Do accidents have mere accidental impacts on the socio-technical development?

Presentation at the Forum Engelberg, March 1999.

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When I was asked by the organizers of this Forum to give a talk on accidents from the point of view of a historian, I did not see any difficulty to put together a few interesting historical cases where socio-technical systems had to be reoriented due to an unexpected event. The first accident, however, occurred when I tried to indicate a title for my presentation. “No ambiguities please, and no questions”, I was told. For a historian who all the time has to deal both with questions and with ambiguities, this is a very strange guideline. No wonder, the title did not reach the printer without suffering from an accident. Just to make it clear: What I *wanted* to talk about is “Do accidents have *mere* accidental impacts on the socio-technical development?” And this certainly is an ambiguous question.

Obviously, my endeavor needs an explanation. I am talking about accidents from a historical perspective, but I am participating on a symposium, which deals with “Risks and Safety of Technical Systems”. “Risk”, as I want to recall, is describing in general terms a certain relation between the present situation and its conceptual shaping of the future. This discussion takes place on the background of the modern societies’ multiplication of individual and collective needs and possibilities of decision and action. An “accident”, by contrast, is something that can never be predicted. Of course, experiences with accidents enhance our possibilities to expect accidents. However, whether they occur or not, always remains to be seen. This is the reason why accidents are not really forming part of the research on risk assessment. “Risk assessment” is rather addressing the horizon of a present future. And accidents, which already happened, cannot be the object of this research, since they form part of the present’s past. They are only a stimulating issue for the perception of new risks, or they become the basis for new forms of probability calculations for the future.

A historical analysis, however, must be treating accidents as something that has already happened, more specifically as something, which is related to the contexts the incident occurred in. The more I was surprised to learn that neither the social history nor the history of technology have ever treated the phenomenon of accidents in a systematic way. And yet I do believe that the history of technology could make an important contribution for a sound understanding of accidents and their impact on the socio-technical development.

In the following, I want to argue this: The history of technical accidents is neither just the sequence of incidents which are reported by the statistics of accidents, nor should we limit our attention to technical and economic aspects of these incidents. Rather we have to ask the following questions: When, why and how is it that an incident is transformed into an accident? In order to do so, I will understand accidents as a deceived expectation of a socio-technical system. The reconstruction of these systems, of their horizons of expectations and of the systems’ range of possibilities to react when confronted with an unexpected event, make it obvious that accidents can’t have accidental impacts on socio-technical systems. They are rather directly depending on the history of these systems. Therefore, the analysis of historical accidents will eventually lead towards a historical analysis of society under the condition of technological change. This is, in my opinion, the mere contribution of the history of technology to the question of risk and safety of technical systems in view of profound changes.

Now, my first reaction to the task of systematizing accidents in historical perspective was to collect some nice examples of both spectacular accidents and heavy failures in different fields of modern engineering. And that’s how I ran into big trouble. After a few days, my list already contained so many different kinds of accidents that it became virtually impossible to classify them in a proper way. My first attempt at creating different *categories* clearly shows that, methodologically speaking, the history of technology is not very well prepared to cope with accidents. The literature offers very little help for the endeavor to systematize accidents as a phenomenon which occurs in the context of socio-technical systems.

A first class of historical accidents for instance seems to foster a very strange kind of admiration culture. These accidents are actually handled by a special kind of cruel entertainment literature, which apparently has the same functions for modern societies as eventually had the collections of *curiosa* and *rara* emerging in the contexts of early modern court societies. These collections used to systematically put together or to imprison everything that was troublesome, monstrous, disturbing, and chaotic in relation to any operative normality of the court society. "*Natura aberans*" is the label the collected items eventually received. Astonishingly enough, many modern accounts of the history of technology follow the same strategy, as they are trying to simultaneously collect and to ban strange accidents as a proof of general technological progress and success.

A second class of accidents I could distinguish is formed by very spectacular, and at the same time very famous accidents. They are the de-luxe type of accidents. Think of the spectacular sinking of the Titanic or the consequences of the famous Challenger launch decision in 1986. Think of the Chernobyl disaster in the same year or think of the accidental shooting of the Iran Air Flight 655 by the USS *Vincennes* in 1988. Tons of reports and tons of books have been published on this kind of accidents. It would not be very helpful to repeat their findings, particularly since there is always a strong narrative of thrill and terrorized excitement, which these books combine with admiration of the unthinkable that came into being by way of such an accident.

