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Standardising Through Concepts: Scientific Experts and the International Development of the HACCP Food Safety Standard

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Abstract

This paper deals with international standard-setting. Using the HACCP food safety standard as the basis of discussion, this paper considers the influence of scientific experts on the regulatory process. What is usually referred to as the diffusion or dissemination of soft or voluntary standards is here explained in terms of transferability of a regulatory concept. It is the ability of scientific experts to transform practices into a universal concept and, conversely, to develop technologies for users which translate the concept into practice, that explains why this reference has travelled so well across countries, industry sectors and historical periods. Scientific experts played a translating role between standard-setters and groups of practical users. This highlights the counter-intuitive distribution of power in standard-setting: while experts dominate the development of generic rules, official rule-makers (such as governments) assert their authority by developing alternative technologies for the appropriation of the standard by users and, sometimes, allow the latter to deviate from experts' universal concepts where these are shown to be problematic.

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Introduction

Voluntary standards, 'best practices', 'guidelines' or 'working principles', are mobile objects. Rules created by international standardising committees, inter-governmental bodies or networks of experts travel across time and borders. This situation is often referred to as a phenomenon of diffusion or dissemination. However, while a standard may indeed be of an international nature and disseminated beyond the point where it was established, the practices it contains generally come from a private and local setting. For a standard to be transported, these practices need to be made transferable to the same extent as the ideas that represent them. Thus, establishing an international standard inevitably involves turning local practices into transferable ones.

The literature has explained how procedural standards are transported from one place to another and how they are adapted to local contexts. But the process by which a standard is created and made transferable has been examined much less. This paper looks at the actors and mechanisms behind the simultaneous elaboration of universal concepts and their appropriation by users, in order to arrive at a better and more nuanced picture of the influence of experts in the establishment of international standards.

These issues are explored in the case of the Hazard Analysis Critical Control Point (hereafter HACCP) food safety standard. HACCP is a process control method. It contains seven principles – (1) hazard analysis, (2) critical control point identification, (3) establishment of critical limits, (4) monitoring procedures, (5) corrective actions, (6) record keeping, and (7) verification procedures. The application of these principles leads to the elaboration of a "HACCP plan" for monitoring and correction of potential incidents by companies along their production chain[2].

This case is interesting because HACCP has had a very long trajectory, starting as a local private experiment and ending as a general legal obligation in the European Union. HACCP was invented in the 1960s by Pillsbury[3] in order to provide 100% safe food to NASA astronauts. As early as 1972, the World Health Organization (WHO) claimed that HACCP was the best method of ensuring food hygiene. At about the same time, the US Food and Drug Administration (FDA) recommended its application to the food canning industry. In 1985, the Codex Alimentarius[4] (Codex), began work on guidelines for the application of HACCP. These guidelines became an international standard in 1994 with the enforcement of the SPS agreement (the sanitary section of the World Trade Agreement[5]), not long after the

[2] See Appendix 1 (page 19) for an example of an HAACP plan for canned mushrooms.
[3] Pillsbury is a Minneapolis-based food company, originally specialising in the production of flour and other baking products. The company expanded through merger and acquisitions after the second world war towards the processing and marketing of a larger range of packaged foods.
[4] The Codex Alimentarius is a joint body of the World Health Organisation and the Food and Agriculture Organisation of the United Nations, with competence for the setting of international food standards. It has been recognised as the body of reference in the framework of the World Trade Organisation agreement.
[5] For a state to block the import of a food product into its own territory, justification has to be made that HACCP guidelines were not adhered to or were not sufficient to ensure food safety.

European Commission integrated the standard in several Directives[6]. The European Union Directive 2003/53/EC eventually made it legally-binding for all operators within the food chain to put in place a quality and safety assurance plan according to the HACCP method.

This paper looks into how this procedural standard has managed to travel across segments of a highly differentiated food industry, across time and countries, while retaining its character as a universal standard for food quality control. Who are the actors who effected the transformation of a private practice into a generic form and facilitated its transfer? How did various professional, international and intergovernmental bodies agree on it, and how did the concept become a standard?

This case is one in which scientific experts have exercised a particularly deep influence over the setting of a standard by highlighting the properties of what could be called a regulatory concept: a pattern of practice grounded in experiment and observation but presented under a generic or standard form. The influence of scientific experts derives from their ability to connect users and rule-makers through such concepts, which work like boundary-objects between the world of ideas and the worlds of practice. In the separation between rule-making and enforcement that characterises standard-setting (Kerwer 2005), authority accrues to experts because of their capacity to connect users and rule-makers. Their influence is also bounded by their failure in doing so, as illustrated later in this paper.

