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Standardising through concepts: the power of scientific experts in international standard-setting

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This paper deals with the power of scientific experts in standard-setting. It looks at the emergence of a set of principles for food hygiene known as HACCP, and their transformation into an international standard. Scientists are key actors of standardisation, because of their ability to include potential users and standard-setters in a common process of generification and replication of practices. In the case of HACCP, this occurred through the conceptualisation of practices, that is the enunciation and encapsulation of their generic properties into an exportable formula. The paper presents the determinants and the limits of the power of scientists to undertake such inclusive tactics of standardisation.

VOLUNTARY STANDARDS, best practices or guidelines are mobile objects. Rules created by international standardising committees, inter-governmental bodies or networks of experts travel across time and borders. For practices to travel in this way, they need to be made transferable to the same extent as the ideas that represent them. Establishing an international standard inevitably involves turning local practices into transferable ones. To understand who is most influential in international standard-setting, it is worth trying to analyse who effectuates the transformation of private practices into transferable forms, something that the literature so far has not focussed on. The way standards are transported from one place to another and how they are adapted to local contexts is known, but the process by which practices are made transferable has been examined much less.

This paper argues that the power of scientific experts in international standard-setting lies in their ability to channel businesses and standard-setting organisations into the development and standardisation of a common generic practice. It does so through 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
7. Verification procedures.

The application of these principles leads to the elaboration of an 'HACCP plan' for monitoring and correction of potential incidents by companies along their production chain (See Table 1 for an example of an HACCP plan).

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. Pillsbury invented HACCP in the 1960s[1] in order to provide 100% safe food to NASA astronauts. As early as 1972, the World Health Organisation (WHO) claimed that HACCP

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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[2] (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[3]), not long after the European Commission integrated the standard in several directives.[4] 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 process 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. This case is one in which scientific experts have exercised a particularly

Table 1. 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	Online 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 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 four hours on consecutive samples, one from each head, 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 Seamer mechanic to adjust closing machine and to inform QC operator to hold. QC to investigate all product run since last. satisfactory inspection
24. 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
25. 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

deep influence over the setting of a standard, due to their ability to elaborate generic practices and have them endorsed by standard-setting organisations.

To explore these issues, this paper proceeds in three steps. First, the literature on international standard-setting is discussed and our analytical framework laid out. Second, I describe the history of the generification and transfer of HACCP principles, along with the establishment of an international Codex standard. The third part discusses the factors that explain the role of scientists in this process. It describes their tactics of conceptualisation and explains how it helped to include users and standard-setters in a common process of standardisation, and simultaneously limited the influence of scientists over the regulation of certain segments of the food industry.

Expertise and experts in standard-setting

Technical expertise and the power of firms and states

The problem that this paper addresses is, What is the power of scientific experts in international standard-setting, relative to that of private firms and states? The place of expertise in international standard-setting has been conceptualised in two ways.

One the one hand, it has been seen as a power resource by authors who study the political economy of standard-setting. Technical expertise is a prerequisite for participation in international standard-setting. The distribution of this resource explains who of firms or states or other intermediary actors dominate the choice of international standards. In this approach, expertise is a resource that contributes to the ability of actors to impose their preferences for a standards. As far as states are concerned, it participates to their regulatory capacity, that is their 'ability to formulate, monitor, and enforce a set of market rules' (Bach and Newman, 2007). While Drezner is of the view that states appropriate the largest share of technical expertise and gain from it (Drezner, 2007), others have argued that firms on the contrary managed to influence the coordination of participants in standard-setting because of their monopoly over expertise on standards, more often than not related to their own products (Mattli, 2001; Mattli and Büthe, 2003; Abbott and Snidal, 2001). From this perspective, expertise is a secondary variable though. It is only one mode of governing the interdependence between states or participants to standard-setting processes, which are marked by issues of coordination and competition as well as of information and knowledge (Lazer, 2001). Modes of coordination or institutional arrangements definitely play a larger role in explaining how standards are chosen and implemented nationally or locally (Werle, 2000; Mattli and Büthe, 2003; Delmas, 2003; Prakash and Potoski, 2006) than the distribution of expertise.

