Beck Back in the Nineteenth Century: Towards a Genealogy of Risk Society

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"Beck back in the nineteenth century. Historicizing Risk Society in the long run."

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There is today an assumption, shared by most thinkers of post modernity that for about two generations we have been experiencing a complete transformation of our relationship with science, progress and risk. The story goes like this: as modern technologies have radically changed the scale of human action, risks have changed in nature; they are global, concern future generations, and pose threats to human nature and/or existence. Consequently, two pillars of industrial society have been undermined. First, the consensus on progress that linked technological achievements and hope of a better future has been breached: anxiety dominates our thought and technological choices now depend on the outcome of social conflicts. Second, the traditional after-the-event management of risk by insurance companies, fire brigades and suchlike, which dealt with the consequences of technological accidents, is rendered inadequate by new major risks that necessitate a new kind of political prudence, summarized by what is known as "the precautionary principle."

Landmark writers of social theory have coined new labels to name our epoch and express its novelty: "risk society" as opposed to "industrial society," "reflexive modernization,"[1] "second modernization,"[2] "high modernity,"[3] or "mode II society;"[4] while

[1] Ulrich Beck, *Risk Society: Towards a New Modernity*, 1984; London: Sage, 1992.
[2] Anthony Giddens, *Modernity and Self Identity: Self and Society in the Late Modern Age*, Cambridge: Polity Press, 1991.
[3] Nicklas Luhmann, *Risk a Sociological Theory*, New-York: De Gruyter, 1991.
[4] Helga Nowotny, Peter Scott, Michael Gibbons, *Re-Thinking Science. Knowledge and the Public in an Age of Uncertainty*, Polity Press, 2001.

philosophers have reflected on the recent transformation of the “nature of human action.”[5] Of course, sociologists and philosophers of risk differ widely on their normative positions,[6] but they all seem to agree that technoscience has transformed the question of risk only very recently.

In this article I would like to challenge the purported *radical* novelty of our situation. I believe that the historical narration underlying contemporary literature on technological risk is (in part at least) a construction which, for the sake of sociological argument, has reduced past risks to somewhat reassuring categories. Contrasting our nuclear and biotechnological times with the old days of coal and steam, when technologies were supposed to be simple enough and the risks limited and insurable, legitimizes at a theoretical level new forms of political engagement and risk assessment, and the call for democratic participation in technological choices. But on the other hand, this opposition between old “progress society” and new “risk society” has two defects. First, it overlooks the polymorphous nature of risk in the nineteenth century and the perplexities that contemporaries expressed in the face of their new technological powers. Secondly, it prevents us from understanding that these perplexities, and the social mobilization they fostered, had an essential role for the construction of safer technologies.

The alternative narrative proposed here is an attempt to historicize the “risk society” thesis and use its hindsight to better understand the relationship between technoscience and society in the nineteenth century.

Presentation of the plan.

But first let me emphasize

This is not only a retrospective construction: thinkers of the mid-1850s already discussed modernization in terms of the transformation of risks, and insisted on such concepts as uncertainty, the fallibility of science, and unpreventable catastrophes. I will present in some detail the works of a completely though unjustly forgotten philosopher, Eugène Huzar, who

[5] Hans Jonas, *The Imperative of Responsibility, in Search of an Ethics for the Technological Age*, 1979, University of Chicago Press, 1984.

[6] Sociologists such as Ulrich Beck, Michel Callon or Arie Rip advocate solutions in terms of new procedures: transparency, good governance, public participation and co-construction of expertise will pave the road for a new form of democracy able to regulate the risks of advanced technoscientific capitalism. Others, building on the precautionary principle elaborate a new kind of political prudence able to deal with new major risks. Philosophers following Hans Jonas construct a new ethics grounded on responsibility for the future, the heuristics of fear or ‘enlightened catastrophism,’ see: Jean-Pierre Dupuis, *Pour un catastrophisme éclairé*, Paris: Seuil, 2002.

wrote two books of great interest, *La Fin du monde par la science* (1855) and *L'Arbre de la science* (1857).[7] Reflecting on the technological shocks of his time (vaccination, steam technologies, railroads, chemical manufacturing, deforestation, transoceanic canals, and so forth) and imagining the future, Huzar prophesized the global disaster that progress entailed. His complete disappearance from our historical knowledge is even more surprising given that, in his time, his arguments aroused great interest and much controversy.

1. Eugène Huzar's technological apocalypse.

As Huzar recalled,[8] his theory was revealed to him when, as a medical student attending an experiment on the solidification of carbon dioxide, he witnessed a dreadful explosion that killed the experimenter. Huzar thereupon realized that "one day, by harnessing the very energy of matter… man will fatally provoke a final catastrophe."[9]

Huzar's originality lies in his proposal, probably for the first time, of a progressive critique of progress founded on technological catastrophism. He is not a romantic writer railing against the ugliness of industrialization, nor a priest condemning the craving for riches. On the contrary, he defends himself from the charge of being in any way reactionary: "I wage war on neither science nor progress, but I am the implacable enemy of an ignorant science, of a blind progress that walks with no guide and no compass."[10] According to Huzar, being "anti-progress" would in any event be nonsense because progress is the driving force of the world and therefore an absolute necessity. He fully integrated into his theory the usual contemporary discourse of progress: nineteenth-century technology was only "the dawn of everything" and progress would accelerate "as the square law" as society itself became increasingly organized to produce innovations. Knowledge democratization and the

[7] *La Fin du monde par la science*, Paris: Dentu, 1855. *L'Arbre de la science*, Paris: Dentu, 1857.

[8] Eugène Huzar seems to have cultivated somewhat eclectic interests. He was a lawyer but showed a strong interest in medicine (which he had studied), politics, philosophy and religion. He mentions going to courses at the *Ecole des arts et métiers* and attending chemical experiments. His political ideas placed him on the left, he was a fervent republican: in 1850, he opposed Louis-Napoléon Bonaparte and published a bill proposing that the National Assembly move to Bourges so as to resist usurpation. In his writings he also praised Rousseau, Condorcet, Fourrier, Hugo and Lamartine. He was well versed in the symbolism and mythology of religions, thanks to his reading of Georg Friedrich Creuzer, *Symbolik und Mythologie der alten Völker,* which had been translated into French in 1851. According to Huzar, all religions across the globe shared one symbol: the Fall of man because of his hubris. Thus, they must all refer to the same actual event; and this was, according to him, a global disaster caused by science, which was the origin of the story of the Garden of Eden. Furthermore, Huzar believed that history is cyclical and that in the nineteenth century mankind was once again approaching Eden and its calamitous conclusion.

[9] *La Fin du monde*, 6.