A third class of accidents simply comes – at least for analytical purposes – much too close to our own experience of having seen very shocking TV reports on very shocking technological disasters. This shock in some instances might be still so big, that we are not yet ready to treat the issues in a critical and cool analysis without immediately mixing this analysis with many on-going contemporary discussions about responsibilities for devastation, collective suffering, political corruption, economic disorder and mass media manipulation. Think of the 1998 train accident in Eschede, think of the MD-11 crash near Halifax or think of the sinking of the Estonia back in 1994. Moreover, how should I possibly deal with the explosions in Bhopal, in Seveso, in Chernobyl or in Guadalajara without making a strong statement about the political economy or, in its case, about the criminal acts of late capitalist structures revealed by a closer look at such accidents?

A fourth class of accidents I find finally noteworthy in this context deals with appealing stories about inspiring and entertaining failures in modern engineering. Think about the Zeppelin's disastrous way into its comforting and comfortable museum on the border of the Lake of Constance. Members of a society that are used to take planes as if they were tramways or a shuttle busses develop some kind of tender relation with pioneering stages of the flight culture. Let me just give you a few hints about the main events on the Zeppelin's burdensome flight into its practical extinction. The first Zeppelin, we might remember, only saw three take-offs before definitely crashing. In 1906, heavy winds transformed its successor, the LZ 2, into a bulk of aluminum; in 1908, LZ 4 was destroyed by a thunderstorm, whereas LZ 5 ended its journey on top of a modest fruit tree. Finally, the LZs 8, 10 and 11 were simply wrapped around their own hangars. In 1937, the history of all Zeppelins finally came to an end in Lakehurst with the well-known and dramatic accident of the Hindenburg. Since this very moment, only the community of devoted Zeppelin freaks is really interested in learning more about the different forms of failures of a failed innovation.

My classifications of historical accidents into (1) technological aberrations, (2) the spectacularly famous accidents, (3) accidents with strong links to a disastrous political economy, and (4) the nice and cozy accidents of pioneering times in engineering has obviously many problems. Why should we separate the shooting of Iran Flight 655 from the train crash in Eschede? Why should we separate the burning of the Hindenburg in Lakehurst from the MD-11 disaster in Halifax? Does the accident in Chernobyl belong to the category of technological aberrations, to the category of spectacularly famous accidents, to the ones only belonging to a disastrous political economy, or will it become - after a few decades - an entertaining part of a strange technology we finally put into the museums? My conclusion with regard to this classification problem is that as a matter of fact any attempt at categorizing accidents must fail, since we don't find any distinctive characteristics in the accident itself which allow us to systematically draw useful differences of general validity between different accidents.

There is, however, a solution to the problem if we develop a theoretically different disposition of the problem. I propose to move the referential framework of accidents away from the observing public, away from the number of casualties, away from its individual characteristics. As I am contemplating once more my list of accidents, I find that despite their heterogeneous aspects and conditions, most of the accidents I have mentioned share some important common characteristics. It is precisely this observation which will eventually lead up to a new definition of accidents that allow for a theoretically more convincing and analytically more fruitful treatment of the phenomenon "accident".

First, all accidents I have mentioned so far always have been connected by the literature with a large set of causes, which stay in direct relation to the history of the socio-technical system, which was hit by an accident. Second, all accidents occurred in very different and very distinct contexts of social, political, technological, economic, and cultural conditions. They all seem to have a unique historical quality of their own. Third, none of them could be really anticipated.

Now, if for analytical purposes we choose the point-of view of a socio-technical system that is hit by an accident, we can make these observations methodologically productive. Let us define an accident as an unexpected event, which happens in the environment of a socio-technical system. This event provokes, if I may speak in general terms, the disappointment of the systems own standardized expectations. The significance of any accident is shaped by the socio-technical system that is involved in the accident.

Such a definition is very crucial for my further argument. It is not the event as such that shows causal effects on the structure of the system. The normative sanctions and the adaptive learning processes that usually take place after an accident has happened, are depending on the very historical conditions or the structural predisposition of the system itself.

In general terms, the reaction of a socio-technical system to an unexpected event can be twofold, and in both cases these reactions entirely depend on the structure and on the history of the system. This means that they do not depend to the same degree on the accident itself. If we look at socio-technical systems as autopoietic systems, they are systems, which permanently produce their own elements and their own structures, while they are operating. Therefore they also permanently produce both their expectations and their possible range of reactions even in the moments these expectations are accidentally threatened by unexpected disappointments. Since there is no direct and causal influence of the environment on the system's capabilities to process information or on the system's structure, accidents are always treated by socio-technical systems following the rules that are given by the system's preexisting operative conditions.

This theoretical modeling immediately produces a structural link between the communicative capabilities of a socio-technical system and its own way to define its expectations as it is operating and functioning long before any accident has happened. In other words: The range of actions a socio-technical system is able to decide upon after any unexpected event has occurred depends both on its communicative capabilities and on the internal discursive shaping of its environment. This means that we can explain the system's reaction as a depending variable of its historical conditions and configuration. By means of context and discourse analysis we have a better chance to explain how a socio-technical system is likely to react when an accident occurs.