To explore these issues, this paper proceeds in three steps. Firstly, the literature on international standard-setting is discussed, with particular attention to the notion of diffusion and limitations therein. In the second part, I describe the development of HACCP. The concluding step discusses the action of a group of scientific experts to explain their ability to channel standard-setting efforts into the development of a shared concept. I also demonstrate that their conceptual advocacy tactics have not given them influence over all sectors of the food industry or all rule-makers.

From the diffusion of standards to their elaboration

International standards as products of interdependence

The proliferation and diffusion of standards across countries has been analysed with various theoretical lenses. One strand of analysis has looked at the political economy of standard-setting. It considers that the relative power to establish standard-setting committees or the competition between consortiums of actors to be a determinant of the effectiveness of standards. In this approach, standards are clearly needed, given the externalities caused by growing transnational interdependencies. Standard-setting processes are representative of institutional arrangements and a distribution of power. Those actors that provide a solution to coordination and connectivity issues are those who are dominant. It is the hegemony of certain organisations or states over others which allows them to

[6] Directive 93/43/CE on food hygiene, Directive 91/493 on fishery products, Directive 92/5 and 92/46 on meat products and dairy products. At the time these were passed, most of the Member-states had placed onto food operators obligations relating to self-control of food quality and safety, such as the United-Kingdom's 1990 Food Safety Act or France's 26 September 1980 decree.

impose their own standards or to make these standards attractive as a form of compromise between them and their opponents (Mattli 2001, Abbott and Snidal 2001, Lazer 2001). Another approach, which may be described as functionalist, has focused on the conditions in which parties with different interests succeed in establishing consensual rules. It points at the fact that standards are established through a consensus-minded and expertise-based deliberation, in which every participant seeks to preserve its credibility as a party to the negotiation and feels accountable for the outcome of the negotiations (Egan 2001). Other analysts have developed an institutionalist perspective on standardisation which considers standards as a distinct form of regulation (as opposed to directives and norms) and standard-setters as actors who circumvent the authority of states and regulate by their own means (Brunsson and Jacobsson 2000). Lastly, the idealist strand of international relations has led to the development of more constructivist or cognitive accounts of the dissemination of standards and norms. The factors behind these phenomena are the entrepreneurial attitude of non-state actors such as NGOs or individual experts and their ability to spread information and ideas in such a way that they eventually influence the preferences of actors, particularly those with decision-making powers (Finnemore 1993, Finnemore and Sikkink 1998, Lazer 2001).

Standards as regulatory concepts

Interestingly, these different accounts have a lot in common: they are fundamentally concerned with the fact that rules can travel. The bottom line is that an organisation with a regulatory function, even a sovereign state, might borrow a rule formulated by another organisation to regulate issues it faces in its own territory or space of intervention. By making this argument, however, these analyses assume that the content of the standard is stable. The source of the standard and the way it is diffused supposedly matters more than what is diffused (Dratwa 2004).

This paper considers that an opposite assumption can be made: the object that is being diffused is not independent of the process of diffusion (Djelic 1998, Fourcade 2006). It undergoes certain transformations to become universal and transferable. Focussing on the ongoing development of these objects forces us to take on board another idea, which is that standards are interpreted rather than just adopted. Users have the power to unpack the logics provided by standards so as to enhance endogenous development of practices and systems, in a way that is compatible with their interests and existing practices (Bénézech 1996, Segrestin 1997, Brunsson 2000)[7]. They also add new meanings and practices to the concept as they show the conformity of their systems, exchange with other users, seek certification or participate in benchmarking exercises.

In this regard, standardisation is a series of primary and secondary elaborations that take place in various sites, in which the relating of local practices to concepts must always be undertaken. The puzzle is how these multiple acts are channelled together; how a common concept emerges out of dispersed acts and remains intact

[7] See Segrestin on ISO management standards (Segrestin, 1997), Westphal et al. on total quality management practices (Westphal, Gulati and Shortell, 1997) and Seidl (2007) on general strategy concepts.

as it is appropriated in different ways by various rule-makers and users. The hypothesis which this paper examines is that experts have the capacity, afforded through authoritative knowledge and multi-positionality, to act as translators between users and rule-makers. They create a correspondence between local practices and general principles, by developing a regulatory concept that is a form of boundary-object (Star and Griesemer, 1989): an object that helps communication between the intentions of standard-setters and different segments of users, and makes it possible for the latter to translate principles into their own practice.

From Pillsbury to the EU food law: the story of HACCP

The trajectory followed by HACCP is quite remarkable. It has a very distinct origin – the invention of the practice by Pillsbury – and one endpoint – the adoption of guidelines for the application of HACCP by the Codex Alimentarius, and their incorporation into EU legislation. The HACCP formula circulated along different paths to get from one point to the other, being portrayed as "the best tool for the management of food safety". In this section, I explore the origins of HACCP. The objective here is to achieve a better understanding of why HACCP has consistently been seen as the most successful and unique approach to food hygiene over a period of forty years.