[10] *L'Arbre de la science*, 40.

increasing interaction between science and industry ("Science makes the industrialist, and in turn, the industrialist makes the savant because industry creates everyday new phenomena to observe") would establish the conditions of an unlimited technoscientific progress as each worker would be at the same time an experimenter, a scientist and an inventor.[11] National rivalries would cease, races would fuse and one language (French of course) will integrate all other tongues. In short, humanity will unify in its quest for technological progress.[12]

Nevertheless, after singing the praises of the future, Huzar warned his readers that however powerful science may become, it will always remain *experimental*, that is, it can, by definition, learn only *a posteriori* and therefore cannot anticipate the far-reaching consequences of increasingly powerful technologies. He called this the principle of "*science impresciente*"; that is, science cannot predict all the results of its own actions. For this reason he believed that science had simply replaced gods or providence as the foundation for a fatalism that lay at the heart of human experience. Reflecting on railroad disasters caused by imperceptible events but killing *en masse* he argued that "it is impossible for our limited reason to anticipate everything so as to prevent everything… With the discoveries of science, death is becoming collective. Fatalities used to be sporadic and were of individuals only; now, with science, they are epidemic."[13]

Consequently, Huzar believed that the gulf between technological ability and limited foresight, as exemplified by the railroad system, would cause the apocalypse. He was actually a very good prophet of doom: he imagined an impressive list of man-made global disasters, some of which seem quite prophetic indeed. For example: who knows the consequences of deforestation and the extensive use of coal by industry? "As man becomes more involved with industry and uses more coal you can predict that in one or two centuries, the world being criss-crossed by railroads and steamboats and being covered by factories and industrial plants, billions of tons of carbon dioxide will be emitted, and as the forests will have been eliminated, these billions of tons of carbon could well trouble a little the world's harmony."[14] Who knows whether, by extracting ton after ton of coal, man will not change the center of gravity of the earth and tilt its axis of rotation? Who knows whether, by digging transoceanic canals, man will not cause a perturbation of maritime currents and terrible flooding? But according to Huzar, the best candidate for the apocalypse is a future substance that man would invent,

[11] *La Fin du monde*, 32.
[12] *La Fin du monde*, 36.
[13] *L'Arbre de la science*, 129-31.
[14] *Ibid.*, 106.

which could set fire to water, burn the oceans, melt the soil and destroy organic life on earth. Of course, scientists argued that such fears were unfounded, but Huzar proposed that on such important matters the burden of proof should be shifted. Scientists must show that canals, mines, deforestation or any other proposed innovations are perfectly harmless. "If we are so demanding toward science it is because nowadays science tends to substitute its blind action for nature's; but before doing so, it is necessary to prove that science will do better than nature."[15]

Modernity, according to Huzar, is characterized by man's feeling of responsibility toward his planet. He systematically compared the earth to a living body (deforestation as earth's baldness, mines as aneurisms and so forth) and man's actions are like wounds inflicted on the earth-cum-body:

> "I will be told that what man does to nature is like a scratch on the skin of a healthy man. I agree, but who does not know that sometimes a simple scratch can cause death? So it is right to say that the smallest causes can produce the greatest effects… I would understand that a primitive man… says that the earth is infinite and therefore man cannot disturb its harmony... But today, with science, this proposition is inverted: it is man who has infinite capacities and the planet that is very finite. For us, our planet is limited, very limited. When one sees something as limited as the earth, and a power as unlimited as man using science, one can only wonder what impact this power will have, one day, on our poor small earth."[16]

The prophylactic measure proposed by Huzar was the global governance of nature and innovation by science. First, a new science "will have to be created so as to determine and study the laws that govern the globe's equilibrium."[17] Second, a world council (*édilité planétaire*) will be instituted as the first authority on earth for "regulating humanity's work" and "watching over the globe's harmony." It will grant authorizations to scientists to perform important experiments, or to nations to deforest, extract coal or cut an isthmus. This breach of national sovereignty was necessary to prevent "abuses of freedom that would compromise the general harmony."[18] Huzar's utopia is clearly technocratic, even though the world governors are to be nominated by their fellow citizens, they are to be chosen only from the elites of science. The world council would work as a global panopticon: based in a major city, its telegraphic network, like a spider's web, would ensure that "nothing important in the world

[15] *Ibid.*, 110.
[16] *Ibid.*, 112-3.
[17] *Ibid.*, 275.
[18] *Ibid.*, 277.

could be done without its being informed…You have to know it: science will be one day the queen of the world, everything will be ruled by her. Her responsibility will become very great; she will have to take care of the world's souls."[19]

However, Huzar thought that the world council, being guided by experimental science, could only delay rather than prevent the apocalypse. Something different from science had to emerge: a kind of "prescience" or "intuition." He remained rather elliptic on this point because it was supposed to be the subject of a third book (*L'Arbre de vie*), which was never published. But he hinted at a new utopia, the construction of a desirable future that would allow mankind to shape the present accordingly and resist the destructive logic of progress, with its tendency to replace nature by artifacts. "Today the oracles are mute and the world is drifting, without compass, without guide, driven by an irresistible force: progress… Man needs a conception of the future, which would allow him to shape the present according to such an ideal type."[20]

Huzar liked to depict himself as a misunderstood prophet: "This is the defect of all prophecies; the milieu in which they are pronounced is not ready to receive them… I resign myself to not being understood; [I am] pretty sure that one day this book will reflect everyone's opinion."[21] "This book is not for this century."[22]

In fact Huzar had an excellent sense of timing: "progress" was of course the buzzword of the 1850s. But, more specifically, he elaborated his ideas during, and in opposition to, the technophile craze which anticipated the Universal Exhibition of 1855 in Paris. The publication of *La Fin du monde par la science* in April of that year was timely, for the Exhibition opened on 15 May. As five million visitors went to the *Palais de l'Industrie* to admire all sorts of machines, and the press was saturated with eulogies of Progress and Industry, the book was obviously intended to be provocative. And it succeeded: every major periodical reviewed it[23] and most of them spoke of it very highly: "This is the book I have always dreamt of."[24] "Mr. Huzar's system does not lack grandeur or truth."[25] "This is a

[19] *Ibid.* 278.
[20] *Ibid.*, 70.
[21] *La Fin du monde*, 24.
[22] *La Fin du monde*, 162.
[23] Among others: *l'Illustration*, *l'Appel*, *la Vérité*, *le Courrier*, *l'Athénaum*, *l'Artiste*, *la Revue française*, *la Revue de Paris*, *l'Organe de l'industrie*, *l'Univers catholique*, *le Moniteur*, *la Gazette de France*, *La Revue Britannique*, *La Revue Chrétienne*, *le Siècle.*
The book was also reviewed in English periodicals. Charles Dickens' *Household words* published a long if not positive critique. Cf. "All up with every thing", *Household words*, No 318, 25 Apr 1856, 336-9.
[24] *Gazette de France* quoted in Huzar, *L'Arbre de la science*, 3.
[25] *Le Moniteur*.

completely new system which, although strange, is based on facts."[26] This first book by an obscure lawyer with some dubious scientific background was unquestionably a great success, and by 1865 it had been through three editions. Celebrated literary and religious figures took some inspiration from it; indeed Lamartine, in his very popular *Cours de littérature,* was accused of having plagiarized Huzar in proposing that Eden was in fact an advanced civilization. Huzar also inspired Father Félix to deliver in Notre-Dame a series of sermons, attended by the great and good of Paris, concerning the dangers of technological progress without its ethical and Christian counterpart.[27] Huzar tried to repeat his success, and offered a sequel with *L'Arbre de la science* which, although much longer than *La Fin du monde* and somewhat lacking its sacred fire, nevertheless got excellent reviews. To the renowned archeologist Felix de Saulcy, it was "one of the most enticing books [he] had ever read,"[28] and the poet Auguste de Vaucelle went so far as to praise "one of the most remarkable books of this century… a book of capital interest for humanity."[29] Thus it would be a mistake to believe that Huzar was an obscure thinker with no readers: the French public of the 1850s and 1860s enjoyed his books and his theory of technological catastrophism circulated widely in the middle of a century said to be intoxicated by progress.

