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# From Distillation to Standardization: A French Perspective on the Shaping of Turpentine Spirit (1909–1976)

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Turpentine is a complex substance of pine resin origin, widely used as a solvent in multiple industries. Attempts to define it, even when elaborated by scientists, have been marked by a whole range of extra-scientific market considerations. While the Pine Institute, a resin chemistry research centre in Bordeaux, succeeded in stabilizing the meaning of the word “turpentine” on the national level in France, its expertise was contested abroad. When the International Organization for Standardization (ISO) Committee 35 tried to establish a new international standard for turpentine, France was accused of protecting its industry by twisting scientific definitions for its own needs. The ISO members clashed over the relationship between trade standards and scientific definitions, at the same time highlighting the epistemological difficulties in constructing both categories.

## Introduction

What is turpentine? Most often it is identified as a paint solvent. Those with a background in industrial chemistry know that its applications are much wider and that turpentine has a variety of uses in chemical syntheses. Yet enumerating turpentine’s many applications does not tell us anything about its nature. Chemists may try to invoke its resin origin and its major constituent – terpenes – but we soon realize that turpentine is not composed only of terpenes and that not all terpenes have the same properties. What orders our knowledge are neat trade standards clearly defining the properties that turpentine should possess, thus freeing us from the burden of trying to find its true “substance.” The problem arises if a more curious inquirer, not satisfied with the empirical specifications he or she finds, attempts to go further and looks for a scientific definition of turpentine. Such a person would discover nothing but contradictions and imprecision, as the

understanding of the term “turpentine” has significantly changed over the last two centuries.

The twisted history of turpentine is not an isolated case. A wide range of commodities, such as oil, use ambiguous terminologies deeply rooted in the past. While the term “oil” was initially associated with olive oil (*oleum* in Latin),<sup>1</sup> it became all-embracing in the twentieth century, extending to a variety of substances of vegetal, animal, or mineral origin, based on their physical properties. The process of renegotiating the meaning of natural objects and of incorporating them into the scientific framework has been extensively studied by scholars of the history of science and of culture. The works of Pamela Smith on artisanal knowledge<sup>2</sup> or on the notion of metals,<sup>3</sup> as well as of Ursula Klein on the classification of materials before and after the Chemical Revolution<sup>4</sup> and on difficulties concerning the classification of botanical substances,<sup>5</sup> provide a larger framework for thinking about the evolution of the ways we understand commodities. In a similar spirit, Barbara Orland describes the “discovery” of milk by chemists at the end of the eighteenth century as the process of “reshaping a bodily substance into a chemical object.”<sup>6</sup>

At first glance, turpentine was reshaped in the same way; a poorly defined forest secretion became “dissected” and carefully analyzed by great chemists such as Jacob Berzelius, Louis Jacques Thénard, Jean-Baptiste Dumas, and Henri Sainte-Claire Deville.<sup>7</sup> From turpentine, August Kekulé isolated hydrocarbons that he named “terpenes” after their mother substance.<sup>8</sup> And yet, in spite of it having been studied by all these great minds, when in the 1950s the International Standardization Organization attempted to produce trade standards for turpentine spirit, scientists could not even agree on the most basic element of the definition: where does turpentine come from? How can we explain this, considering the amount of data accumulated since the beginning of the nineteenth century on this curious substance?

We can find some hints by studying the history of other complex botanical substances, such as rubber or resin. The complexity of the terminology at the boundary of botany and chemistry has been extensively studied by Jean Langenheim in her

<sup>1</sup> Maguelonne Toussaint-Samat, *A History of Food* (Oxford: John Wiley & Sons, 2009), 187.

<sup>2</sup> Pamela H. Smith, “Making as Knowing: Craft as Natural Philosophy,” in *Ways of Making and Knowing: The Material Culture of Empirical Knowledge*, ed. Pamela H. Smith, Amy Meyers, and Harold J. Cook (Ann Arbor, MI: University of Michigan Press, 2014).

<sup>3</sup> For example, Pamela H. Smith, “The Matter of Ideas in the Working of Metals in Early Modern Europe,” in *The Matter of Art: Materials, Practices, Cultural Logics, c. 1250–1750*, ed. Christy Anderson, Anne Dunlop, and Pamela H. Smith (Manchester: Manchester University Press, 2014).

<sup>4</sup> Ursula Klein and Wolfgang Lefèvre, *Materials in Eighteenth-Century Science: A Historical Ontology* (Cambridge, MA: MIT Press, 2007).

<sup>5</sup> Ursula Klein, “Contexts and Limits of Lavoisier’s Analytical Plant Chemistry: Plant Materials and their Classification,” *Ambix* 52 (2005): 107–57.

<sup>6</sup> Barbara Orland, “Enlightened Milk: Reshaping a Bodily Substance into a Chemical Object,” in *Materials and Expertise in Early Modern Europe. Between Market and Laboratory*, ed. Ursula Klein and E. C. Spary (Chicago, IL: University of Chicago Press, 2010), 163.

<sup>7</sup> Paul Dessort, “Du pin maritime et de ses produits” (Ph.D. dissertation, Ecole Supérieure de Pharmacie de Paris, 1869), 24.

<sup>8</sup> Rodney Creteau, “The Discovery of Terpenes,” in *Discoveries in Plant Biology: Vol. 1*, ed. Shain-dow Kung and Shang-Fa Yang (London: World Scientific Publishing, 1998), 321–43.

work on resins.<sup>9</sup> We know today that the frontiers of the concept of resin are far from rigid. For example, while older conceptualizations treated gums and latex as subtypes of resin,<sup>10</sup> today they are considered distinct materials.<sup>11</sup> Botanical categories that insisted on broad similarities between different secretions gave way to chemistry and molecular biology, which are interested in the composition of the material. But this trend is far from uniform. The father of resin chemistry, Alexander Tschirch, defined resins at the beginning of the previous century by their physical properties, explaining that they are “neither fat, neither oily nor elastic” but resistant when touched, “strongly internally coherent,” insoluble in water, and soluble in alcohols.<sup>12</sup> These criteria apply not only to vegetal resins but also to animal (shellac) and of course synthetic ones. In a broad sense, the definition of resins extending to these synthetic materials remains empirical and has not changed over the last one hundred years.

The same logic applies to rubber. What is rubber? Let us have a look at the contemporary trade standards. International Organization for Standardization (ISO) Standard 1382:2012 offers two major definitions. It is either a “family of polymeric materials which are flexible and elastic” or a “natural or synthetic elastic polymer (elastomer) which forms the basis of the compound used in many rubber products.” What was once a substance explicitly associated with the secretions of some South American trees<sup>13</sup> is now defined as a “kind” of material having specific physical properties, while its exact composition (chemistry) and origin (botany) are unimportant. To put it bluntly, rubber is what the industry considers to be rubber for practical uses.

