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Occupational and environmental safety standards in nanotechnology: International Organization for Standardization, Latin America and beyond

Guillermo Foladori
Universidad Autonoma de Zacatecas, Mexico

Abstract

In the absence of government safety regulation in the field of nanotechnology, ISO standards are being used as the basis for establishing technical and management guidelines at an international level. There are more than 50 current ISO standards on nanotechnology. Some of these relate to the working environment and occupational risk management. In Latin America, entities that are members of ISO are enunciating national versions of the international standards. In this article, this context is analysed critically, starting from the Mexican standard on occupational risk management in the working environment. Even though risk management standards may guarantee better and safer working conditions, in the field of nanotechnology, they simultaneously unlock detrimental implications for workers and society. Reliance on such private and voluntary forms of industry self-regulation is identified as a by-product of global neoliberalism.

JEL Codes: I19, J52. K32

Keywords

Corporate self-regulation, environmental risk management, ISO, labour standards, Mexico, nanoparticles, nanotechnology, neoliberalism, occupational health, voluntary standards, workplace safety

Corresponding author:
Guillermo Foladori, Unidad Académica en Estudios del Desarrollo, Universidad Autonoma de Zacatecas, Av. Preparatoria S/N, Col. Hidráulica, Zacatecas 98000, Mexico.
Email: gfoladori@gmail.com

Introduction

A feature of globalisation and neoliberal policies is the increasing role of private organisations in governance. The International Organization for Standardization (ISO) is one of these organisations that has growing presence in standardising production and management processes and systems worldwide, and it is one of the few whose standards are accepted by the World Trade Organization (WTO) in cases of international litigation – unlike, for example, International Labour Organization (ILO) standards which, also being voluntary, are not accepted as definitive reference points in international litigation.

Nanotechnologies are characterised by manipulating matter at the atomic and molecular levels. The US National Nanotechnology Initiative defines nanotechnology as 'the understanding and control of matter at dimensions between approximately 1 and 100 nanometers (nm), where unique phenomena enable novel applications not feasible when working with bulk materials or even with single atoms or molecules' (Executive Office of the President of the United States, 2005). Nanotechnology is said to be a disruptive technology, which is predicted to bring about changes in computing, medicine, energy, drinking water and materials in general – changes that are believed to hold great commercial potential. As a result, some 60 countries are investing public funds in nanotechnology, from basic research to commercialisation. According to the consulting firm Lux Research, global nanotechnology funding for 2010 was approximately USD17.8b (Sargent, 2013). Despite the sustained growth of Research and Development (R&D) and the market entry of products with nanocomponents, the regulation of such materials is virtually nonexistent. It is true that countries apply the existing regulations on chemicals to products of nanotechnologies. The European Union, for example, applies its regulatory body for chemicals (Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)) to nanomaterials; but as nanomaterials have different physicochemical and biological behaviour from the same materials in larger size, uncertainty emerges as to whether a regulatory body like REACH, which does not consider the specificity of nano size, can be effective in avoiding the inherent dangers of the new properties of these materials.

ISO has been issuing norms on nanotechnology since 2005. The ISO member entities in different countries reproduce those standards, adapting them to their context and turning them into national standards. In Latin America, four countries have institutions that are full members of the nanotechnology committee of ISO (Brazil, Mexico, Colombia and Peru), and one is an observer member (Argentina). It is expected that these countries reproduce the ISO standards nationwide. Mexico has already issued several regulations on nanotechnology. This article analyses the Mexican nanotechnology standards concerning risk management of nanomaterials, which are already in force and which are under discussion in Argentina. It is presumed that other countries in the region might follow the same path.

The purpose is to use this analysis of the Mexican form of ISO standards in order to raise more general questions of the implications for workers and for society generally of reliance on ISO standards. Although risk management standards guarantee better and safer working conditions, they simultaneously have detrimental implications for workers and for society.

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Goods incorporating nanotechnology in Latin America

Nanotechnologies can be understood as a number of different techniques that allow manipulation of matter at the atomic and molecular levels. What they have in common, which is also their strength, is that matter in nano size manifests different physicochemical properties from the ones that the same materials present in larger size (Colvin, 2003; Maynard et al., 2006; Oberdörster et al., 2005; Poland et al., 2008). By controlling these previously non-controllable properties, practically all industries have begun to incorporate nanotechnologies into their processes and products. In some cases, the advantages in productivity, efficiency and innovation of processes and products promise revolutionary economic and social possibilities. However, as in the case of new chemicals, nanoparticles can pose risks to health and the environment that need to be anticipated when possible.

Nanotechnologies are expanding in Latin America as they are in the rest of the world. Several countries produce goods with nanocomponents, others import them; and products with nanotechnology are found in supermarkets of any country in Latin America. Some of these products have explicit mention of the presence of nano-sized particles in the labelling; the vast majority offer no information for the consumer. In some industries, such as cosmetics, the quantity and variety of products is large, but in most industries, products are only now emerging. There are no national records that can be used to estimate the type or volume of products using nanotechnology on the market. Some research has collected information about businesses that produce using nanotechnology. Estimates vary from more than 400 companies to over 1000 in Brazil (Bagattolli and Invernizzi, 2016), from 130 to more than 180 in Mexico (Appelbaum et al., 2016; Instituto Nacional de Estadística y Geografía (INEGI), 2014) and around 40 in Argentina (Foladori et al., 2017).

Although there are plenty of combinations of nanoparticles of different materials, their size-specific physicochemical characteristics may result in biological-toxicological properties that differ from those of the same materials in larger size. This difference suggests a precautionary treatment against potential unknown risks.[1] It is a key reason to regulate nanotechnology products, standardising (or normalising) their composition and arrangements.

