The globalization of social risks and technological accidents*

La globalización de los riesgos sociales y los accidentes tecnológicos

A globalização dos riscos sociais e os acidentes tecnológicos

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Abstract

Social and technological risks can be understood as a kind of antechamber to the occurrence of accidents or other unwanted events. The debate about the multiple forms and treatments of risk seems to have become crucial nowadays, although the risk has always been present throughout the history of Mankind. We do not know, however, if the world is now more risky than in the past, but we know, for example, that Western citizens have increased their average life expectancy, infant mortality has dropped dramatically and we are now healthier than in the past, due for instance to technological development. Despite all the benefits it provides, technology also simultaneously generates new serious and terrifying risks. For example, our ancestors did not have to live with nuclear power plants, air transport (aviation), oil platforms, genetic engineering, and so on. This paper discusses the ambivalence of technology from the notion of risk, including its positive and negative aspects.

Keywords: Risk, Technology, Accidents, Uncertainty.

Resumo

Os riscos sociais e tecnológicos podem ser compreendidos como uma espécie de antecâmara para a ocorrência de acidentes ou de outros eventos indesejados. O debate sobre as múltiplas formas e abordagens ao risco parece que se tornou central nos dias de hoje, apesar de o risco sempre ter acompanhado toda a história da humanidade. Todavia, não sabemos se o mundo é actualmente mais arriscado do que foi no passado, mas sabemos, por exemplo, que os cidadãos ocidentais têm vindo a aumentar a sua esperança média de vida, que a mortalidade infantil baixou drasticamente e que somos hoje mais saudáveis do que no passado, fruto, por exemplo, do desenvolvimento tecnológico. Apesar de todos os benefícios que a tecnologia nos proporciona são também gerados, paralelamente, novos riscos graves e assustadores. Por exemplo, os nossos antepassados não tiveram de conviver com centrais nucleares, transportes aéreos (aviação), plataformas petrolíferas, engenharia genética e por aí adiante. Este trabalho pretende discutir a ambivalência da tecnologia a partir da noção de risco, incluindo os seus aspectos positivos e negativos.

Palavras-chave: Risco, Tecnologia, Acidentes, Incerteza.

Resumen

Los riesgos tecnológicos y sociales pueden entenderse como una especie de antesala a la ocurrencia de accidentes u otros eventos no deseados. En estos días parece que el debate se ha centrado sobre las múltiples formas y enfoques de riesgo, a pesar de que el riesgo siempre han acompañado la historia de la humanidad. Sin embargo, no sabemos si el mundo es ahora más riesgoso que en el pasado, pero sabemos, por ejemplo, que los ciudadanos occidentales han ido aumentando su esperanza de vida, la mortalidad infantil se ha reducido drásticamente y ahora estamos más saludable que en el pasado, debido, por ejemplo, al desarrollo tecnológico. A pesar de todos los beneficios que ofrece la tecnología también genera al mismo tiempo nuevos riesgos graves y aterradores. Por ejemplo, nuestros antepasados no tienen que vivir con las plantas de energía nuclear, el transporte aéreo (aviación), plataformas petrolíferas, la ingeniería genética y así sucesivamente. Este documento analiza la ambivalencia de la tecnología la noción de riesgo, incluyendo los aspectos positivos y negativos.

Palabras clave: Riesgo, Tecnología, de accidentes, incertidumbre.

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Introduction

There are some signs in contemporary societies that indicate an increased concern about some risks, namely social and technological. This issue is gaining importance, especially when these risks originate scenarios of social tension (especially when faced with high levels of unemployment, precariousness, xenophobia or social inequalities), natural disasters, serious industrial accidents or when there is no consensus on the effects that they (risks) can produce. The problematization of the social acceptability of risks and the multiple factors that contribute to the formulation of risk perceptions (Areosa, 2011; 2012a; 2014) are two small examples that demonstrate the current complexity of the debate on these issues. However, when we talk about risks we find that we are always faced with uncertainty scenarios, where results can never be guaranteed at the start (otherwise they would not be risky situations). The concept of "risk society", played by Beck (1992), expresses precisely the uncertainty about some future results. In this paper, after discussing the notion of risk (including some of its social implications), we turn to the discussion of technological risks in the contemporary world, knowing that this is one of the topics widely discussed in the perspectives of Ulrich Beck, Anthony Giddens and Charles Perrow.

Risk: Reflections Regarding Conceptual Definitions

The origin of the word risk, referred to in literature, is far from consensual and has not been precisely defined (Mela et al., 2001, p.159). For Spink (2001), the term risk had its genesis in premodernity, specifically in the period of transition between feudal societies and the emergence of nation-states. The author claims to have found the first record of the word risk in a fourteenth-century Castilian document. According to Luhmann (1993, p.9) the etymology of risk is unknown, although it is suspected that its origin may come from Arabic. For the author the *risk* may have arisen in the transition from the middle ages to the modern era. In the same line of thought, Bernstein (1996) states that the concept of risk seems to have arisen in the Arabian civilizations. From the perspective of Giddens (2000), it is indicated that the notion of risk may have appeared in the Iberian peninsula during the sixteenth or seventeenth century, where an attempt to characterize the navigation of unknown seas was made, not yet described in the maritime charts of the time. In the etymology of risk the dimension of space is included, particularly the notion of physical space or unknown territory. Subsequently, the concept of risk was used by banking systems to project investments; from that moment on, the notion of risk began to include the dimension of time which is fundamental to make the probable calculations of these same investments.

As can be seen, the positions on the etymol-

ogy of risk are very diverse. In one of his most recent works, Neto (2013) deepens the debate on this issue in a very consistent way. The first reference to the notion of risk that could be detected was written in the 13th century (April 4, 1248), in an Italian document from Genoa related to aspects of navigation (see Rebelo, 2005). The dangers associated with the navigation of this time (both in terms of loss of property and of people) would surely be well known, so it is very likely that the word *risk* emerged closely linked to maritime activities.

Bernstein (1996) corroborates that the origin of the term *risk* occurred about seven or eight centuries ago, derived from the Italian expression risicare, which means to dare or to challenge[1]. Thus, it would be expected that a risk would not be configured as much as a pre-determined, but rather a choiceable option. Some authors do not share this view, given that in the early stages of the term *risk,* it did not appeared to be associated with human choices. In this perspective, a risk was seen as a greater force, a divine act or an objective danger that could not be imputed to the man. In this conceptual view, both responsibility and human faults were excluded. Risk was perceived as a natural event[2] (storms, floods, or tornadoes) or as a divine will and not as something that could be done by man. This notion also pointed out that some adverse events for mankind could be seen as punishments of the gods[3], provoked by their wrath against humanity (Lupton, 2003).

