concern the three levels that are mentioned by the author (experimental activity, laboratory and social world), but also implies an inter-organizational level. Taking into account this fourth level enables us to shed light on some of the differences of professional and institutional cultures between the protagonists of the two platforms. It also questions the binary nature of pooling: rather than considering instrumentation sharing as a dichotomic alternative (sharing or not sharing), inter-organizational articulation work questions the degree of pooling and the nature of the rules that could enable an harmonization of scientific and technical practice between both platforms; it also underlines the existence of possible alternative options (the reciprocal opening and harmonization of rules without merging, for instance).

Before analyzing the nature of such an articulation work, it is necessary to describe briefly the origin and conditions of the merging process.

3. A Never-Ending Merging Process

Boxed text 1 briefly presents some methodological information and the main technological and institutional features of the engineering institute and CEA platforms.[2] Schematically, the merging process between the two platforms can be split into three steps that partially overlap (i.e. the time periods are not strictly independent and sequential).

[2] The CEA (Commissariat à l'Énergie Atomique et aux Énergies Alternatives) is one of the main French national laboratories.

The two platforms are part of a new research and innovation campus that gathers three thousand researchers, technicians, engineers, and graduate and postgraduate students. The campus is specialized in micro/nanotechnology research and innovation. It implicates various public and private research institutions that share instrumentation thanks to technological platforms—and, among them, the two studied platforms.

The first platform was created in the 1970s by an engineering institute that gathered together several engineering schools from different specialities (materials science, electronics, computing, etc.). Initially opened as a "common facility" of several materials science laboratories, the "engineering institute platform"—as it will be referred to for the rest of the text—gathers a dozen technicians and engineers (one of them is the manager of the platform) who experiment with different instruments of material characterization, such as electron microscopy, Raman spectroscopy, or X-ray diffraction. Its missions are to support public research (70% of the activities), student teaching (15%), and industrial development (15%). People, instruments and experimental activities are divided between two sites that are situated at the two extremes of the city. Indeed, a part of the platform was moved in 2006 from the university campus where it was historically situated to the new research and innovation campus that I have already mentioned. At the same time, a "collaboration opportunity" (as one of the platform managers puts it) arose when the management of the CEA decided to found its own characterization platform at the beginning of the 2000s.

The new "CEA platform" was created by merging three independent facilities of the CEA Grenoble. In 2005, it was opened to "external users" (i.e. coming from outside the CEA) and, in 2006, it was moved to one of the buildings of the same research and innovation campus, which had just been inaugurated. It brings together fifty technicians, engineers, postdocs, and permanent researchers who experiment with various characterization instruments such as electron microscopy, surface analysis, and X-ray and ion beam spectroscopy. In contrast with the engineering institute platform, it exclusively supports research activities. Characterization activities that are considered as "service" or "routine" are realized by a private company that rents the instruments and infrastructures of the public platform during the night and sells their "technical service and expertise" to other private companies.

The fieldwork is based on twenty days of direct observation conducted within both platforms, as well as twenty in-depth interviews conducted with staffs and users between 2005 and 2009. It was part of a broader STS project concerning the creation of the research and innovation campus (Hubert et al., 2014). This collective fieldwork implied a cross-sectional reading and categorization of excerpts from about two hundred detailed interviews and observations accounts using a qualitative analyzis software (NVivo).

BOXED TEXT 1.

3.1. First Step: Sharing a Single Instrumental Technology to Initiate Collaboration

The first step of the merging process was launched by the management of both the CEA and the engineering institute. On the one hand, they decided that the collaboration would be tested with a single type of material characterization device. In their view, the creation of a common area was an initial experimental test to evaluate the feasibility of further collaboration. On the other hand, some researchers that use the platform daily, as well as some of the technicians and engineers that are in charge of the maintenance of the machines and of the preparation of the experiments, have two types of concerns. First, concerning the engineering institute staff, CEA administrative procedures could complicate their daily access to some shared instruments (see section 3.2). Second, inter-institutional relations between the CEA and local academic organizations have been troubled by a long history of tensions and conflicts that the local scientists often analyze in terms of "cultural differences." Schematically speaking, they draw an opposition between the liberal academic culture of the engineering institute scientists and the technocratic and hierarchical culture of the CEA engineers.[3]