2. From Eugène Huzar to Ulrich Beck.

On one point at least, Huzar's prophecy proved to be right: his anxieties concerning technological progress are nowadays shared by more or less everyone and he could be praised as a precursor of twentieth-century technological catastrophism. But my reading is quite different: even if Huzar's tone and intent are prophetic, he derived many of his arguments from actual technological and environmental disputes he witnessed himself, such as those concerning the effects of vaccination on human degeneration, the causes of railways disasters, and the relationship between deforestation and climatic change. Rather than being a prophet, Huzar was in fact a critic of mid-1850s technological risk, and the fruitful question that his

[26] *L'Artiste*.
[27] *Courrier de Paris,* 21 Oct. 1857. See: Lamartine, *Cours familier de littérature*, 2, Entretien 12, Paris: Didot, 1857 and R.P. Félix, *Le Progrès par le christianisme, conférences de notre dame de Paris*, 2^{e} année 1857, Paris, 1858. Other of Huzar's legacies could well be Jules Verne's novels: *Sans dessus dessous* and *l'Eternel Adam,* which describe catastrophes similar to Huzar's.
[28] *Courrier de Paris*, 21 Oct. 1857.
[29] *L'Artiste*, 9 Aug. 1857.

works invite us to ask is “whether the society that Huzar lived in can be analyzed as an early form of risk society, and if so, in what sense?”

Ulrich Beck’s Risk Society thesis will be my point of reference in the vast sociological literature on technological risk and post-modernity because he is one of the rare sociologists who has clarified his historical construction and pointed out what he considers to be the fundamental transformations defining post-modern and risk society as opposed to modern and industrial society.[30]

Beck says risks have changed in nature. They used to be natural or sanitary; they are now produced by modernization. They used to be limited in space and time; they are now global and potentially of unlimited duration. They used to be insurable; they now defy any risk calculus. Indeed, their probabilities are minuscule or undeterminable but their potential consequences are limitless. In brief, technological choices have to be taken in a context of perplexing uncertainty. Although science is increasingly necessary, it is often powerless to foresee the consequences of technological systems, some of which have reached a degree of complexity that renders their behavior undeterminable. Technologies are tested in the real world: technoscience has turned society into a laboratory.

In this process, Beck concludes, industrial and capitalist societies have been deeply transformed. The traditional class divides are remodeled by the environmental conflict: in prosperous post-industrial societies, arguments about the repartition of risks have overshadowed the class struggle over the repartition of wealth. This leads to a ‘scientifization’ of society: as risks become the center of social conflict, expertise plays an increasing political role for it gives the social realization of otherwise insensible threats. Thus the functioning of expertise is becoming a key political issue.

My aim is twofold: I discuss this historical narrative of risk and modernization, and at the same time I use it as a guide for exploring the complex and variegated landscape of technological risk in nineteenth-century France.

3. *The “new risks of the past”: uncertainty and catastrophe.*

To start with, the clear-cut opposition between old natural and sanitary risks and new technological ones is difficult to sustain. Risks can be a mix of old and new, of the natural or

[30] Ulrich Beck, “From Industrial Society to Risk Society”, *Theory, Culture & Society*, 9, 1992, 97-123.

sanitary with the technological: for instance, the technological management of germs and miasmas.[31] In 1833, the entrepreneur of the fecal dump of Paris located in the town of Bondy could not get rid of the water and urine that was mixed with the precious fecal matter that he intended to sell to farmers. He decided to use the new technique of "absorbing wells" to empty the 80,000 square meter basins. The idea was to drill deeper than the water table of the Paris wells so that the fetid liquids (but not the fecal matter) flowed into a permeable layer seventy meters underground. On the first day of its use 200 cubic meters of liquid were absorbed. However, on hearing about this the Prefect of Police ordered the immediate closure of the new well and ordered an expertise because at that time, right after the 1832 cholera epidemic, there was too great a risk of a general contamination of the Paris water table and so of a return of the epidemic. We do not know the exact story of this well, but it is not sure that the experts of the *conseil de salubrité* of Paris succeeded to convince the Prefect of the absence of danger. Indeed, they used rather doubtful geologic evidence in attempting to show that his fears were unjustified because the waters in the deep layers were like torrents which would carry the noisome liquid far away. The 40,000 cubic meters of dilute urine that annually poured into the well could not, they said, do any harm.[32]

Many catastrophes that we might consider as having natural causes were not so considered in the nineteenth century. Rather, they were ascribed to a complex mix of natural and human causalities: for example it was common knowledge that deforestation caused climate change and flooding.[33] In April 1821, the Minister of the Interior sent a curious instruction to every prefect: "*Messieurs*, for a few years we have been witnessing a noticeable cooling of the atmosphere, sudden changes in the seasons, tempests and extraordinary flooding, to all of which France seems to have become more and more prone. They are attributed in part to deforestation… These evils might not be without remedies." Questionnaires were accordingly sent to the prefects, who ordered mayors to conduct enquiries. Elders, peasants, millers, amateur meteorologists and agronomists were asked about ancient agricultural practices, the seasons, rain and hail, the winds and temperatures, the state

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[31] Sabine Barles, *La Ville délétère*, Paris: Champs Vallon, 1999.

[32] Girard and Parent-Duchatelet, "Des puits forés ou artésiens pour l'évacuation des eaux sales et infectes", *Annales d'hygiène publique et de médecine légale*, X, 1833.

[33] The history of the forest-climate relationship (which can be traced back to Theophrastus of Erasia) is yet to be written. Since the sixteenth century at least, one can find such anxieties regularly voiced by the French provincial Parliaments. For a good overview of this problem in the 18th century tropical and colonial setting with the botanist and administrator Pierre Poivre as a father figure of environmentalism see Richard H. Grove, *Green Imperialism, Colonial Expansion, Tropical Island Edens and the Origins of Environmentalism*, *1600-1800*, Cambridge: Cambridge University Press, 1995.

of rivers and forests, and so forth. This information was sent back to the *Académie des sciences* which refused to come to a definite conclusion because "rigorous calculus" and numerical measurements were lacking in most of the reports.[34]

Nevertheless, the link between deforestation and climatic change gained in credibility as the century progressed. In 1836 the question was raised officially in the National Assembly. When a deputy from the opposition proposed a law granting the freedom to clear land, the Minister of Commerce and Public Works asked François Arago, the famous deputy and scientist, for his opinion. Arago's response was a plea for the role of scientific expertise: he said that there were too many areas of uncertainty, and so climatologic research was badly needed before taking a decision upon such an important issue. "If you authorize land clearance it might be, I don't say it will be, please notice the difference, it might be that one day you may regret it."[35] But after this cautious preliminary remark, he gave an apocalyptic portrayal of deforestation, which could transform temperate climates into extreme ones, increase the number of hailstorms, transform peaceful rivers into torrents, raise river-beds and cause extensive flooding. On his recommendation, the assembly voted to form a parliamentary committee, chaired by himself. The opposition retorted that the question was political rather than scientific, and that the government had used purported uncertainty so as to delay the law: floods were providential scourges, and river-beds were raised because of geological laws about which the government could do nothing.

