Science, Technology, & Human Values
37(6) 627-652

DOI: 10.1177/0162243911428623
http://sthv.sagepub.com
SAGE

The Sociotechnical Alliance of Argentine Quality Wine: How Mendoza's Viticulture Functions Between the Local and the Global

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Abstract

Constructivist research in Science and Technology Studies (STS) is committed to revealing the heterogeneity of technological change and the fluid boundaries between the elements involved. Its major theories, the Social Construction of Technology (SCOT) and Actor Network Theory (ANT), have however both been criticized for limiting themselves to the micro-level of cases, impeding a structural analysis of technological systems. This article seeks to bridge any such divides. We research the recent changes in the

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viticulture of Mendoza, Argentina, which underwent radical changes over the past decades: once governed by low-cost yield maximization, grape production now revolves around "quality." To show how the particular quality definition developed, we depart from a social-constructivist framework, following the sociotechnical shaping of problem-solution relationships across the wine production system. To include relevant social groups from different settings around the world, we gradually incorporate the ANT concepts of obligatory passage points, enrollment, convergence, delegation, and codes into the analysis. Combined into the concept of "sociotechnical alliance," our analysis follows the dual process of creating agreement while establishing heterogeneous practices across settings at different levels. It shows that functioning involves alliance building and highlights the hybridity and continuous dynamics of systems at large.

Keywords
expertise, markets economies, other, space place scale dynamics, academic disciplines and traditions, politics, power, governance

There has been much debate about the relative value of two major constructivist theories of technological change: the Social Construction of Technology (SCOT) and Actor Network Theory (ANT). Some suggest integrating them, but this has led no further than general frameworks (e.g. Bruun and Hukkinen 2003). This article proposes a concrete integration of specific elements from ANT into SCOT, through the concept of "sociotechnical alliance." It relates a technological system's functioning to problem solution relationships and shows why certain problem solutions were constructed rather than others. It also offers constructivist theory a more systemic connection between micro and macro dynamics.

Our case study follows how recent changes in the vineyards of Mendoza, Argentina's wine capital, relate to a turn toward quality in wine production in Argentina and globally. Grape production changed from low-cost yield maximization to intensive quality management. Most explanations see this development as a logical process, involving globalization, technology transfer, and fixed quality standards (e.g. Azpiazu and Basualdo 2003, Stein 2007). This article argues such developments are contingent. Yet where most constructivist research focuses on heterogeneity at the micro-level, we primarily question the construction of shared standards across heterogeneous dimensions.

After introducing the case of Argentine wine and our research problem, we start—in the tradition of SCOT—with an analysis of the social groups relevant to Mendoza's new quality vineyards. To accommodate for the wide range of groups involved from across the world, elements from ANT are gradually incorporated into the concept of sociotechnical alliance. It explains how relevant social groups and artifacts interact across levels to define new problem solution relationships. This leads to a specific definition of "quality," associated with specific technologies and practices by which Mendozine vineyards function. Our concept highlights both the convergence across levels and the continuous dynamics involved in the functioning of obdurate systems.

A Brief History of Argentine Wine

Argentina is the fifth wine producer in the world—after France, Italy, Spain, and the United States (Wine Institute 2010)—and has been since the mid-nineteenth century, when the country welcomed large waves of Italian and Spanish immigrants. While Mendoza formed the wine capital since the sixteenth century, now the government promoted a veritable industry there to supply the working masses of Buenos Aires. The last decades of the nineteenth century were geared toward copying French wines. As the railway and increased industrialization boosted trade throughout the first half of the twentieth century, the thirst for wine proved unquenchable. Mendoza increasingly focused on low-cost production, in part because wine formed a daily commodity back then. Perhaps more importantly, Argentina's protectionist politics prevented any competition—or comparisons—with other wines.[1]

As a result, by the mid-twentieth century high-yield grape varieties, typically of little flavor, planted in low-maintenance fashion, dominated Mendozine vineyards. Active government involvement contributed to expansion into inferior lands, consolidation into monster-size wineries, and aggravated price fluctuations (see Mateu 2006). By the sixties and seventies, even heritage vines were ripped out for more cost-effective table grapes. The tragedy here was that Argentina harbored some of the oldest stocks in the world, as the country had been spared the nineteenth century phylloxera crisis that decimated Europe's vineyards.[2] Toward the end of the seventies, overproduction, falling demand, failing quality, state-led price monopolization, and the military regime contributed to a structural destabilization of the sector. Its final collapse came in 1980, with a major speculation scandal: within a few

years 36 percent of all vineyards were eradicated; of the now coveted Malbec, only 10 percent survived[3] (Mateu 2006).

In the nineties and early naughts, Argentine wine production underwent radical changes, supplanting the focus on quantity with one on quality (Stein 2007). One factor was the sector's need for alternatives to declining national table wine consumption. Another was president Menem's liberalization politics, which allowed for wine exports and the import of foreign technologies, experts, and capital. Many wineries turned toward the growing international market for high-end wines, changing their production methods accordingly. This era, with its artificial currency stability and strong promotion of private business, proved foundational for technological change and foreign investments in wine (Azpiazu and Basualdo 2003). Cynically, it was the turbulent crisis in the following decade—unleashed by the questionable economic policies and corruption of the previous government—that hooked an international clientele and sealed Argentina's current wine status: the radical devaluation of the peso in 2002, so detrimental to most citizens, made export products highly competitive (Azpiazu and Basualdo 2003; Schamis 2002). Argentina is now recognized internationally for providing reliable quality wine at excellent value.