Despite these concerns, an initial contractual agreement was established between both institutions in order to organize the "experimental collaboration." It decided what type of instrumentation would be shared (in this case, Raman spectrometry) and where it would be installed (in the engineering institute). Raman spectrometry was chosen because it is a quite common technology, contrary to some very recent and advanced instruments—such as some electron microscopes, for instance—that to a large extent contribute to the platform's reputation and are often considered as "showcases" for their public relations. Furthermore, by sharing a widely used technology such as the Raman spectroscope, the platform management aimed to avoid planning overload and consequent criticism by their daily users. Finally, there were agreements for the provisional assignment of a CEA engineer and the transfer of a Raman spectroscopy instrument belonging to the CEA. To avoid CEA administrative procedures, both of them were installed in the engineering institute building next to three other Raman spectrometry instruments in its already existing "Raman area."

In spite of these precautions, the merging process came up against "strong resistance" that justifies, according to both platforms' management, paying special attention to its incremental progress. They consider such gradualism to be a "necessary evil" that could lead to future "more advanced cooperation," according to the platform manager. That is why, in 2007, the possibility of a complete merger was still considered to be premature. The official discourse of both platform managements was a mixture of prudence and mutual curiosity. They insisted on the reversibility of the merging process: "With the idea of why not? Identify common needs. Might we go further? Maybe, but it is necessary to go through this process: people learn to understand each other." However, most of the engineering institute platform technicians and

3 Part of the CEA's activities deal with military and nuclear research and development.

engineers were against the merger and the potential effect of the pooling on their work conditions. They considered the official rhetoric of prudence as merely strategic and denounced the "hidden agenda" of the management that focused their communication on the "step by step" process in order to avoid the "resistance" of the staff. On the other hand, the CEA platform staff were much more concerned about the planning overload that could arise when opening up rare and coveted technologies to a larger user community. They demanded the option to keep a privileged access to these technologies.

Finally, in spite of the "strong resistance" of the staff, both managements considered that their gradual reorganization (i.e. testing the pooling by sharing a single type of instrument) was a success, and that they could rely on it to go further in the merging process.[4] "Fortified by this first experience," they organized, from the beginning of 2007, a dozen monthly meetings with two objectives: first, to present each platform's activities to the other; second, "to open one up to the other, see what we could do together, without defining a framework," according to the platform manager. However, "defining a framework"—i.e. harmonizing the functioning rules between both platforms—will be part of the next step in the merging process.

3.2. Second Step: Toward a Complete Integration?

The central point of the merging process deals with the negotiation of common rules to organize users' access to the platforms. However, some of the strategic and military activities of the CEA are classified. Access to the CEA site is regulated by a set of procedures (security ID, detailed background checks of personnel undertaken by the security service, etc.), the strict enforcement of which tends to irritate some academic researchers and may delay the obtaining of authorised admission (and sometimes forbid it, in the case of some foreign students or researchers). For new users, the delay in obtaining an access badge is sometimes incompatible with the short timespan of research projects. To solve this problem, the platform management calls a steering committee bi-annually. Among its many missions, the committee is supposed to update the list of people who are authorized to access the platform. However, some platform users consider the frequency

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[4] The reason why the management evaluates that the pooling of Raman spectroscopy is a success could seem enigmatic. However, as no criteria has been previously defined to evaluate the success or failure of this first experience of pooling, the managers could communicate their positive evaluation without being questioned by their respective institutions. In a way, their positive evaluation may be considered as a rhetorical argument. The main point to be underlined here is that the pooling of single type of instrument is clearly a preliminary step toward a complete integration of both platforms.

of the meetings to be insufficient: whereas a six-month delay is acceptable for medium or long term projects (including PhD students), it excludes shorter projects—such as some student internships, visiting scholars who visit occasionally, or some postdoctoral contracts that are limited to a few months. From the platform management's point of view, as well as for the technicians and engineers in charge of the instruments, the expansion of one-off users is a source of an increased workload for the administration and maintenance of the platform (authorization and training of the new users; increased "corrective maintenance" because of improper use of the machine are more frequent with neophytes, etc.).