The risks of nanomaterials may be present to consumers, workers and/or the environment. In the case of consumers, regulation has not gone beyond labelling in some countries and for some products. In the case of workers, safety at work was recognised as a basic human right in the declaration of the ILO in 2008 in Seoul (ILO et al., 2008), with reference to which the new technologies, and in this case the nanotechnologies, should be responsibly analysed. Several countries, including Germany (Bundesanstalt für Arbeitsschutz und Arbeitsmedizin (BAuA), 2007), the United States (National Institute for Occupational Safety and Health (NIOSH), Centers for Disease Control and Prevention (CDC) 2009, 2012) and the European Union (Employment, Social Affairs and Inclusion, 2013), have developed voluntary guides to detect, reduce and avoid risks of nanotechnologies in the workplace, recognising that workers are the first social sector exposed to potential dangers.

While much information about potential risks of nanomaterials is inconclusive, the precautionary principle has been raised as a legal and ethical approach to preempting any damage. The precautionary principle states that when there are indications that an activity could pose a threat or danger to human health or the environment, precautionary measures should be taken, even if there are no causal relations scientifically established

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(European Union Legislation, 2000). The European Environmental Agency (EEA) (2002, 2013) published two books with illustrative case studies of detrimental effects on health and the environment that could have been prevented by a precautionary approach.

The other reason for precautionary regulation is of a commercial nature. Globalisation has encouraged the development of value/supply chains throughout many countries. The need to regulate imported raw material which is also incorporated into successive work processes requires nomenclatures and technical specifications for interchangeability of parts, uniformity and smoothness of the final process. The rate of introduction of nanotechnology products on the market is, however, faster than the regulatory process, and, at a global level, some countries have barely begun to make regulations and to demand registration. The European Union took the lead by establishing some minimum criteria, such as labelling biocides, food and cosmetics with nanotechnology (The European Parliament – The Council, 2009, 2011, 2012). Nothing similar is happening in Latin America (Urquijo, 2014). The governments of Latin America have shown no signs of concern about this source of risk.[2] Given this gap, the private organisation ISO has begun to issue voluntary standards and technical specifications, which are being replicated by some countries. In Latin America, these include Mexico, Argentina and Colombia, and it is expected that the ISO standards will also extend quickly to others like Brazil and Peru, with pressure on other countries to also follow suit.

Methodology

The main research question investigated in the study reported here is as follows: To what extent does the ISO standard for nanotechnology, which refers to risks to occupational health and which is being implemented in Latin America, represent a non-conflictual gain for workers, who are the group most directly benefiting from the norm? The primary objective of the research is to identify potential socio-political conflicts that the technical standard analysed could eventually raise. The working hypothesis states that in the development of labour standards such as are analysed here, a crucial requirement is mandatory participation and with equal weight by the main social sectors involved (workers, management, the general public), in order to guarantee social and technical responsibility.

The study method was based on a comparative analysis of cases discussed in the press and in other documentary sources. The ISO standard is compared to ILO safety standard in terms of potential conflicts in the use of the two standards: overlapping functions, formal composition of the membership of standard-development committees, and the language used in drafting the standards (including omissions) and its implications. Second, information about the position of trade unions on the relevant ISO standards was collected, given that this social sector does not have full membership in the organisation.

ISO standards and nanotechnology

Standards concerning production processes have a history dating back to World War I, when the German military industry began to implement them in order to facilitate the exchange of supplies and parts. ISO is a worldwide federation of national standardisation bodies, a private non-governmental organisation that has been working since 1947, with a presence in more than 160 countries, and with the purpose of developing relevant standards

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that facilitate the harmonisation of production, processes and systems to enhance international trade. The first ISO standards date from the 1980s. They are technical specifications to ensure quality, safety and efficiency (ISO, n.d.-a). As an example of an ISO standard, credit cards have the same format so that they can be used anywhere in the world. There are more than 21,000 ISO standards and related documents covering all technology, food, health and other industries.

Standards tend to facilitate harmonisation of international regulations by creating a uniform technical language. These features make ISO a private instrument that becomes the basis of quasi-official regulations. For example, if there is an international conflict that requires technical specifications, the WTO recognises ISO standards as appropriate in litigation so that, despite being private and voluntary, at the end, they acquire a higher authority in certain situations.

In order to establish a standard, the ISO distinguishes among member countries, who are entitled to vote, other countries acting as observers without voting rights, and a wide range of international and regional organisations that are consulted but have no vote, including those of the United Nations. The rule that is promulgated as a final result is copyrighted and must be purchased on order to be consulted. This process can take years, having intermediate stages, such as technical specifications that have not yet acquired the necessary approval to become a standard. ISO issues standards, but does not offer certification. A large number of entities outside the ISO offer the certification of those standards that are likely to be used for certification purposes, such as the family of standards 9000 or 14000 on quality in business management, enabling companies and/or their products to carry a seal of approval in this regard. Other families of standards are guides for operation and harmonisation that are not certified. Although historically the standards emerge to homogenise products, particularly supplies for subsequent industrial processes, nowadays ISO also includes standards for processes and even for services. This extension of the application of standards for products to processes and services has the dual purpose of assuring consumers that the service or production process has been conducted within certain criteria internationally accepted, and optimising activities and business management to reduce time and avoid loss of resources between tasks.