Research Problem: Change in Context

One way to explain the recent changes is that Argentina was incorporated into the rising global market for "new-world wine." The United States established a name for itself in the late seventies (Taber 2006), after which many countries previously unknown for wine production followed suit. A popular view couples this development with globalization, observing that the scientific and business-driven approach propelled by California and later Australia now dominates the wine market, including in Europe (e.g., Mondovino 2004). Also, the periods of crisis and restructuring and the switch from table to gourmet wine roughly seems to coincide between countries, suggesting global trends at work.

Yet careful comparison shows that developments in each wine region are unique. For example, neighboring Chile gained international ground a decade before Argentina, despite its shorter history and smaller industry. Also, the structure of the sector is different, with Chile dominated by a handful of wineries (Visser and de Langen 2006), while Argentina has a distributed power structure. Regarding technology, some claim Argentina passively adopted foreign technologies over local viticultural traditions (Richard-Jorba 2000;

Martin 2007). However, for a long-established industry even "incorporation" would demand innovative capacity. In reality, a broad range of vineyard technologies can be found in Argentina, among and within regions, and this diversity is only growing. Mendozine vineyards demonstrate a tremendous heterogeneity in planting, conduction, pruning, binding, and irrigation systems, including several unique artifacts, like the Malbec grape.

While we see global trends, at the same time there is constant heterogenization. To understand the changes that took place, we need to tread beyond generalized analyses and look into the ways in which global developments entered into Mendozine vineyard practices. This article follows the interactions relevant to the changes in Mendozine vineyard management, in order to show the sociotechnical construction of these practices.

Theory

This research takes the SCOT (Bijker, Hughes, and Pinch 1987; Bijker 1995) as the departure point for analysis. SCOT explains how technologies develop through interaction with relevant social groups: it is a process of mutual shaping. According to Bijker (1995), an artifact's function is not intrinsic to the characteristics of the device, but a contingency that is constructed socially, technologically, and culturally. The operation of a sociotechnical device should not be regarded as the explanans, but the explanandum: it is a continuous building process which unfolds from the very beginning of its conception and design. Thus, for our case we need to follow how quality is constructed.

Thomas, Fressoli, and Aguiar (2006) argue how "functioning" is the result of a process of sociotechnical construction that involves heterogeneous elements: material conditions, systems, skills, regulations, funding, provisions, and so on. It involves complex processes of adaptation of technological solutions to concrete and historically situated sociotechnical articulations. A symmetric analysis is needed of the "functioning" or "nonfunctioning" of artifacts. ANT (Callon 1986, 1998; Latour 1996) assumes such symmetry.

For our case, ANT offers several concepts that accommodate for the large number of groups and processes involved in the complex configuration of Argentine quality wine, and which cannot be easily grouped in terms of relevant social groups and their technological frames. It also provides better insight into the mechanisms of change (Bruun and Hukkinen 2003). Yet we also agree with these authors that ANT offers no causal explanatory framework. We therefore choose to weave several of its elements into social-constructivist theory, through the concept of sociotechnical alliances.

A constructivist case study departs from its representation by the actors, weaving its way back to the construction process of the (now) neatly defined categories, functioning artifacts and obdurate systems. Alliance building illuminates how this works systemically: creating a new frame for grape production in Mendoza involves the globe-spanning setting of wine production and consumption, and this requires not only processes of closure and stabilization (as in SCOT) but also constant enrollment and negotiation (as in ANT).

Method and Sampling

This research applied the "follow the actors" method common to SCOT and ANT. Literature research established an initial image of the quality turn in Argentine wine. I then identified and interviewed members of different relevant social groups in viticulture, following Bijker's (1995) definition: each group that shares a specific interpretation of viticulture.[4] These members were selected by their centrality in the network-image drawn of the change process, as well as their accessibility.[5] In-depth, semistructered interviews identified their view on what changed and the social groups, technologies, relationships, and processes they deemed relevant. The interviews provided references for further research and this snowball-cycle continued until most references proved redundant. The combined information was drawn into maps of relevant social groups and their technological frames, following SCOT. We then used several ANT concepts to draw in the relationships between all of them, as explained in the section on Relevant Social Groups and Technological Change and beyond.

In all 46 people were interviewed, representing all the relevant research departments within the National Institute for Agricultural Technology (INTA), the National Wine Institute (INV) and universities; the wine cooperation of Argentina (COVIAR); a broad selection of professional unions, associations, and chambers; a selection of agronomists, enologists, managers, marketers, and owners of quality wineries; and the specialized media. In addition, all relevant materials provided by these institutes and the INTA archives were studied.

Quality and Control in Argentine Vineyards

Modern Indicators for Quality

The professionals interviewed conjure the following explanation of the changes in Argentine wine. Quality has improved through increased process

control. This extends beyond the winery into the vineyard: when winemakers know how many sugars, acids, and phenolic compounds grapes contain, they can adjust their work to it. In "integrated wineries" control is taken one step further: wineries plan for specific wines and then manage backward down the chain toward the desired effect. For premium wines, this involves intricate vineyard techniques to realize the best grapes. But what determines "best"?