Within this terminological evolution, national and international standardization organisms play a crucial role in ordering our knowledge and defining complex chemical objects. For Lawrence Busch, standards are “recipes for reality.” They can shape our perception of things around us.<sup>14</sup> The problem is that the standards are always a result of multifaceted historical processes deeply rooted in local contexts. Each attempt at standardization involves disregarding soft social and cultural factors in order to construct universal justifications.<sup>15</sup> To achieve this goal, standards rely on scientific expertise providing “objective” categories. And yet, as Lara Huber puts it, standards are “both prerequisites for scientific practice and outcomes of scientific expertise.” In other words, there is a two-way relationship

<sup>9</sup> Jean Langenheim, *Plant Resins: Chemistry, Evolution, Ecology and Ethnobotany* (Portland, OR: Timber Press, 2003).

<sup>10</sup> René Lombard, *Produits résineux, gemmes, colophanes & dérivés* (Paris: Dunod, 1946), 3.

<sup>11</sup> Langenheim, *Plant Resins*, 24.

<sup>12</sup> Alexander Tschirch, “Résines, Baumes, Caouthouc et Guttapercha,” *Bulletin de l'Institut du Pin* 28 (1926): 190.

<sup>13</sup> John Tully, *The Devil's Milk: A Social History of Rubber* (New York: NYU Press, 2011).

<sup>14</sup> Lawrence Busch, *Standards: Recipes for Reality* (Cambridge, MA: MIT Press, 2011).

<sup>15</sup> The question of universal justifications and of the authority of scientists and engineers was widely studied in the works on standardization of measurement. See in particular Graeme Gooday, *The Morals of Measurement: Accuracy, Irony, and Trust in Late Victorian Electrical Practice* (Cambridge: Cambridge University Press, 2004); Simon Schaffer, “Late Victorian Metrology and its Instrumentation: A Manufactory of Ohms,” in *The Science Studies Reader*, ed. Mario Biagioli (London: Routledge, 1999), 457–78.

between standards and science. This is problematic, since many scholars have observed that social shaping of standards is, by definition, a process where a whole range of interests comes into play, with science being just one of many factors.<sup>16</sup> As a consequence, the borders between scientific definitions, products of laboratory work, and trade standards, made in standardization committees, become blurred at best.

The goal of this paper is to address the relationship between scientific expertise and standardization of complex chemical substances. I argue that the process of renegotiating the definitions of commodities, and of incorporating them into the categories of modernity, did not end in the nineteenth century but remains an ongoing phenomenon. However, the task of shaping their understanding is no longer confined to curiosity-driven scientists but to standardization committees, whose motivations are explicitly contingent on industrial and economic factors. I argue at the same time that complex chemical substances such as turpentine are simply impossible to define without putting them into a broader framework, since they are themselves social artefacts, impregnated with cultural practices. My case study demonstrates that the question of chemical identity, origin, and practical applications all intervene in the process of standardization. Finally, the article is intended to fill a gap in the history of commodities that seems to have neglected turpentine.

The case study follows the French perspective on the history of the standardization of turpentine, a seemingly uncontroversial object, in order to show how local terminology became nationally “incontestable,” and how its objectivity was put into question when confronted with the international trade environment. I present two major acts in turpentine’s history. First, I show how turpentine laws emerged in France and the United States before World War II in two distinct industrial environments, and how the categories used in the two industries affected national legislation. In the second part, I analyze the conflict that arose between France and other countries inside the ISO committee 35 over the definition of turpentine spirit.

## Standardization of turpentine before World War II

### *Early developments*

We can find one of the first attempts to define turpentine in a scientific way in Diderot’s *Encyclopédie*, which explains that turpentine is a special type of resin coming from certain trees. It enumerates five types of turpentine (*térébenthine*). The most expensive ones are Chio<sup>17</sup> and Persian turpentines, which are secreted by *Pistacia terebinthus*, a species of *Pistacia* widely known as terebinth or turpentine tree. In antiquity, it was this tree that gave name to turpentine in the first place, and,

<sup>16</sup> Tineke Egyedi, *Shaping Standardization: A Study of Standards Processes and Standards Policies in the Field of Tele-matic Services* (Delft: Delft University Press, 1996).

<sup>17</sup> The name coming from the Greek island Chios.

according to eighteenth-century scholars, it remains the source of the highest quality turpentines. Other types of turpentine include Venice turpentine, secreted by a species of larches in the Apennines; Strasbourg turpentine, from the silver firs of Alsace; and, finally, common turpentine, of lowest quality, produced from pines.

Interestingly, in the largest French pine forest, in the departments of Landes near Bordeaux in Aquitaine, the vocabulary slightly differed. The term “*térébenthine*” did not apply to raw resin extracted from pine trees, but to a volatile liquid appearing in the pine resins in a heat treatment process. One of the ways to obtain *térébenthine* involved pouring raw resin into huge, shallow, open boxes and then placing them in the sun. Under the influence of solar heat, a clear division became noticeable between the solid part on the bottom, *galipot*, and the liquid “sun turpentine,” or *térébenthine de soleil*, on the surface.<sup>18</sup> This *térébenthine* quickly found its uses as a solvent in varnishes, paints, and sealing waxes. Its remarkable properties encouraged turpentine farmers and local artisans to discover new production processes, and the inhabitants of Landes quickly learned to heat pine resin in cauldrons to obtain syrup that was richer in “essence” than sun *térébenthine*. In 1709 the Bordeaux chamber of commerce defined the “*esprit de térébenthine*” as a result of distillation of pine gum resin in an alembic, and by 1749 one could buy in Aquitaine a set of tools necessary for the proper distillation of turpentine oil (*huile de térébenthine*).

While considered marginal by the authors of the *Encyclopédie*, the perception of pines as a turpentine source changed drastically in the nineteenth century. The constantly growing demand for resinous products, known in Anglo-Saxon countries under the term “naval stores” because of their traditional maritime uses, encouraged the use of lower-quality but cheaper resins. The vast pine forests in southern regions of the United States became a major source of turpentine for the entire world, with Germany and the United Kingdom being the largest consumers. France profited from this trend, and resin became an important source of wealth in Aquitaine. The surface area of the Landes forest covered by pines grew ninefold, from 100,000 ha at the end of the eighteenth century to 900,000 ha at the beginning of the twentieth century.<sup>19</sup> By this time, the United States and France became the most important resin producers in the world, outclassing all the competition in terms of production and scientific expertise.

The French forest, largely artificial, was more similar to a factory than to a monument of nature. It was crowded with forest workers, *résimiers*, and their workshops, where they produced two substances by distillation of resin: *essence de térébenthine*, a volatile liquid used as a solvent for paints and varnishes, and *colophane* (rosin), a solid substance of lesser value having a variety of applications. From the technical point of view, the whole fabrication process was relatively simple. The pines had

<sup>18</sup> Robert Aujan and François Thierry, *Histoire des produits résineux landais* (Arcachon: Société Historique et Archéologique d’Arcachon et du Pays de Buch, 1990), 14.