After the terrible flooding of 1855 and 1856, deforestation was commonly cited as the cause. For the popular science magazine *Cosmos*: "The main cause of flooding and hails which are nowadays so frequent is the deforestation of mountains. Altitude forests should become, as they used to be, the object of a religions cult".[36] Subsequently a political consensus was built, which paved the way to the reforestation law of 1860.[37]

If we focus on the new technologies proper, and the socio-technical controversies that they fostered, we can discern the same concerns about uncertainty and the potential, long term, catastrophic consequences of human actions.

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[34] *Procès-Verbaux de l'Académie des sciences*, 16 Feb. 1824.

[35] François Arago, *Œuvres complètes*, Paris: Gide, 12, 432.

[36] *Le Cosmos*, 11 July 1856.

[37] On mountains reforestation, the (conservative) ideology of the forest engineers corps, and the social history of forest management see: Andrée Corvol, *L'Homme au bois*, *Histoire des relations de l'homme et de la forêt, XVIIe-XXe siècle*, Paris: Fayard, 1987; Bernard Kalaora, Antoine Savoye, *Forêt et sociologie, les forestiers de l'école de Le Play, défenseurs des populations de montagne* (1860-1913), Paris: INRA, 1984.

Let us take, for instance, the debates that occurred when vaccination began in France in the early 1800s. Opponents of Jennerian vaccine claimed that governments, by advocating general vaccination, played Russian roulette with their population. They argued that vaccinators knew nothing about the long-term effects of their practice because it was analogous to no other existing remedy. Eighteenth-century smallpox inoculation only involved a known disease, whereas the effect of cowpox on the human constitution was completely unknown. The opponents therefore asked for longer and more rigorous clinical experiments before vaccinating hundreds of thousands of children across Europe. For example, Dr. Markus Herz who, in 1802, sent from Berlin his comments to the French *comité de vaccine,* argued that two years' experience was completely insufficient for judging the efficacy of a national vaccination campaign. He wanted experiments to be made progressively, and claimed that the number of cases was not really significant: "50,000 trials or 100,000 trials could not decide the question." The problem was the nature of the long-term consequences. Thus the first thing to do was to stop vaccinating and observe the fate of those who had already been vaccinated. Then, after eight or ten years of observation, the results should be published and discussed by the medical world. After that, it might be decided to vaccinate another 100,000 people. Finally, only if vaccination was still considered safe and effective after a generation should the practice be universalized. Herz could not understand that vaccinators "could, without a qualm… expose an entire generation to a procedure that is still experimental… Great happiness or great sorrow can come out of it."[38] In the same way, Dr. François Goetz stated that the French government would not endorse vaccination "because it could not accept the burden of this enormous responsibility."[39]

The potential disaster linked with vaccination was thought to be not only about body-counts but also about the human constitution itself, which could be altered irreparably, thus jeopardizing the health of future generations. Dr Vaumes believed that it was probable that vaccination could transmit hereditary diseases such as syphilis or scrophulas, and so vaccine could "propagate its malignant influence over future generations."[40] In 1821, in a memoir read at the *Académie des sciences*, Chambon de Montaux, a renowned antivaccinist doctor and

[38] Marcus Herz, "L'inoculation brutale", Archives de l'Académie de Médecine, Paris, Box V1; and Marcus Herz, *Die Brutalimpfung*, Berlin, 1801.
[39] Goetz, *De l'inutilité et des dangers de la vaccine prouvé par les faits*, Paris, 1802, 11.
[40] Vaumes, *Les Dangers de la vaccine*, Paris: Guiget, 1800.

mayor of Paris during the Revolution, warned the audience that the matter "concerned the safety both of our contemporaries and of our descendents."[41]

The debate on vaccine and degeneration flourished in 1850s France. In 1849 Hector Carnot, using statistical data, argued that vaccination had changed the laws of mortality, but not for the better. True, the life expectancy had increased since the beginning of the nineteenth century, but for children only. A twenty-year-old Parisian man had a life expectancy of 37 at the end of the eighteenth century, but of only 26 in 1844.[42] Vaccine, Carnot said, was responsible for the change: smallpox killed mainly during infancy, but vaccination allowed the survival of delicate children who later succumbed to other ailments, thus transferring the burden of death onto the adults. The consequences of such an interference with natural laws were disastrous: fertility had decreased, depopulation loomed and, worst of all, the balance between the generations had been disrupted, thus forcing the able-bodied workers to support the needs of a proportionately larger population, which in turn had resulted in pauperism and—as Carnot hinted—in the 1848 revolution.[43] Medical explanations of Carnot's statistics drew on the hygienists' observations that gastroenteritis and tuberculosis were on the rise: the conclusion was that vaccination had simply replaced smallpox by these major new killers. I must emphasize that the antivaccinists, who are often depicted in modern histories of vaccination as reactionary eccentrics, were not described as such in the medical press of the 1850s.[44] The debate between the *comité de vaccine* and antivaccinists such as Verdé-Delisle, Duché, Bayard, Noirot, Villette de Terzé and Ancelon was reported in rather neutral terms, and antivaccination discourse can be found in mainstream medical reviews such as *la Gazette des hôpitaux* and *la France médicale*. Indeed, the general public was shocked to find that matters of such crucial importance were still uncertain and controversial. Eugène Huzar, however, regarded this "medical logomachy"[45] as illustraing his thesis of a "science imprescience."

One distinctive characteristic of the "new risks," according to Ulrich Beck, is precisely that they are not risks any more, by which he means that they cannot be subjected to risk calculus and insurance because they have minute probabilities but potentially unlimited

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[41] Chambon de Montaud, *Comparaison des effets de la vaccine avec ceux de la petite vérole inoculée par la méthode des incisions*, Paris, 1821, 128.
[42] Bertillon demonstrated later that Carnot's use of mortality tables was questionable. See: Bertillon, *Conclusions statistiques contre les détracteurs de la vaccine*, Paris: Masson, 1857.
[43] Hector Carnot, *Essai de mortalité comparée avant et depuis l'introduction de la vaccine en France*, Autun, 1849, 3.
[44] For instance Pierre Darmon, *La Longue traque de la variole*, Paris: Perrin, 342.
[45] Huzar, *L'Arbre de la science*, 124.