One aspect is uniformity. The more consistent the primary material, the more control over winemaking. This means preferred technologies promote homogeneity among plants and even ripening. Other quality aspects are the character and intensity of the grape aromas. Much attention is focused on phenolic compounds, which provide nuances in taste and smell. Winemakers want these substances to have maximum presence and ripeness, while also ensuring an equilibrium with the acids and sugars. This is crucial for deciding the moment of harvest: acids diminish as the fruit ripens, while phenolic compounds mature only after sugar levels reach their most desirable point and the grape starts losing moisture (eventually becoming a raisin or rotting). The balance point is influenced by the grape variety, the place and conditions of the vineyard, the winemaking methods, and/or other production materials.

As a result, even though taste remains subjective, there seems to be agreement on the elements that contribute to a wine's character. For viticulture these are primarily the grape variety, the fruit's uniformity, and the intensity of its juices.

Changes in the Vineyard

The first change seen in Mendozine vineyards over the past decades is varietal purification: ideally, each vineyard contains plants of one correctly identified variety. This relates to the aforementioned need for predictability. An important result of this focus has been the refinement of Malbec as an emblematic variety.

A second change is the interest in grape intensity. Vines are usurers and need to be restricted to reserve energy for fruit. Thus, viticulture always involves controlling the vine. It has however become more important now that quality is equated with a high concentration of flavor and aroma. Premium viticulture pursues grapes high in phenolic compounds, the carriers of the varietal characteristics, and a variety of methods are seen across Mendoza to induce concentration: reducing the fruit per plant, regulating water supplies to manage plant stress,

increasing plant competition, different pruning methods, and so on (see Goode 1995).

A third development is an increased interest in the ripening process at large, particularly yield uniformity, again to increase control during winemaking. Once the fruit is fully developed, the more sun and less (unexpected) water, the better. However, too much light, heat, or water stress harm the plant and its fruit. Several technologies help regulate sunlight, including the type of trellis, the planting direction, and pruning techniques (particularly de-leaving). Irrigation systems manage water supplies, sometimes to the drop. Harvesting is also relevant, and here too producers adhere to a variety of solutions: some insist on manual labor to protect grape quality, while others consider machines a pinnacle of modernization (Maclaine Pont and Thomas 2007).

From the combined interviews, we find that the interest in variety, intensity, and uniformity are interdependent. Many of the technologies mentioned are seen to strengthen each other and are therefore combined. In short, while a Malbec wine may be considered better because of that grape's qualities, vineyard conditions typically "bring out" these characteristics. All of these technologies are seen as part of a logical package. In the following sections, we investigate how such logic develops.

Relevant Social Groups and Technological Change

Most of the experts interviewed believe that technological packages of best practices are obvious: the improvements introduced over the past decades form a set of new methods and technologies needed to obtain better quality. I wish to question, however, the need to define quality in the particular way that it is defined now.

Bijker (1995) explains how artifacts have interpretative flexibility: as different relevant social groups interact with them, they negotiate their interpretation. Over time, interpretations close and as such, artifacts gain stable functions. Bijker uses the concept of technological frame to describe the interactions and relationships between relevant social groups and artifacts. The frame defines how things are interpreted, and includes key problems, theories, methods and procedures employed, strategies and requirements for finding solutions, and the traditions, beliefs, and informal practices that influence problem definitions and solutions.

To understand the changes in Argentine vineyards, we should explore the technological frame for quality wine production, asking why control

became an issue, and why it translates to a need for crop uniformity, grape intensification, and certain varieties.

Enologists and Phenolic Compounds

The key problem. Enologists are seen as crucial in formulating demands toward the vineyard. To them, quality is related to the visual, taste, and aroma characteristics that they consider intrinsic to particular types of wine (see Jackson and Lombard 1993). Wineries associate different users with different wine styles Thus, a key problem for enologists is to obtain the tastes and aromas for the type of wine associated with a certain user. Enologists interpret this largely as a matter of preserving the characteristics of a grape variety. This in turn is achieved through correct vinification techniques: those that enhance and/or do not destroy the particular grape characteristics.

To understand this definition, we need to understand the underlying science: the theory of phenolic compounds. "Phenolic compounds" are a group of chemical substances in plants that can provide for color, taste sensations, mouth feel, and so on. Tannins are a well-known example: found in grape skins and seeds, and therefore especially in red wine, they add astringency and bitterness (Robichaud and Noble 1990). Important to preserving phenolic compounds is that many are fragile or volatile: incorrect treatment may lead to their loss or destruction (Cheynier 2005).

Throughout the interviews current developments are depicted as a logical consequence from the increased attention to quality. For example, some say that there were always enologists interested in grape quality, they were simply not numerous enough to impose it on the industry. We, however, argue that these developments are not continuous: it is not that more people share the views of "quality enologists of old." New relevant social groups have been enrolled and their association implies a shift in the technological frame, now known as quality.

Quality discontinued. To understand the shift among enologists, we should take into account changes in their training. The Don Bosco school for enology in Mendoza gained academic status in 1965 through an alliance with Juan Augustin Maza university. Its first graduates entered the field around 1970. At the time, the school's shifting status had to do with the increased professionalization of the Argentine table wine industry, which was one of the largest in wine history: the enormous quantities processed required specialized experts (Stein 2007). Becoming an academic institution meant enologists were incorporated into the technological frames of other

scientists. For example, they encountered the methods, technologies, and practices of food chemists for defining taste and aroma characteristics. This led to new ways of working—think only of the laboratory setting.