<sup>19</sup> Jean Guinaudeau, *La Forêt Landaise* (Bordeaux: Station de Recherches Forestières de Bordeaux, 1968), 3.

to be tapped regularly (the wound had to be renewed to stimulate resin secretion), and the resin was collected into small terracotta pots. Then it was filtered and cleared to become, according to the local terminology, *térébenthine*: a resin free from water and other impurities. Later, in various types of distillation, *térébenthine* was heated and the *essence de térébenthine* was extracted, leaving the rosin residue. Interestingly, while in French there was a clear differentiation between the meaning of the terms *térébenthine* and *essence de térébenthine*, in English the two terms, turpentine and turpentine spirits, were used almost interchangeably.

In 1899, the Laboratoire de chimie appliquée à l'industrie des résines was established in Bordeaux under the direction of Maurice Vèzes (1864–1935), professor of mineral chemistry at Bordeaux's Faculté des Sciences and a graduate of the prestigious Ecole Normale Supérieure in Paris.<sup>20</sup> Although the Laboratoire was housed in the Faculty buildings, it was financed by the resin industry and local communities who sought to improve the prices of resinous products and protect the local economy against the rise of petroleum derivatives. The laboratory's profile was unusual, but it fit other similar initiatives in Bordeaux in this period. Ulysses Gayon (1840–1929), the godfather and friend of M. Vèzes in the Academy of Letters and Sciences, was one of the leaders of the industrial orientation of the Faculty of Sciences of Bordeaux. In the 1880s he opened the Agronomic and Oenological Station of Bordeaux to provide scientific services to the wine industry and the School of Chemistry Applied to Industry and Agriculture.<sup>21</sup> Both institutions were mentioned by Vèzes as an inspiration for his own resin laboratory.<sup>22</sup>

The resin laboratory collected and studied a variety of resins from different pines. Thanks to its work, multiple new industrial applications were developed (e.g. synthetic camphor synthesis or road coatings emulsions). However, one of its most important contributions was a deepened analysis of the composition of *essence de térébenthine*. The laboratory's chemists succeeded in developing simple methods and procedures to differentiate turpentine spirits of different origins and to detect adulterants, which allowed for much more precise quality control.<sup>23</sup> The nature of frauds had evolved over the ages, but around 1900 the most common ones consisted of adding water or white spirit (low-quality, oil-based solvent) to *essence de térébenthine*, or distilling *térébenthine* in an improper way, such that the *essence* had too much resinic acid. Nonetheless, for countering frauds, establishing quality control was not sufficient. What was necessary was establishing thresholds that a proper *essence de térébenthine* should satisfy. In other words, what was needed was standardization.

<sup>20</sup> Maurice Vèzes, *Rapport du fonctionnement du Laboratoire de chimie appliquée à l'industrie des résines pendant l'année universitaire 1901–1902* (Bordeaux: Imprimerie G. Gounouilhou, 1903), 1.

<sup>21</sup> Harry Paul, *From Knowledge to Power: The Rise of the Science Empire in France, 1860–1939* (Cambridge: Cambridge University Press, 2003), 196.

<sup>22</sup> Vèzes, *Rapport du fonctionnement du Laboratoire de chimie*, 3.

<sup>23</sup> List of publications of Maurice Vèzes, *Bulletin de l'Institut du Pin*, 2 (1935): 32.

In 1909, during a Congress of Fraud Repression Service in Paris, Maurice Vèzes formulated the first rudimentary scientific definition of *essence de térébenthine* applicable to commerce. The definition insisted on the necessity of distilling resin with water or steam without overheating, and it proposed a few general parameters to identify adulteration with white spirit.<sup>24</sup> At the time, it was known that pine resins were made of poorly known resinic acids and of terpenes. The main terpenes in *essence de térébenthine* were  $\alpha$ - and  $\beta$ -pinenes in the case of the most popular pine species (maritime pines in Aquitaine, longleaf and slash pines in the USA). However, other terpenes, such as limonene or sesquiterpenes, were also identified, and the proportions of  $\alpha$ - and  $\beta$ -pinene varied significantly between different pines. What is crucial is that the distillation of pine resins never gave “pure” terpenes. A certain quantity of resinic acids and other impurities was always present in *essence de térébenthine*, depending on the quality of distillation and of the purification of the resin before the distillation. In this sense, every attempt to define *essence de térébenthine* involved establishing an arbitrary boundary between a properly distilled substance and an “impure” one.

Ironically, the definition from 1909 was quickly judged inapplicable by the laboratory scientists themselves. On the one hand, this definition ignored the fact that turpentine was still fabricated in many workshops “à cru” in primitive direct distillation apparatus (as a consequence, it was distilled in an uneven way); on the other hand, it proscribed the use of new distillation methods that did not involve steam or water.<sup>25</sup> The definition thus had to adapt to the requirements of local industries that were both the least and the most innovative.

While the definition proposed by Vèzes was not legally binding as such, the French Service of Fraud Repression was already asking Vèzes’s laboratory to detect frauds in resinous products in 1908.<sup>26</sup> In practice, this meant that the laboratory had the unique capacity to define what *essence de térébenthine* was in France. The laboratory’s chemists, strongly linked to the local industry, acquired the power to impose their own ideas about this product on the national level. The specialists at the laboratory in Bordeaux knew traditional practices from the local markets, and the main goal of the laboratory was to provide analytical services and support to local merchants and producers, thus following trade definitions predating scientific analysis. Although the local communities developed certain trade and business practices that could be legitimately sanctioned without contestation, problems appeared with the imported products of different origin.<sup>27</sup> What were they to do with solvents sold as *essence de térébenthine* but fabricated with methods that were not used in the region and from different pines (not to mention even from different coniferous

<sup>24</sup> “Rapport de la Commission désignée par la société des experts chimistes pour étudier la question de l’essence de térébenthine,” *Bulletin de l’Institut du Pin* 1 (1924), unpaginated.

<sup>25</sup> “Rapport de la Commission.”

<sup>26</sup> Roger Bentejac, *Historique de l’Institut du Pin et de ses activités dans le domaine de chimie* (1996), 2, Pine Institute Archives.

<sup>27</sup> Marcelle Barraud, “Défense de l’Essence de Térébenthine contre la Fraude et les succédanés étrangers,” *Bulletin de l’Institut du Pin* 7 (1930): 71–73.



trees)? One could, for example, obtain solvents similar in properties to *essence de térébenthine*, not by distilling resin extracted from trees but by distilling resins directly from the pine wood itself in a more complex industrial process involving high-pressure steam treatment of pine trunks. The French answer was to use the authority of science to prove that all these substances were simply different products and that, scientifically speaking, they were not *essence de térébenthine* at all.