consequences. Therefore the possibility of an accident cannot be admitted, and the politician has to invoke a dogma of technical infallibility so as to legalize these new risks. The management of such a risk was precisely at the center of a controversy that occurred in 1820s Paris concerning the dangers of a gasometer of an unprecedented size: at 200,000 cubic feet it was ten times bigger than the biggest in London at that time.[46] Its opponents thought that it was simply unconscionable to establish this structure in the French capital. They imagined Paris razed to the ground: "Six hundred thousand citizens are at the mercy of a single malfunction," warned one, while another claimed that a million lives could be destroyed through an act of negligence or malice.[47] Even without the inevitable exaggeration, this was obviously a major risk. Opponents of the scheme recalled that in 1794 the explosion of the gunpowder manufactory at Grenelle in Paris had caused more than one thousand casualties. The academicians, very much in favor of a technology that they had helped to develop and in which some were financially interested, also acknowledged that an explosion "would be a disastrous event for the whole neighborhood," but they immediately added that it was practically impossible. Such a statement failed to reassure the opponents, who subtly employed this small but frightening uncertainty in their petitions to the government, where they pointed out that the actual risk was unknown, and that, in consequence, the insurance companies would insure neither their houses nor the gasholder. They also challenged the government to take moral responsibility for the scientific uncertainty, small as it might be: "It is very improbable that this enormous gasholder will explode, but one cannot deny that such an event is possible, and who knows the exact measure of this probability?"[48] "[The academicians] told you that the explosion is possible but very improbable, thanks to prudent planning and the measures suggested by science, but we ask you, *Messieurs,* if one or the other might not fail, and if you will have on your conscience such a responsibility?"[49] The answer, as it turned out, was affirmative, but the government imposed very strict technical requirements in order to make the infallibility dogma credible.

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[46] For a micro-study of this public controversy, the French and British expert's practices, the construction of objectivity and the regulating effort see: Jean-Baptiste Fressoz, "The Gas Lighting Controversy. Technological Risk, Expertise and Regulation in Nineteenth-Century Paris and London", *Journal of Urban History*, in press (July 2007).

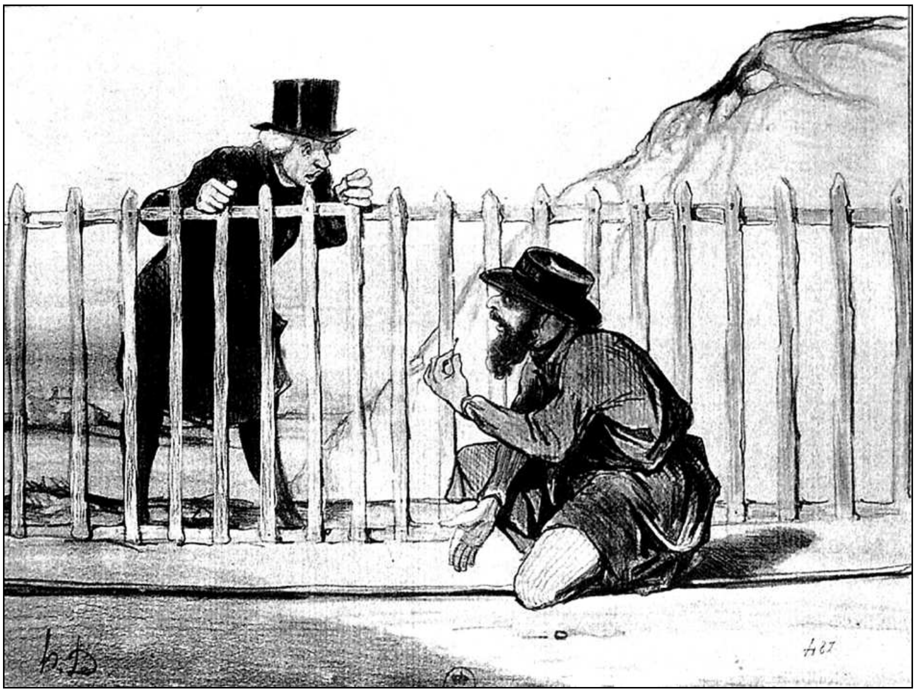
[47] Charles Nodier, Amédée Pichot, *Essai critique sur le gaz hydrogène*, Paris: Gosselin, 1823, 4 ; *De l'éclairage par le gaz hydrogène*, Paris: Dondey-Dupré Père et fils, 1823, 6.

[48] Archives Départementales de la Seine, box V8O1 1002, letter of Walckenaer to the *ministre de l'intérieur*, june 1823.

[49] *Des Dangers de l'existence des gazomètres en ville*, *A Messieurs les conseillers d'Etat*, 1823, 7.

4. Complexity and unpredictability: testing innovations in society.

However, the entrepreneurial discourse of the 1820s on technological infallibility, even when backed with the government's support and the enforcement of safety norms, soon became outdated as accidents and catastrophes continued. These were increasingly ascribed to technology itself in general, and to modern, complex technological systems in particular. For instance, accounts of the early railroad accidents in the 1840s often mobilized the notions of complexity, unpredictability and instability to explain the regular and statistical occurrence of accidents, despite safety procedures and strict regulations. In a book paradoxically called *Les Merveilles de l'industrie*, Arthur Mangin explains that railroad disasters are complete mysteries with no ascertainable cause. They are the results of "minuscule accidents… which should not be attributed to error or incompetence… They occur in consequence of the inhering causes of the system, which nobody can predict or prevent given its complexity."[50] Félix Tourneux, a prominent railroad engineer, thought that trains are "analogous with what the scientists call unstable equilibrium, which the smallest force can disrupt."[51] This 1845 cartoon by Honoré Daumier broaches the same theme of small causes entailing major consequences: the dialogue is between a passer-by and a railway lineman.



[50] Arthur Mangin, *Les Merveilles de l'industrie, machines à vapeur, bateaux à vapeur, chemins de fer*, Tours: Mame & Cie, 1858, 216-8.
[51] Félix Tourneux, *Encyclopédie des chemins de fer et des machines à vapeur à l'usage des praticiens et des gens du monde,* Paris: Renouard et cie, 1844, 3.

The lineman:

"the next train has certainly had a narrow escape!

—Why?

Good lord! A pin! Its head was right on the rail! Fortunately I saw it in time!"