The original meaning given to the term *risk* refers to some neutrality. That is, a risk itself is a neutral and (Ewald, 1991) abstract entity that needs to be linked to a concrete situation to make sense. At present, due to the multitude of situations and connotations that the notion of risk incorporates, it seems difficult to conceive a neutral entity.

> "From the original use of the various social uses that have been made of the term "risk" in diverse areas of social experience, a reality appears, stripped of neutrality and constructed with different shades, unrecognizable in the matrix of its original conception.The idea of its multidimensional configuration and the idea of heterogeneity of its meanings are associated with risk" (Carapinheiro, 2001, p.198).

1 Other investigations on the etymology of risk suggest that this word may have originated in another Italian term: resecare (which means to cut). This expression was also used to describe irregular and "cutting" geographies related to sea voyages, such as submerged rocks or sandbars that cut or damaged the hulls of ships (Guzzo, 2004).

2 Particularly after the Lisbon earthquake occurred in the year 1755 (Areosa, 2008).

3 Curiously in Evans-Pritchard's (1937) study of the Azande, it was observed that in the beliefs of this people, the daily adversities of their members (whatever they are) were always attributed to acts of witchcraft, The essence of negative events are imputed to other members of society (this idea recalls the expression of Jean Paul Sartre in the play entitled "The Closed Door", where the author preached "hell is the others"). Thus, the potential divine punishment in pre-industrial times as a source of risk in the Western world finds parallel with this African people through witchcraft.

As a rule, the concept of risk is associated with potential negative factors or events, unwanted or sometimes unexpected, fruit of the condition of strong uncertainty of daily life. Some risks are global, so the way they influence the direction of societies is an aspect that must be considered in several areas, namely political, social and economic. It seems that today the notion of risk is assuming central importance in societies; within this logic we argue that the debate around the concept of risk should be widely promoted and demystified at the scientific level and clarified before public opinion[4]. In some cases we know that risks can lead to fear or panic; but risks should not always be associated with a negative and pessimistic approach, since it can be analyzed and evaluated in a positive way. This is demonstrated, for example, by the following quotation: "while risks generally have a positive side - the probability of achieving the expected benefits - and a negative side - the probability of having to bear the expected disadvantages" (Hespanha and Carapinheiro, 2002, p.14).

In addition, it also seems relevant to point out that the distribution of risks is usually asymmetrical among the different social groups. Although, risks have become an inevitability endured daily by the masses (Sennett, 2001, p.125) or, as Dean (1999, p.146) advocates, risks can be seen as a continuum and in this sense never completely disappears. In fact this means that we are perennially at risk. For Beck (1992, p.46) risks are not an invention of modern times, although it has significantly altered its meaning during this period. Due to their ancestral connection with the history of humanity, some risk situations end up being well tolerated in certain activities of social life. In Beck's perspective, modernity has become a period of return to uncertainty, or as Bauman (1991) states at the end of unambiguity. At the same time, some authors argue that it should be the uncertainty (and not the risk per se) the center of analysis in modernity (Martins, 1998). This is also why risks should be seen as a specific way to try to turn future uncertainties into something manageable. However, one must never forget the innumerable limitations and hesitations the forecast of the future can hold for us (Taleb, 2008).

It is relatively common to try to rationalize the risks that we believe to run (Kahneman, 2012); but in many situations this is no more than a delusion, for the risks that end up affecting us are sometimes very different from the ones we idealized.

> "What is ironic about risks is that rationality - that is, the experience of the past - stimulates the prediction of a wrong kind of risk,

4 As we will emphasize later, the probabilistic approach is hegemonic in the technical appraisals of risk, but this view supposedly objective is likely to give rise to skewed or distorted interpretations.

> from which we suppose we can calculate and dominate, but the disaster comes from what we do not know or cannot calculate. The bitter variations of this irony of risk are virtually endless: mad cow disease, 9/11 attacks, global financial crises, swine flu virus, and the latest, but not the last: clouds of volcanic ash that disrupts air traffic in Europe and the world" (Beck, 2013, p.31).

Kaplan and Garrick (1981) argue that when we ask "what is a risk?" we are in fact asking three questions: what can happen? How likely is that to happen? And if that happens, what will the consequences be? The first question relates to the danger scenario. The second question is about the probability or possibility of a given event occurring. And finally, the third question is related to the unwanted consequences in the projection of a specific scenario.

Covello and Merkhofer (1993) characterize risks as a situation where two or more outcomes are possible, without knowing which particular outcome will occur. The concept of risk refers us to probabilities or possibilities about the occurrence of future events, arising from the various dynamics of the social world. Although the approach to *risk* is essentially directed towards possible future situations, this does not mean that we fail to incorporate our past experience in assessing possible future events, as this allows us to obtain some comparative parameters to "know" how to deal with similar risk situations. To try to counter future uncertainty factors, we usually use our capital knowledge as a guide for our actions in the present. According to Giddens (1994, p.114) we would take greater numbers of risks in our daily lives if our socialization did not contemplate various protective and vigilant mechanisms for dealing with risks; this is defined by the author as normality conquered. Our general learning also includes learning about risk situations. The various capacities that we gain and build throughout our lives to deal with multiple forms of risks form what Giddens calls protective cocoon.

The essence of risk is not what is about to happen but rather what could happen (Adam and Van Loon, 2000). According to Douglas and Wildavsky (1982) the risk is socially constructed, and sometimes it seems uncontrollable, since we do not always know if what we are doing is safe enough to prevent accidents from happening or unwanted effects.

Nobody can know more than a small fraction of the dangers and risks around them, given that the social actors' view of the risks to which they are subject is always partial or incomplete. In fact risks are always with us! In a way, this means that risks are omnipresent and sometimes becomes a kind of "ghost" that hangs over our minds and is likely to fright-

en us. But this is not really good news, for fear can be paralyzing; and it also seems that we are increasingly scared, even though we are the healthiest, richest, and longest-lived people in all of human history (Gardner, 2008).

The essence of risk refers us to hypothetical or conditional scenarios, there is always a certain amount of uncertainty on the results about to come. If the future were something predetermined and independent of the occurrences of the present (human activities or forces of nature) the term risk would not make sense (Renn, 1992). Despite the conceptual plurality of risk[5], there seems to be a cross-cutting element to all of its definitions: the distinction between possibility and reality (Renn, 1992), that is, what can happen may or may not become a reality. For this reason, uncertainty is one of the most important assumptions of risk. In any case, risks will always be a kind of antechamber for future events. When we state that someone or something is at risk, this means the event has not yet occurred. It is in this sense that, according to Adams (2005), risk is partly the result of our mind, since it essentially translates into an uncertain projection of "events" that may or may not occur. In a similar line of thought, Slovic (2001, p.23) advocated that "the dangers are real, while risks are social constructs".