The "academic shift" implies that the way in which enologists think and work now was not possible at a different time. For example, the reasoning behind their interest in primary material would have been different. We see this in Argentina and elsewhere. In his classic work, Winkler (1974) states that, "the most significant criteria of wine grape maturity are sugar, acidity, pH and Brix-acid ratio of the freshly pressed juice" (p. 577). His reasoning focuses on the timing of harvest. Modern enological theory, however, focuses on phenolic compounds, which are nurtured throughout a plant's life and influenced by many elements. Thus, interest shifted to the entire growth cycle. Factors, like soil, plant density, cover crops, support methods, sun exposure, (hydro) stress and so on, are all considered minutely as to how they influence the phenolic compounds. These delicate particles are subsequently protected and nurtured from the vineyard to the bottle (Downey, Dokoozlian, and Krstic 2006).

The knowledge guiding enologists has changed, changing their job, and vice versa. This led to a new type of enologist: the winemaker. Yet enologists cannot change their work alone. They partake in a complex dynamic with other social groups now relevant to winemaking. Also, the shift is not only one of reasoning but also of methods, practices, and technologies, which are defined in the cooperation among social groups. Knowledge is not created in a vacuum, and the way that knowledge is incorporated into daily practice depends on the network in which it takes place.

The Rise of the Professional Agronomist

The need for agronomists. That winemakers want to be involved in viticulture implies many things. To interact with grape producers they have to learn about viticulture, while those in charge of the vineyard need to comprehend enologists. To work together, they need a common language. Through their interactions, winemakers and grape producers construct a common set of practices and preferred technologies, which through closure and stabilization contribute to a new technological frame of "quality viticulture."

In the current configuration, agronomists link winemakers and vineyards. Their successful cooperation is in part explained by shared training. Agronomists at the Universidad de Cuyo (UNCU) are cotrained as authorized enologists, while at the Don Bosco faculty for enology, students

officially study "fruit farming with a specialization in winemaking." Traditionally this did not guarantee the two groups were interested: the courses were considered irrelevant and disregarded after university. However, later developments set such training in a new light, turning it into a facilitator for relationship building. Winery agronomists became a relevant social group in the marriage between grape production and enology, which lies at the heart of the technological frame for quality.

Creating a frame. The interaction between agronomists and enologists led to the foundation of practices, methods, theories, and so on, which in turn define how artifacts and technologies are interpreted. Winemakers took to entering the vineyard, observing and tasting grapes, predicting their potential for wine, and taking part in agronomical decisions. They needed to understand agricultural technicalities and vineyard artifacts to comprehend the grape producer's possibilities and problems. Agronomists are learning about wines and translate this to vineyard management. They see a need for understanding volatile compounds and look toward many qualities besides sugar content and how these might influence the wine. To do so, tasting both grapes and wines has become a central practice.

Agronomists and enologists have entered each other's territory, and this new alliance constructed specific working methods and artifacts in which both are able to find represented "their own" key problems. Thus, "quality grape production" is defined so that both groups may reconcile with it. In their common language, tasting sessions are an important point of exchange.

We see this at wineries but also in research and education. INTA performs integrated research on how vineyard technologies affect winemaking, while MAZA university founded a postgraduate in "Planning and management of quality from the vineyard to the wine." Another interesting point is that several key experts in Mendoza's development have received training in both fields and such dual training has increased in popularity.[6] Thus, the integration of vineyard and winery for quality wine was institutionalized in several respects.

The other consequence of this cooperation is that groups change through their interactions. Agronomists and winemakers are different from other enologists and grape producers, because they need shared knowledge, methods, skills, and quality definitions to work together. Put in other words, the SCOT analysis shows us how new theories, methods, and technologies are intrinsically connected to specific social groups and the way in which they cooperate.

Mechanisms of Power: the Need to Expand SCOT

In a social-constructivist interpretation, power is the capacity of (human) actors to transform to their own use the agency of others. These others may be humans or artifacts (Bijker 1995). Bijker specifies two ways in which power plays a role in shaping technology (ibid, p. 264). Semiotic power describes the diminishing of interpretative flexibility through closure and stabilization: how the meaning of artifacts is fixed. Micropolitical power refers to practices that transform and structure the actions of relevant social groups: how technological frames restrict and encourage developments. In neither case is it an object of possession. Rather, key to understanding technological change is understanding how power is assigned.

Yet many have argued that SCOT does not do well at explaining the mechanisms by which power is distributed (Bruun and Hukkinen 2003; Thomas 2008). Let us analyze first what SCOT does explain: how technological frames maintain themselves in their turbulent environments.

Technological frames establish boundaries between the inside and the outside through closure and stabilization. Bijker (1995) considers this a strategy for creating obduracy, which he differentiates from the strategy of flexibility. The latter is used on the inside of a frame, where a lively variety of interpretations allows those closely involved with an artifact to interact playfully to develop it further. In other words, Bijker argues that flexibility on the inside helps maintain the hardness of the technological frame as a whole over time.

This distinct treatment between inside and outside helps reveal strategies of micropolitics. However, it also creates two problems. First, there are no tools to analyze the processes simultaneously. Thus, we are forced to choose between a focus on differences or on similarities, in each case obscuring the dynamics that explain change. Second, current concepts fail to account for situations in which an increasing number of allies cause more permeable boundaries, while at the same time increasing the technological frame's functioning—as with modern quality wine in Argentina.