The origin of the concept

HACCP originated from the need of the Pillsbury food company to create a system of quality assurance adapted to the risk of microbiological contamination of the food of astronauts. NASA was concerned that existing monitoring methods were imperfect. Food safety was at the time based on end-of-chain testing, and only the multiplication of these tests could increase the level of certainty that products were safe. However the probability that viruses, bacteria or toxins contaminate the product could only be calculated ex-post and was seldom reduced to zero.

Paul Lachance, a scientist in charge of flight food and nutrition at NASA, wanted to apply the same sort of systems approach that was used in engineering. NASA approached Pillsbury, who assigned the task to Howard Bauman - a microbiologist who had previous experience preparing food for submarines. He thus developed a concept, inspired from existing quality assurance methods, to apply in-line control methods to the production of food. This exercise gave birth to the HACCP concept, which immediately served as a standard of practice in Pillsbury and was quickly disseminated to the wider industry through Bauman's publications and conference talks.

The concept served as a point of reference for the development of internal practices, and became a diffusible standard, probably because the context of its development was that of a command by a public agency. HAACP contained a series of abstract directions (called "principles" in the vernacular language) that form a seemingly coherent logic to be applied in the establishment of practices and monitoring systems elsewhere. Much like other management standards, HACCP is a procedural

approach. It does not impose a pre-defined system but helps users to construct their own.

Very quickly after the inception of the practice in Pillsbury, the concept was advertised to food regulators, notably the Food and Drug Administration (FDA) and other bodies establishing microbiological criteria. The value of the concept was immediately recognised by the FDA[8], which asked Bauman to train food operators in the method and recommended its use in the canning industry. Shortly thereafter, The World Health Organisation (WHO) branded it as the best approach to food hygiene.

Working towards the adoption of an international standard

In the 1980s, three different organisations had followed suit and published recommendations or explanatory texts concerning HACCP. Each of these organisations sought to better define the key principles of HACCP, and to clarify the methods of hazard classification and detail ways in which the principles could be applied to the production of various foodstuffs.

The first of these organisations was the International Commission for the Microbiological Safety of Food (ICMSF), a small professional group of about twenty co-opted internationally renowned food microbiologists. This self-described "action-oriented" group began studying HACCP principles in the early 1970s, following a request by the WHO and the initiative of Howard Bauman, himself a member of the group. The result of that work was a seminal book published in 1988 (ICMSF 1988).

The second organisation to publish a text on the subject was the International Life Science Institute (ILSI), a foundation dedicated to food safety and nutritional issues and funded by a number of food multinational corporations. ILSI utilised the expertise of those who had been involved with setting up HACCP plans in companies that were part of ILSI.

The National Advisory Committee on Microbiological Criteria for Foods (NACMCF), a committee of the US National Academy of Science, was third to elaborate on the standard. NACMCF brought together microbiologists, food hygienists and food inspectors in the production of its own recommendations in 1989. The NACMCF work represents an attempt by US regulators to spread their own version of a HACCP standard, and to create more uniformity at the international level, as HACCP started to spread around industrialised countries and to be used without harmonised guidelines upon which companies could rely (NACMSF 1991).

These texts were in their turn synthesis of other contributions. NACMCF recommendations used the experience of Pillsbury, the National Marine Fisheries Service, the National Food Processors Association, the FDA and the National Academy of Science as well as the book by the ICMSF (NACMSF 1991). The

[8] The US regulatory agency for food and pharmaceuticals.

ICMSF book built on the first publications by Bauman. The work of ILSI drew on the experience of several food companies, such as Nestlé.

The eve of the 1990s thus appears to be a turning point, as three sets of recommendations were submitted and considered jointly by Codex in 1992. The Codex guidelines clearly reflect the input of the organisations, for example, through the inclusion of a decision tree for the determination of critical control points that was first established internally by members of the food quality unit of Nestlé and taken up in the ILSI document. The Codex guidelines also incorporated input from learned societies, national scientific academies and private foundations.

The convergence of several texts in a given arena is due to the close connections existing between the different contexts in which the concept was considered. Independent of the Codex guideline development, " an effective coordination effort [between] the regular food safety programs of WHO, FAO, the EU, ICMSF, ILSI, other groups, and [NACMCF]" means that "national and international approaches to HACCP are decidedly similar." (Garrett et al. 1998)

Adjustments to the HACCP formula and the limits of its diffusion

HACCP substantially prescribes food hygiene. It substitutes a self-regulation tool to a more classic type of control of the compliance with food hygiene criteria (which includes direction on the size of the building, height of the ceiling, cleaning instruments, contamination thresholds etc) by inspectors. It modifies the role of the latter from the control of compliance to providing assistance and checking the conformity of internal HACCP-based self-control systems. Accreditation and certification bodies emerge as a new actor in that configuration, with the obligation to audit and approve HACCP systems.