On the other hand, technical expertise has been construed in a new institutionalist vein as a source of cultural legitimacy for standards and professional actors involved in defining rules for global markets. Loya and Boli (1999) have shown how experts embody a technical rationality that permeates standard-setting. They are the vector of a technological diplomacy (Hawkins, 1995), by which expertise helps participants to work in a seemingly neutral, depoliticised and consensus-minded way. It is instrumental to the success of negotiations, 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). In a scientised world (Drori and Meyer, 2006), the rules that are recognised as appropriate are those that are crafted by experts. Expert network, epistemic academic communities stand among the main producers of standards of this world (Brunsson and Jacobsson, 2000).

In summary, expertise is conceived of either as a power resource or as the reflection of a deeper cultural legitimacy. Experts are either associated to powerful firms or states, or wield a more diffuse influence through the legitimacy provided by their knowledge. This paper offers an alternative way to conceptualise the role of expertise in standard-setting, which could be termed a cognitive approach.

Mediating standardisation: the cognitive action of experts

Standard-setting is characterised by decoupling rule-making and enforcement (Kerwer, 2005) and by the hybrid and politically non-functional character of the authority of organisations which deliver them (Graz, 2001). In this sense, standardisation is not about making, prescribing and following rules. Although there is less difference between legal and voluntary rules than what is generally assumed (Dudouet *et al*, 2006), one such difference is the fact that the practices that are described in standards need to be made acceptable and actually imported by new users. This is done by defining the 'domain', the 'applicability' and 'conditions for compliance together with the rules themselves' (Sahlin-Andersson and Jacobsson, 2003). Alternatively, this is done by generifying practices and by making them transferable (Djelic, 1998; Dratwa, 2004; Fourcade, 2006).

In other words, rule-setting and rule-following are part of the same process of generification and localisation of practices (Pollock *et al*, 2007). Standards are practices that are exported, from the locale in which they were first experimented, towards another locale, where they serve to enhance the endogenous development of practices and systems in a way that is compatible with local interests and previous practices (Bénézech, 1996; Segrestin, 1997; Brunsson, 2000; Seidl, 2007). Standardisation can thus be defined as a circular process of making practices transferable and establishing technologies to facilitate their replication.

This paper argues that scientists are instrumental in channelling these two processes, because of their simultaneous action on the practices and on technologies to transfer them, in the sites where practices emerge and in standard-setting arenas where guidelines, protocols — that is, the standards themselves (Lelong and Mallard, 2000) — are established. Scientists include businesses and standard-setting organisations in the circular process of standardisation. They do so by the conceptualisation of practices, that is, the enunciation and encapsulation of their generic properties into an exportable formula. The paper explains the determinants and the limits of the power of scientists to undertake these inclusive tactics of standardisation.

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

The origin of a generic practice

HACCP originated from the need to create a system of quality assurance adapted to the risk of microbiological contamination of the food of astronauts. NASA was concerned with the fact that existing monitoring methods were imperfect. The safety of food was at the time verified through end-of-chain testing, a method which was inapplicable in space flights.

With such methods, the probability that viruses, bacteria or toxins contaminate the product can only be calculated *ex-post* and was seldom reduced to zero. In the early 1960s, NASA approached the US food company Pillsbury to establish a quality control system. This task was assigned to an engineer, Howard Bauman. He developed HACCP as a food-specific quality control system, inspired by quality assurance methods from engineering science.

The very invention of HACCP shows that the experimented practices were almost immediately, in the same breath, turned into a generic formulation. HACCP is the result of a ‘deductivist’ process. It was in fact inspired by other quality control systems used in engineering, which Bauman (who had some experience in the preparation of food in submarines) and Lachance (the scientist in charge of flight food and nutrition at NASA, who defined the mandate of Pillsbury) were knowledgeable in and thought of transposing to food production. Furthermore, the context in which Pillsbury invented a system for NASA, its client, also implied that the effectiveness and validity of the practices could be demonstrated logically. The new hygiene method thus took the form of abstract procedural principles.