In the everyday social universe, new forms of risk increase exponentially (Giddens, 2000). Risks have become hegemonic. That is, a risk is not always a selectable situation for the majority of the population in terms of voluntary exposure, sometimes resulting in cohabitation imposed on their complex domains. In today's "more developed" societies it seems to make perfect sense to distinguish between the risks attributed to causes of natural origin and the risks produced by man himself[6].

By natural risks we refer to all events caused by the natural environment and on which man does not contribute directly to its occurrence. We include in this type of risk, for example, volcanic eruptions, earthquakes, cyclones, fires (where there is no human participation), rays resulting from the different electric charges of air masses, etc.

From man-made hazards, we mean all kinds of situations where equipment, products or substances synthesized by multiple human activities, such as nuclear power plant technology, the use of toxic gases, chemicals and ra-

5 Here is another example of its conceptual definition: "The notion of risk, I must emphasize, is inseparable from the ideas of probability and uncertainty. It cannot be said that someone faces a risk when the outcome of the action is fully guaranteed. (...). A risk is not the same as a chance or danger. The risk refers to hazards calculated in the light of future possibilities. It is only in current use in a future-oriented society, which sees the future precisely as territory to be conquered or colonized. "(Giddens, 2000, 32, 33).

6 These two definitions reveal some similarities with the concepts of External risk and provoked risk, proposed by Giddens (2000).

dioactive substances, or the hazards and consequent risks produced in contemporary societies have assumed unprecedented proportions throughout human history (Beck, 1992).

What can be seen today as safe behavior, becomes risky behavior tomorrow, in the light of the new claims of scientific knowledge or of the lay knowledge itself. For Giddens (1998, p.28) knowledge in reflexive modernity does not have the same meaning as the past, that is, it no longer means to be sure. And this novelty is valid for both the social sciences and the natural sciences. In modernity the concept of risk is associated with trust and it replaced the notion of fortune by altering certain perceptions (Giddens, 1998, p.24). Trust operates primarily in risk environments and is only necessary when there is ignorance (Giddens, 1998). It is true that ignorance can also provoke in the lay public some skepticism, caution or anxiety. The symbolic guarantees of abstract systems depend to a large extent on the trust that is attributed to them, for it is through them that one intends to create broad areas of security for the contemporary ordinary citizen's lives (Giddens 1994, p.119). But we must be aware that this goal is not always possible to achieve.

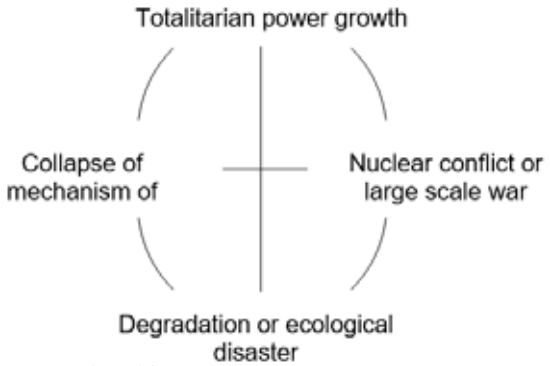
For Giddens (1998) no one can make choices completely outside the abstract systems, that is, without involving modern institutions; although abstract expert systems are at the same time potential generators of new situations of risks, which we are not always able to face, namely the high risks of the modern world (Giddens, 1994, p.211). Some of the high risks of modernity are virtually impossible to predict, since no one can say with "absolute certainty" whether a given situation can or can't happen, and if so, what will the results be. The potential negative consequences of global warming are within this high risk standard (Giddens, 1994, p.122).

Thus, certain global risks such as: nuclear wars, ecological disasters or the collapse of the global economy, they imply, according to the designation of Beck (1992), the "end of the others", due to the rupture of borders between those who are affected and those who are not. Faced with this type of risk we are all vulnerable to its possible effects. In reality, some of the current risks seem to assume a kind of boomerang effect, that is to say, metaphorically, those who "risk" also risk being one of their potential victims. Following the thinking about global risks, Giddens emphasizes on four major risk structures in modernity, that is, what he defines as high risks of modernity. This concept is understood by the author as situations likely to affect a large number of individuals, from which any threat to their own lives may result (Giddens, 1994, p.100).

In Figure 1, Giddens presents four points

that can exemplify the high risks of modernity. These new risks generate potential instabilities, which are known from the notion of "risk climate". The climate of risk experienced in contemporary societies is unsettling for all and cannot be avoided by anyone.