The expansion of standardising products and systems to the standardisation of processes poses some challenges. First, it has created uncertainty about who certifies the certifier entities. The certifiers themselves may be required to have a certificate of compliance with management, environmental impact or other operational criteria, and the bodies that certify the certifiers may, in their turn, require certification. Thus, a restricted business of certification of certifications might be created, distancing the processes from the original spirit of harmonising products (Rothery, 1998). Second, to receive a product whose production process has been certified may be of importance to the consumer, in particular for the entrepreneur who buys supplies, but also for the final consumers interested in knowing the content and characteristics of the goods they buy. However, to receive a product whose management processes have been certified may be more remote from the immediate interests of the consumer. A pair of shoes can have a certified product quality; but the same pair of shoes may have been created either by an industry that pollutes the environment, or by one with sustainable practices, and this is a distinction that is not visible in the final product. Third, while the rules that are certifiable must be

applied by the company in the package, the technical standards that are not certifiable give the manager of the processes the chance to choose which ones to follow (Cilona, 2013), creating an uncomfortable situation for workers and consumers who do not know to what extent they can place trust in the application of the rule by the company. Fourth, the generalisation of rules affecting broader social behaviours, such as ISO 26000 on social responsibility, means the advancement of private standards in areas of international agreements, and also within countries, so that the distinction between governmental public regulation and private law tends to dwindle, and global responsibility may end up being regulated by a private body that is increasingly recognised as arbitrator by international institutions (Webb, 2012).[3] The concept of governance originates precisely to extend older ideas of government regulation in the public domain, to an idea where other social sectors also regulate through the spread of less enforceable social norms and the imitation of cultural or cognitive assumptions and practices (Scott, 1995).[4]

From the business point of view, the regulation of financial management, for example, has positive effects due to optimisation, which is why companies seek the application of some rules and, where appropriate, their certification. This positive effect comes from combined causes. So, for example, the harmonised management of processes can reduce accidents, save working time and supplies by harmonising and systematising tasks, and also by attracting customers (see, for example, Naveh and Marcus, 2007). But whether there are the same incentives to adopt ISO standards for working with nanotechnology is another issue.

From the point of view of the workers, standards such as ISO 26000 on social responsibility do apply to them. The adoption of such standards, however, may conflict with other existing standards, or with institutions whose standardisation field appertains to them, such as the norms of the ILO. On the other hand, while unions do not participate directly in ISO standards – they do not have a vote – ILO standards are of tripartite resolution (government, employers, workers), a process which guarantees greater decision-making power and democratic dialogue (Cilona, 2013; International Trade Union Confederation (ITUC), 2014). So it is likely that workers will be better served by the latter, and will not be well serviced by efforts to substitute ISO standards.

In 2005, ISO created a Nanotechnology Committee, the *ISO/TC 229 Nanotechnologies*. According to the ISO itself, this committee justifies its existence by the need to standardise the definition of nanomaterials, their characteristics, mechanisms of measurement and simulation, and even the management of processes, including 'science-based health, safety, and environmental practices' (ISO, n.d.-b). Up to early 2016, ISO had issued about 48 rules on nanotechnology that range from a definition of nanomaterials to technical specifications of risk management.

Among the many participants of the nanotechnology committee, there are several that represent regulatory agencies of countries from Latin America. Brazil, Colombia, Mexico and Peru are represented as full members, and Argentina as an observer. In Brazil, the commission of the Brazilian Association of Technical Standards (ABNT Nanotechnology) was formed in 2007.[5] For Colombia, the Colombian Institute of Technical Standards and Certification (ICONTEC, n.d.) is the national counterpart. For Mexico, the National Metrology Centre (CENAM) is the participating institution; for Argentina, the Argentine Normalization and Certification Institute (IRAM, n.d.). Peru formed its nanotechnology committee in the National Institute of Quality (INACAL) in 2015.

Nanotechnologies, ISO and workers in Latin America

ISO management standards may refer to areas previously covered by other organisations and standards, as has been the case with the ILO. This implies the possibility of a conflict between institutions. To avoid differences with the ILO, ISO signed a collaboration agreement in 2005 in regards to the area of social responsibility standards – ISO 26000 (ILO, 2015). In 2013, the cooperation agreement was renewed by a memorandum of understanding (MoU) for every area of convergence between ISO and ILO, which stipulates that ISO will respect the ILO standards in case of conflict (Blackett and Trebilcock, 2015). In this regard, the resulting ILO document says,

> Given the broad mandate and action of the ILO to promote social justice and decent work, and ISO's broad mission, ISO standards that relate to issues within the ILO's mandate (ILO issues) should respect and support the provisions of ILS and related ILO action, including by using ILS as the source of reference with respect to ILO issues in case of conflict. (ILO, 2013, Appendix 4)

With this agreement, ISO launched in 2013 a new family of standards relating to the named *Occupational Health and Safety Management Systems – ISO 45001*. This family of standards relates to management standards in workplaces, a specific field of the ILO, one, however in which the ILO had made no progress.

Some unions consider that even the cooperation agreement between the ILO and ISO violates the principle of autonomy by allowing a private corporation to determine standards to be applied in the management of occupational health and safety in particular countries. They argue that the agreement also hides the fact that it was the responsibility of the ILO to make progress in standards of such nature (Robertson, 2016). In addition, the process of developing the ISO 45001 standards was not conducted in accordance with ILO standards, violating the MoU itself. According to the global union federation Public Services International (PSI), the ISO has 'ridden roughshod' over the ILO with these ISO 45001 standards:

> Whatever the reasons, ILO is being challenged by the ISO processes and purposes, and despite its evident good faith and methodical defence of labour standards, is being ridden rough-shod by the preparatory committee, especially in regard to the definition of workers' representatives and their free election by workers, which grievously undermines the participation of workers at all levels of occupational health and safety management. ILO's Workers' Representatives Convention, 1971 (No. 135) is flouted. In addition, ILO resources for an ILO delegation to the committee meetings, even including trade union representatives, are spread thinly relative to the ISO committee members, given that they work in multiple concurrent task groups. Furthermore, language may be changed in its gist by ISO internal editing that is not transparent. The odds are not good for an effective partnership. (PSI, 2015; see also, PSI, 2016)

In fact, the ILO guide on international labour standards includes many recommendations that do not appear in the ISO (see, for example, Organización Internacional del Trabajo (OIT, 2014: 148–149), regarding emergencies in the workplace); and in other cases when it comes to informing workers, the ISO standard changes the ILO's language from 'must' to 'recommends' (PSI, 2016). This watering-down reflects the situation where workers have no direct involvement in the development of ISO standards. At last, and

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after a long mobilisation of trade union organisations that condemned the agreement, the MoU was rejected by ISO member bodies in early 2016 (PSI, 2016), possibly entering a new drafting.