Very quickly after the inception of the practice in Pillsbury, the standard was advertised to food regulators, notably the Food and Drug Administration (FDA) and other bodies in charge of the establishment of criteria of microbiological contamination. The value of the standard was immediately recognised by the FDA.[5] Bauman was asked to train food operators in the method and recommended its use in the canning industry. Shortly after that, the World Health Organisation (WHO) branded it as the best approach to food hygiene.

The development of an HACCP standard

HACCP was very early on said to be the best tool for the management of food safety, with a series of international and professional organisations advocating the adoption of its principles across the food industry. As noted by a scientists who took part in the development of the standard, ‘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).

Indeed, different organisations converged towards HACCP and consistently reasserted the sequential application of these seven principles. In the 1980s, three different organisations had followed suit and published recommendations or explanatory texts concerning HACCP (see Table 2). The first of these organisations was the International Commission for the Microbiological Safety of Food (ICMSF), a small professional group of about 20 co-opted internationally renowned food microbiologists. This 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 large agri-food multinational 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

Table 2. 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 UK, recommending adoption of HACCP throughout the food industry
1988	Publication of ICMSF book
1986	Publication of 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 of WHO and ICMSF
1979	HACCP incorporates 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

Science as well as the book by the ICMSF (NACMSF, 1991). The 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 in 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 (see Figure 1). The Codex guidelines also incorporated input from learned societies, national scientific academies and private foundations.

Generification and its limits

The history of HACCP shows an extraordinary continuity and coordination around a set of principles. This is the result of a generification of the initial practices under the form of principles and of their defence by an invisible college of scientists that was active across the sites where the practices were tested and standards established.

A group of scientists were used concomitantly as practitioners of industrial food hygiene by large businesses and as advisers by the WHO, the Codex,