### **French law on resinous products**

In 1924, during the French National Congress of Industrial Chemistry, Georges Dupont, the director of the newly established Pine Institute that had absorbed the laboratory of resin chemistry, proposed a new set of scientific definitions to describe resinous products in a much more precise way.<sup>28</sup> The Pine Institute, similarly to the resin laboratory, was almost entirely funded by local communities, turpentine farmers, and resin industrials investing in science in hope for immediate returns that would help them to confront economic difficulties. Its definitions were the result of many years of scientific research by resin laboratory chemists and of interactions with the most important resin-producing companies from the Landes forest.<sup>29</sup> Thanks to this shared expertise, Dupont's turpentine standards rapidly gained widespread approval in the region. However, they had to wait until 1931, the middle of the most severe crisis to affect the resin industry in Aquitaine, to become not only scientifically but also legally binding. On 30 December 1931, a new law on "the repression of frauds in the commerce of *essence de térébenthine* and resinous products"<sup>30</sup> was issued, followed in the next year by a decree and a ministerial circular defining precisely what was hiding behind the term "*essence de térébenthine*." Both regulations simply reproduced the results and definitions that had been elaborated by the Pine Institute throughout the 1920s. The law abolished

using the name *essence de térébenthine* and every other expression with the word *térébenthine*, as well as combinations, derivatives, or imitations of this word to designate any product not coming directly and exclusively from distillation, at a temperature below 180 degrees, of oleoresin juices obtained by tapping a variety of different living pines which are cultivated according to loyal and constant custom to produce *essence de térébenthine*.

The subsequent decree added:

*Essence de térébenthine* is a colourless liquid whose density is never less than 0.860 at the temperature of 15°C; it is made of terpenes; it begins boiling ... at a temperature above

<sup>28</sup> Georges Dupont, "Le pin maritime et les industries dérivées," *Bulletin de l'Institut du Pin* 1 (1924), unpaginated.

<sup>29</sup> The market for turpentine products was diversifying over this period. Turpentine spirit was still predominantly used as a solvent in the production of paints and varnishes, but new uses, such as camphor synthesis, fuels, perfumes, and even insecticides, became more and more important in the region.

<sup>30</sup> "Loi sur la répression des fraudes dans le commerce de l'Essence de térébenthine et des Produits résineux," *Bulletin de l'Institut du Pin* 35 (1932): 251.

152°C and during the distillation has to lose at least 90% of its weight before reaching the temperature of 170°C.<sup>31</sup>

We see here numerous interesting elements. The law on resinous products prescribed in practice the use of the term “turpentine” and any of its variants for products that did not contain *essence de térébenthine* as defined by the law. In other words, one could not sell, for example, merchandise called “turpentine oil” unless it satisfied the same criteria as *essence de térébenthine*. What is even more troubling is that the term “*essence de térébenthine*” was divorced from its etymological origin, as according to the law it should be distilled from oleoresin, not from *térébenthine*. As such, the term “*térébenthine*” became an empty shell, legally meaningless. An administrative circular published in 1932 allowed for an exceptional use of the term “*térébenthine*” in traditional contexts enumerated in the *Encyclopédie*; however, their market was very small.<sup>32</sup> This created an interesting paradox. The very word “turpentine” came from *Pistacia terebinthus*, the source of Chio turpentine. But in the 1930s, Chio turpentine ended up on the list of exceptional uses.

Another interesting aspect was that *essence de térébenthine* could be produced from trees that “according to loyal and constant custom” normally produced *essence de térébenthine*. This reasoning was obviously circular and had clearly protectionist aspirations. In France, only pine trees from the region of Bordeaux satisfied this criterion.

However, the most important measure adopted by the law concerned the terminology used to describe other substances that were similar to turpentine spirit but could not use the name *térébenthine*.<sup>33</sup> First was *essence de pin* (pine spirit), which, according to the law, was distilled either from pine wood (not resin!) or obtained from any process other than traditional pine resin distillation, for instance in paper mills. Its quality thresholds were also lower than for *essence de térébenthine*: its boiling point should be at 150°C, and at least eighty-five per cent of its weight should be distilled below 190°C. The second category was *essence de bois* (wood spirit), which could originate from any coniferous wood (no matter the extraction method) and should “give” eighty per cent of its weight between 80°C and 200°C.

We see here a double classification, that depended on both the origin of the substance and its properties. This means that even if a spirit obtained from pine wood satisfied the threshold fixed for the normal *essence de térébenthine*, it could not use this label. In other words, the names *essence de pin* and *essence de bois* hid a whole range of substances of different origins with very different properties. A French

<sup>31</sup> “Décret sur la répression des fraudes dans le commerce de l’Essence de térébenthine et des Produits résineux,” *Bulletin de l’Institut du Pin* 35 (1932): 253.

<sup>32</sup> “Circulaire sur la répression des fraudes dans le commerce de l’Essence de térébenthine et des Produits résineux,” *Bulletin de l’Institut du Pin* 35 (1932): 255.

<sup>33</sup> “Décret sur la répression des fraudes dans le commerce de l’Essence de térébenthine et des Produits résineux,” *Bulletin de l’Institut du Pin* 35 (1932): 254.

customer, when faced with a choice between *essence de térébenthine* and *essence de pin*, was inclined to choose the first one, since the law guaranteed its quality, but in theory the latter might have had exactly the same properties. This arrangement is not surprising once we realize that France produced *essence de térébenthine* almost exclusively. When a foreign high-quality product of wood origin was sold on the French market, it had to use the label that made it indistinguishable from low-quality products.

The entire regulation was based on the supposedly neutral scientific expertise of the Pine Institute, which was considered the largest resin research centre in Europe. However, on the other side of the Atlantic Ocean, chemists working for the naval stores industry built a nomenclature considerably different from the one elaborated by their French counterparts, and one that also recurred to science.

### ***Turpentine definitions in the United States***

In the United States the first standards for turpentine were issued in 1915 by the American Society for Testing Materials (ASTM).<sup>34</sup> They were later revised in 1924, 1926, and 1934. While ASTM standards were voluntary, a different compulsory regime was established by the Naval Stores Act of 1923, guaranteeing minimum quality thresholds and proper labels on products.<sup>35</sup> Both regimes were based on the work on turpentine done in the naval stores laboratory of the Bureau of Chemistry in the United States Department of Agriculture (USDA). The American standards made a distinction between four types of turpentine. The first category, gum spirits of turpentine, corresponded to the French *essence de térébenthine*. According to the Naval Stores Act, this substance came from the distillation of resins extracted from living pines. Whereas in France the most popular pine variety was maritime pine, in the United States longleaf pine and slash pine were the dominant species. Their resins gave a product with a very similar composition to the French *essence de térébenthine* and with almost exactly the same properties. Interestingly, gum spirits of turpentine is a traditional name to describe products of pine resin origin, contrary to those of wood origin. The word “gum” (in French “*gemme*”) is used in this context as a synonym for “resin.” However, the pine resins are not gums according to contemporary conceptualizations.<sup>36</sup> In this sense, the expression “gum spirits” is quite anachronistic today. It shows once more, though, how convoluted and complex the terminology became.

Three other types of turpentine described by Americans are significantly different from what we saw in France. The second type was “steam-distilled wood turpentine,” meaning “wood turpentine distilled with steam from resin within or extracted from the wood.”<sup>37</sup> This kind of turpentine used pine wood, especially old resinous

<sup>34</sup> Georges Brus and Pierre Legendre, *Rapport sur la normalisation de l'essence de térébenthine*, 20 May 1949, 10, Pine Institute Archives, box “Normalisation ISO,” folder “Norme France.”