All these narrations echoed the scientific and juridical debates which occurred after France's first railway disaster on the 8 May 1842 on the Paris-Versailles line. The Academy of Science debated at length possible explanations of the sudden rupture of the locomotive's axle, which was new and made of good quality iron. Various hypotheses were proposed: metal oxidation, the effect of a magnetic force, a change in the molecular structure of the metal, or vibrations causing micro-cracks.[52] Subsequently the railway company and its officers were charged with manslaughter. During the trial, experts' testimonies were so contradictory that no explanation could be settled upon; therefore no guilt could be demonstrated and no compensation paid, which greatly shocked public opinion. The company's defense, that progress necessitates heroic sacrifice, and that the passengers on the Paris-Versailles line were the worthy sons of the brave of Valmy and Austerlitz, convinced neither the public, who demanded a culprit, nor the public prosecutor, who insisted that engineers and scientists could indulge in heroics, good for them, but not at the expense of passengers.[53]

This ambiguity of purpose between innovators and users, which led to experimental results being gleaned from commercial implementations, was also deeply resented by the public in the case of gas lighting. In 1823 one of the rare academicians to oppose the new system insisted that hydrogen was still the cause of dreadful accidents in chemical laboratories, and unless one wanted to turn "every house into a delicate physical instrument," and every consumer into a careful experimenter, accidents were bound to recur. Even worse, as the gas system was not yet developed in Paris it was not really possible to judge its safety. For example, gasholders contained unprecedented volumes of gas, and it was feared that its explosive power might be more than proportional to the volume. During the 1823 House of Commons enquiry on gas lighting, Humphrey Davy pointed to this gulf between the laboratory and the industrial scales: "From experiments made on a small scale, it is not possible to reason with perfect confidence when the scale is 100,000 times larger." In the

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[52] *Comptes rendus de l'Académie des sciences,* XV, 1842

[53] Jules Lan, *Les Chemins de fer français devant leurs juges naturels*, Paris: Librairie internationale, 1867, 99. On the press coverage see : Hélène Stemmelen, "Une catastrophe technologique au XIXe siècle à travers le journal le Temps", *Culture technique*, 11, 1983, 309-315.

same way, the circulation of gas under pressure through many miles of pipes was a new and little-understood process. The problem derived from the elasticity of gas, which rendered its flow and pressure irregular. This could cause massive leakage, as in 1840s Paris when approximately 25% of the gas was lost to the atmosphere! Moreover, in the customer's house the flame could become a foot tall or be suddenly extinguished which, of course, posed considerable safety problems. Scientists elaborated complex equations to describe the flow of gas using the gas network as an experimental apparatus, and gave some rules about pipe-laying in order to limit the consequences of the elasticity of gas,[54] but the problem was not solved until the late 1840s when the introduction of "*gazocompensateurs*," complex technical devices placed along the pipes, enabled a proper regulation of pressure. Therefore it is clear that, in the early history of gas lighting, the experimental phase largely overlapped the commercial.

The same overlapping occurred in the case of steam technologies, with disastrous consequences for those enginemen who became the victims of explosions. Boilers may seem exemplars of a deterministic system obeying simple natural laws relating pressure to temperature, but in fact, during the first half of the nineteenth century, the explosion of steam boilers proved to be a baffling mystery for scientists and engineers. If many such explosions could be blamed on worn-out components, or on an engineman who screwed down the safety valve or overheated the boiler, many others remained unaccounted for. The technical literature of the time abounded in theories purporting to explain "sudden explosions." For example, boilers sometimes exploded when the pressure and temperature were *decreasing*, and a supposed spheroid state of water was invoked to explain this. According to the somewhat confused theory, in certain conditions the water was "flying" upon a bubble of overheated steam, and so not in contact with the metal plates of the boiler. If at some point the metal then cooled slightly, the water, no longer supported by a bubble, was brought into contact with the plates and thereupon flashed into steam causing a dramatic explosion.[55] Other theories could involve water foaming in overheated steam, electrical phenomena, the variation of material strength with temperature, the chemical decomposition of water, and much else.

[54] Girard, *Mémoire sur l'écoulement uniforme de l'air atmosphérique et du gaz hydrogène carboné, dans des tuyaux de conduite lu à l'Académie des sciences le 12 juillet 1819*, Paris: Feugueray, 1819.
See also : Claude Louis-Marie Navier, "Sur l'écoulement des fluides élastiques dans les vases et les tuyaux de conduits," *Annales des mines* 6 (1829): 371-442.

[55] Arago, *Oeuvres complètes*, 5, 117-77; Boutigny, *Etudes sur les corps à l'état sphéroïdal, nouvelle branche de physique*, Paris: Masson, 1857.

In France, between 1820 and the late 1860s, steam boilers became the subject of an essentially scientific and administrative management. On the scientific side, Arago, Dulong, and Regnault tried to establish with greater accuracy the law of pressure at high temperatures in order to devise better regulations. At the same time, a rigorous administrative surveillance of steam boilers was established with a twofold aim: first, to impose throughout France the compulsory regulations that the Academy had devised; and second, to collect data pertaining to explosions. The *ingénieurs des mines* kept a register of steam boilers with all their characteristics, inspected them every year, and above all made very detailed inquiries concerning the circumstances of any explosions. The police were also told to maintain vigilance over steam boilers, their proprietors and their enginemen. And at the center of this network an expert body, the *commission des machines à vapeur,* collated all this information. Thus the French administration had consciously constituted the whole industry, including every steam boiler and every engineman, as a vast laboratory in which boilers, different safety devices, and the regulations concerning them could be tested in the real world.

5. Experts' definition of risk, and its critics.

More generally, technological risk played an important role in the empowerment of institutionalized expertise in early nineteenth-century France. I will take as an example the Parisian hygienists who organized themselves around the *Conseil de salubrité,* a body of a dozen experts founded in 1802 to advise the Prefect of Police on public health matters.[56] These doctors, pharmacists and chemists argued that industrialization had created many new insensible threats which neither the public nor the administration understood, and thus the guidance of experts was badly needed. In 1829, the prospectus of the *Annales d'hygiène publique et de médecine légale* stated that the review would deal with the "multiplied dangers… to which population is exposed … by the influence of the tendency toward industrialization." Its aim was no less than that of establishing both the "true nature of this

[56] On the conseil de salubrité see: Alain Corbin, *The foul and the fragrant. Odor and the French Social Imagination*, Cambridge, Harvard University Press, 1986 ; Ann LaBerge, *Mission and Method: The Early Nineteenth-Century French Public Health Movement*, Cambridge: Cambridge University Press, 2002 and André Guillerme, Gérard Jigaudon, Anne-Cécile Lefort, *Dangereux, insalubres et incommodes: paysages industriels en banlieue parisienne, XIXe-XXe siècles*, Paris: Champs Vallon, 2005.

influence" and also, at the same time, the unique status of hygienists as the experts in these new threats.[57]

This status was acquired in the face of opposition from the "public" and the doctors. Contrary to the opinion of the public —that is, of the factories' neighbors and customers— whose perception of threats was biased, personal and subjective, hygienists considered such threats from the impersonal, disinterested and scientific standpoints. And contrary to medical doctors—who tended systematically to confirm the symptoms of their clients[58]— hygienists' information came from a modern and specialized discipline which drew evidence from statistical data, medical topographies, toxicological studies, dissections, animal experiments and chemistry.[59] The statistical and interdisciplinary approaches which are a striking feature of the *Annales d'hygiène* had the essential function of setting a boundary for the definition of the true experts of the insensible new risks.