Figure 1. High risks of modernity

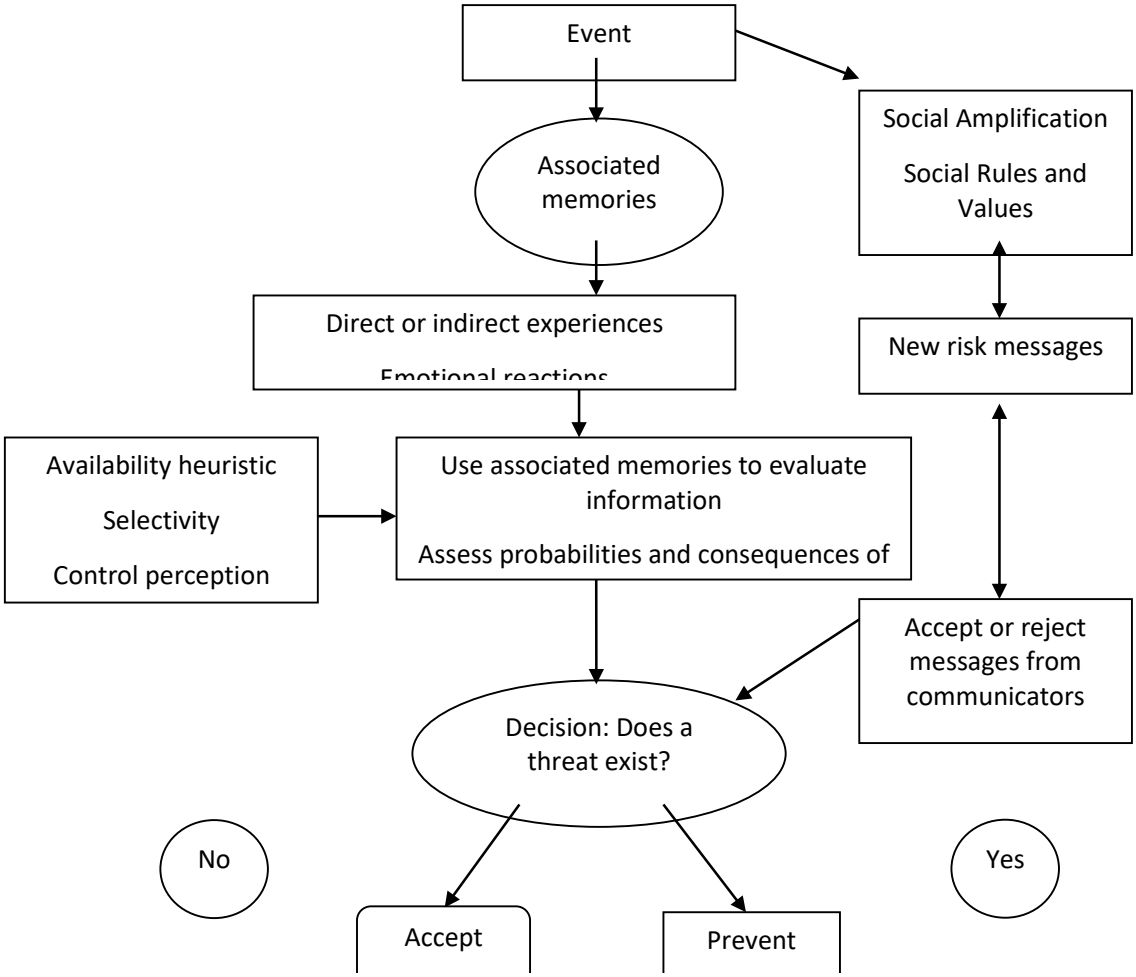


Source: Adapted from Giddens (1998, p.120)

A risk is not only a problem of individual action, but also falls on the individual. In Giddens's (1998, p.25) perspective there are innumerable "risk environments", so this condition reveals their collective character. Today's life forces us to live in a world of risks. This means that there is always the possibility of something going wrong, but, worst of all, that possibility cannot be eliminated (Giddens, 1998). To define this condition the author advances with the concept of risk profile. This notion comprises the particular set of threats (or dangers) that characterize modern social life. The British sociologist outlines seven major items that he intends to outline as the most significant points in the risk profile of modernity, particularly potential global catastrophes, which represent a horrifying horizon of risks for all humanity. The first four points refer to the objective distribution of risk and / or intensity of risk, commonly understood as threatening elements of the modern world, while the last three points deal with the ways of changing the perception of the risks observed.

> "1 Globalization of risk in the sense of intensity: for example, nuclear war can threaten the survival of humanity; 2 - Globalization of risk in the direction of the increasing number of contingent events affecting all people or at least a large number of people on the planet: for example, changes in the global division of labor, 3 - Risks arising from the created environment, or Socialized nature: the infusion of human knowledge into the material environment; 4 - development of institutionalized risk environments that affect the life chances of millions of people: for example, investment markets; 5 - Risk awareness as risk: "knowledge failures" about risks cannot be converted into "certainties" through religious or magical knowledge; 6 - Broad awareness of risks: many of the dangers we face collectively are known to vast audiences; 7 - Consciousness of the limitations of the expertise: No expert system can be wholly in terms of the consequences of adopting principles of expertise"(Giddens, 1998, p.87 and 88).

Figure 2. Flow diagram of the representation of the process of public risk judgments



Source: Adapted from Eiser (2004, p.40)

There are always going to be some dangers and unsuspected risks in our lives. Certain inventions have been created aiming to protect us, to make things safer, but sometimes they end up bringing us adverse effects, turning into new hazards; Douglas and Wildavsky (1982) give as an example, the cases of RX and asbestos. As our knowledge increases the relation between cost / benefit of certain risks can change. A risk can be considered acceptable today, and then tomorrow it can be completely repudiated in society. We must bear in mind that anything can create risks (Douglas & Wildavsky, 1982, p.19).

It is pertinent not to forget that people make their own assessments of risks, and it is, to a great extent, from here that their decisions result in accepting or avoiding those same risks. Eiser (2004) has created a simplified flowchart,

in which he develops some factors that influence public judgments in the face of risk or threat scenarios. In this representation (figure 2), besides the social dimensions, the portfolio of individual experiences of each social agent is also incorporated. Douglas and Wildavsky (1982) affirm that, as a rule, the different social actors make a clear distinction between risks in which they assume to run voluntarily and the risks imposed on them. Involuntary risks are more likely to be rejected by the public compared to voluntarily accepted risks. Another important aspect mentioned in the work of these authors is the indication that the social distribution of risks is not carried out in a homogeneous way. Some classes or groups of people face more risks than others.

Douglas and Wildavsky (1982) present the following example: On average, the poorest people are less healthy than the rich, they die earlier and have more accidents. However, it cannot be said that these people, incurring higher levels of risk in their lives, do so voluntarily. For certain types of risks, the relationship between costs and expected benefits is an important aspect of decision making.

Some Individuals may prefer to be exposed to certain occupational or environmental risks than to be unemployed. When the chances of keeping a job (and enduring certain occupational hazards) or leaving the job (and no longer being exposed to the occupational hazards associated with it) are often put on "scales", job preservation is usually preferred. Work is still the main source of livelihood for the vast majority of the world's population, that is, it is a huge work-life class (Antunes, 2008). Therefore, there are certain social constraints, some of them coercive, that influence the acceptability of risk (for example, I have to accept certain risks to be able to have this job, which in turn will allow me to support my children). It is true that some types of risks may not be desired, but people have to make choices, particularly when they have to weigh the costs and benefits for certain important aspects of their lives. It is also important to consider that the sub or over-valuation of some risks does not emerge in a kind of "social vacuum", instead they may result from different segments of scientific knowledge or lay knowledge, interests acquired or to be won, economic or political issues, different valuations (Influenced, for example, through the social group of belonging), struggles to control certain types of resources, organizational or institutional strategies, and so on. In this regard, we are now beginning to realize that the definition of what can be considered as a risk in the social world is an object increasingly less objective, and even more a phenomenon vulnerable to multiple interpretations, interests and subjectivities. For

example, Perrow (1999) describes how risks assessments in some complex systems are influenced by organizational aspects that sometimes have nothing to do with the real nature of risks themselves.