<sup>35</sup> F. P. Veitch, “The Federal Naval Stores Act,” *Industrial and Engineering Chemistry* 16 (1924): 640–41.

<sup>36</sup> Langenheim, *Plant Resins*, 24.

<sup>37</sup> Veitch, “The Federal Naval Stores Act,” 640–41.

TABLE 1  
ASTM STANDARD D13–1934 ON TURPENTINE (EXTRACT)\*

	Gum spirits of turpentine	Wood turpentine		
		Steam-distilled	Sulphate	Destructively distilled
Density 15.5°C (Min – Max)	0.860–0.875	0.860–0.875	0.860–0.875	0.860–0.866
Refractive index at 20°C, D line	1.465–1.478	1.465–1.478	1.465–1.478	1.463–1.483
Boiling point (760.00 mm Hg)	150°C–160°C	150°C–160°C	150°C–160°C	150°C–157°C
Distilled below 170°C	90%	90%	90%	60%

\*A.S.T.M. *Specifications Standard de l'Essence de Térébenthine*, Pine Institute Archives, box “Normalisation ISO,” folder “Norme France.”

pine stumps, as a prime resource.<sup>38</sup> In France, the corresponding product was called *essence de pin* (pine spirit). The third category was “destructively distilled wood turpentine,” which meant turpentines obtained in wood carbonization and similar processes. In France, its properties would qualify it as *essence de bois* (wood spirit). The final category was “sulphate wood turpentine,” which was produced by the paper industry as a pulp production by-product. In France it also qualified as *essence de pin* because of its origin. Interestingly, the analysis of ASTM standards shows that properties of all these products were very close to each other (Table 1). Moreover, in the vast majority of practical applications, all these turpentines were interchangeable.

We see that the American approach was significantly different from the French one. The method of extraction was not without impact on the label, as wood turpentines could not be sold as gum spirits of turpentine, but in practice the requirements for both were identical. They were both “turpentines” having to satisfy the same constraints. Contrary to France, the United States produced all these types and was a major exporter. It had no protectionist aspirations but was interested in guaranteeing high quality on its own territory. On the other hand, the French *essences de bois* could be produced from other coniferous trees. In the US, pines were the only accepted source of turpentine.

Although at the beginning of the twentieth century France and the United States were the largest turpentine producers, controlling together about ninety per cent of the world’s markets, we should also look at the definitions of some of the largest consumers, namely Germany and the UK. In Germany regulation was somewhat similar to that in France, although it was much simpler. The basic distinction was between

<sup>38</sup> The obvious question is why the French remained so attached to their traditional productions. There are a few reasons. First, they used forest conservation methods involving constant reforestation. The Americans, on the contrary, exploited their natural forests using extremely destructive techniques and left behind vast wastelands covered with dead pine stumps. Resins accumulated inside them, and after a few years these stumps themselves became a source of “wood turpentine.” Another reason is that the French regulations, because of their extremely restrictive vocabulary, discouraged the use of new technologies, such as extracting turpentine from paper pulp. One could not enter the turpentine market without producing traditional gum spirits turpentine.

TABLE 2  
COMPARISON OF SOME PROPERTIES OF GUM SPIRITS OF TURPENTINE STANDARDS FROM 1949  
(EXTRACTS)

	France	United States	United Kingdom	Germany	
	Law (1931), Decree, Circular (1932)	Naval Stores Act (1923), ASTM D 13–34 (1934)	Type I B.S. 244 (1926)	Type II B.S. 290 (1929)  R.A.L. Blatt 848 (1927)	
Density	$d_4^{15}$ : 0.860 (min)	$d_{15.5}^{15.5}$ : 0.860–0.875	$d_{15.5}^{15.5}$ : 0.862–0.872	$d_{15.5}^{15.5}$ : 0.859–0.875	$d_4^{20}$ : 0.859–0.875
Boiling point	Minimum 152°C	150–160°C	Maximum 1% distilled below 150°C	Maximum 1% distilled below 150°C	152–155°C
Distilled below temp.	Minimum 90% below 170°C	Minimum 90% below 170°C	Minimum 95% below 170°C	Minimum 70% below 170°C; min. 90% below 180°C	Minimum 90% below 170°C

Source: Adapted from Pine Institute Archives, box “Normalisation ISO”. All the values are for the year 1949; they may have been revised multiple times after the first standardization attempt.

*Balsamterpentinöl*, corresponding to the French *essence de térébenthine*, and *Holzterpentinöl*, which can be translated as wood turpentine, similar to the French *essence de pin*, or *essence de bois*. Quality thresholds for gum spirits of turpentine were slightly higher than for the wood-based one in Germany. In the UK, there was a distinction between Type 1 turpentine and Type 2 turpentine. Type 1 corresponded to the French *essence de térébenthine* but was of very high quality (density between 0.862 and 0.872, and at least ninety-five per cent of the weight should distill before reaching 170°C). Type 2 included all the gum spirits of turpentine of lower quality, as well as wood turpentine regardless of quality (Table 2).<sup>39</sup>

The standards defined many other properties, such as evaporation or polymerization residue, but for the sake of clarity of the argument, we will not dwell on details. The key point is that all these nations abandoned the *Encyclopédie*'s vocabulary and opted for industrial definitions limiting turpentine to pine products satisfying very clear specifications. In spite of divergences, the values produced by different countries were relatively close. This is not surprising, though, since both Germany and the UK imported turpentine from the United States. And yet, with all the similarities between national standards, the task of international standardization became much harder than anyone would have expected.

## International standardization of turpentine (1950–1976)

### *ISO meeting in Zurich and the French project*

In the 1920s and 1930s the economic situation of the resin industry was far from satisfactory. A once thriving trade was struggling to survive. One way to stabilize

<sup>39</sup> Brus and Legendre, *Rapport sur la normalisation de l'essence de térébenthine*, 3.

prices was to secure market outlets abroad. The International Federation of the National Standardizing Associations (ISA) planned to standardize turpentine to facilitate international exchange as early as the 1930s. It asked the French standardization agency, AFNOR, to prepare a new international standard on turpentine in 1936.<sup>40</sup> ISA suspended its activities because of World War II, but AFNOR was aware of the act so that after the end of hostilities, the question of turpentine standardization would return. It invited Georges Brus, the director of the Pine Institute of Bordeaux and the dean of the local Faculty of Sciences, already known as one of the greatest specialists in the field of resin chemistry, to become involved in standardization work.<sup>41</sup> After the war, the successor of ISA, the ISO, renewed its interest in turpentine, and Brus voluntarily agreed to participate in the international negotiations. He prepared a proposal for an ISO standard, and his suggestions were entirely incorporated by AFNOR into the new French national standard T33-001, published in 1950. This updated the French definition of *essence de térébenthine* and provided detailed regulation of the analytical methods necessary to control its properties.<sup>42</sup> That same year, AFNOR, the French national representative of ISO, invited Brus to an ISO meeting in Zurich to present the new project to the representatives of other countries. The work was done inside the ISO Technical Committee 35, specializing in paints and varnishes.