Because of these contradictory interests and strategies, the managements of both institutions finally decided to implement (what they call) a "controlled and limited reciprocal opening." This prudence is not only rhetorical and the merging process made slow progress: by the end of 2008—i.e. two years after the first information meetings between both platforms, and four years after the sharing of Raman spectroscopy instruments—the "reciprocal opening" is still embryonic: "there are still few scientific exchanges", says one of the platform managers. Yet, the formalisation of the collaboration continues: a "draft contract" establishes the list of shared instruments; "it is about to be signed", says one of the managers. It establishes some concrete issues regarding platform access, such as health and safety regulations and employers' responsibilities during the workers' provisional reassignment into another workspace—when they move from one platform to another. However, according to one of the managers, the final signing is delayed by the legal department.

At the end of 2008, reciprocal platform access had not yet been formally authorized for researchers, technicians, and engineers, but the merging process continued gradually, and some concrete effects appeared. The CEA platform hired an engineer who had previously been working for the other platform, and a joint X-ray characterisation training has been designed and implemented by some members of both platforms. Over the same period, the manager of the engineering institute platform was invited to the steering committee of the CEA platform for the first time. The objective was to "evaluate what can be done together, propose some new ideas, etc. It is the first step toward a more complete integration," said one of the managers. Furthermore, a tripartite agreement was signed to buy a shared sophisticated instrument (a FIB or Focus Ion Beam). A few years later, it was installed in the CEA building, and is currently used alternately by the staff of three platforms (two days per week for the CEA platform, two for the engineering institute platform, and the fifth day for another platform that is located in the same research and innovation campus).

Beyond the delay concerning the collaboration contract, there have been some small steps forward in terms of dealing with the governance and the daily functioning of the (hypothetical) future merged platform—despite the fact that it does not legally exist yet. By doing so, the “reciprocal opening” is presented by the management as a part of some incrementally progressive and reversible dynamics in which each step seems unimportant but forms a concrete part of the merging process. However, regulation harmonization is not limited to an extended and smooth negotiation process between platform managers. As I will detail in the next section, staff and users’ resistance to the merging process focuses on one central difference between the members of both institutions in relation to the valuation of experimental work.

3.3. Third Step: An Impossible Harmonisation of Accounting and Pricing Regulations?

Finally, the lack of support that the merging process received made the platform managements delay it, without really affecting their final objective (the “complete integration” of both platforms). However, several years after its initiation, the merging process is still stumbling over one particular issue. It concerns cost evaluation, the calculation of which is used as a basis to establish invoicing scales (i.e. the evaluation of the price that has to be paid by users). The lack of agreement over this particular issue has slowed down the merging process and even, in the short term, has prevented a complete merger from being realised.

In both platforms, the modalities of calculating users’ financial contributions depend on the type of instruments, materials, and samples they use, the duration of the experimental work, the human resources needed to prepare the experiments, and the accounting options that have been adopted. In particular, the majority of experimental activities are invoiced on the basis of a cost per hour that is annually updated, but part of the difficulty with harmonization comes from the different ways of categorizing the prices depending on the type of user. Indeed, the objective of financial rationalization that (at least partly) justifies the platform policies involves its opening to external users who are not directly involved in its daily management, maintenance, and use. Whereas one-off users do not invest in the purchasing of instruments, they do pay for the platform’s management and maintenance costs. On the one hand, the engineering institute platform offers a lower “internal price” for partner laboratories and schools, because these “internal users” have already paid by investing in the purchase of the machines and/or by accommodating part of the platform (and thus assuming incurred costs). On the other hand, the CEA platform’s pricing policy is partly defined by the national network to which the platform belongs: it has to offer a basic price that is approximately a quarter of the rate for the users coming from other members of the network.[5]