The Probability Risk Assessment

Risks, while being the object of probabilistic evaluation, are a mathematical expression that varies between the interval of 0.0 (impossibility of occurrence) and 1.0 (absolute certainty of occurrence), excluding both said values. In the scope of the study of probabilities Bertrand Russell formulates *the principle of induction* from the frequent association of events. This author states that if an event has been observed a significant number of times in the past, this constitutes proof that the same will apply in future situations. Contrary to this principle, Goodman (1954) advocates that not all regularities observed in the past are likely to predict the future. In the same line of thought we can find the essay carried out by Nassim Taleb (2008), where it is mentioned that making predictions in certain fields of the social world can be considered as a playful fallacy, since the principle of induction can hardly be applied to strong random scenarios.

Nowadays, the concept of risk is being criticized for its inadequate application in certain situations, as well as for the skewed use of some experts.

> "However much a risk analyst knows that probability theory does not Intends to make predictions about each individual occurrence but over a very large number of occurrences (so one very likely event may never happen, while another with very low probability may occur at the first opportunity), it is not in this modest and abstract perspective That the applications of this theory are presented to the "lay" public, or are erected before it on a rational basis for the taking of options" (Granjo, 2006, p.1176).

In spite of this the technical concept of risk continues to be described as a probability of occurrence of certain events, which is usually associated with the specific magnitude of its consequences (Areosa, 2010). The presentation of risk in terms of probabilities may, in certain situations and for certain types of public, become problematic. The reader views the following example, presented by Gigerenzer (2005, p.18):

> "The probability of a 40-year-old woman having breast cancer is about 1%. If you have breast cancer, the probability of a positive mammogram is 90%. If you do not have breast cancer, the probability of a positive

> mammogram is still 9%. How likely is a woman with a positive mammogram to actually have breast cancer?".

After reading this little piece of text, she may feel confused and will probably find the probability 90%. In the excerpt below the author presents the same information, only this time using what he calls natural frequencies, that is, he presents the data without resorting to the format of probabilities.

> Think of a group of 100 women. One (1) of them have breast cancer, and a mammogram is likely to be positive in a mammogram. Of the 99 women who do not have breast cancer, 9 will also get positive tests. Thus, a total of 10 women will get a positive test. Of those who test positive, how many actually have breast cancer?

Can you answer the question above relatively easy? If so, then how many women with a positive result actually have breast cancer?

Several authors use the unfolding or the multiplication of risk from two main factors: low consequences versus high probability and high consequences versus low probability[7]. In general, this view is that of the technicians who use the probabilistic model. However, this strictly technical view of risk tends not to take into account their social dimensions (perceptions, feelings, fears, etc.), and this may cause some problems of acceptance and legitimacy.

According to Slovic (1987), people demonstrate a broader understanding of risk, contrary to the one-dimensional approach of the technicians[8]. There are other important aspects,

7 The notions of "high-risk" and "low-risk" are also used by LaPorte and Consolini (1991, p. 23) to define and characterize these highly reliable organizations; as for us, these notions are contradictory and should not be used simultaneously to characterize the same reality, since risks arise from hazards when a danger is high, by deduction, the risk will also tend to be so (Areosa , 2012b). Still on the subject of the high-risk versus low-probability split, we find that this notion is already implicit in some aspects of traditional societies. In an extraordinary field work carried out by the geographer Jared Diamond (2013) in New Guinea, the author noted that the natives almost suspiciously avoided some risks of low probability of occurrence. Among other things, Diamond found that the New Guineans who accompanied him in his field research were peremptorily refusing to sleep around a dead tree despite the geographer's insistence (on a given day) that it would be the best place to stay overnight. But what, after all, was the reason why the New Guineans were reluctant to comply with an indication from the head of the expedition? Quite simply because they know that the dead trees, sooner or later, fall! Although the probability of a dead tree falling in precisely the few hours at night (on that particular day and during the sleep period) is very low, they know that if this happens the consequences can be worse (very serious injuries or death by crushing). This situation does not inhibit New Yorkers from circulating in the forest (where there are many dead trees), but it implies a kind of risk-hiding and, at the same time, a cautious warning through the temporary reduction in exposure to danger. This preventive attitude of the New Guineans was designated by Diamond as a constructive paranoia.

8 Against the backdrop of the technical language of experts or experts on risk, there is a certain tendency for this group of social agents to be able to present it in a one-dimensional form, for example, the estimate of the number of deaths during a given exposure time. "The risk measure used here is the statistical probability of fatalities per hour of individual exposure to the activity considered" (Starr, 1969, p.165). For the majority of the non-specialist population this one-dimensional description reveals some practical lack of meaning, and the perceptions of risks of the lay public are usually characterized by the multidimensionality of the presented factors. "People's perception and attitudes are determined not only by the sort of unidimensional statistics used in these tables (risk per hour of exposure, annual

besides probabilistic aspects, for the approach of risk, such as: Influence risk, familiarity with hazards, equity, controllability and public response to a catastrophic potential (Kasperson et al., 2000, p.232). Thus, the inclusion of social values should be seen as an important contribution to the definition of social and technological risks.

Within this line of thinking, Granjo (2006) states that the probabilistic notion of risk is not the only rational way to observe the scenarios of risk or threat. Moreover, in certain situations, this perspective may become inadequate or even expose certain sources of danger, particularly when faced with complex technologies. In fact, the use of the probabilistic notion of risk may even create new dangers; owing to the illusory sense of security it may cause over any future events, as these may be more uncertain or random than what formal analysis seem to indicate. In this context, Granjo (2006) states that the current technical apprehension of some probabilistic abstractions seems to be able to induce a collective illusion and exclude the essence of risk itself, where what is uncertain seems to become certain.

> "I just pointed out; the generalization of probabilistic logic can stimulate dangerous attitudes and new hazards. As we may deduce that the potential consequences of this phenomenon will be proportional to the number of unknown factors and interactions that are present in each case, hypercomplex and "risky" technological systems will be precisely one of the contexts where thinking in a probabilistic way will be dangerous (Granjo, 2006, p.1177).

In our recent history it seems to have become clear that accidents such as Seveso, Bhopal, Chernobyl and Fukushima have demonstrated their devastating consequences for thousands of humans and / or the environment. Probabilistically speaking these events would be ranked very close to zero, but despite their residual probability we all know that they happened. In the next point of this paper, we will focus a large part of our attention on the discussion of the risk scenarios that are upstream of this type of catastrophic events[9].

probability of death) but also by the variety of quantitative and qualitative characteristics reflected by our analyzes. To many people, statements such as "the annual risk of living near a nuclear power plant is equivalent to the risk of riding an extra three thousands in an automobile" give inadequate consideration to the important differences in the nature of risks from these two technologies. In short, "riskiness" means more to people than "expected number of fatalities" (Slovic, 1987, p.285)

9 If the reader is still thinking about the problem presented by Gigerenzer (2005, p. and has not been able to calculate how many of the 10 women with a positive result on mammography actually have breast cancer, I'll tell you that the result is one (1) woman! This means that if after reading the first excerpt of text you got the feeling that the probability would be 90%, you can now verify that the probability of a woman with positive result in mammography actually having breast cancer is only of 10%. It seems indisputable that the way we express ourselves will influence how others understand the world; If we do not do it right we may be leading others to error!