However, this ideal configuration (for which specialists of HACCP pleaded) remained difficult to apply. The use of HACCP principles has rapidly been shown to be easiest for larger companies with in-line production processes and that are able to master formal systems, have an awareness and control of the company's internal production parameters (organisational structures, personnel competences, good hygiene practices[9]) and have a strategic desire to change the relationship with food inspectors.

These conditions are not always met. It remains complex for operators to appropriate the highly abstract principles of HACCP. HACCP was invented on an in-line production chain that was suited to proceduralisation. Operators that do not follow a linear production process find it more difficult to use the philosophy of HACCP to organise their own control systems. Hospitality and retail businesses can hardly grasp the meaning of what is a critical control point and have little capacity to establish their own criteria for intervention. Although guidance is created to help them in doing so, such as the aforementioned decision tree in the Codex guidelines,

[9] A HACCP plan in a company where good hygiene practices are effective would only comprise ten critical control points, whereas in another context up to a hundred critical control points may be required.

small users have difficulty working the guidelines or can get lost among the many versions that the Codex published.

However, smaller users have recourse to other sources of expertise and information in order to understand the principles better (e.g. external consultants and auditors, internet discussion groups). Consulting companies multiplied in the 1990s to provide the missing expertise – something which academic specialists (who themselves have often acted as consultants to larger businesses) tend to denounce. The ability of consultants and certifiers to help small companies apply HACCP principles has also been questioned. There has been a multiplicity of attempts to reform the training of inspectors, but the new type of relationship inspectors are meant to establish with operators (one of advice and guidance in the establishment of HACCP plans) have been hard to implement locally.

EU governments took these limitations into account when they amended the European Commission proposal to make HACCP mandatory for all operators in the food chain. They argued that primary producers would not be able to establish and run a HACCP plan. The European Commission agreed with this point, although the obligation remained for certain categories of small users, such as small egg producers. The French Ministry of Agriculture subverted the issue by requiring small egg producers to establish some sort of HACCP-inspired quality assurance system, but not to implement each and every principle of HACCP. The European Commission offered training programmes and technical assistance to operators in industrialised countries exporting food to the EU (Sperber 1998).

Appropriation of a regulatory concept and limits of expert influence

The international development of HACCP shows an interesting pattern of diffusion, that is highly dichotomous. On the one hand, a set of principles has been established, whose seemingly logical and generic character assisted its upload as an effective approach to food safety by WHO, Codex Alimentarius, the ILSI, various professional and trade associations as well as the European Commission. On the other hand, flexibility was sometimes taken with the awarding of HACCP standards, and certain segments of a highly differentiated food industry received some support in their use of HACCP principles. In other words, the universal HACCP principles have only been exported alongside the development of devices to anchor them in local business practices. The regulatory concept as a boundary object proved to be effective for only the range of actors that could be interested (Callon 1986) by experts in the properties of that concept as a way to modernise food hygiene and as a management tool.

Invisible college of experts and coordination of a regulatory space

By tracing the trajectory of HACCP and looking at the membership of the various committees and working groups in which the guidelines were developed, it is evident that the consensus on Codex guidelines was manufactured by a relatively

small pool of scientists, who were used concomitantly as advisers by WHO, Codex, national delegations to Codex, and other industrial and professional bodies.

According to a member of ICMSF, half of the specialists of HACCP around the world are members of the group. The role of ICMSF illustrates the fact that scientific experts were instrumental in producing coordination between professional, scientific, inter-governmental and governmental organisations on HACCP. Bauman himself was a member of the ICMSF. His publications on HACCP were written for this small and immediate audience of specialists who thereafter spread the concept through their own publications. The members of ICMSF consciously form a corps of specialists and pride themselves on being a productive elite group.

Frequent meetings reinforced the cohesion of this group, and assisted them to harmonise the recommendations issued by various organisations. The degree of inter-personal knowledge between them is high. They form what may be called an "invisible college" of productive scientists, and enjoy a central position in the scientific and regulatory field of food hygiene[10].

The scientists have worked for various organisations across the regulatory space, using their expertise to inform industrial or trade associations, national standard-setting bodies as well as inter-governmental organisations on HACCP. For instance, the NACMCF was put together and given its mandate by the National Academy of Science, while the ICMSF is a think-tank of the WHO to which the development of new ideas is delegated. In this sense, the college is comprised of scientists who are recruited "for the quality of their work", or "their reputation", but are placed in a situation where their knowledge is made relevant to the solving of a public regulatory issue by particular organisations. It often happens that these scientists turn into advisers or consultants for organisations required to implement the regulations resulting from their work, or even receive official positions within these organisations, as has been the case with scientists becoming officials of the FAO or the FDA[11].