For the area of nanotechnology, ISO began to publish technical standards and specifications relating to health and safety in workplaces in 2008. First was the *ISO/TR 12885: 2008. Nanotechnologies – Health and safety practices in occupational settings relevant to nanotechnologies*; then the *ISO/TS 12901 – Nanotechnologies – Occupational risk management applied to engineered nanomaterials. Part 1: Principles and approaches*; followed by the *ISO/TS 12901-2: 2014 – 2. Nanotechnologies – Occupational risk management applied to engineered nanomaterials – Part 2: Use of the control banding approach*.

As expected, the countries of Latin America that are members of the ISO nanotechnology committee are beginning to replicate the standards. In 2016, Mexico approved the national equivalent of the technical specification *ISO/TS 12901* with the code PROY-NMX-R-12901-1-SCFI-2015. Argentina is studying its equivalent standard IRAM 39504. Nanotechnologies: Occupational risk management applied to manufactured nanomaterials; and Colombia is expected to follow them.

A sociological and political analysis of the role of ISO standards and their relationship with the trade unions must be placed in the context of globalisation and neoliberal deregulation efforts, and through an approach comparing similar standards and historical backgrounds. The individual analysis of a standard may be innocent, and seem purely technical, when in reality the rules meet not only a technical but also an economic, political and even ideological function.[6]

Many of the criticisms of the ISO standards are based on analysing absences. For example, if the ISO norms of occupational health and safety do not include, as do the ILO ones, provisions for certain emergencies.[7] The ISO norm is not deficient for what it says, but by what it hides or does not say, which means denying a previously recognised labour victory. The Mexican standard PROY-NMX-R-12901-1-SCFI-2015, for example, states that risk controls should be 'based on national regulatory requirements and supplemented with appropriate additional controls' (Secretaría de Economía, 2016: 28), without mentioning at all that the controls must also be based on the agreements established by the ILO and ratified by Mexico. The ILO standards are, like the ISO ones, voluntary guidelines, but while they are drafted in a tripartite manner, the ISO ones reflect almost exclusively the position of the large member corporations. When ISO standards omit the incorporation of previous union gains recognised by ILO standards, they are detrimental to the labour sector; even if those rules seem an advance for referring to processes or products previously unregulated. Governments that consider the regulation of chemicals as a voluntary and private matter support ISO nanotechnology standards as a mechanism that frees them from any intervention.

Another kind of criticism of the ISO standards is based on comparisons. If previous standards establish the duty of employers to inform workers when hazardous materials are handled, and ISO standards weaken the wording, for example, changing 'must' to 'should', critique cannot arise from analysing the ISO standard in isolation, but only from comparison with the other standard representing greater progress in trade union rights. The Mexican standard PROY-NMX-R-12901-1-SCFI-2015 offers several examples of this. Table 1 compares text fragments of ILO standards and the Mexican standard on nanotechnology.

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Table 1. Wording differences: ILO and equivalent Mexican ISO safety standards.

ILO standards	Mexican Standard PROY-NMX-R-12901-1-SCFI-2015
Workers and/or their representatives **must** be given adequate information and appropriate training and be consulted by the employer. They also have to cooperate with the employer. Workers **have to** report forthwith to their immediate supervisor any situation which they have reasonable justification to believe presents an imminent and serious danger to their life or health. The worker **must** immediately inform his or her immediate superior of any situation of which he or she has a reasonable cause to believe it entails an imminent and serious danger to life or health. Until remedial action has been taken, the employer **cannot** require workers to return to a work situation where there is continuing danger. A worker who has removed him or herself from such a work situation **has to be** protected from undue consequences. (ILO, 2014: 111–112)	Information about it **should** be included in the operating instructions. As necessary, routine monitoring **should** be performed. Application of medical surveillance **should** also be considered. Work clothing **should** undergo cleaning on the part of the employer and be stored separately from everyday clothing. It **is expected** that cleaning of the workplaces is regularly performed in accordance with risk management plans. (Secretaría de Economía, 2016: 27 author's highlight) In all cases, the selection of controls **should**, at least, be based on national regulatory requirements and supplemented with appropriate additional controls. (Secretaría de Economía, 2016: 28 own highlight) Agreements **should** include instruction, updating and training of those individuals who have to use control measures and procedures to ensure that the measures are working as they **should.** Everyone involved or who may be affected **should** have at their disposition the information, instructions and training required to ensure safety. (Secretaría de Economía, 2016: 30, author's highlight)

Source: Author's analysis.
ILO: International Labour Organization; ISO: International Organization for Standardization.

Although the fragments do not refer to the same subject, they are useful to show the difference in verb conjugation, from the ILO form conveying a mandate to the form in the Mexican standard, conveying a suggestion.[8]

Yet another criticism of the ISO standards is based on the general concept of the regulations. ISO management standards are intended to improve the competitiveness of the company; in order to do that, they divide, systematise, classify and organise the work and the whole management process. This planning and parcelling is similar to what occurs at the level of the actual production processes, using technical divisions of labour, time and motion analysis, and similar mechanisms that are all designed to make the work or management process simpler and more standardised (Brenner et al., 2004; Parker, 2015). This standardisation of activities is always positive from the point of view of the employer because it reduces costs by facilitating the replacement of employees. Unions and labour process theorists have long argued that such management techniques are ways of deskilling the workforce (Smith, 2015; Thompson, 1989). Contradictorily, the company will argue that the increased complexity of the automation processes parallel to management standards, combined with teamwork and simultaneous attendance of several machines, is a