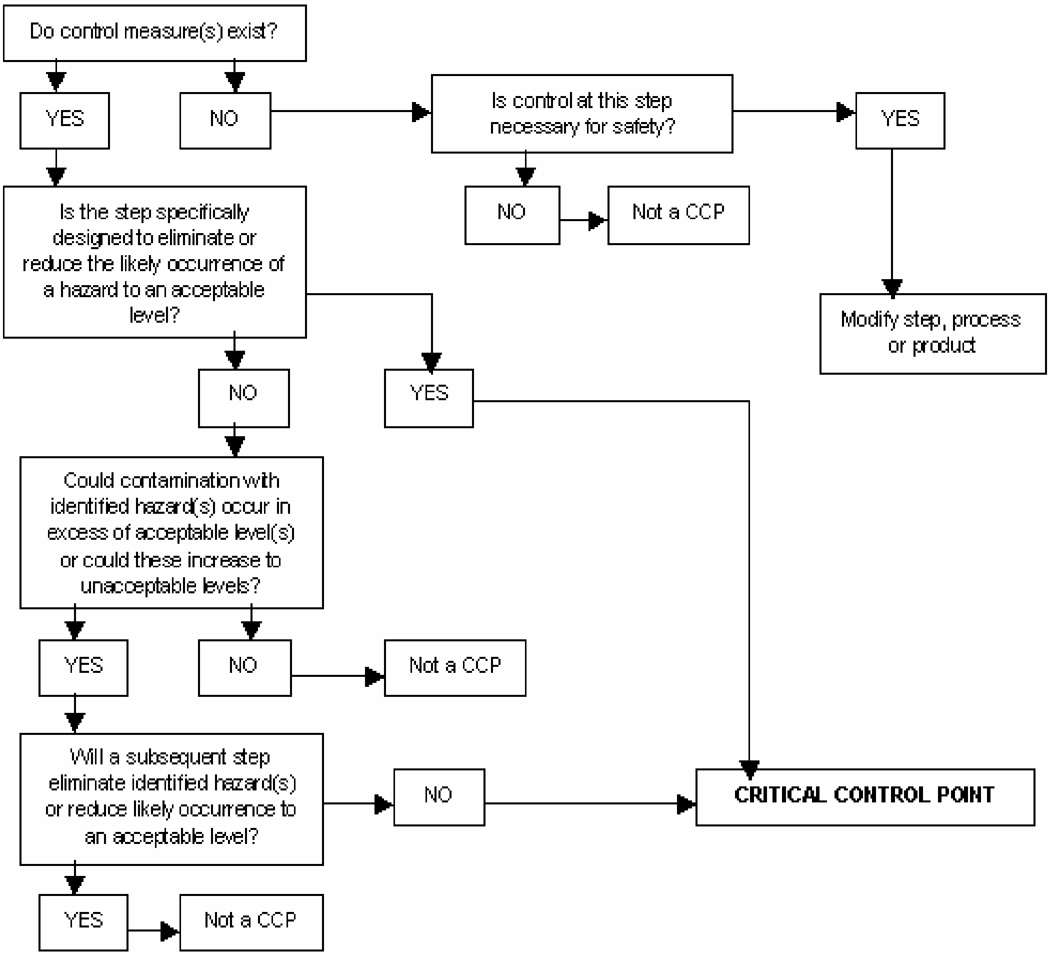

Figure 1. Decision tree for the determination of critical control points

national delegations to the Codex, and various 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 scientists were instrumental in producing coordination between professional, scientific, inter-governmental and governmental organisations on HACCP. Bauman himself was a member of the ICMSF. A Dutch colleague of Bauman also illustrates by his trajectory this combination of roles: a member of ICMSF, he has been head of quality at Nestlé, active in ILSI, adviser of the WHO and member of the Dutch delegation to the Codex. A French professor of microbiology, who also joined the ICMSF at the end of his career, has similarly been at the same time adviser of the French consumer protection administration, consultant for businesses, and later on a civil servant at the European Commission and the FAO.

These scientists, industrial hygienists and food microbiologists, as members of a cohesive group, worked at strengthening the HACCP principles and keeping the integrity of the formula over time. They for instance created a vocabulary that could attend to differences between various food businesses. The expression ‘control point’ was better suited than ‘targets’ to show that the principles could equally apply to physical and chemical contaminations, as much as biological ones. They asserted the fact that HACCP was a ‘philosophy’ (Panisello *et al*, 1999) rather than a set of substantial prescriptions. As a ‘logical approach’, it was meant to be 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).

This generification does not mean, however, that the process of localising HACCP is automatic. HACCP substantially changes food hygiene practices. It substitutes a self-regulation tool to a more classic control of the compliance of food businesses with substantive microbiological 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 advice and assistance for the setting up of HACCP plans. Accreditation and certification bodies emerge as a new actor in that configuration, with the obligation to audit and approve HACCP systems.

This reorganisation of hygiene practices and systems is easier to achieve for larger companies with in-line production processes, that are able to master formal systems, work with explicited internal production parameters (organisational structures, personnel competences, good hygiene practices[6]) 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. 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 'critical control points' are and have little capacity to establish their own criteria for intervention. The aforementioned decision tree in the Codex guidelines is difficult to use for small users that do not have a team of engineers and scientists to work with these abstract schemes. Many users appear to be simply lost between the different versions of the Codex guideline. In this context, food businesses, smaller one in particular, often make recourse to external consultants or Internet discussion groups to find assistance.

In other words, while HACCP is the product of a successful process of generification that channelled organisations that issue standards for varied segments of the food industry together, the transfer of these practices to all food businesses was not necessarily achieved. The conflicts around HACCP, in the Codex and outside, thus related to which technology could best help the transfer of these principles. A dilemma emerged 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 specific food codes by professional or regulatory bodies, specifying the critical points and thresholds. This was the object of recurring discussions in Codex, were some members of the Committee for Food Hygiene pleaded for other Codex committees (e.g. on fresh fruits and vegetables, or fish and fishery products), transposed the HACCP principles into their own standards.