Bruun and Hukkinen (2003) argue that ANT offers valuable insights into the mechanisms of change, where SCOT offers a coherent explanatory framework for the causal relationships. We attempt here to create one coherent concept that describes change beyond the boundaries of a micro or macro perspective. In the following sections we elaborate on additional concepts from ANT that help to study the movement of sociotechnical practices between different relevant social groups but also across technological frames. Considering the strong explanatory value of SCOT, we

choose to integrate these ANT concepts into the social-constructivist framework with the concept of sociotechnical alliances. This will allow us to include many more social groups relevant to modern quality wine.

Customers and the Need for Control

The previous section showed how winemakers and agronomists were instrumental to the new technological frame of precision agriculture. However, it did not explain their technological preferences. For example, why is quality equated with increased plant control? The two groups do not operate in isolation. To understand the changes perceived, we need to include other groups. It is in the cooperation among all groups—each with different interests in "quality wine"—that a new frame is realized.

Winery managers, for example, have a central responsibility to keep business running at a profit. They set budgets and target users, thereby shaping criteria for the winemaker. Any changes in the management problem thus reflect in the winemaking. This leads us to relationships situated further away from the vineyard, including the buyers of wine: how do they figure into the production process?

Users, Delegates, and the Sales Force

A key problem for wineries is to sell their wine. A variety of professionals is involved in this objective, including owners, managers, investors, marketing, and sales people. This "sales force" regards end users as central to its problem in two ways: getting users to the wine (marketing) and getting wine to the user (sales).

Modern quality wineries break marketing down along the following lines: which market segments are profitable? What do consumers in that segment want—which characteristics at which price? How to provide this within acceptable profit margins? How to ensure user groups actually buy the wine? To answer such questions, the sales force makes simplifications that are represented in various ways throughout production. For example, consumer groups are defined and their descriptors go on to lead their own life. For one, they support estimates on who will buy what kind of wine at which price. Such estimates combine a heterogeneous mix of information, including different kinds of research from a variety of sources, but also experiences, beliefs, and categories imposed by other groups in the wine market.

In other work in science and technology studies (STS), a myriad of microprocesses has been revealed by which users/nonusers and technologies are co-constructed (see e.g., Oudshoorn and Pinch 2003). For our case of Mendozine grape production we seek to focus on the question how wine drinkers—from around the world—became relevant in the first place. We therefore started with the social groups that define grape quality and now trace our way back through the network of quality definition, to focus on how new groups and artifacts are enrolled and connect, finding end users to be connected to winemakers through intermediate users by several processes.

One work on user–producer interaction, by Pinch and Trocco (2002), specifically demonstrates the great agency of salespeople: moving between the developers and users of synthesizers, they not only connected these groups but shaped much of their relationship. Over the following sections we hope to flesh out concepts to address such agency at a theoretical level. We choose to stick here with the original ANT terms of obligatory passage points and delegates, hoping our elaboration of them conveys the power and mobility of the sales and trade groups involved here.

Delegation. One mechanism for achieving simplification in networks is described by ANT (see Callon 1986; Latour 1996) by delegation. Bijker and Law (1992, 294) provide the following interpretation: human and nonhuman delegates are used as a way "of ensuring that things will stay in one place once those who initiated them have gone away." Establishing a set of actions within one artifact or person simplifies things. A well-known example is the speed bump as a "sleeping policeman," while a policeman is a delegate of the law. All delegates need to be policed in some way to assure they perform as intended by the delegators. The creation of such control, Law and Bijker argue, has two aspects: (1) Distinguishing between inside and outside and defining a set of exchanges between the two. (2) For the "inside" to become an obligatory passage point for those on the "outside." The first point refers to the boundaries previously mentioned, and the second to the enrollment of new relevant social groups and artifacts into the alliance.

Obligatory passage points. Obligatory passage points are network nodes through which element/elements on one side need to pass to get to element/elements on the other side. Law and Callon (1992, 46) consider "the capacity of the project to impose itself as an obligatory point of passage" as a defining factor for the shape and fate of technological projects. However,

a disadvantage of their theory is that it never allocates responsibility in the network. Each actor is in itself a network, allowing for a constant zooming in and out, which disarms the analysis of explicative power.

Embedding the ANT concept of alliances into a social-constructivist framework allows for drawing causal relationships, while adding insight into the mechanisms of delegation and boundary work, which is necessary to explain power differences. Bijker (1995, 266) embraces the concept of obligatory passage point in the context of boundary objects to reveal that artifacts may have power when they are necessary for a technology to function. This is however limited to inside/outside relations: the obligatory passage point is a gatekeeper, promoting compliance to the inside, and thus obduracy. Yet obligatory passage points can play a larger role in our understanding of the construction of alliances and how obduracy and fluctuation go hand in hand.

Sales Representatives and the Need for Control

The supermarket as client. An important source of information on end users is the sales channel, where interaction with consumers takes place. Yet, only in boutique wineries do final clients engage directly, for example through visits, tours, or cellar-door sales.[7] For most wineries, the direct clients are wholesalers, distributors, exporters, and merchants of retail stores. What they buy is driven by their own evaluations of who wants to buy what at which price, considering their own business dynamic and profit margins. In this way, interim clients actively represent wine drinkers through the act of buying wine. Different buying practices involve different kinds of delegates. Cellar-door sales require labeled bottles in the cellar and some payment facility, but could also include tours, tastings, events, membership, direct marketing, and even restaurants, lodgings, or museums. For people to buy a wine at a supermarket, however, involves a complex alliance of sales and merchandizing.