The invisible college has increased interaction and coordination in what can be described as a transnational regulatory space. These scientific experts, as members of a cohesive group, improved coordination by occupying positions or advising a variety of organisations which fed into each other's work. By formulating a

[10] An invisible college is the informal structure that ties together the most productive scientists (in terms of number of publications, number of citations, capacity to renew paradigms, attract funding and train fellow researchers) of neighbouring research domains (Crane 1979). In contrast with that of "epistemic community" (Haas 1992), the concept shows that hierarchy is a key property of scientific or expert communities. It helps us incorporate into the analysis a sense of the structural influence of certain actors in a regulatory space, because of their particular positions and resources.

[11] For instance, it is normal practice in the US to appoint academics as heads of the national delegation to Codex. A French microbiologist, professor in one of the national veterinary schools, became a quasi-permanent member of the national delegation to Codex and a consultant for the ministries of Agriculture and Trade. In the last years of his career, he joined the European Commission and the Food and Agriculture Organisation thereafter. Another member of the ICMSF was head of the food quality division with Nestlé and a member of both the Swiss and Dutch delegations to Codex.

concept, and linking various efforts of standardisation to a common generic logic, they actually pre-empted the building of a consensus in the Codex arena. In this regard, the Codex guidelines and the European Union Directives that prescribe the use of HACCP are the outcomes of this ability of scientific experts to generate a common approach to food safety.

Generic principles and technologies of appropriation

Coordination does not mean the guidance created by the various bodies was merged into one unique code. A multiplicity of guidelines have been established. Codex produced the most generic guideline, with wide applications across sectors of the food industry and across countries, but in different versions that superseded each other quickly. The European Commission at first opted for a different version, but eventually approximated its standard with Codex guidelines. Other examples include the already mentioned decision by the French Ministry of Agriculture to word the obligations of small-egg producers in a different way. The US authorities have chosen a different approach: the Ministry of Agriculture is of the view that it must issue detailed regulations, laying down the list of critical control points, contamination thresholds and corrective measures for each type of foodstuff within official regulations – whereas the European Commission decided to leave the details of the implementation of HACCP to professional bodies and to stay at the level of very general principles.

In other words, HACCP as a common set of generic principles has been appropriated at different levels and at different times through different technologies. The influence of scientific experts on diffusing a coherent set of principles is counter-balanced by the variations in the way HACCP has been prescribed or appropriated by users. The dichotomy is between the establishment of guidelines by supranational bodies for all operators of the food chain, leaving them the possibility to define for themselves the critical control points and contamination thresholds; or the establishment of mandatory rules and norms by professional or regulatory bodies for specific segments of the food industry.

The scientific experts themselves took part in the competition to establish what may be called the technologies for appropriation, or ‘anchoring devices’. First of all, being closely involved with the WHO as well as with national delegations to the Codex, they took close part in discussions in Codex. They tried to use it as the receptacle for HACCP in its most orthodox version and pushed for creation of voluntary trans-sectoral and trans-national guidelines. Experts have also developed guidelines outside Codex. Most of the members of the ICMSF advise food companies, and depict themselves as an “action-oriented” group, aiming at the development of “tools that help” (Mayes 1998). They document their experience implementing HAACP and the results of these experiments are contained in journal articles and books based on consulting missions, public hearings, workshops and “countless private debates” (Adams 2002). Through them, the experts established detailed guidance on what each of the principles of HACCP could mean in different contexts. One of the consequences of their action has been the possibility to extend the use of HACCP to other kinds of food safety issues: beyond biological contaminations, to chemical and physical risks as well.

Scientific experts have proven very successful at influencing the agenda of the Codex Alimentarius. Their work as advisers to the WHO (through ICMSF) and to national governments puts them in a position to effectively advocate for the creation of a HACCP standard by relaying within formal arenas the conceptual work undertaken externally. This is well illustrated by the pressure their work placed on organisations like Codex or the European Commission. Well into the 1990s, the specialists kept arguing that HACCP was still at an experimental stage, that more time and more work should be put into developing it (Kaferstein and Motarjemi 1999), and that, in spite of the adoption of Codex guidelines, "further refinement" was needed (Mayes 1998). Scientific experts have continually been active in working group meetings as members of national delegations, recalling what the state of knowledge is on one or other item of discussion, thereby always replacing inter-governmental discussions within a process of constant conceptual refinement[12].