In spite of the two platform managements' willingness, the divergence regarding the accounting rules is difficult to minimise, because it would entail some thoroughgoing modifications of their internal accounting systems. Indeed, on the one hand, the CEA "full cost" policy requires taking into account the depreciation expense of the machines and the human resources cost in the pricing. On the other hand, the scientists from the partner laboratories of the engineering institute platform give priority to lower costs, that do include depreciation expense and human resources costs (with the exception of the service for industrial users, that is already priced on the basis of a "full cost" calculation).

Even if there is a "political will" (as one of the managers says) from the engineering institute management to implement a full cost accounting, the laboratory partners of the platform resist, and this reform cannot be adopted without their agreement. Indeed, the pricing scale is decided by a yearly vote by the members of the orientation council of the platform, which is comprised of the directors of the laboratory partners (and a representative of the engineering institute). The rejection of the new internal accounting system is justified by the increasing price that it would imply for users. By taking into account the depreciation expense of the machines and the human resources costs in the pricing, users' financial participation would double, or triple, depending on the experimental activity (an hour of electron microscopy would increase from 15 to 50 euros, for instance). The eventuality of such an increase has provoked strong opposition from the engineering institute users (especially the researchers), who are used to paying a low price and, in return, buying new equipment thanks to specific grants: the machines are bought on an ad hoc basis, depending on needs, by applying for regional, national, or European grants; in contrast, the new accounting rules would entail an advance payment for their replacement or upgrade.

4. Articulating Different Ways of Valuing the Pricing and Accounting Rules

The harmonizing process between the regulation of both platforms falters over the definition of a common system of accounting and pricing. However, it would be incomplete to

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[5] The "national network of large scale platforms for Basic Technological Research (or "RTB network") is a national instrument launched in 2003 by the ministry in charge of science. It has widely contributed to the financing of investments and functioning costs for most technological platforms in the field of micro/nanotechnology.

reduce this issue to its technical dimension. Beyond the pricing scale, the lack of agreement regarding aspects of accounting is also a consequence of some more fundamental divergences regarding the research financing system (both the existing one, and the one that would be desirable to apply). These divergences are bound up with researchers' activity, their professional cultures, and the institutional (local and national) policies in which they are embedded. In the following section, I will offer arguments in support of this point by using the concept of "articulation work" (Fujimura, 1987).

4.1. *Articulation Work to Align Several Levels of Constraints*

The determination of accounting and pricing norms can be analyzed in terms of articulation work between different levels in the organization of scientific work. The first level deals with experimentation (Fujimura, 1987). Indeed, the nature of the experimental work (the type of instruments and samples, the duration of the experiment, the necessary preparation activities, etc.) modulates users' financial participation: the sum increases when the experimental work is less routine and imposes some more complex technical tunings. Reciprocally, the implementation of some platform modalities of pricing and accounting implies an increased formalization of experimental practice by users (ex ante, when they fill a form to obtain access to the platform, and ex post, when they fill in a notebook that accounts for the experimental interventions that have been carried out on each machine).[6]

Joan Fujimura (1987) has identified a second intermediary level for articulation work: the laboratory. Indeed, platform management has to take into account the exigencies and routines of the laboratory partners of the platforms (i.e. those who have contributed to the purchase of machines). Reciprocally, the platform profoundly redefines the organization of work inside the laboratory: the rules that organize the access to instruments, the division of roles between PhD students, postdocs, researchers, engineers and technicians, and the management of laboratory financial resources are directly impacted by the platform regulation. In particular, accounting and pricing rules determine a set of constraints for laboratory strategy: the concrete modalities of pricing and accounting condition researchers' capacity to finance their experimental activity and, consequently, influence their scientific orientation.