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process of workforce upskilling (National Research Council, 2008; World Economic Forum (WEF), 2016). Both perspectives, deskilling and upskilling, although they seem opposed, are potentially right; and the contradiction may reflect different levels of problem analysis. From the labour point of view, it can be considered that there is deskilling because standardisation of behaviours and activities facilitates the replacement of jobs and tends to cheapen wages; that is, the concept of deskilling is tied to the salary of the worker or employee, or the increase in work intensity without increasing wages. From the business point of view, it is considered that there is higher skill requirement because the workers or employees must control more sophisticated processes and different machines in different areas of the production chain; that is, the concept of higher qualification is tied to knowledge. Salary and knowledge do not necessarily change in the same way; since the wage includes, besides the skill level of the workforce, the supply of it, which is directly related to the ease of replacement, it should also be related to work intensity (Parker, 2015; Parker and Slaughter, 1988; Ximénez Saenz and Martínez, 1998).

The way in which the concepts and actions they tie down are used can also be criticised. For example, the efficiency that the ISO proclaims to be attained is financial efficiency, whereby many outsourcing processes accompany the ISO standards almost naturally. But it may result in loss of quality in the final product. This is something that the sum of the norms of each of the companies in the value chain does not register. Applied to work, efficiency derived from management standards leads to the individualisation of responsibility of workers, setting wage standards according to productivity and behaviour. This tends to weaken any union collectivism. Ximénez Saenz and Martínez, (1998) systematise the effects of such regulation as stricter control, pace and intensity of work, increased individual responsibility, psychological and physical effects, and the tendency to competition among workers (see also Brenner et al., 2004).

From a social perspective, the managerial rules that are liable to certification involve a process that has costs: they can be slow, require new procedures and might have to pass audits that are not always easy to meet (Delmas, 2000; Rothery, 1998).[9] So small and medium enterprises in particular may see the registration and maintenance hindered by this regulatory burden, and ISO might end up being a mechanism favouring big business and the concentration of capital (Ximénez Saenz and Martínez, 1998). Furthermore, ISO standards, although voluntary, can be used as mechanisms for limiting the access of some countries to the markets that have ISO standards, and in case of litigation, they can be used with international validity by the WTO (see, for example, WTO, 2017).

Last but not least, the general spirit of the ISO standards can be criticised from a social and macroeconomic perspective. Indeed, what can be an improvement at the individual level of each company becomes a new challenge at a social level and for consumers. Let us see this contradiction through the example of nanomaterials and the management of their wastes and residues.

ISO standards consider nanomaterials as hazardous materials, whose wastes require special treatment (Chapter 5.4 of the Mexican standard), and which must be replaced when possible. However, the norm does not reward the company that replaces hazardous materials, but the one which applies the guidelines to use them. Thus, even though the standard has a chapter regarding residues and waste management at the workplace – Mexican norm Chapter 14 – and even if this standard is met, the end result is that more companies will produce dangerous nanomaterials whose final product, once it has left

the company to enter the market, has an unknown destination, both in terms of consumption as well as of its disposal when the lifecycle is completed.

Note that if companies adopt the standard for waste treatment, they turn a work process with risk into a work process without risk, or limited risk, which is beneficial at the enterprise level for both employers and workers.[10] Nevertheless, this encourages global production with nanotechnology – which by the way is the purpose of these ISO standards – which leads to the proliferation of goods with nanotechnology. These eventually turn into waste being processed in landfills and dumps, incinerators or sanitary landfills, with possible detachment of hazardous materials from their matrices. In some cases, like shampoos and other cosmetics that end up in the drain as they are used, this process is almost simultaneous with consumption. Dealing with this pervasive and dangerous waste would require a change to the entire garbage collection system, treatment and disposal of world waste, all of which will become dangerous. Imagine the waste of Latin America. The bulk of hazardous waste (e.g. hospital, batteries) is incinerated, while most household waste is thrown into different types of dumps, and a smaller part into landfills (Pan America Health Organization, 2005). That means that all users of goods with nanoparticles will end up throwing their hazardous products into the environment, unless the entire waste system in the world is changed. By solving individual risks, the norm tends unconsciously, but inevitably, to generalise collective risks, going against its own spirit and intent, to improve living conditions.

The problem gets worse because when the private standard is individualised for certain activities, this blocks the possibility for a country to decide, for example, not to use certain hazardous supplies in its work processes, or to prohibit importing goods that contain them. These measures would go against free trade and investment treaties, based on criteria of the WTO (2017) that recognises ISO standards as the only valid ones for purposes of international disputes. Of course, the argument in favour of promoting new technologies is that they entail more benefits than risks; however, the balance is achieved only at the microeconomic level of the immediate action of the product, never at the social costs of broader scope or longer time frame.

Conclusion

In the last 25 years, neoliberal policies have promoted the participation of private companies in regulatory fields which were previously matters of public responsibility. This is the case with ISO standards, which, in turn, have advanced from the original spirit of standardising products to facilitate interchangeability between companies, to a standardisation of processes and systems, such as management processes and risk control; this has a direct impact on work activities, coming into conflict, in some cases, with the operation of other regulatory bodies such as the ILO.

As of the beginning of this century, several national and international agencies have begun issuing work safety guidelines to address the potential risks that nanomaterials pose to workers; and they have relied on the precautionary principle when scientific information is not conclusive. Also ISO, since the middle of the second decade of this century, has issued standards for nanotechnology, recognising the dangerous nature of its materials. Some of these standards deal with the management of occupational risk, suggesting procedures to reduce risks and accidents. In Latin America, this type of standards

is being developed by the ISO member bodies into national legislations, as in the case of Mexico and other countries in process. It has been argued here that such standards are not arrived at in a tripartite way and may involve a watering-down of ILO safety processes. Moreover, the focus on firm-level self-regulation does not take account of the externalities of releasing nanomaterials into the environment via production chains and the disposal of consumer waste.