Conceptual advocacy and limits to the application of HACCP by users

The objective of scientific experts has been to defend the properties of what they saw as a concept, thereby displaying a rather high level of faith in the principles of HACCP. They have consistently shown HACCP to be the approach of the future, and the only possible choice (Jouve 1994, Untermann 1999, Motarjemi and Käferstein 1999):

> "It took nearly 50 years and the necessity of providing '100% safe' foods for the astronauts to get acceptance that line control in a systematic way is more reliable than end-product testing. It took another fifteen years for HACCP to get the recognition it merits." (Jongeneel and van Schothorst 1992).

According to the scientific experts, HACCP is a valuable tool, notably because it is merely a set of logical principles or (in the experts' own terms) a "philosophy" (Panisello et al. 1998). This logical approach is seen as adaptable to the specificities of each company – its products, its physical and organisational structures, its objectives and standards in use (Jouve et al. 1998, Holt and Henson 2000). In these circumstances, HACCP should be declared "innocent" for its slow diffusion (Adams 2002). The reason for that is that it has neither been properly "understood" (Adams 2002) nor translated into different languages (Untermann 1999), meaning this "tool that is known to increase our control over foodborne safety hazards" (Mayes 1998) has not yet made a full impact on the prevalence of food contaminations (Panisello et al. 1999).

Scientific experts highlighted the connections between HACCP and other standards in the making. They demonstrated that HACCP-based self-control systems were the best possible tool for producers to comply with the legal principle of primary

[12] They influenced the European Commission in the same way, in its decision to move from the "deviant" five principle version of HACCP defined in the 1993 General Hygiene Directive – deemed too "vague" (Untermann 1999) and too "implicit" in its reference to HACCP – to the orthodox seven-principles-based version. The term by term comparison between proposed standard and existing ones by several scientists was influential in the Commission eventually correcting its legislation. The Commission approach was soon reworked with the help of these very experts that advised the WHO and Codex.

responsibility for the products they release. HACCP records are sufficient evidence for businesses if they need to demonstrate before a court that they have taken all necessary actions to prevent contamination of foodstuffs, as required by the "due diligence" rule (Blanchfield 1992, Jongeneel and Van Schothorst 1992). Experts defined how HACCP principles fitted with ISO 9000, and, later on, with ISO 14000 systems. They also involved producers of management technologies and standards, by explaining how HACCP is an instance of "Total Quality Management". Most recently, scientific experts have started to establish similar linkages with the risk analysis principle by showing how received risk assessment techniques were the most appropriate way to define "critical control points". For scientists, HACCP is a central element of "food safety systems": data collected internally by companies should be centralised to allow governmental bodies to make better informed risk assessments. These assessments in turn should help companies to focus on the most immediate dangers and prevalent risks, leading to a global increase in food safety.

The definition of the properties of HACCP and the subsuming of other tools under their generic technology form what could be termed conceptual advocacy. Scientific experts have emphasized the properties of the procedural approach, thereby giving a substance to HACCP. They created a concept that eventually, comes to be the 'black box' (Latour 1987) through which things as diverse as producer's responsibility, quality control and food safety were logically connected and simplified.

This action is motivated by the attempt to dominate food safety practices and to develop the abstract techniques that would legitimise their monopoly over this emerging jurisdiction. In more concrete terms, these specialists would benefit from as large a diffusion of HACCP as possible, both in their roles as government advisers and as independent business consultants. Scientific experts from the ICMSF (and other groups) who took part in the development of HACCP defended the position of their own professional group on food hygiene and food safety more broadly, understood as a new professional jurisdiction (Abbott 1988). The HACCP contestations epitomise the intention of microbiologists to preserve their monopoly over food hygiene and to position them on the larger territory of "food safety" for which they compete with toxicologists, nutritionists, and doctors[13]. It also illustrates the attempt by veterinary doctors to cast themselves in a new role and to protect their desire to be the leading "food doctors" (Hubscher 1999).

However, the scientists were not acting neutrally. Firstly, they placed the concerns of larger in-line companies at the centre of their work, and used supranational organisations as a platform for the work on the concept, thereby illustrating a preference for working with larger entities. Local or professional bodies, including those that take care of small and medium sized retail and hospitality businesses, were partly excluded. For instance, the scientists have mostly used the terrain of larger in-line processing companies. This is illustrated by the fact that the scientific experts acted as consultants for larger companies and that a key contribution in the development of the concept has been the work carried out within the industry-funded ILSI foundation. Their emphasis on the generalisation of HACCP as a

[13] The fact that the WHO announced that HAACP was the best and unique approach to food hygiene just after the take-over of the food safety department by a veterinarian and its explicit wish to prioritise hygiene, comes as evidence, if anecdotal, of this.

concept applicable across production lines, and attentive to the latest management and accountability constraints placed on businesses, resulted in a preference for very generic forms of standard and technologies of appropriation, such as the Codex guidelines.