The hygienists had a very high estimation of the power that they could wield thanks to this monopoly. They had overthrown doctors as the moral authorities for defining health hazards. They would draft laws for the industrial age, help fathers to choose their children's profession, provide actuaries with the information necessary to calculate annuities and the risk of occupational diseases, and even contribute to fixing fair salaries by reference to the inherent risks of the job. On the question of industrial pollution they were, as Darcet and Parent-Duchatelêt put it, "the arbiters, the real judges whose advice can determine the fortune of an industrialist or the well-being of a whole neighborhood."[60]

However, although administrative expertise constituted itself as the main center for the social definition of risks, criticisms founded on alternative models flourished. The Enlightenment's discourse of the public sphere —that is the public space of rational and critical discussion— was often mobilized in technological controversies to criticize expertise. It was argued that the public was the only impartial and disinterested body able to take correct and fair decisions. For example, in the first decade of the nineteenth century, when the official *Comité de vaccine* was accused of partiality in denying the existence of any causal link between vaccination and subsequent syphilitic infections, Dr Vaumes addressed to the Interior

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[57] *Annales d'hygiène publique et de médecine légale*, I, 1829, xvii.
[58] Parent-Duchatelêt, "Quelques considérations sur le conseil de salubrité de Paris", 1833, 249.
[59] Parent-Duchatelêt insists on the knowledge gap between private doctors and the hygienists of the *conseil de salubrité*: "the doctors believe they know enough for deciding upon important questions that can be solved only through special studies." And he lists the many scientific disciplines necessary to be an accomplished hygienist.
[60] Parent-Duchatelêt and Darcet, "Sur les véritables influences que le tabac peut avoir sur la santé des ouvriers occupés aux différentes préparations qu'on lui fait subir", *Annales d'hygiène*, I, 1829, 170-3.

Minister a secret memorandum asking for the setting-up of an "independent jury" composed of medically ignorant but "*honnêtes hommes"* (honorable men) who could "impartially assess the facts."[61] Doctors were to be excluded because they were already either passionately for or against vaccination.

In the same way, during the Parisian gas lighting controversy numerous pamphlets were addressed to the "*public éclairé,*" which was supposed to be the ultimate judge of the pro- and anti-gas-light arguments because, unlike entrepreneurs and experts, the public was disinterested. Indeed, public debate was even praised for producing *better* knowledge than specialized expertise, because it involved a greater variety of competencies and personnel.[62] In 1819 Clement-Désormes, a prominent chemist and professor at the *Conservatoire national des arts et métiers* who opposed the gas lighting system, made an interesting plea for a kind of "democratic technology assessment." He compared the progress of civilization to a series of bets with "immense risks present in the nature of things," and called for public debates which would help humanity to distinguish between beneficial and harmful technologies:

> In the complicated entities on which our moral and physical existences depend… only public debate, which attracts the attention and participation of a great many people, can produce a sound decision. Most of the time… inventions [are] considered only from the technical point of view; their worth to society is ignored because the science necessary for judging this belongs to other men who are not consulted… Public discussions would have the immense advantage of uniting in the same spirit all the ideas indispensable for good judgment. Of course, self-interest will appear in these debates… but the majority is interested in the best: the majority will discern it.[63]

In the second half of the century, insensible risks fostered a general distrust of experts and administrators, who were accused of concealing vital information from the public. The only perceived remedy against this silent conspiracy was public self-organization, and popular medical reviews such as Raspail's heterodox *Manuel annuaire de santé* were keen to publish stories about industrial poisoning that showed the incompetence or carelessness of the hygienists. In 1862 Raspail wrote a virulent book against "industrial poisons" in order to warn the public "about the misdeeds of industry," which threatened the health of both present and

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[61] Vaumes, "Mémoire confidentiel sur la vaccine," 1806, Archives de l'Académie de médecine, box V1.

[62] On this point see the "Hybrid forum" model proposed by Arie Rip and Michel Callon in Rip, A., Th. Misa, J.W. Schot (eds.), *Managing Technology in Society. The Approach of Constructive Technology Assessment*, London: Pinter Publishers, 1995

[63] Clément-Desormes, *Appréciation du procédé d'éclairage par le gaz hydrogène du charbon de terre*, Paris: Delaunay, 1819, 1-2.

future generations by allowing dangerous chemicals such as arsenic, white lead, mercury, and phosphorus to proliferate. According to him the Administration and its *conseils d'hygiène* could not be trusted because they had the same economic interests as the industrialists, and also because the industry cheated discreetly. The danger was coming not from gross adulteration, which *was* prosecuted, but from the regular ingestion of very small, scientifically-determined doses of chemicals that the Administration's toxicologists could not detect, and which could therefore not be the subject of a prosecution. The only analysis that worked was the "intestine still." Raspail wanted to "teach suspicion" to the reader, who should become knowledgeable about his own body, testing on himself the effects of different dietry regimes and by elimination discovering which food was contaminated. Furthermore, the public should also organize itself by creating a network of trustworthy producers and retailers.[64] Raspail's proposals were not unique: the number of manuals on food adulteration that were published for the general public shows that the second half of the nineteenth century was an era of great suspicion. Indeed, networks of producers and retailers were actually formed: for example, in 1889 the *Société générale de contrôle et de garantie alimentaires* paid for a team of chemists to check the quality of food and label it accordingly.[65]

However, the most attractive model for the definition of risks, and the most effective competition to administrative expertise, was probably provided by the civil courts. The way that they handled expertise was much more appreciated by people bringing actions concerning industrial pollution, who could choose their own experts, than that of the Administration, whose hygienists were very often closely linked with the milieu of the chemical manufacturers. The procedure in the courts was transparent and even-handed: for example, complainants could attend experiments and propose different ways of measuring and tracing the pollution. The result was that judgments in the civil courts often effectively reversed administrative decisions by imposing high fines on factories that government hygienists had authorized. The civil courts thus became the fundamental institutions for regulating locally the new kinds of conflict being created by industrial pollution.

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[64] F.V. Raspail, *Appel urgent au concours des hommes éclairés de toutes les professions contre les empoisonnements industriels qui compromettent de plus en plus la santé publique et l'avenir des générations*, Paris, 1863.

[65] Raoul Bravais, *De l'alimentation hygiénique, société générale de contrôle et de garantie alimentaires*, Paris: imprimerie centrale des chemins de fer, 1889.
On the construction of the notion of "natural product" and the birth of the 1905 Food Regulation see: Alessandro Stanziani, *Histoire de la qualité alimentaire*, Paris: Le Seuil, 2005.

6. Innovation, risk and social conflict.

Environmental historians have recently started to study these innumerable conflicts, the records of which crowd the French administrative and judicial archives.[66] As Beck argues, they seem to define new lines of opposition which largely cut across the capitalist social order. For the *conseil de salubrité* of Paris this was a "war between property and industry" and thus an "absurd antagonism between capital and capital." It seems that until the 1860s the workers' movement did not address questions of pollution or health hazards and was thus quite absent in these debates. My analysis of three working-class newspapers of the 1840s (*L'Atelier*, *l'Echo de la fabrique*, and *l'Artisan*) returned very few articles about workplace accidents or health hazards, and the few that do exist simply echo the external debates of the hygienists. In fact, issues relating to industrial pollution were raised only by the urban middle classes, and, in the country, by farmers and wealthy landlords.