The analysis of the standards shows that the supposed improvement in work processes has not necessarily ensued, being conceived too narrowly, besides unleashing implications at a social level that cannot be addressed at the individual level of the company. This article has analysed some of these implications, to which as yet there are no solutions.

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Notes

1. The Mexican standard PROY-NMX-R-12901-1-SCFI-2015 considers it so:

   > This document considers the CNT [carbon nanotubes] as substances of very high concern, and a precautionary approach should be considered for risk management of all types of CNT. It also establishes that if their use cannot be avoided, a high level of control is expected to be used. (Secretaría de Economía, 2016: 29)

2. Venezuela has issued a decree in 2015 by which pharmaceutical products with nanotechnology are considered 'new A and new B', with controls similar to new formulations (Instituto Nacional de Higiene 'Rafael Rangel', 2015).
3. In his analysis of this process, Webb concludes that, among other things, the International Organization for Standardization (ISO) 26000 implies a transfer of functions that derive from international agreements, and which were previously destined to be obeyed by States, to private decisions destined not only to States but also to corporations, all types of organisations and as a mechanism of worldwide regulation of social responsibility that went from the public to the private sphere (Webb, 2012: 28). Another article by the same author begins with the suggestive title 'ISO 26000 standard social responsibility as Proto-Law …' Clapp, for his part, refers to the implications of the privatisation of environmental regulations by ISO as public–private mechanisms dominated by private industry (Clapp, 1998: 296).
4. When regulations are established, there is always the risk of the 'lowest common denominator' approach where the negotiation is reached only by accepting minimum safety levels (Jachtenfuchs, 2001; Winterton, 2009). In addition to this, there is the problem that the regulations are not always simple to apply in contexts where there is no adequate knowledge to do so (Faure, 1995).
5. According to conference of PB Costa, Brazil had not participated in international meetings of ISO nanotechnology and had abstained from voting at least until the end of 2008 (Brazilian Industrial Development Agency (ABDI), 2011).

6. Clapp writes about the ISO 14000 standards something applicable to all ISO standards: 'It appears as though states are embracing these standards in part because doing so fits well with the prevailing liberal ideology held by most states, which calls for a reduced regulatory role for the state' (Clapp, 1998: 312).
7. For example, Article 13 of the Convention 155 of the International Labour Organization (ILO) stipulates,

> A worker who has removed himself from a work situation which he has reasonable justification to believe presents an imminent and serious danger to his life or health shall be protected from undue consequences in accordance with national conditions and practice

but there is no corresponding provision in the ISO standard.
8. International labour standards are developed by the ILO in a tripartite manner (governments, employers, workers) that establishes principles and basic rights at work. These standards include binding agreements, once approved by States, and recommendations. The reference to the mandatory nature of the verb refers to binding agreements which bring together the principles and fundamental rights at work.
9. 'Certification is open to abuse by over-zealous inspectors, it confers policy-type powers to petty officials, and it can become a barrier to enterprise to small companies and single traders' (Rothery, 1998: 209). Between the time when Rothery was writing and the present day, ISO has developed a successful policy to facilitate the entry of small and medium enterprises (Callaghan and Schnoll, n.d.); nevertheless, his description of the power of the inspector remains valid.
10. The risk depends on the hazard and the degree of exposure. With the application of the precautions established in the norm, nanomaterials will still be dangerous, but the exposure will be reduced and consequently the risk will also be reduced.

References

Appelbaum R, Záyago Lau E, Foladori G, et al. (2016) Inventory of nanotechnology companies in Mexico. *Journal of Nanoparticle Research* 18(2): 1–13.

Bagattolli C and Invernizzi N (2016) Difusión de la nanotecnología en Brasil. Análisis preliminar a partir de la Encuesta de Innovación Tecnológica 2011. In: Foladori G, Invernizzi N, Záyago Lau E, et al. (eds) *Nanotecnologías en América Latina. Trabajo y Regulación*. México: Miguel Ángel Porrúa, pp. 233–250.

Blackett A and Trebilcock A (2015) *Research Handbook on Transnational Labour Law*. Cheltenham: Edward Elgar Publishing.

Brazilian Industrial Development Agency (ABDI) (2011) Nanotecnología. Panorama da nanotecnologia no mundo e no Brasil. Agência Brasileira de Desenvolvimento Industrial. Available at: http://www.desenvolvimento.gov.br/arquivos/dwnl_1266607883.pdf (accessed 1 July 2016).

Brenner MD, Fairris D and Ruser J (2004) 'Flexible' work practices and occupational safety and health: exploring the relationship between cumulative trauma disorders and workplace transformation. *Industrial Relations* 43(1): 242–266.

Bundesanstalt für Arbeitsschutz und Arbeitsmedizin (BAuA) (2007) Guidance for handling and use of nanomaterials at the workplace. *Federal Institute for Occupational Safety and Health*. Available at: http://www.baua.de/en/Topics-from-A-to-Z/Hazardous-Substances/Nanotechnology/pdf/guidance.pdf?__blob=publicationFile&v=2 (accessed 27 March 2017).

Callaghan N and Schnoll L (n.d.) ISO 9000 for small companies. *Quality Digest*. Available at: http://www.qualitydigest.com/aug97/html/cover.html (accessed 10 June2017).

Cilona O (2013) Trade union involvement in non-technical standardization. *Hesamag* 7: 28–30. Available at: http://www.etui.org/Topics/Health-Safety-working-conditions/HesaMag/(offset)/allI (accessed 23 June 2016).

Clapp J (1998) The privatization of global environmental governance: ISO 14000 and the developing world. *Global Governance* 4(3): 295–316.

Colvin VL (2003) The potential environmental impact of engineered nanomaterials. *Nature Biotechnology* 21(10): 1166–1170.