The meeting in Zurich was very fruitful for the French delegation. The minutes from the meeting clearly indicate that Brus was considered a world expert in the field of resin chemistry by other international participants.<sup>43</sup> The committee worked using an exhaustive report comparing turpentine standards all over the world prepared by Brus and Pierre Legendre, also from the Pine Institute.<sup>44</sup> The French explained that “this report is limited to the gum spirit of turpentine, which is the only one that has a right to have the name ‘turpentine spirit’ (*essence de térébenthine*) in France.” Brus underlined that there cannot be confusion between genuine gum spirits of turpentine and wood spirits. Under his influence, the committee agreed that the gum spirit of turpentine should have a separate standard of its own, thus protecting it from abuses and other similar substances.

The French report recognized that some turpentines contain terpenes other than pinenes (e.g. limonene in *Pinus pinea*) and that some do not contain terpenes at all (*Pinus sabiniana Douglas* and *Pinus Jeffreyi*). These and other similar cases “are out of the scope of the definition of typical commercial spirits” according to the French delegates, and as a consequence cannot be regulated by the standard in question.<sup>45</sup> In other words, two independent definitions of turpentine were

<sup>40</sup> Brus and Legendre, *Rapport sur la normalisation de l'essence de térébenthine*, 3.

<sup>41</sup> Letter from Henri Rabaté to Georges Brus, 26 October 1944, Pine Institute Archives, box “Normalisation ISO,” folder “Normalisation Essence de Térébenthine correspondance.”

<sup>42</sup> Turpentine spirit standard proposition, Pine Institute Archives, box “Normalisation ISO,” folder “Norme France.”

<sup>43</sup> Draft Report of the Meetings of ISO/TC 35 held at Zurich, Switzerland on 26–29 June 1950, Pine Institute Archives, box “ISO,” folder “Zurich.”

<sup>44</sup> Brus and Legendre, *Rapport sur la normalisation de l'essence de térébenthine*.

<sup>45</sup> Brus and Legendre, *Rapport sur la normalisation de l'essence de térébenthine*, 5.

possible: one that was broader, based on scientific consensus, including substances containing chemical compounds other than terpenes, and the other one that was narrower, following trade and industrial requirements. No such distinction was made in the French national regulations. This also shows a continuous tension between what constitutes a proper scientific definition and what a mere trade standard.

One could presume that the French delegation to ISO, after having recognized the arbitrariness of the proposed categories in its own report, would have been willing to accept more flexible trade definitions of turpentine. On the contrary, only a few paragraphs later, the French report proposed to abolish the use of the term “*essence de térébenthine de bois*” (wood spirits of turpentine). It was judged incorrect because, according to the French experts, *essence de térébenthine* came only and exclusively from the distillation of pine resin, not wood. For the same reason, the French delegation affirmed that the English term “gum spirits of turpentine” and the German *Balsamterpentinöl* constituted a pleonasm (just as the French *essence de térébenthine de gemme* would).<sup>46</sup> Brus explained that turpentine was always of “gum” origin and that using a double qualification might suggest there were other kinds of turpentine. In the conclusions of the report, the French appealed to American authorities to give up ambiguous terms such as “steam-distilled wood turpentine,” “sulphate wood turpentine,” and “destructively distilled wood turpentine,” and to replace them with the French-inspired “steam-distilled pine spirit,” “sulphate pine spirit,” and “destructively distilled pine wood spirit,” respectively. The French delegation also criticized the British regulation for making a distinction between Type 1 and Type 2 turpentines as illogical and as simultaneously too restrictive and too permissive. It was too permissive because Type 2 also included wood spirits, and too restrictive because Type 1 characteristics were applicable only to the purest and best distilled gum turpentines (still relatively rare on the French market).

### ***The Hague meeting and the French defeat***

The scope and audacity of the propositions of the French delegation may seem surprising if we recall that it was the United States that controlled the majority of production of the naval stores in the world. Indeed, the report was not welcomed by everyone. During a subsequent meeting at The Hague in 1953, the ISO Technical Committee 35 decided to return to the question of turpentine in spite of French protests: “Mr. Dionisi (France) asked if it was necessary to rediscuss the resolutions of the first meeting. The chairman observed that many new members are present now and it was decided that the resolutions of the Zurich meeting shall not be considered final.”<sup>47</sup> Moreover, contrary to French objections, a new subcommittee was formed

<sup>46</sup> Document ISO/TC 35 (Franc – 2) 27, 10, Pine Institute Archives, box “ISO.”

<sup>47</sup> Report of the Meetings of ISO/TC 35 held at The Hague, Netherlands on 11–15 May 1953, Pine Institute Archives, box “ISO,” folder “Haye.”

to deal with standardization of wood turpentine. Even worse, many delegates suggested the possibility of merging two standards into one, dealing with all turpen-  
tines (of resin or wood origin). The possibility of establishing one common standard  
had already been conceived in 1951.<sup>48</sup> Georges Brus explained then to AFNOR that  
such a regulation would be unacceptable because it might “provoke confusion  
among customers” and “would require developing a new nomenclature for  
French products, similar to the one in the USA where the word ‘turpentine’ had  
much wider applications,” a solution that was completely unacceptable because it  
would undermine the “objective” scientific definitions of the Pine Institute.

The problem with two standards concerned more than just nomenclature. For  
example, the Netherlands and Belgium opted for lowering the required lower  
limit of density of gum spirits of turpentine from 0.860 (the value proposed by  
Brus) to 0.855 ( $d_4^{20}$ ).<sup>49</sup> Brus rejected these demands, claiming that density was a  
prime factor in differentiating *essence de térébenthine* from *essences de bois*  
(wood turpentine). The Netherlands replied that the turpentine they had imported  
from Indonesia had a density of 0.857, and Belgium noted that low density was  
common for products imported from the Soviet Union. France disagreed with  
Belgium and responded that the Soviet Union itself required a density of 0.860. It  
also accused the Netherlands of bad will, doubting whether gum spirits from Indo-  
nesia were truly obtained from the distillation of pine resin. The Netherlands quickly  
responded that their turpentine came from *Pinus merkusii* from Sumatra, the density  
of which was simply lower than that of European and American pines.<sup>50</sup> The Dutch  
explained that in many parts of the world, “authentic turpentine spirits” had den-  
sities between 0.855 and 0.856.<sup>51</sup>

We clearly see here one of the major limitations of the expertise of the French  
scientists. It was built upon samples coming from the pine forests close to Bordeaux;  
the Pine Institute was mostly unfamiliar with these more exotic turpen-  
tines, which were rarely sold on the European markets. On the other hand, the question arose  
as to what an “authentic turpentine spirit” was and how to define it. Some simply  
considered it impossible to establish any such universal standard for all types of tur-  
pentine. For example, the Austrian standardization organization Oesterreichischer  
Normenausschuss pushed to construct a separate set of standards for each geo-  
graphical region in order to differentiate, for example, turpentine of Bordeaux  
and turpentine of Austria, but in the end the proposal was rejected.<sup>52</sup>

In 1955 the French delegation, represented by Brus, lost one more time. France  
was the only country that opposed the fusion of two standards, one concerning

<sup>48</sup> Letter of Georges Brus to AFNOR, 30 June 1951, Pine Institute Archives, box “ISO,” folder “Zurich.”