To show how industrial pollution segmented communities, I will take as an example the alkali industry around Marseilles,[67] where hydrochloric fumes caused damage, extending for miles around, to orchards, vineyards and olive trees. Of course, the farmers were enraged: indeed, in 1816, they gathered around the alkali factories and threatened to burn them down, whereupon the Prefect put the leaders in jail and sent the gendarmes to guard the factories. As violence clearly offered no solution, and as the administration was obviously on the industrialists' side, farmers and landlords organized an impressive judicial battle. In the 1820s approximately 10% of all civil cases in the Marseilles and Aix tribunals were actions against chemical manufacturers. Some lawyers created a business *ab initio* out of these trials by persuading small farmers to sue the chemical companies and advancing the money for the court fees in exchange for a share of the damages that the companies would be required to pay.

In the long run, chemical factories divided the population in two groups. In Istres, for example, there were the *plouvino* ("white frost" in *Provençal*), composed of landlords and small farmers, and the *fumado* ("smoke"), composed of factory workers. Each group had its own church, its own communal fountain, its own shops and its own local festivals. Political life was also organized around this opposition, with the mayor being either a director of the chemical company or the biggest landlord. It must be emphasized that factory workers always

[66] Geneviève Massard-Guilbaud, *Histoire de la pollution industrielle en France, 1789-1914*, Paris: Belin, in press ; Guillerme *et alii*, 2005.

[67] See: John Graham Smith, *The Origins and Early Development of the Heavy Chemical Industry in France*, Oxford: Clarendon Press, 1979 and Xavier Daumalin, *Du sel au pétrole*, Marseille: Tacussel, 2003.

sided with their employers: in the litigation that occurred no worker ever complained about the fumes, and on the contrary many testified in the courts as to their good health. In fact, the companies prevented any workers from mobilizing against the health hazards by extensively importing foreign labor, with the most dangerous tasks being performed by single male foreigners whose diseases or deaths were of little consequence to the community. Already, by 1820, of the 72 workers in one factory, 34 were Genovese. This repartition of risks according to nationalities continued: a century later there were in Istres 1040 foreigners, mainly Kabyles and Armenians, employed by the company, out of a total population of 7040.

The case of alkali manufacturing in the Marseilles region echoes a larger issue that historians of technology have abundantly studied, namely the extent to which technology and society are both reshaped in the process of innovation. More specifically, in each community where factories were located there was a kind of contest between social and technological forces: who was to adapt to whom? In Septêmes, social mobilization took on an exceptional intensity and went far beyond the question of lost harvests. Health was invoked at first, with little success: opponents of the chemical industry, using parish records, tried to demonstrate that the factories had increased the mortality rate, but the causal link was too uncertain for use in court. Ultimately it was arguments invoking air quality, water purity and the beauty of the landscape, arguments analogous in many ways to our contemporary notion of the environment, which served as the principal weapon against the chemical manufactures. For the opponents of acid fumes, topography, region and landscape were laden with sentiment. In 1819 a group of erudite writers created a literary review named *La Ruche provençale* in which they sang the beauties of nature and Provence. However, these very same authors wrote pamphlets and court depositions against the factories, and thus provided opponents of industry with a powerful rhetoric: they described the country around Septêmes (in which were concentrated seven alkali producers) as a waste land where "spring would not return," acid fumes having performed a "general castration." Desertification was looming: the region would little by little be transformed into a "desert of charred rocks… one monument only with the inscription 'HERE WAS SEPTÊMES' would recall the name of the region."[68]

In any case, Septêmes landlords argued that even if they received compensation for the damage to their crops, they still suffered *moral damage* from this environmental degradation. What is very remarkable is that in 1826, after virulent judicial debates, the Cour Royale

[68] *Mémoire et consultation contre les sieurs Mallez*, 1818.

d'Aix, contradicting the Conseil d'Etat's jurisprudence, acknowledged the existence of this *moral* damage. In consequence compensation skyrocketed, as major landlords could receive up to 80,000 francs for moral damage plus annual compensation amounting to several thousands francs. At a lower level, expertise was astutely instrumentalized by opponents of the factories (under the benevolent eyes of the judges): they asked the expert to perform a great number of chemical experiments in order to make the expertise very expensive for the industrialists who were condemned by the system to pay the court fees. In some cases, damages of a few francs were awarded by reference to an expert report of a hundred pages, which had cost the manufacturer one thousand francs!

All in all, given the high cost of polluting, it appeared that a technique of condensing the hydrochloric fumes might be financially attractive, and so some technological effort was expended in that direction: famous Parisian engineers and chemists such as Péclet and Clément-Désormes traveled to Marseilles in order to devise such a means of condensation, but with no success. It was a Septêmes manufacturer named Rougier who designed a somewhat awkward but nevertheless efficient apparatus which required half-mile-long tunnels to be dug in the chalk hills surrounding the factories: the hydrochloric acid fumes were trapped by the chalk. However, the process eroded the tunnels which therefore had to be rebuilt every two years.[69] In fact, being expensive, the condensation scheme lasted only as long as the local community was vigilant and prepared to sue the industrialists for damages. In other towns, where litigation was more rare, where farmers did not succeed in instrumentalizing the judicial system, or where the courts did not recognize the concept of moral damage, alkali manufactories continued to pollute just as before and the community dissolved under acid clouds.

Conclusion: Historicizing the risk society and politicizing the history of technology.

Technologies as different as gas lighting, railroad, small pox vaccination, steam engine or chemical manufacturing and problems such as deforestation or the management of miasmas testify that risk society is not a radically new phenomenon in the history of mankind. Major risks, the failure of insurance techniques, uncertainty, unpredictability, the need of testing innovations in society, the struggle for defining risks and finally the reorganization of

[69] De Villeneuve, "Des condensateurs des fabriques de soude", *Annales des sciences et de l'industrie du midi de la France*, Marseille: Feissat, 6, 1832, 129-46

social conflict from the repartition of goods to the repartition of risks, all those phenomena on which Ulrich Beck called the attention of social scientists have a long history. Eugène Huzar who presented himself as the prophet of risk society, was, in fact, its first critic.

Shall the historian conclude with a shrug “Nothing new under the sun?” Not at all: acknowledging that risk society has a past calls for a rethinking of what is really changing in the nature of risk, and in the relationship that our contemporary societies have with technoscience. The first aim of an historical inquiry on technological risk could be to characterize different regimes of relationship between technological risk and society: how expertise was formed, who stood up against innovations, which shapes took social mobilizations, how regulation was organized (by technical norms, through the judiciary, by insurance companies…) and how all that interacted in different historical/national settings?

Second, in contemporary debates historians could bring an essential input: hindsight. Indeed, they can objectify risk by studying accidents that occurred during one or two centuries, and their causes. A retrospective assessment of technological assessment can be proposed. Such questions as: which organization of expertise produced better risk assessment? which regulation was most efficient? which factors were decisive for the construction of safety? could start to receive an historical answer.

Finally, taken in the long run, technological innovations do not appear as rigid, external entities that society has to accept or refuse. As the alkali manufacturing case suggested, they should rather be conceived as fluid entities that can take very different forms according to the nature of the regulations and social mobilizations for safety that surrounds them. Hence what in history of technology is traditionally put in the footnotes, under the label of “opposition” or “resistance” to progress turns out to be essential for the construction of safer technological systems.

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