Delmas M (2000) Barriers and incentives to the adoption of ISO 14001 by firms in the United States. *Duke Environmental Law and Policy Forum* 11(1): 1–38.

Employment, Social Affairs and Inclusion (2013) Guidance on the protection of the health and safety of workers from the potential risks related to nanomaterials at work. *European Commission*. Available at: http://ec.europa.eu/social/BlobServlet?docId=13087 (accessed 12 June 2017).

European Environmental Agency (EEA) (2002) Late lessons from early warnings: the precautionary principle 1896–2000 – European environment agency. Available at: http://www.eea.europa.eu/publications/environmental_issue_report_2001_22 (accessed 24 June 2016).

European Environmental Agency (EEA) (2013) *Late lessons from early warnings: science, precaution, innovation*. EEA, Report no. 1/2013, 22 January. Available at: http://www.eea.europa.eu/publications/late-lessons-2 (accessed 12 June 2017).

European Union Legislation (2000) The precautionary principle. *Summaries of EU Legislation*. Available at: http://europa.eu/legislation_summaries/consumers/consumer_safety/l32042_en.htm (accessed 24 November 2014).

Executive Office of the President of the United States (2005) The National Nanotechnology Initiative: research and development leading to a revolution in technology and industry (Supplement to the President's 2006 Budget). Report, National Nanotechnology Initiative, July. Available at: http://www.nano.gov/sites/default/files/pub_resource/nni_07budget.pdf (accessed 18 October 2006).

Faure M (1995) *Enforcement issues for environmental legislation in developing countries*. UNU/INTECH, Working paper no. 19, March. Maastricht: United Nations University, Institute for New Technologies.

Foladori G, Lau EZ, Carroza T, et al. (2017) Sectorial analysis of nanotechnology companies in Argentina. *Journal of Nanoparticle Research* 19(6): 186.

Instituto Argentino de Normalización y Certificación (IRAM) (n.d.) Búsqueda de Normas. Available at: http://catalogo.iram.org.ar/carritoiram/BuscaInicialCD.asp (accessed 17 June 2016).

Instituto Colombiano de Normas Técnicas y Certificación (ICONTEC) (n.d.) Normalización Comité 243 Nanotecnología. Available at: http://www.icontec.org/Ser/Nor/Paginas/CTN/Ct243.aspx (accessed 1 July 2016).

Instituto Nacional de Estadística y Geografía (INEGI) (2014) *Encuesta sobre Investigación y desarrollo tecnológico y módulo sobre actividades de biotecnología y nanotecnología 2012 Síntesis metodológica ESIDET – MBN. Aguascalientes, Mexico*: INEGI.

Instituto Nacional de Higiene 'Rafael Rangel' (2015) Registro Sanitario de Especialidades Farmacéuticas con Nanotecnología. National Standard.

International Labour Organization (ILO) (2013) Further developments in relation to the International Organization for Standardization, including in the field of occupational safety and health (OSH). Available at: http://www.ilo.org/wcmsp5/groups/public/—ed_norm/—relconf/documents/meetingdocument/wcms_222296.pdf (accessed 7 July 2016).

International Labour Organization (ILO) (2014) *Guide to International Labour Standards*. Turin: ILO. Available at: http://www.ilo.org/wcmsp5/groups/public/—ed_norm/—normes/documents/publication/wcms_246945.pdf (accessed 8 July 2016).

International Labour Organization (ILO) (2015) Review of the implementation of ILO–ISO agreements (GB.325/INS/11). Available at: http://www.ilo.org/wcmsp5/groups/public/—ed_norm/—relconf/documents/meetingdocument/wcms_420998.pdf (accessed 13 July 2016).

International Labour Organization (ILO), International Social Security Association (ISSA) and Korea Occupational Safety and Health Agency (KOSHA) (2008) Seoul declaration on safety and health at work: the safety and health summit. Seoul Declaration Organization. Available at: www.seouldeclaration.org (accessed 27 March 2017).

International Organization for Standardization (ISO) (n.d.-a) About ISO. Available at: http://www.iso.org/iso/home/about.htm (accessed 11 July 2016a).

International Organization for Standardization (ISO) (n.d.-b) ISO – technical committees (ISO/TC 229: Nanotechnologies Standards Development). Available at: http://www.iso.org/iso/iso_technical_committee?commid=381983 (accessed 25 November 2014b).

International Trade Union Confederation (ITUC) (2014) La ISO no pasa el examen. Available at: http://www.ituc-csi.org/la-iso-no-pasa-el-examen (accessed 30 June 2016).

Jachtenfuchs M (2001) The governance approach to European integration. *Journal of Common Market Studies* 39(2): 245–264.

Maynard A, Aitken R, Butz T, et al. (2006) Safe handling of nanotechnology. *Nanotechnology* 444(16): 267–269.

National Institute for Occupational Safety and Health (NIOSH), Centers for Disease Control and Prevention (CDC) (2009) Approaches to safe nanotechnology. *CDC*. Available at: http://www.cdc.gov/niosh/docs/2009-25/pdfs/2009-125.pdf (accessed 24 November 2014).

National Institute for Occupational Safety and Health (NIOSH), Centers for Disease Control and Prevention (CDC) (2012) General safe practices for working with engineered nanomaterials in research laboratories. *CDC*. Available at: http://www.cdc.gov/niosh/docs/2012–147/ (accessed 13 January 2015).

National Research Council (2008) Research on future skill demands: a workshop summary (ed M Hilton). Washington, DC: National Academies Press. Available at: https://www.nap.edu/download/12066 (accessed 17 June 2017).

Naveh E and Marcus A (2007) Financial performance, ISO 9000 standard and safe driving practices effects on accident rate in the U.S. motor carrier industry. *Accident Analysis and Prevention* 39(4): 731–742.