<sup>49</sup> *Essence de térébenthine, Projet de Recommandation ISO n. 67*, Pine Institute Archives, box “ISO,” folder “Haye.”

<sup>50</sup> Letter of the Dutch normalization agency to AFNOR from 17 December 1953, Pine Institute Archives, box “ISO,” folder “Haye.”

<sup>51</sup> *Observations du Comité membre français sur les résultats de l'enquête à laquelle a été soumis le projet de recommandation ISO n. 67 : “essence de térébenthine,”* August 1956, Pine Institute Archives, box “ISO.”

<sup>52</sup> Lettre de l'Oesterreichischer Normenausschuss to AFNOR, 10 March 1953, Pine Institute Archives, box “ISO,” fichier “Haye 1953.”



*essence de térébenthine* and the other dealing with wood turpentine spirits. France tried to convince other committee members that “it is necessary ... to have as many standards as different chemical products recognized as such, independently of all business and economic considerations. ... Gum spirit of turpentine is a well-defined product and it is necessary to regulate it with one specific norm.”<sup>53</sup> As we can see, when the situation grew difficult for the French delegation, the former ambiguous distinction between “trade” and “scientific” definitions was quickly forgotten. The standards were not supposed to guarantee minimum quality of a commercial product, but to reflect scientific reality. The choice whether to create one or two standards was meant to be based on scientific considerations; and since scientific expertise (of the Pine Institute) had confirmed that *essence de térébenthine* was a separate product, it had to be regulated on its own.

Paradoxically, the Dutch delegates criticized the French position in a 1955 letter to AFNOR also by appealing to science:

The working group is rather disappointed that the Secretariat of ISO/TC 35 [administered by France] decided ... to adopt a position that does not take into account contemporary scientific achievements. Studies of the working group clearly prove that different types of turpentines form a unique entity. Their characteristics are identical for practical applications. ... The working group has the impression that AFNOR, instead of taking care of general interest, is prejudiced because France produces only gum spirits of turpentine ... The French definition [of turpentine spirit] comes from the times when other processes of extraction were not known ... when new processes are being developed, the language has to adapt.<sup>54</sup>

Finally, the Dutch representatives added:

The goal of ISO is to make things easier for chemists and trade agents. The new generation will not consider sufficient the historical fact that turpentine spirits had been once obtained from living pines, before other processes were invented, to justify publishing long specifications differing from one another only by a few numbers.

While the descriptive power of science was used by the French to justify a diversity of definitions, the Dutch appealed to the “converging,” “transformative” force of scientific thought. Both delegations enlisted scientific rhetoric to their needs. It would probably be too far-fetched to claim that both of these positions reflect in reality some deeper cultural conditioning – that in France a more descriptive, positivistic tradition of science made it a “stabilizing” factor of post-revolutionary order, while in the Netherlands science was more practical and engineering-oriented, thus reinforcing its “dynamic” aspect. It is, however, clear that these two narratives were used in practice by the arguing parties and that personal affiliation might have also

<sup>53</sup> *Observations du Comité Membre Français sur le projet de recommandation ISO n.364 “Essence de Térébenthine et Essences de térébenthine de bois,”* Document ISO/TC35 (Secrétariat-50) 82, Pine Institute Archives, box “ISO,” folder “Haye.”

<sup>54</sup> Letter of Dr Ing. W. Beissel from HCNN to AFNOR, sent in September 1955, Pine Institute Archives, box “ISO,” folder “Haye.”

played a role in constructing them. As a matter of fact, Brus, who represented France, was the head of faculty and a long-time scientist who contributed to numerous major discoveries concerning terpenes and pine resins, while his Dutch interlocutor, W. Biessel, was an engineer.

### *ISO standard 412 and after*

In the following years, the Pine Institute continued to criticize the countries that opposed the French definition: “The determination of some countries, not producing *essence de térébenthine* or producing *essence de bois*, to maintain ... the name turpentine for products that in reality try to replace it is a result of their own business interests tending to create confusion among customers.”<sup>55</sup> The French position was entirely rejected, but AFNOR did not leave the committee and collaborated on the preparation of a unique standard on turpentine, thus greatly contributing with its expertise to the development of many precise technical details concerning the testing methodology. However, due to the French obstruction and because of the general change in business trends, the work on the standard slowed down and ceased to excite interest among the French delegates (the role of the resin industry in the local economy had become negligible by the end of the 1960s). That is why even though the first French draft of the standard was ready as early as 1953, the final standard, ISO 412, was only adopted twenty-three years later, in 1976<sup>56</sup> (Table 3).

The final version regulated two types of turpentine, gum spirits of turpentine and wood turpentine, the latter being divided into three categories inspired by the American regulations (steam-distilled turpentine, destructively distilled turpentine, and sulphate turpentine). It also stipulated that the density of gum spirit of turpentine should not be lower than 0.855 (rejecting the French-proposed minimum of 0.860), thus making it indistinguishable from steam-distilled wood turpentine in this respect. As a consequence, the sole specification proper to gum turpentine spirit was one of the secondary properties, namely its polymerization residue that was slightly lower than for other turpentines. The only success of the French delegation was the possibility of conserving its traditional vocabulary in the French version of the standard, which meant that the term “*essence de térébenthine*” was clearly distinguished from “*essence de bois*” on the French market.

But this success was bitter. Already by 1968 Canada had revoked its own standards in this field because of a “lack of use,”<sup>57</sup> and many countries followed. More and more sophisticated fractionation methods allowed for obtaining not a mixture but precisely defined terpenes that could be consequently used in more

<sup>55</sup> *Observations du Comité Membre Français sur le projet de recommandation ISO n.364 “Essence de Térébenthine et Essences de térébenthine de bois,”* Document ISO/TC35 (Secrétariat-50) 82, Pine Institute Archives, box “ISO,” folder “Haye.”

<sup>56</sup> ISO Norm 412, “Gum spirit of turpentine and wood turpentines,” Pine Institute Archives, box “ISO.”

<sup>57</sup> “Änderungsvorschläge zur “International Norm ISO 412 ‘Gum spirit of turpentine and wood turpentines’,” an internal report of the German delegation DIN/geg/goh/002-5, 10 September 1980, Pine Institute Archives, box “ISO.”

TABLE 3  
ISO STANDARD 412 (EXTRACT)

	Gum spirits of turpentine	Wood turpentine		
		Steam distilled	Sulphate	Destructively distilled
Density $d_4^{20}$	0.855 to 0.870	0.855 to 0.870	0.860 to 0.870	0.850 to 0.865
Refractive index	1.465 to 1.478	1.465 to 1.478	1.465 to 1.478	1.463 to 1.483
Distilled below 152°C	0%	0%	0%	0%
Distilled below 170°C	Min. 90%	Min. 90%	Min. 90%	Min. 60%
Polymerization residue	Max. 12%	Max. 16%	Max. 16%	Max. 16%

demanding industries. In 1987 in Budapest it was proposed to revoke the relatively young standard 412, and in 1990 it was withdrawn by almost unanimous vote.