The social world (outside the laboratory) is a third level that has to be articulated with the two others. In the case of accounting and pricing regulation, this level includes some

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[6] The experimentalists indicate what they have done, how long they have been using the machines, what kind of instruments, materials and samples they have used, etc.

characteristics of public management. Indeed, platforms are, at least partially, the result of a national budgetary policy that has also been applied to scientific institutions.[7] In that sense, platform implementation consists of making visible, transparent, and accountable the cost and financing of experimental activities: it attributes a monetary value to an experiment, systematizes its monitoring, and classifies it. Its aim is to re-assign and gather some costs that were formerly scattered across various budgets (grants or project-based funding to buy instruments, laboratory technicians' salaries, "recurring credits" that research centres use for daily expenditures and for the purchase of small instruments and samples, etc.).

In the present case study, these different levels of constraints (experimental work, laboratory organization, and public policy) are articulated together, and this articulation work should contribute to the definition of some acceptable accounting and pricing rules for all stakeholders. However, the merging process between both platforms does not only collide with some practical problems that could be solved by the articulation between these three levels. It also encounters the harmonization of accounting and pricing rules—some difficulties that depend on the articulation between the regulations of both platforms. That is why it is necessary to add a fourth level of analyzis to understand fully the difficulties of the merging process.

4.2. Articulating Different Ways of Valuing Science Funding

Contrary to Joan Fujimura's case study (1987), articulation work does not only occur, in the present case study, between the three levels mentioned by the author, but also entails an inter-organizational level. Taking into account this fourth level is necessary for at least two reasons. On the one hand, as the platform externalizes experimentation out of the laboratory (i.e. experimental activities are not any more realized inside the laboratory), the three levels that have been identified by Joan Fujimura are no longer nested one within the other; consequently, her model cannot be fully applied in the case of platforms. On the other hand, the merging process involves two platforms whose governance (access and functioning regulation, institutional status and relations, etc.) is quite different. Thus, platform stakeholders have to take into account these differences.

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[7] In particular, platforms policy follows the logics of accounting, transparency, and result evaluation that is inscribed in the *Loi Organique relative aux Lois de Finances* (LOLF), and the logic of pooling (*mutualisation*) of support functions that is contained in the *Révision Générale des Politiques Publiques* (RGPP) in order to focus the public organizations' missions toward their "core business."

However, as the case study shows, the harmonization of operational rules and procedures is problematic. In particular, accounting and pricing rules are controversial issues. Analyzing inter-organizational articulation work enables us to account for the nature of these controversies and to distinguish this issue from other problems that are due to the articulation between the three levels identified by Joan Fujimura. More precisely, taking into account this fourth level is necessary to account for the constraints (and, eventually, the opportunities) that are related to the differences of professional and institutional cultures between both platforms. In particular, the harmonization of accounting and pricing rules questions the way in which some of the engineering institute staff perceive their professional engagement. Indeed, the platform management recognizes the importance of the changes that are induced by the harmonization of accounting and pricing rules, but they consider these changes to be a mere operational translation of awareness and the "slow evolution of mentalities" (as a platform manager puts it) regarding the modes of financing in science. On the other hand, the opponents of an increased financial contribution by users consider that significant public financing is necessary: "We must receive a true State funding," because "cost must not be an obstacle to innovation," as a laboratory director stated during a turbulent meeting in which a platform manager presented the access and pricing rules that will be applied.

Finally, inter-organizational articulation work reveals the existence of alternative proposals regarding accounting and pricing modalities (complete or marginal cost, depending on users' institutional origin, etc.). More fundamentally, it shows the existence of divergent conceptions of research funding: Does science "have no cost," a "symbolic cost," or a "real cost" (following the categories that are used by a platform manager)? In other words, can scientific activity be valued (and evaluated) according to technocratic or managerial standards? Or, is it necessary to guarantee "a true State funding" (laboratory director) that does not consider getting a previous project grant to be a condition for experimenting with new technological solutions? By opening the cost and financing "black box," inter-organizational articulation work reveals the differences of professional and institutional cultures between both platforms users. It also shows that accounting and pricing practices are not the mere translation of management or policy priorities, they are also the object of many organizing activities that occupy some of the platform stakeholders (in particular, but not only, platform managers).