Also, regional or national regulatory authorities finally had to facilitate the use of HACCP principles, by taking distance from the Codex guidelines or by complementing them. The European Commission offered training programmes and technical assistance to operators in industrialised countries exporting food to the EU (Sperber, 1998). EU governments also 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 HACCP plans. The European Commission agreed with this point, although the obligation remained for certain categories of small users, such as small egg producers. Symbolically, 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. Egg producers are encouraged to identity the sources of contamination and the actions they may take if they detect a problem, but not to map out the production process and establish contamination thresholds nor to keep records. The generification of practices indirectly legitimises the development of practices that mimic rather than faithfully replicate the sequential application of the seven HACCP principles.

Characterising scientists' power in standard-setting

In summary, while scientists appear influential in making a practice transferable and exporting it, their regulatory power is bounded by the difficulty in anchoring and using these abstract principles. On the one hand, a set of principles has been established, whose seemingly logical and generic character was recognised by various professional, regulatory and international organisations. On the other hand, flexibility was sometimes allowed with the HACCP principles. This section of the paper discusses how to interpret this paradoxical process of standardisation, where the generification of a practice opened the way to the establishment of a standard and at the same time hampered its diffusion across the food industry. The action of scientists was one of conceptualisation, by which they included or channelled a series of potential users and standard-setting organisations into a common cognitive context and process of standardisation, while excluding others.

Conceptualisation of practices and influence over the standard-setting agenda

HACCP is a concept, in the sense that it can be characterised by explicit properties, in term of its contribution to the regulation of food hygiene and safety. These properties, highlighted over time by the scientists, are summarised in the preamble of the Codex guideline:

> Any HACCP system is capable of accommodating change, such as advances in equipment design, processing procedures or technological developments. HACCP can be applied throughout the food chain from the primary producer to final consumer. As well as enhanced food safety, benefits include better use of resources and more timely response to problems. In addition, the application of

The expression 'control point' was better suited than 'targets' to show that the principles could equally apply to physical and chemical contaminations, as much as biological ones

> HACCP systems can aid inspection by regulatory authorities and promote international trade by increasing confidence in food safety … The application of HACCP is compatible with the implementation of quality management systems, such as the ISO 9000 series, and is the system of choice in the management of food safety within such systems. (Codex, 1993)

The Codex guideline reflects the publications of Bauman and other scientists that repeatedly advocated the application of the HACCP principles and distillated its regulative properties.

Scientists for instance proved that HACCP-based self-control systems were the best possible tool for producers to comply with the legal principle of primary 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). Scientists defined how HACCP principles fitted with ISO 9000 and, later on, with ISO 14000 systems. They demonstrated how HACCP fitted with the 'new approach' of the European Commission, by which the latter decided to contain its role to the definition of product essential requirements and delegated the establishment of technical specifications to standard-setting bodies (Egan, 1998; Borraz, 2007). They also contended that HACCP is an instance of 'total quality management'.

Most recently, they established similar linkages with risk analysis techniques for the calculation of 'critical control points'. Finally, they showed how HACCP is a central element of what they call a 'food safety system', comprised of all the institutions, policies, laws and guidelines that form the regulation of food safety (Schilter *et al*, 2003). In their approach, 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 (Notermans *et al*, 1995).

Another aspect of generification is a description of a promising future. The maturity of the concept of HACCP marks the start of the departure from particularistic practices (Pollock *et al*, 2007). It is the excuse for scientists to rewrite the history of hygiene (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)

In these circumstances, HACCP should be declared 'innocent' for its slow diffusion (Adams, 2002). The true reason is that it has neither been properly 'understood' (Adams, 2002) nor properly translated into different languages (Untermann, 1999). 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). The conceptualisation of HACCP marks the attempts by scientists to demonstrate how HACCP responded to a set of challenges such as the harmonisation of hygiene practices across a highly differentiated food industry, the determination of responsibilities in cases of food contamination, the increase of international food trade, etc. In other words, they formed an agenda for Codex. 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 generification work undertaken externally.