Bocco et al. (2007) show a heterogeneous group of clients in their morphology of the Argentine wine market. For fine wines, these include super- and hypermarket chains, export companies who sell fractioned wines to the Northern hemisphere, international distribution and/or import firms, national distribution channels, and small businesses like stores, restaurants, and hotels. Supermarkets are by far the most dominant client: within Argentina, 81 percent of bottled wines over AR$ 3 is bought in supermarkets. For exported wines the situation is more complex. Nevertheless, in the

United Kingdom—the largest importer from Argentina—supermarkets account for 80 percent of retail wines, and one chain dominates that market.

Sales dynamics and trust. Typically, supermarkets aim at a high turnover, which they realize by attracting mass customer groups. They bind these through competitive pricing as well as the convenience of a wide variety of choice. In comparison to other stores, supermarket profits are derived from sale volumes rather than profit margins. Also, because of their large demand they can negotiate lower prices, which helps maintain competitive margins.

Important differences with the sales dynamic of boutique wine channels are the personal relationship between vendors and end users, and their mutual dependency. Users need information to make a decision. Above all, they want their expectations about a wine to be met. Storeowners depend on customers for their livelihood: if the latter feels misinformed, chances are that instead of switching wines, they will switch stores. Therefore, boutique owners ensure themselves of a close relationship to their wines: they taste them and know a lot about them. This installs trustworthiness back to the boutiques, explaining how they may provide more expensive wines.

This does not mean, however, that supermarkets do not sell expensive wines. It does mean that—as the alliance between users and producers is indirect—trust needs to be organized differently. Where in boutiques the personal relationship allows for a heterogeneous offering, supermarkets depend on standardization to realize trust.

Trust through standards: controlling the delegates. While high-quality wines operate in different sale channels, there are important similarities in the sales mechanisms. First, while wineries sell most fine wines to intermediary companies (Bocco et al. 2007), these companies themselves supply supermarkets, chain stores, and other businesses with similar sales dynamics. More importantly, large wholesalers and distribution companies share something with supermarkets: a complex type of agency involved in the buying and selling of wine. As opposed to cellar-door sales, many delegates are enrolled into the sociotechnical alliance, which all need to be controlled.

Sales representatives form a strong obligatory passage point for selling wine: they are the most important user delegate for the winery, and as such have become crucial to its sales process. This means that the way in which sales representatives measure wine quality has gained power toward the winery and in effect in its production process. According to the sales people interviewed, supermarkets are governed by three adagios concerning

product quality: information should be accurate, and customer loyalty and product turnaround should be high.

Supermarkets gain power through their central position. This power is enacted and enforced throughout the wine production process. Vineyard technologies are increasingly aimed at controlling the vine, as the adagio for many Argentine wineries chimes: predictability, consistency, and over-delivery. The first point refers to the demand that the content of the bottle be predictable. Second, the offering must remain consistent over time. Third, production cannot be too exclusive, because of the sheer size of the sales and distribution channel.

The most important consequence, however, is that the definition of quality needs to be transferable across different alliances, each with a different "logic." This drives quality indicators to become numerical, in the sense that they be measurable and thereby controllable by all. Callon's theory of Techno-Economic Networks (1998) accounts for this transfer process between social groups and artifacts, explaining how both may obtain power, and the power to act, in the process.

Transferring Quality, Making Allies

Enrollment and Convergence

Callon (1991) describes enrollment in the context of constructing "irreversibility." He calls this process convergence, which consists of two dimensions. First, alignment is the degree of success of a translation, that is, the extent to which actors complement or substitute each other. A strong alignment simplifies a complex network structure. Second, coordination describes the forming of translation regimes. Complex networks of translations can be simplified through codification, the organization of attributions, and the like. The scope of a regime may vary from specific to general, and its coordination may be weak or strong: in the latter case, the network is shaped by both local and general rules. Within such a "Techno-Economic Network," Callon sees different forms of cooperation functioning at the same time.

Convergence is a process of simplification, by which relationships are made more durable, as in the case of creating obduracy through closure and stabilization as explained by SCOT (Bijker 1995). However, Callon's concepts of alignment and coordination provide insight into the way in which this is obtained. To integrate Callon's concept into the social constructivist framework, we redefine alignment as the process by which interpretations by relevant social groups complement or substitute each other. This

addition helps to explain the forming of what we call sociotechnical alliances: they are irrespective of the status of a technological frame. From the concept of coordination we use the notion that ''codes''—whether language, numbers, money, or the like—help to organize relationships. In our interpretation, the relevant social groups that interact with these codes in the context of a specific technological frame do so as part of preestablished sociotechnical alliances—for example as with money.

Power and Action

Relevant social groups delegate meaning to artifacts. Through this delegation an artifact may obtain a powerful position in the alliance, depending on the extent to which the artifact forms an obligatory passage point. Artifacts in a central, obligatory position can enroll new allies. Certain interpretations are delegated to artifacts in a deliberate manner (e.g., through the design and engineering process), but other uses and interpretations are imposed in the encounters with other relevant social groups and artifacts and then act to alter the alliance. This becomes more important when artifacts are easily transferable, enrolling new allies across settings. Stability then turns into a power to set into motion on its own: the artifact gains power. This ability to enroll is a form of action: understood in this way, then, artifacts are able to act.