Technological Risks and Risk Societies: The Case of Complex Systems With Catastrophic Potential

The perception about the role of Technology in society has undergone some changes since the industrial revolution. During this period, technology was almost always valued positively (although there was also a fear that it could "steal" jobs), since it was thought that it would allow social progress and development, including the Whipping Belief in the benefits of technology was seen as a form of emancipation of man whose purpose would be to provide him with happiness. In the post-World War II period, the first skeptical or critical movements to the role of technology, not to technology itself, began to emerge, but to its use and real distancing from the benefits to mankind (Marcuse, 1982). It is within this ambiguous context that we intend to debate technological risks and exploit their negative or perverse effects.

One of the perspectives that best discussed the role of technology in society was the so-called critical theory of the Frankfurt school, which aimed (in an Ideological point of view) the overcoming of social injustices and the emancipation of man, since technological society was understood as a system of social domination. This perspective was developed by Marcuse where it was emphasized that man has become dominated by technology. The proposal of this author goes to reformulate the whole role of technology, not in the sense of seconding it, but before placing it at the service of man (so that it can acquire a liberating character).

In a way Marcuse's theory had a premonitory character on some of the harmful effects of technology, although the author did not properly identify industrial technological risks, which would only be truly understood a *posteriori*. It was later found that some types of technology gave rise to catastrophic accidents[10]. Some man-made technologies have such a destructive risk potential that it might be useful to rethink whether the benefits they undoubtedly entail warrant the harmful risks associated with them (Perrow, 1999). This issue should be further grounded in a serious and broad socio-political debate at the global level. It is within this context that Garcia refers to the following:

10 For example, we refer to what is probably the worst industrial accident in the history of mankind. The disaster struck in the Indian city of Bhopal, where several tons of toxic gas was leaked. About 3,000 people died and more than 500,000 were injured. The immediate cause of the discharge was due to the influx of water into a methyl isocyanide storage tank, but the latent conditions that allowed the occurrence of this event are much more extensive (Reason: 1990). It is important to bear in mind that accidents usually result from the articulation of several factors (Areosa, 2009; 2012b; 2012c), that is, they have multiple causes and circumstances (Areosa and Dwyer, 2010), are hetero-determined. At the same time, the Bhopal disaster also allowed us to break with some of the "certainties" of the past: "The disaster raised three distinct questions about the 'big development' project, which had been hitherto unquestioned for five decades. It drew attention to the asymmetric inequities built into the very structure of the project. Next, it questioned the promises of the hubris underlying the idea of development. The following example illustrates exactly this situation: "Another example of a change in" (Rajan, 2002, p.376)

> "It is no longer unreasonable to question whether a particular technology contributes to increase or decrease the environmental crisis, the conditions of justice in society or even to alter in an extreme way the nature of the human condition such as we have known; The ballast of our eyes remains fixed on its mere utility and economic contribution" (Garcia, 2003, p.80).

In Lagadec's (1981) perspective, the alliance between know-how and modern science allowed the development of a complex industry. In turn, this alliance made possible the emergence of new technological risks. This condition leads the author to state that we are living in a civilization of risk. As a general rule, new risks of technological origin, when perceived by the public (as such), are not based on social consensus, on the contrary, they may be a source of controversy between the risk-producing agents and the public exposed to them (This last set of actors is designated by Palmlund as "victims"). According to Perrow (1999, p.310) the risks from the most risky technologies are not "born" equally for the different social classes. This situation leads us to the ancient question of the sacrifice of the majority of the population to ensure quality of life of some social elites (Palmlund, 1992).

In the concrete case of technological risks, some social agents (the "victims") must endure the costs of technological progress and this is where the center of drama and social controversy is situated (Palmlund, 1992). Sometimes the public looks with suspicion at the results of risk assessments promoted by the most powerful groups that usually try to soften the effects of certain risks with high harmful or catastrophic potential and these situations can turn into conflicts. Although the conflicts over technological risks are characterized by life cycles, where their social visibility goes through different moments, oscillating between cycles of strong agitation or moderate tranquility (Palmlund, 1992, p.206). Technology itself is also determined by the wheel of life[11], although these cycles are in the modern world increasingly shorter.

If, on the one hand, advances in science and technology have made it possible to control certain types of risks, namely some infectious diseases, on the other hand, gave rise to new risk scenarios involving, for example, chemical, biological and radioactive agents

11 The master coupling paradigm has been moving from balloons to airplanes in air transportation. For nearly half of a century between 1875 and 1925, commercial public air transportation was successfully made by airship. The airship totally collapsed in a short period after the Hindenburg accident in New York in 1936, and was immediately replaced by the emerging airplane industry. Again, this change is full preserved the main function of the system (transporting passengers by air) "(Amalberti, 2006, p.266).

(such as nuclear power plants)[12]. This idea is also expressed by Beck (1992) when he states that development and technological production have led to the creation of new types of risks. In a similar line of thought, Delicado and Gonçalves (2007, p.695) suggest that the new forms of risk are linked to the modes of production of wealth in "advanced modernity", which in many cases are triggered by the use of technologies.

Duclos (1989 - quoted in Douglas, 1992) denounces two types of fears concerning technological risks; the former is linked to fear of dying due to technological disasters, while the latter associates fear with alleged oppression by those who control the new technologies. From Douglas and Wildavsky's (1982) point of view, some technological risks play a prominent role in our minds, due to the anxiety and uncertainty they produce. At the same time, Theys (1987) states that the analysis of technological risks is an important factor in understanding the various social vulnerabilities of the modern world.

So far we have mainly outlined some of the unfavorable aspects associated with technology. However, according to Fischhoff et al. (1984), the risks arising from modern technologies cannot be seen only from the negative consequences they produce, because nobody produces the technologies if they do not generate benefits and nobody can produce them without a certain investment or economic cost.

We have already mentioned that technological risks can lead to major disasters, potentially fatal and / or devastating in terms of human lives or material goods (Areosa, 2012b), but also, paradoxically, they bring us a higher quality of life. Metaphorically, technology can be seen as a "poison" that simultaneously can carry the "antidote" to some contemporary evils. When deciding to adopt a certain technology we have to accept its range of characteristics (benefits and / or losses), since both come in the same "packaging". Otway (1992) points out that technological risks are not only perceived in abstract scenarios, but are a part of a wider set of attributes and social considerations that can lead people to accept or reject them.