Scientists have continually been active as experts in meetings of national delegations, recalling what the state of knowledge is on one or other item of discussion, replacing inter-governmental discussions within a process of constant conceptual refinement. By formulating a concept, they maintained close connections existing between the different contexts in which the standard was considered. They eventually pre-empted the building of a consensus in the Codex arena.

The Codex indeed was the arena that was most receptive to scientists' constructions. 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 its development (Käferstein and Motarjemi, 1999) and that, in spite of the adoption of Codex guidelines, 'further refinement' was needed (Mayes, 1998). 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 the very scientists that advised the WHO and Codex.

The determinants of scientists' power

Conceptualisation took place through scientific publications and participation at meetings in all organisations that were developing a HACCP standard.

They formed a common agenda to standard-setters. Conceptualisation is a tactic of inclusion of standard-setters and users in a common cognitive context and process of standardisation. Three factors explain the inclusion and coordination effect of these tactics of conceptualisation.

The first of these factors is the cohesion and collaborative potential of a group of scientists, kept together by their belonging to the scientific elite or what can be termed an invisible college of scientists.[7] These scientists share a common conception of their role of experts, to provide to regulators the best possible tools for hygiene. Sharing a vision of the relation between science and policy (Waterton, 2005), they see themselves as constituting a special elite.[8] The members of ICMSF consciously form such a cadre. The frequent meetings with the WHO and Codex reinforced the cohesion of this group and the degree of inter-personal knowledge.

Their interest in engaging with standard-setting is linked to inter-professional competition (Abbott, 1988). The HACCP epitomises the intention of microbiologists to preserve their monopoly over food hygiene and to position themselves on the larger territory of 'food safety' for which they compete with toxicologists, nutritionists, and doctors. It also illustrates the attempt by veterinary doctors to cast themselves in a new role of 'food doctors' (Hubscher, 1999). There are at least two clues that this was an essential drive in the action of scientists. Tellingly, the WHO announced that HACCP was the best and a unique approach to food hygiene just after the take-over of the food safety department by a veterinarian, and at the same time as a decision to put microbiological issues first as the main matter in food safety. In the same way, the elite scientists regularly denounce the proliferation of consultancies, which take their place as intermediaries between standardisers and businesses. The scientists embody the academic segment of the occupational group of hygiene industrialists and microbiologists, which is meant to produce the abstract techniques that legitimise and protect their involvement in food hygiene and food safety (Abbott, 1988).

The second key factor is the multi-positionality or social polyvalence of scientists, that is, the fact of working simultaneously or successively with a multiplicity of standard-setting organisations as well as businesses. Their careers are formed of a variety of experiences and mandates with organisations in the economic sector. 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 act formally or informally as consultant, and tend to denounce the multiplication of consultancies which specialise in selling HACCP plans to food businesses. At the same time, the scientists have worked for various organisations, using their expertise to inform industrial or trade associations, national standard-setting bodies as well as intergovernmental organisations on HACCP. They were part of their national delegations to the Codex Alimentarius. They were often sent, as specialists of HACCP, to preparatory meetings, ahead of the intergovernmental negotiations within the Codex Committee for Food Hygiene. 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.[9]

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This social polyvalence explains why scientists were able to judge the extent to which HACCP could or should be generalised. Scientists not only outlined an abstract standard. They both established the generic version of the rule and tested it on a variety of terrains, fulfilling the role of a large-scale regulatory experiment (Lezaun and Millo, 2006) and slowly constructing common ground for all participants to the standard-setting process and describing a new way to control food hygiene.