Secondly, their action was directed at international organisations such as WHO and Codex. As a matter of fact, the invisible college was created thanks to the overlap between the composition of ICMSF, working groups convened by WHO and FAO and that of certain national delegations to Codex[14]. Codex was the arena in which the receptiveness to constructions of experts was highest. Conceptual advocacy grew and produced its strongest results there. Codex's trans-sectoral and trans-national guidelines are the technology that best conveyed the properties of the HACCP concept: self-regulation, food safety as a matter of accountability and decentralised risk management.

Development of HACCP involved a range of organisations in conceptual advocacy - mainly international organisations and larger businesses. Limits on the capacity of smaller users to adapt HACCP thus results from the fact that they were not involved in the initial process. Thus, HAACP guidelines remain difficult for them to handle, constant conceptual developments are seen as unhelpful[15], and some governments allow producers flexibility with regards to implementation.

Conclusion

This paper illustrates the influence of scientific experts in maintaining the illusion of high transferability and the universality of a tool. The unique selling point of HACCP was the amount of research invested in establishing a procedural approach to food hygiene. As one of the scientific developers put it, what differentiates HACCP from other quality assurance methods is its "maturity" as a concept (Mayes, 1998). Experts have been very influential in promoting HACCP through their involvement with a variety of arenas in which guidelines for HACCP were created. They channelled them into a continuous process of refinement of the concept, sustaining its dominance.

Several interesting findings have emerged within this paper. Firstly, it is useful to consider the actors and places in which technologies of appropriation are developed. These technologies allow standards and abstract ideas to be anchored in

[14] As one of these scientists explains: "All the ground work is done by the WHO and the FAO. They invite people with whom they have good contacts. That is why you find the same names everywhere. Because you want the best people. And they get good because they feed themselves. […] United Kingdom, Denmark, Germany, Netherlands, and a bit France. Later on Belgium. Then the United States of course, Australia, New Zealand. And there is the whole mafia behind this, everybody talking to each other… always the same six heads. The advantage is that you can work very quickly." (Interview with the author).

[15] Experts tend to seek conceptual developments where practitioners seek practical solutions. In the concluding speech to a food safety conference, one expert thus argued: "The aim of this conference was to improve the understanding of HACCP as a food safety management tool. One of the participants deplored that we raised more questions than answers. But I see that as a very positive sign. This conference shows how much effort is put into research – we have achieved progress while raising better questions to solve in the future." (Sperber 1998).

local settings. The actors who create them are in a position to connect ideas and practices and disseminate them jointly, thus gaining an important regulatory power.

Secondly, this paper has shown that the influence of scientific experts lies in their ability to play a translating role between standard-setters and users, and between ideas and practice, as various professional, industrial bodies or governments consider and disseminate the standard. This unveils an interesting aspect of standard-setting. Standard-setting contains successive phases of assembling and dis-assembling of the fundamental concept. Standards are effective in as much as the assemblage of practices into a concept can be easily unwrapped by users in order to understand the logics behind the principles, its origins and the goals it achieves. In other words, there is effectiveness and authority for standard-setters in a field of practice only as long as there are two-way translations between standard-setters and users. One can say a standard is "effective" as a rule when there is a correspondence between practices and the concepts used to depict them. Effectiveness arises where the same actors develop the concept and promote its convergence with local practices or, in other words, when the same actors dominate the regulatory space in which the concept was developed and the field of practical use.

Thirdly, this paper shows that there is competition to dominate the regulatory space and fields of practice, involving scientific experts, governmental actors and other professional groups. The scientists described in this paper partly succeeded because they managed to act both as experts in official standard-setting arenas like Codex and as practitioners. They also partly failed. Their technologies did not help in anchoring HACCP in certain segments of the food industry because the need to apply the guidelines in diverse contexts and industry sectors meant the experts were, in part, replaced by private consultants, auditors and national governments.

There are complex hierarchies in standard-setting, much more than what is implied by the flat notion of "diffusion". These hierarchies can only be revealed if the researcher does not adhere to the illusion that one unique object is being diffused. There are variations and transformations of the ideas and practices contained within a single common concept. With regards to HACCP, experts sustained the perception that this concept existed and was shared by users across countries and segments of the industry. As a result, they established the rule in its most generic form. Rather counter-intuitively, governments then allowed deviation from it, showing they retain a form of authority in local rule-making. This case thus demonstrates that what is distinctive about standard-setting is the intersection of different forms of power, rather than the unilateral influence of non-governmental or private standard setters over fields of practice.