## Conclusions

The history of standardization of turpentine shows in the first place that the process of constructing the vocabulary to describe commodities is a phenomenon that is by no means limited to the transition period towards modernity in the eighteenth and nineteenth centuries. On the contrary, it continued throughout the twentieth century. After all, Diderot's *Encyclopédie*, the pinnacle of the Enlightenment, ordered our knowledge about turpentines in a comprehensive way. And yet its definitions were almost completely abandoned and the terminological borders profoundly reshaped, not only because of subsequent scientific research, but mostly because the industrial vocabulary, limited to cheap pine resins, supplanted the first "scientific" attempts to define turpentine. Both the Pine Institute of Bordeaux and the USDA Bureau of Chemistry worked in service of the industry that used the name turpentine in a much more restrictive way than had the authors of the *Encyclopédie*. However, in spite of this general rejection of traditional categories, the researchers in France and the United States in the 1920s and 1930s constructed definitions that were contradictory. They seemed to reflect first and foremost national trade interests, playing a role as protectionist measures instead of corresponding to neutral knowledge. The process of negotiations surrounding turpentine continued after World War II. Turpentine became an object of multiple vigorous discussions by experts from all over the world struggling to find a common ground until the publication of the ISO standard 412 on turpentine in 1976.

This paper has traced the evolution of the conflict and the major sources of difficulties during the negotiations. Most importantly, it has shown that the definition of complex substances, such as turpentine, is a process that is never fully completed. We continue to define turpentine as long as its definition is of use for industrial purposes, but with the evolution of the industry and the development of new technologies, these definitions can change or simply become redundant. That is what

happened in the 1980s and the 1990s, when turpentine standards were abolished because of lack of use. The contemporary definitions of the substance, based more on a past trade consensus than on actual scientific scholarship, are fragile at best. There is no one single proper meaning of turpentine today, scientific and trade definitions intermingling one with another.

However, the process can be reversed. As explained by Jean Langenheim, a scientific category of resins lost its pertinence by the end of 1940s when chemists slowly realized that tree secretions can radically differ from each other in terms of physical and chemical properties. And yet, Langenheim reconstructed this category as empirically useful by referring to “soft” sciences, such as ethnobotany.<sup>58</sup> Resins are inevitably linked with their economic and cultural context. In this sense, turpentine can still be a practical concept as long as we think about it inside the industrial environment throughout history. It is a category that does not belong entirely to the realms of science or of industry, but rather to the history of these two fields of human activity.

This brings us to another conclusion of this paper. Objects with stable meanings in given economic, cultural, or environmental contexts can be renegotiated when the context itself changes. Defining oil, resin, or turpentine always involves a certain degree of arbitrariness. Scientists simply cannot give full-fledged “objective” definitions of these kinds of complex substances, because their basic understanding is shaped by extra-scientific factors. That is why standardization organizations and similar institutions play a crucial role in dealing with these ambiguities, especially when a variety of languages is involved. Contemporary specialists in linguistics and standardization, such as Hans Teichmann, explain that “natural and uncontrolled evolution of technical terms can no longer be relied on to ensure unambiguity and efficiency in use of language.”<sup>59</sup> This means that the evolution of terminology should be directed through the activity of competent organizations, such as standardization committees, that have sufficient resources to gather different stakeholders and build a consensus.

When it comes to scientific standards, this perspective seems counterintuitive. Leaving aside philosophical debates, scientific definitions, in a traditional sense, are not supposed to constitute a consensus of different stakeholders but to reflect reality. As we have seen, that is how French scientists defended their own trade standards, claiming that *essence de térébenthine* and *essence de bois* are simply two different chemical products and that this is a sufficient reason to produce two independent regulations. But at the same time we clearly see that science did not have the final word in the negotiation process, at least not in a straightforward sense. The French specifications from 1931 did not radically differ from the ones in ISO standard 412 of 1976. The change was not brought about by scientific research that

<sup>58</sup> Langenheim, *Plant Resins*.

<sup>59</sup> Hans Teichmann, “International Standardization of Technical and Scientific Terminology,” *Homo Oeconomicus* 27 (2011): 527–41, on 531.

allowed for the molecularization of the industry (even though the molecularization might be to blame for the standard's disappearance in 1990). What evolved was the general perception of turpentine, as the American approach, privileging practical applications, became prevalent. It was the industrial and economic context that changed, in the same way as it had changed in the nineteenth century, when pine resins had been popularized, overriding the *Encyclopédie's* categories. The industry designed the nomenclatural "moulds" that were later filled with scientific knowledge. Today, the "mould-shaping" procedure is formalized with the standardization committees that constantly rework the vocabulary in use.<sup>60</sup> Scientists are but one of many groups of actors in the process.

I want to suggest one final conclusion of this paper. While on its own, this study inscribes itself into a larger reflection on the notion of historical ontology,<sup>61</sup> it also indicates that this kind of reflection is not purely speculative and confined to academia. It is a serious issue especially when negotiating international standards. We have seen that Americans are major producers of turpentines, supplying European markets for almost a century, and they have succeeded in enforcing not their standards as such but the underlying scientific thought on which the standards were constructed. France, being self-sufficient and intellectually autonomous, was not obliged to follow this logic. If the French had been the only turpentine producers, their differentiation between *essence de térébenthine* and *essence de bois* might have passed smoothly into the world of standards. But France did not succeed because its industry, although huge, became less and less significant on the global level after World War II.<sup>62</sup>

The way we build seemingly neutral standards may have tremendous economic consequences. In a good-will effort to ensure a consensus, stakeholders might be tempted to appeal to science as a common ground for standardization. The problem, of course, is that science itself is not always free of bias. Having in mind the research gap in some fields between different countries, certain actors may profit from their privileged position by rejecting competing scientific mindsets that may impact standardization. Only a careful historical analysis of scientific definitions will allow us to discern how science has supported both conflict and compromise in the setting of standards. In this sense, historians and philosophers are as important as scientific experts in the process of constructing standards for complex substances whose meaning is contingent on social factors.

<sup>60</sup> Similar questions were asked by Sheila Jasanoff in her studies on the notion of objectivity in regulatory science. In regulatory science, there are also political agendas that set the framework inside of which scientists have to operate, undermining their intellectual autonomy. See Sheila Jasanoff, "The Practices of Objectivity in Regulatory Science," in *Social Knowledge in the Making*, ed. Charles Camic, Neil Gross and Michèle Lamont (Chicago: University of Chicago Press, 2011), 307–35.

<sup>61</sup> Ian Hacking, *Historical Ontology* (Cambridge, MA: Harvard University Press, 2004).

<sup>62</sup> Roger Bentejac, *Historique de l'Institut du Pin et de ses activités dans le domaine de la chimie* (1996), 8, Pine Institute Archives.

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