5. Some Conclusions

In this article, it has been shown that the merging process between the two platforms can be usefully analyzed in terms of "articulation work" (Fujimura, 1987) between various levels of work organization. In the present case study, articulation work does not only occur between the three levels mentioned by Joan Fujimura (experimentation, laboratory, and social world), but also implies an inter-organizational level. As many other studies of inter-organizational collaboration in science (Cummings & Kiesler, 2005),[8] it sheds light on some differences of professional and institutional cultures regarding, in this particular case, the different manner of valuing the accounting and pricing rules among some protagonists of the two platforms. However, from the case study, it is possible to identify three main reasons why focusing on the concept of articulation work was useful to go deeper in the understanding of how sociotechnical infrastructures can be shared effectively. First, using the concept of articulation work denaturalizes the logic of rationalization that justifies the merging process by: (1) considering seriously the protagonists' doubts and the uncertainties that they have to cope, and (2) highlighting the unintended consequences of the merging (and, sometimes, its negative effects). Instead of facilitating the management of experimental activities, the efforts to pool resources and to harmonize the operational rules induce an increased burden for the platform protagonists. Such an expansion of the necessary articulation work reveals some of the concrete difficulties that scientists currently experience when they deal with an injunction of rationalization of their work.

Second, using the concept of articulation avoids a binary and static vision of pooling. Rather than considering the pooling of instruments as exclusive options (merger or not), the merging process questions the degree of pooling, its concrete modalities and its evolution over time. Thus, a merger appears to be only one option among others: reciprocal opening via rules harmonization (without merger); partial pooling (only one or a few types of instruments, for instance, such as Raman spectrometry in the case study); or the sharing of scheduled slots between user groups (some hours per day, some days per week, or day and night shifts) are some of the many alternatives—ultimately compatible—options. Moreover, these options are likely to be adjusted over time, depending on the emergence of technological innovations or new institutional configurations. In that sense, the search for an appropriate degree of pooling is an obstacle course, an uncertain process that faces doubts, pitfalls, and resistances.

[8] In their study of 62 scientific collaborations supported by the US National Science Foundation, Cummings & Kiesler (2005) shows that multi-organizational collaborations are more problematic than multi-disciplinary ones.

Third, the concept of articulation work underlines the controversial nature of the merging process.[9] Indeed, from its beginning, the possibility and relevance of achieving the merging are not consensual. Whereas each protagonist has its own vision and projects different forms of desirable collaboration, the final objective is not clearly nor conclusively defined for all the protagonists: does it aim to result in a complete integration that leads to the creation of a single organizational unit? Does it aim toward the harmonization of access and operating rules in order to increase the range of technological options for users and to highlight the complementarities between the two platforms? Or, is it pure institutional communication in order to justify (discursively, at least) the reality of the "convergences" that are supposed to emerge from the creation of the new research and innovation campus where the two platforms are located? Focusing on articulation work avoids answering these questions a priori by analyzing the merging as a controversial process—i.e. accounting for the protagonists' arguments and debates without presuming the nature of their interests and intentions. It enables us to examine concretely some current debates concerning the evolution of regulation and control in the scientific profession and to question what is at stake in the confrontation of managerial and professional logics in public research (Bezes et al., 2011).

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[9] In that sense, inter-organizational articulation work is similar to what Bjørn & Christensen (2011) called "relation work, understood as the fundamental efforts of achieving the very basic human and non-human relations that are a prerequisite for multi-site work such as, for example, global interaction and coordination" (Bjørn & Christensen, 2011, p. 139). The main difference is that the former deals with *organizational* boundaries, whereas the latter focuses more specifically on *spatial* boundaries. I thank one of the reviewers for this bibliographical reference.

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