In Daniel Kahneman (2012) perspective, the world that is idealized in our heads is not an exact replica of reality. We, as a species, are quite vulnerable to construct and imagine illusory scenarios based on emotions, preferences, and feelings. The heuristics of fondness "help us" in this task, since they are likely to produce

12 According to a survey carried out in Portugal on "new risks", 75% of the respondents considered the possibility of a nuclear accident to be very serious and 57% said they were very concerned about the effects on Portugal if an accident occurred at a nuclear power plant in a near country. (Delicado e Gonçalves, 2007, p.692).

multiple biases. In an investigation reported by the author it was found that there was a high negative correlation between the level of benefit and the level of risk that the respondents attributed to certain technologies. Thus, when people had a positive feeling about certain technologies, they referred to them as containing various benefits and few risks; on the contrary, when they had a negative preference for any technology, they tended to see only their disadvantages and few benefits came to mind. The most surprising part of this experience came when researchers, after respondents completed the initial survey, provided them with arguments in favor of the technologies. Some subjects in observation were put forward several arguments that highlight the benefits of certain technologies; others were given arguments that underlined their low risks. What the researchers found was that even people who had just received information about the benefits of the technologies ultimately changed their beliefs about the risks of those technologies. Although these people did not receive any information about the risks associated with them, they came to see them as less risky. The reverse situation also occurred, namely the ones who were told that a given technology had fewer risks, ended up forming a more favorable opinion on its benefits. The author comes to the following conclusion:

> "The heuristic of affection simplifies our lives by creating a world that is much tidier than reality. Good technologies have low costs in the imaginary world we inhabit, bad technologies have no benefits and all decisions are easy. In the true world, of course, we often face painful compromises between benefits and costs" (Kahneman, 2012, p.189)

We reiterate that in Ulrich Beck (1992) point of view, the development of science and technology allowed the economic progress of Western societies and the fruit of this development contributed to the emergence of new risks. A risk, from Beck's perspective, defines modern societies and it is for this reason that the author has designated them as risk societies. The notion of risk arises associated with the concept of reflexive modernization.

> "Risk may be defined as a systematic way of dealing with hazards and insecurities induced and introduced by modernization itself. Risks, as opposed to older dangers, are consequences which relate to the threatening force of modernization and its globalization of doubt. They are politically reflexive." (Beck, 1992, p.21)

Beck (2001) identifies that in today's risks societies; no one wants to take on the harmful effects of globalization processes and techno-

logical development. But, in fact, no one can escape its consequences, since we are all retained in the web of globalized technological risks. The author states that, to a certain extent, we live in a period in which responsibility is diluted by various segments of society. Policy makers state that they are not responsible for the effects of technological risks; at the very most they regulate their development. Scientists say they only generate new technologies, but they do not decide on how they are used. Entrepreneurs advocate that they only meet consumer needs. It is for this reason that the author designates this situation as an organized irresponsibility. It seems that today's society has become a laboratory where no one wants to take responsibility for the outcome of the "experiments."

One of Beck's central theses reveals that some of the new risks may no longer be thought of as local phenomena, circumscribed to a particular area or situation, since they have assumed a global character. The approach of the *risk society* had an enormous social impact in its initial phase, although later it was also the target of several criticisms of its theoretical conception (Mol and Spaargaren, 1993; Lash, 2000; Elliott, 2002)[13]. Risk society emerges in response to the obsolescence of industrial society, where erosion of some social roles also occurs (Beck et al., 2000).

The terminology of risk society essentially designates a condition of contemporary societies, in which social risks, individual, political and economic tend to increasingly escape the protection, control and monitoring of industrial society. According to Beck, there are two distinct stages for these two social realities, that is, risk society succeeds industrial society. The transition from industrial society to risk society is irreversible and Beck will designate this period as reflective modernity or reflexivity[14]. Thus, at first, the risks, threats and perverse effects of industrial societies coexist equally, but are not part of the media agenda or public discussion, nor are they at the center of political debates and conflicts; while in a second mo-

13 The critics of Ulrich Beck argue that the success of the concept of risk society is due to historical circumstances (e.g. Luhmann sees this concept as a model) than properly to a true social theory consistent, that is, they defend that the theory of Beck circulates between the truth and the prophecy. It also points to a lack of precision in policy proposals to deal with its global risk diagnostics. Beck was also dubbed as the theorist of catastrophe or apocalyptic. It is true that some statements by Beck are likely to cause some social alarmism, particularly when he says that nuclear power plants can destroy or contaminate a whole millennium. The author also recommends that this type of risk is socially devalued and the use of the (probabilistic) notion of risk is poorly compared with, for example, smoking, where the latter is considered statistically more risky (Beck et al., 2000, P.17). In this situation it is clear that Beck is more concerned with the possible consequences of accidents at nuclear power stations (social risks) than with the high probability of health damage from smoking (individual risks).

14 Reflective modernization means self-destruction Industrial society. The term reflexivity in Beck's perspective does not essentially mean reflection; it means, above all, self-confrontation between the effects of risk society and the industrial society, since the latter is incapable of monitoring and solving certain uncertain situations (Beck et al., 2000).

ment, the discussion about the effects of risks come to occupy these spaces. The media plays an important role in risk societies.

In the first stage, the most striking characteristic of industrial society still prevails, where threats or risks to the public are devalued and not legitimized by the various centers of decision and power, which attributes an insignificant value, generally being designated as residual risks resulting from daily life. In a second stage of development, there is real awareness of risk situations, where hazards tend to become the center of public and private political debate. According to Beck, current organizations have become simultaneously producers and consumers of the multiple forms and sources of risk that they cannot control.

"The transition from the industrial period to the period of modernity risk occurs in an unwanted, invisible and compulsive manner at the onset Of the autonomous dynamism of modernization, following the model of latent secondary effects. Virtually we can say that the constellations of the risk society are (The consensus about progress or the abstraction of ecological effects and accidents) dominate the thinking and action of the people and institutions of industrial society. The risk society is not an option that can be accepted or rejected in the course of political disputes. It arises in the continuity of the processes of autonomized modernization, which are blind and deaf in relation to their own effects and threats" (Beck et al., 2000, p.5).