Oberdörster G, Oberdörster E and Oberdörster J (2005) Nanotoxicology: an emerging discipline evolving from studies of ultrafine particles. *Environmental Health Perspectives* 113(7): 823–839.

Organización Internacional del Trabajo (OIT) (2014) Guía sobre las normas internacionales del trabajo 2014. Available at: http://www.ilo.org/wcmsp5/groups/public/—ed_norm/—normes/documents/publication/wcms_246945.pdf (accessed 8 July 2016).

Pan America Health Organization (2005) *Report on the Regional Evaluation of Municipal Solid Waste Management Services in Latin America and the Caribbean*. Washington, DC: Pan American Health Organization.

Parker M (2015) A union strategy for skilled work and technological change. *Labor Notes*, 9 August. Available at: http://www.net4dem.org/cyrev/archive/issue6/articles/UnionStrategy/UnionStrategy.pdf (accessed 30 June 2016).

Parker M and Slaughter J (1988) *Choosing Sides: Unions and the Team Concept*. Boston, MA: South End Press.

Poland CA, Duffin R, Kinloch I, et al. (2008) Carbon nanotubes introduced into the abdominal cavity of mice show asbestos-like pathogenicity in a pilot study. *Nature Nanotechnology* 3: 423–428.

Public Services International (PSI) (2015) ILC 2015 Agenda: the current status of ILO standards on occupational safety and health systems in respect of management, requirements and guidance for use. Available at: http://www.world-psi.org/sites/default/files/attachment/news/en_104th_ilc_agenda_item_iv_on_social_protection.pdf (accessed 7 July 2016).

Public Services International (PSI) (2016) No to privatization of occupational health and safety! Available at: http://www.world-psi.org/sites/default/files/attachment/media/en_iso-ohs_pr_final.pdf (accessed 7 July 2016).

Robertson H (2016) *A New ISO Standard for Occupational Health and Safety Management Systems: Is This The Right Approach?* 3rd ed. ETUI Policy Brief. Available at: http://www.etui.org/content/download/23279/193994/file/ISO+OSH+management+systems+Robertson+2016.03.pdf (accessed 12 June 2017).

Rothery B (1998) Standards and certification. In: Lock D (ed.) *The Gower Handbook of Management*. 4th ed. Aldershot; Brookfield, VT: Gower Publishing Company, pp. 199–210.

Sargent J (2013) Nanotechnology: a policy primer. CRS Report for congress. Available at: https://www.google.com.br/?gfe_rd=cr&ei=W-S0Vcf1CYeq8wfsn4SwAg&gws_rd=ssl#q=sargent+nanotechnology (accessed 26 July 2015).

Scott WR (1995) *Institutions and Organisations*. Thousand Oaks, CA: SAGE.

Secretaría de Economía (2016) Nanotecnologías – Gestión de riesgo ocupacional aplicado a nanomateriales manufacturados. Parte 1: Principios y enfoques. Available at: http://www.dof.gob.mx/nota_detalle.php?codigo=5477511&fecha=24/03/2017 (accessed 19 June 2017).

Smith C (2015) Continuity and change in labor process analysis forty years after labor and monopoly capital. *Labour Studies Journal* 40(3): 222–242.

The European Parliament – The Council (2009) Cosmetic products (applicable from 2013). Regulation (EC) No. 1223/2009. Available at: http://europa.eu/legislation_summaries/consumers/product_labelling_and_packaging/co0013_en.htm (accessed 12 June 2017).

The European Parliament – The Council (2011) On the provision of food information to consumers. Regulation (EU) No. 1169/2011. Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:304:0018:0063:EN:PDF (accessed 13 June 2017).

The European Parliament – The Council (2012) Regulation of the European parliament and of the Council concerning the making available on the market and use of biocidal products (PE-CONS 2/12, Common Guidelines). Available at: http://register.consilium.europa.eu/pdf/en/12/pe00/pe00003.en12.pdf (accessed 13 June 2017).

Thompson P (1989). *Ne Mature of Work: An Introduction to Debates on the Labour Process*. 2nd ed. *London: Palgrave Macmillan*.

Urquijo W (2014) Regulación de las nanotecnologías en América Latina. *Observatorio Del Desarrollo* 3(12): 15–18.

Webb K (2012) *ISO 26000: bridging the public/private divide in transnational business governance interactions*. Comparative Research in Law & Political Economy Research, Report no. 21/2012. Osgoode Hall, ON: York University. Available at: http://digitalcommons.osgoode.yorku.ca/cgi/viewcontent.cgi?article=1030&context=clpe (accessed 7 July 2016).

Winterton J (2009) Competence across Europe: highest common factor or lowest common denominator? *Journal of European Industrial Training* 33(8–9): 681–700.

World Economic Forum (WEF) (2016) Human capital report. Available at: http://www3.weforum.org/docs/HCR2016_Main_Report.pdf

World Trade Organization (WTO) (2017) Technical information on technical barriers to trade. Available at: https://www.wto.org/english/tratop_e/tbt_e/tbt_info_e.htm (accessed 18 June 2017).

Ximénez Saenz D and Martínez OA (1998) Los trabajadores y las normas ISO 9000. *Taller de Estudios Laborales*. *Unión Obrero Metalúrgica*. Available at: http://www.tel.org.ar/spip/descarga/iso9000.pdf (accessed 30 June 2016).

Author biography

Guillermo Foladori is a Professor in the Development Studies programme at the Autonomous University of Zacatecas, Mexico. An anthropologist with a PhD in economics, he has worked as professor in universities in Mexico, Honduras, Nicaragua, Uruguay and Brazil and had been visiting fellow at the Consortium for Science Policy and Outcomes at Columbia University. He undertakes research in the fields of sustainable development, environment, public health and nanotechnology. He is coordinator of ReLANS, the Latin American Nanotechnology and Society Network, and has edited three books on nanotechnology as well as articles in scientific journals.

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