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Annex I. Example of HACCP plan
(Selected steps from a plan for canned mushrooms)

Process step	CCP No.	Hazard description	Critical limits	Monitoring procedures	Deviation procedures
20. Weighing	***CCP 2B***	*Overfilling resulting in underprocessing*	*Maximum fill weight as specified in the scheduled process*	*On-line check-weigher to eject over- and underfilled cans after filling*	*Line operator to adjust weight of ejected can manually by adding or taking away mushrooms*
22. Head spacing	***CCP3B***	*Insufficient headspace resulting in excessive internal pressure and distorted seams*	*Minimum headspace as specified in the scheduled process*	*Headspace check done after closing on consecutive samples, at least one from each head, by seam mechanic at start-up and every hour*	*Closing machine mechanic to adjust headspaces and to inform QC Operator to hold and QC to investigate all product run since last satisfactory results*
23. End feeding/closing/inspecting	***CCP 4B***	*Post-process contamination resulting from damaged or defective ends or improper double seams*	*Can manufacturer's specifications* *No serious problems*	*Continuous visual monitoring of ends by closing machine operator*	*Closing machine operator to remove any damaged or defective ends and to inform. QC Operator to hold and QC to investigate ends and sealed cans if necessary*
				Visual examination of sealed cans at start-up, after severe jam-ups and after adjustments as well as every half hour, and teardown examination every 4 hours on consecutive samples, one from each head, by closing machine operator	*Seamer mechanic to adjust closing machine and to inform QC Operator to hold. and QC to investigate all product run since last. satisfactory inspection*
25. *Thermal processing*	***CCP 5B***	*Inadequate heat treatment*	*Maximum time lapse between closing and retort up, minimum IT, minimum time and temperature for vent and cook as specified in the scheduled process Heat-sensitive indicator changes colour*	*QC to check on time lapse between closing and retort up (at least once per period) Retort operator to check on IT, time and temperature for vent and cook and thermograph Busse unloader to check heat-sensitive indicator tape Busse unloader to segregate product if no indicator tape or no colour change of indicator tape*	*Retort operator to adjust time and temperature of cook as per authorized contingency plan and to inform QC* *Operator to hold and QC to investigate all product suspected of deviation*
26. Cooling	***CCP 6B***	*Post-process contamination of product from cooling water*	*Detectable residual chlorine levels to 2 ppm in the cooling water*	*Chlorine checks every hour at exit of cooling water*	*Retort operator to adjust chlorine and to inform QC* *Operator to hold and QC to investigate all product run since last satisfactory check*

Appendix II. Chronological view of the development of the HACCP standard

Date	Organisation and text published
1998	WHO Expert meeting on HACCP systems regulatory audit
1997	Adoption of a new version of Codex guidelines
	WHO expert meeting on the revision of Codex guidelines
1995	Adoption of WTO agreements making HACCP an international standard of reference
	Publication of the final version of FDA and Food Safety and Inspection Service official texts on HACCP
1993	Adoption of Codex guidelines
	Publication of ILSI monograph on HACCP
	Adoption of EC horizontal hygiene directive 93/43
	WHO meeting on veterinary inspectors training
1992	Adoption of National Advisory Committee on Microbiological Criteria for Food recommendations on HACCP
	Codex preparatory expert workshop at Chipping Campden
1991	Conference of the International Society for Food Protection and publication of a text intended for food inspectors
1990	ILSI starts working on HACCP
1989	Adoption of NACMCF conclusions by the National Academy of Science
	Publication of the Richmond Report in the United-Kingdom, recommending adoption of HACCP throughout the food industry
1988	Publication of ICMSF book
1986	Publication WHO Europe expert group conclusions
1985	Green Paper on the role of microbiological criteria by the National Academy of Science
1984	WHO expert meeting on HACCP and salmonella control
1983	WHO Europe expert meeting
	National Academy of Science recommendations, drawing on ICMSF guidance
1982	« Aliment 2000 » policy program by the French Ministry of Agriculture sets HACCP as key aspect of food industry modernisation
	First ICMSF publication on HACCP
	WHO requests guidance on HACCP from ICMSF
1980	Edition of internal HACCP-based guidelines by Nestlé
	Common meeting WHO and ICMSF
1979	HACCP incorporated in Codex good practice guide for low-acid canned foods
1976	WHO expert meeting on microbiological aspects of food hygiene
1973	Promulgation by the FDA of a regulation recommending the use of HACCP by canned food industry. First audits based on HACCP principles
1972	WHO meeting in Argentina and publication of a report on HACCP
1971	National Food Protection Conference in the United-States with presentation by Bauman of Pillsbury's experience
	WHO expert meeting on HACCP
1970	First WHO internal note mentioning HACCP