Through delegation, artifacts move and can obtain powerful positions. This power depends upon alliances with social actors, while at the same time the actions and (execution of) power by relevant social groups cannot be understood without taking into account artifacts. A strong obligatory passage point has more negotiation power. The power of sociotechnical alliances inside a technological frame is related to their level of coordination outside of it, and how this then affects the formation of the technological frame. Thus, in Argentine wineries the highly coordinated and centrally placed sales alliance has instilled a mantra that equates quality to predictability and consistency, which in the vineyard is translated to a need for measurability and control.

Making it Work: Consultants, Critics, and Courses

The explanation of power offered in the previous section addresses the dominance of certain quality interpretations in grape cultivation, but not why specific technologies are preferred over others or how these are put to use. According to most accounts, technologies were transferred from

abroad. But how does this work in practice? To explain this, we take a closer look at the roles of consultants.

Consultants as Obligatory Passage Points

Winemakers, managers, and agronomists mention many reasons for hiring consultants. First, they typically start off as owners/winemakers of internationally successful wineries. This experience is expanded by their subsequent work around the world. They are valued for the prestige all these wineries afford them but also for their hands-on knowledge. Furthermore, consultants have a good network: they offer valuable sales and distribution connections in new countries. Finally, foreign experts function as a link to Western users: for being "Western" themselves, for catering to this public, and for constantly traveling and keeping up with trends around the world.

Consultants have a high level of agency because they ally with many things: the different technologies available; the integrated art of modern quality winemaking; sales and distribution networks; prestigious wineries; hitherto unknown users. Also, they are individuals who act both as winemakers and managers. Consultants can thus communicate with different relevant social groups and as such bridge different interpretations of quality.

Because of the codes they share, consultants can obtain a strong position in the sociotechnical alliance of international quality wine. A winery can do without, but consultants offer a shortcut to participate in it. Their function as (almost) obligatory passage point helps explain the international organization of wine production: regardless of large geographical distances and low levels of direct producer-consumer interaction (Lundvall 1988) there is high mobility and innovation.

Critics and their Code

Critics also function in multiple roles. They create simplifications for users, as they gather information, test, select, and order. Trust is important to fulfill this role. Critics achieve it, for example, by demonstrating independence from wine makers and by maintaining an information advantage: they may taste hundreds of wines per month.

On the other hand, communication is crucial for interaction to take place. Historically wine expertise was demonstrated by literary skill: the more allegoric the review, the better. This was likely so because wine was clad in a mystique of unpredictable processes. McCoy's (2005) history of Robert Parker's rise to fame points toward an important element in his success:

shifting emphasis from vocabulary to numbers. For McCoy, the power of this move was in the system he chose: Parker employed the scale for school grading used throughout the United States. He thus achieved a way of communicating his opinions of wine in a way intuitively comprehensible to a huge audience. He also created a basis for claiming expertise: numbers serve experts to claim objectivity in the face of subjective matters (Porter 1995).

Critics function as delegates toward users, informing them in commonly understood codes through the media. The centrality of this relationship is illustrated by the current practice to publish high grades alongside wines, both in advertisements and in stores. Additionally, critics represent the user toward producers. Their rating process is taken to reflect what users want, especially when producers notice ratings lead to higher sales. Critics and their ratings help to bridge the large distance between producers and users. As the merchants and consultants mentioned previously, they derive power from their central position. This is precisely what antiglobalization critics rave against. Contrary to their depictions, user–producer interactions are not limited to passive acts of delegation: there is active agency involved. At the same time, we can imagine how the increased mobility of critics through numerical ratings could help enforce standardizations in winemaking, including of vineyard techniques.

Wine Courses as Delegates for Learning

Grades—and price—are not the only codes that function as quality indicators. Increasingly, labels feature technical details. How is it that users understand these terms? Users are not a passive, homogenous group but have variable degrees of expertise, shaping the way in which they judge and buy wines. Many actively seek information about winemaking, and an entire industry has emerged including books, magazines, courses, tastings, tours, conferences, holidays, and even home winemaking. Diverse media ally these social groups. In courses, for example, people are taught to form a personal opinion on taste, rather than what good wine should/should not be. At the same time, however, a technological frame for evaluating taste and wine quality is being established in those classrooms, closing and stabilizing specific interpretations across relevant social groups.

The different winery professionals interviewed notice this professionalization of users, which they claim affects winery practices. On one hand, managers need increased understanding of user groups and preferences, which change and diversify at a high rate. They then have to translate the

winery's possibilities to the market. On the other hand, managers need to understand about winemaking, to translate between sales and marketing objectives and winemaking decisions. Their "user-oriented language" is communicated to winemakers, who also need to understand user groups. Increasingly they are educated in marketing and consumer preferences, influencing their interpretation of winemaking. For example, where a traditional enologist saw his job as making the best possible wine according to his own taste, a modern winemaker seeks to please consumer types in the best possible way.

Combined with all the previous developments, including winemakers' influence on viticulture and the push on them toward more predictable and consistent wines, we see a development of wines planned from vine to bottle—and beyond.