Perrow's (1999) work, first published in the mid-1980s, is one of the most prominent systemic approaches and presents a diagnosis on the subject of the technological risks associated with major accidents, as well as the underlying factors. In his own words, the central theme of his book is power and not risk- the power of elites to impose certain kinds of risks on many for the benefit of the few. Parallel to this discussion, we can say that high-risk technological systems are the subject of a privileged analysis, addressing organizational realities as diverse as; nuclear power plants, oil platforms, marine, chemical industry, aviation, space missions or genetic engineering. These and other (unreferenced) activities have a catastrophic potential that can save hundreds of human lives and affect thousands of others, as well as the losses they can generate at material, social, economic and environmental levels (in the latter case, designated by literature as Ecocide). Probably, this will be on of the reasons why the study of risks and major accidents gained some social visibility (Areosa, 2009; 2010).

In Perrow's (1999) perspective, some of the technology that was developed from the 1970s it's characterized for being extremely complex. This specific type of technology was designated by the author as highly interconnected complex systems. The dysfunctions of a sub-system can give rise to the so-called *domino effect* and

initiate systemic accidents, where a significant part of the system or even the entire system is destroyed. Technological accidents usually involve heavy losses. Perrow reveals some examples of accidents of this type related to aeronautical engineering, nuclear power stations and the chemical industry. Technological risk assessments should not only consider these risks technologically, as they are included in a social and human system. Some risks analysis underestimate key factors within organizations, such as the inevitable human error[15], the dilution of responsibility within hierarchical chains, pressure on worker productivity (often nullifying or reducing safety levels), the use of (Eg, control systems), obsolete or inadequate control systems, different ways of perceiving and interpreting organizational risks and exceptional work situations (which expose the risks and consequently the occurrence of accidents) (Areosa, 2012c).

In Perrow's (1999, p.23) the essence of accidents of technological origin lies in the interaction of multiple faults whose sequence is not directly anticipatory. Some of these unexpected interactions have a catastrophic and self-destructive potential of the system itself, and it is these singular interactions that normally cause major accidents due to rare, very specific circumstances. It is pertinent to note that technological accidents (or major accidents) are *heterodetermined* (Areosa, 2015). The difficulty in anticipating and preventing these situations is due to the almost infinite number of possible interactions between failures in the various components of complex systems, although the interaction of failures with catastrophic potential is supposed to be reduced, partly due to safety devices[16]. But this does not mean that

15 On the night of March 6, 1987, a large ship turned up a few seconds after leaving the port of Zeebrugge (Belgium). The accident caused close to 200 fatalities. The main cause pointed out to explain this accident was: human error. The boat that was transporting cars to England began its march ("to the disaster") with the doors to access the deck, open (zone of passage of the cars into the boat). It was precisely here that an enormous amount of water entered, which caused the imbalance of the ferry. There was a great deal of pressure on the crew to meet schedules (and this seems to have contributed to the potential for several errors to occur). We believe that every worker has tried his or her best to optimize the cost / benefit ratio (for the company), in a world in which the organizations are, more and more, impelled to be competitive. The problem is that this type of competition sometimes generates errors and accidents (Rasmussen, 1997). It is pertinent to remember that in complex high-risk organizations, it is difficult for someone to have a joint vision so complete that they can always avoid (such as always) the type of situations (Areosa, 2012b). It is also important to remember that security can become an objective in conflict with other objectives of the organization (not always the multiple objectives of the organizations appear in perfect harmony, in fact, they are often not in tune). However, it is almost always so easy to find some villain who has made any mistake deemed unacceptable. But, as Perrow (1999) points out, it would be best if we stopped blaming innocents, for the mistake seems to be not so much in people but rather in the ultra-complexity of some systems. Moreover, it is through living labor (that which is added to the formal prescriptions) that many problems are solved; In fact, this is what makes organizations effective.

16 In complex and tightly interconnected systems, one of the ways to try to ensure security is through the creation of mechanisms. Organizational redundancy (parallel systems) is generated by systemic duplication for the same function (in case of failure of the first unit the second works). In this way, redundancy can be seen as a "mechanism" that protects against the occurrence of failures. According to Sagan (1993, p. 251), we have some historical evidence that demonstrate the inadequacy of trying to ensure the reliability and security of organizations by joining more and more redundant parts into systems.

in exceptional circumstances accidents cannot occur. Perhaps it is the small number of failures (in articulation with each other) with catastrophic potential why systemic accidents are relatively rare events. The major concern related to large-scale technological accidents is that they are situated in the damage or damage caused and not so much in the frequency of their occurrence. This is precisely why we should not ignore constructive paranoia, debated by Jared Diamond (2013).

Final Considerations

Technology is usually "undisciplined" and its "black boxes" are sometimes difficult to decipher (Wynne, 1988). In Paul Virilio (1983) perspective, any and all technology is likely to produce accidents. The author mentions the following examples: the invention of ships gave rise to shipwrecks; the creation of the locomotive enabled the derailments; and the construction of airplanes allowed aerial disasters. For this reason, the continuity of technological development implies that we have to think more about its negative consequences (not just the benefits they offer us), including the type of accidents they can cause. It is pertinent to remember that accidents are an inevitable feature of the universe (Green, 1997). Complex technologies incorporate certain "poorly understood" uncertainties that we cannot control, including their interactions with the social system. However, it seems that we are still far from accepting this condition with some humility and seriousness. The omnipresence of technological risks in complex systems is, to a large extent, the antechamber for accidents (Areosa, 2009).

The uncertainties of the socio-technical systems transform current societies into true experimental laboratories, the consequences of which may be unforeseeable (Beck, 1992). There are no risk-free organizations, so accidents are inevitable events that can occur at any time. This does not mean that prevention is not useful, but it is pertinent to consider that even the "best" prevention strategy has its limits. According to Perrow (1999), organizations that have complex or ultra-complex technological systems have proven that they do not have conditions to eliminate all accidents. However, this does not necessarily mean that we are facing "incompetent" organizations or unable to control the risks of their activities, it means, above all, that security of organization reveals limits inherent to their own condition. Often, we ignore our own ignorance, and that can become dangerous.

In a way, accidents are socially produced and have become a "normal" event because of the high complexity of some systems and their nonlinear interactions. This implies that

we cannot think of preventing all accidents, otherwise it will be an unrealistic and utopian view of the reality of organizations. We re-emphasize that the whole theory of Perrow (1999) reinforces the idea that accidents are inevitable events and their prevention, in certain contexts, becomes virtually impossible to accomplish. Even the experience of previous accidents cannot add to the prevention of future accidents, since the alignment of their causes and circumstances is usually singular or almost unrepeatable. There is no doubt that technologies usually offer us a beneficial and a harmful side (we think this aspect is relatively consensual). What becomes complex and problematic in the debate over some technologies is the political decision to either accept or reject them. Kahneman (2012) has already shown us that the way we look at technologies is not always as rational and objective as we knew.

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