The third factor to mention is the existence of a systemic delegation of standard-setting from international and national public authorities to individual scientists. This appears to have been the case quite systematically for HACCP. For instance, the NACMCF was put together and given its mandate by the National Academy of Science, while the ICMSF is a quasi-think-tank for the WHO. States also recruited scientists and integrated them to their national delegations to the Codex. Scientists get recruited 'for the quality of their work', or 'their reputation'. As seen above, this systematic delegation led to an overlap between the composition of ICMSF, the working groups convened by WHO and FAO and that of certain national delegations to Codex, which was essential in maintaining the coherence of the seven HACCP principles. In other words, a crucial determinant of the power of experts is the 'systemic' delegation of functions to individual scientists, and their becoming the 'agents' of these processes (Morris, 2003), and the competition between principals to recruit the most credible sources of scientific authority (Weingart, 1999).

The limits of the inclusive tactics of scientists

These three factors combined explain why scientists, as experts, so efficiently included economic actors and standardisers in a common cognitive context and process of standardisation, and how their conceptual product landed on the agenda of the Codex. The limits to the influence of scientists are, conversely, linked to the exclusion of other potential users from this process. This exclusion was reflected in the inappropriationess of the Codex guideline for these users.

There are diverse ways for food businesses to become HACCP users, and various technologies to use. The scientists competed to impose their technologies of transfer. 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, which best conveyed the properties of the HACCP concept: self-regulation, food safety as a matter of accountability and decentralised risk management.

This preferrence for a generic technology reflects the nature of the businesses or types of users with which they worked and they included in their conceptualisation. Scientific experts acted as consultants for larger companies, or through ILSI, whose agenda is marked by the concerns of large multinational food businesses. This terrain of large in-line food processing companies took precedence over that of smaller businesses, such as hospitality. Their emphasis on the generalisation of HACCP as a concept applicable across production lines and compatible with other general management systems and standards (ISO 9001, 'due diligence' rule) also highlights the particular configuration which they drew up by including certain types of businesses rather than others.

Limits on the capacity of smaller users to adapt HACCP thus results from the fact that they were not represented in the conceptualisation by scientists and, hence, in the process of standardisation: HACCP guidelines remain difficult for them to handle, constant conceptual developments are seen as unhelpful,[10] and some governments allow producers flexibility with regards to implementation. 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 Department 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.

The influence of scientific experts is counterbalanced by the variations in the way HACCP has been appropriated by the actors which were not included in their conceptualisation.

Conclusion

This paper illustrates the influence of scientists in maintaining the illusion of high transferability and the universality of a standard. The unique selling point of HACCP was the amount of research invested in establishing a procedural approach to food hygiene. As one of the scientists put it, what differentiates HACCP from other quality assurance methods is its 'maturity' as a concept (Mayes, 1998). Scientists 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. This role opened the possibility for them to get involved in the creation of a Codex guideline.

I have explained this power by phenomena of collegiality, social polyvalence and delegation. The three factors all contribute to explain the capacity of scientists to mediate between potential users and potential standard-setters, and to include potential standard-setters in a horizontal process of generification and replication of practices.

This paper has shown that a standard is 'effective' insofar as there is some form of overlap between local practices and the concepts used to depict them. Effectiveness arises where the same actors dominate the arenas in which the standard is established and the field of practical use. The scientists described in this paper partly succeeded because they managed to act 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. These hierarchies can be revealed only if the researcher does not adhere to the illusion that one unique object is being diffused. 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 demonstrates that behind the supposed domination of firms or states hides a complex intersection of actors that co-regulate markets. This case shows that the unique power of scientific experts lies in their ability to foster this intersection.

Notes

1. 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 towards the processing and marketing of a larger range of packaged foods after the Second World War.
2. 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.
3. 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.
4. Directive 93/43/CE on food hygiene, Directive 91/493 on fishery products, Directives 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.
5. The US regulatory agency for food and pharmaceuticals.
6. 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 100 critical control points may be required.
7. 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.
8. 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).
9. For instance, it is normal practice in the USA 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.
10. 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).

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