Conclusions

After a period of crisis, Mendozine viticulture underwent radical changes and now successfully participates in a global system of quality wine. While a plethora of technologies and systems can be found in Mendoza's vineyards, most of them respond to a shared interest in varietal purification, grape intensity, and ripening. To show how the underlying logic of grape quality was constructed, we drew out a vast network of agronomists, enologists, winery management, sales, resellers, consultants, critics, and wine drinkers, but also polyphenols, varietal grapes, tasting sessions, supermarkets, numerical indicators and grades, and courses. This quality alliance incorporated different technological frames among its many relevant social groups and artifacts. It is hard to say where one frame starts and the other ends, yet different ones are continuously established and interactions take place between them in various ways. Through these interactions new problem solution relationships are formed, thereby defining the quality by which production functions.

We argued that SCOT requires additional concepts to account for this dynamic and to involve at once micro and macro levels in the sociotechnical shaping of problem solution relationships across a system. We therefore elaborated the ANT concepts of obligatory passage points, enrollment, convergence, delegates, and codes, weaving them together as sociotechnical alliance. This concept addresses internal differences explicitly, in order to understand the dual process of creating agreement while also allowing for heterogeneity. It does so by showing which elements of the technological frame have been formed in different contexts, thus bringing in different logics—without necessarily interfering with the frame under analysis. We

then illustrated for the case how a quality definition involving a preference for control established itself throughout an ever-expanding alliance, running from the vineyards of Mendoza to wine drinkers around the globe.

We should not leave unmentioned that our argument for more dynamic mechanisms stems in part from the heart of SCOT itself. A central concept in Bijker's (1995) understanding of the conditions under which technology functions, is interpretative flexibility. Bijker uses it to explain divergence, that is, how one artifact can have different uses or levels of success for different social groups. Each group interprets an artifact in relationship to their own mode of problem solution definition. However, SCOT never stresses that, precisely because of interpretative flexibility, groups with different problems are able to ally with the same artifact or with each other. Thus, interpretative flexibility allows for alliance formation. To explain this requires mechanisms that account not only for simplification through closure and stabilization but also for the continuous change and heterogeneity observed in functioning systems. Integrating ANT concepts allowed us to highlight this alliance-building dynamic of technological development.

A similar argument holds for obduracy. Obligatory passage points are crucial, but their power lies not only in a function as gatekeeper, as SCOT stresses but also as delegate: they serve to avoid more complex alternatives. The more a delegate represents, the more obligatory it becomes to make use of it—hence the more new allies. The term boundary object implies that the obligatory passage point regulates the uptake of new allies. Because SCOT shows meaning and function to be defined by the interactions between *all* the elements, this implies each new ally brings new negotiations, changing the original functioning.

Adding the aspect of delegation makes obligatory passage points two-sided: now they account for the simplification or stabilization of the alliance, as well as its heterogeneous makeup over time. Delegates offer new possibilities for interpretation, by which new alliances are enrolled: sales people, consultants, or quality indicators shift the boundaries of the quality configuration. The more a sociotechnical alliance functions over time, the more it is confronted with other artifacts and relevant social groups. Thus, closure and stabilization are only one part of obduracy: to last over time, constant adaptation is needed. In other words, functioning involves alliance building: boundaries are in constant flux, even though they may vary in strength over time. By adding ANT's mechanisms for change to the social constructivist framework we see that obduracy, rather than a state or condition, is a constant path of enrollment and negotiation *and* closure and stabilization.

For the case, adding this dimension to SCOT allows us to see the establishment of quality viticulture in Mendoza as a development involving at

once the micro and the macro, in which each new social group contributes a different dynamic to the quality configuration—whether situated in a Mendoza vineyard or a faraway tasting room. This explains the hybridization of local industry with globally functional quality standards, showing how these are constructed across heterogeneous dimensions.

We hope our conceptual integration contributes to the structural capacity of constructivist theories and offers a first step toward a more profound union. Bruun and Hukkinen (2003) argued for combining SCOT and ANT with evolutionary economics (e.g., Lundvall 1988). We also hope our elaboration allows for interweaving the rich body of work in STS that addresses the micro-level dimensions of agency (e.g., the previously cited Pinch and Trocco 2002; Oudshoorn and Pinch 2003). For only then can we speak of a comprehensive framework of the sociotechnical construction of function.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the financial support for the research, authorship, and/or publication of this article: This article was made possible in part through funding by the Argentine research agencies CONICET and ANPCYT and the UNQ.

Notes

1. Data compiled from interviews, Ruiz. (1999), Stein (2007), and Mateu (2006).
2. Also the remedy for combating phylloxera was to graft vines on so-called American rootstocks, which are of a different grape family. Argentina, on the other hand, still boasts vines on their original rootstock, though the practice of American rootstock is becoming more common, as part of a general technological package that some wineries like to adhere to.
3. Of the once more than 50,000 hectares of Malbec only 10,000 survived. Data from the National Wine Institute (INV).
4. As Bijker (1995) also clarifies this is an "actor category" defined by the actors themselves. Each group consists of those individuals that adhere to a certain interpretation, whereby each individual may participate in various groups (e.g., as in the case of someone with a multidisciplinary education).
5. We are very grateful for the help of Juan Carlos Pina, manager of Bodegas Argentinas, in establishing contact with many of the key figures to this story.

6. For example, Carlos Catania of the National Institute for Agricultural Technology (INTA) is one of the most widely recognized experts. He mastered in both agronomy and enology and has headed research "from the vine to the bottle" for decades.
7. According to experts, enological tourism in Mendoza is growing out to become a sector in its own right: several wineries house exclusive restaurants headed by top chefs and/or offer hotel facilities.

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