I will give you in the following part of my presentation an example, which is able to illustrate these circumstances. I deliberately take an accident that has almost no spectacular characteristics, an accident that could not be anticipated, and an accident that does not involve us in any contemporary discussions about the outline of the political economy of a socio-political system in our days. On the other hand, the example brings into evidence the huge variety of normative and cognitive reactions that a socio-technical system can produce when threatened by an accident.

In the morning of April 2, 1898, the city of Zurich received an unexpected load of heavy and wet snow. Several telephone lines could not resist this weight. As the wires broke, they fell on top of the electricity supply lines of the city's tramway system and caused a very dangerous situation. When one of the telephone operators tried to manually connect two customers, the whole switchboard station was set to fire and, within a few hours, the whole building on Bahnhofstrasse was laid in ashes.

This accident filled the newspapers during many weeks, and in the following four years it was again and again referred to as a catalytic event in the course of a profound reorientation of the electricity supply industry.

Let me briefly recapitulate the socio-technical context in which this accident happened, in order to explain the dimension of its consequences. The second half of the 1890s had seen a strongly booming electricity supply industry. Not only every bigger city in Switzerland, but also many small towns and even the first villages had started to implement own networks of power. The accelerated growth of this technology was mainly due to the new possibility of transmission and distribution of electricity in wide areas, which the Frankfurt Electrotechnical Exhibition in 1891 had demonstrated so successfully. However, this enormous growth of the country's electricity supply industry was not backed-up by any sufficient security regulation and standard proceedings. Even in urban areas, where public utilities such as gas, water, and electricity supply, sewer systems and transport or telecommunication networks where installed within a very short period, the administrations were not able to coordinate the implementation and operation of this wide range of different technologies. Moreover, they could not delegate responsibilities to a well-trained group of professional engineers. Whoever knew how to connect two wires was already called a specialist. The lack of professional standards was reflected by the absence of legal regulations and clearly defined responsibilities. It was also reflected by a low level of self-description in terms of statistics, maps, and planning. Therefore, it was practically impossible to know what kind of wires and tubes crisscrossed the urban space. On the other hand, the discursive shaping of electricity supply had made a strong connection between this technology on the one hand and the notions of progress and modernity on the other hand. Any decent city had to be able to electrify its representational spaces; and it had to supply electricity to the workshops of craftsmen and the houses and streets of residential areas. Electricity supply was a public utility that at the end of the century had become an intrinsic part of the self-esteem and the political pride of most cities. Thus, during the 1890s, this technology was more and more discursively connected with important parts of the political agenda of most urban administrations. On the other hand, telephone networks also belonged to a strong emerging market and had their defendants as well. The conflict, which was initiated on April 2, 1898 with the accidental burning of the telephone central, was not only a conflict between low and high voltage technologies. It involved many different actor networks, many different groups of interests; it involved indeed two socio-technical systems.

It was precisely this contextual setting of the 1890's electricity supply industry in Switzerland which determined the consequences of the accident Zurich. As a catalytic event, the accident triggered, on a national level, a wide discussion not only about security standards, but also about legal frameworks, professionalization, education and training, institutionalization of control and statistical description. In the course of a four years' discussion – which was full of references to the accident of April 1898 –, the definition power of electrical engineers was very much strengthened. They could successfully claim to be the only profession, which could help avoiding further accidents. The loosing partner in the game was the federal telephone company, which had to reinvest into its own security measurements. In 1902, the institutional role of the Swiss Association of Electrotechnology (SEV) was stabilized to a very high degree. Electrical engineers had achieved an extremely high level of control not only over their profession, but also over technical standards, over means of self-description of the socio-technical system, over professional training, and even over the federal legislation in electrotechnical issues. The Technical Inspectorate for instance, which was run on a private basis by the Association, acquired within a very short period an official function and served now as a vehicle to promote the Association's power of definition. It was even backed-up by a federal law and financed by the federal government. Finally, new curricula for the training of electrical engineers were established both at the Swiss Federal Institute of Technology (ETH) and in the technical schools. The statistical self-description of the electricity supply industry was set up by this Association and acquired a strong legal authority.

Thus, it was a mixture of normative sanctions and cognitive processes of adaptive learning, which resulted from the accident in Zurich. The accident as a catalytic event offered and structured a platform of discursive reorientation. It did so, however, under the preset configuration of the discursive shaping and institutional framework, which characterized the electricity supply industry in the 1890s. Therefore, we can conclude that the consequences of accidents, understood as a disappointment of expectations of a socio-technical system, are very much depending on the system's historical preconditioning. They are structurally coupled with the systems development and with its historical configuration. This is why I want to claim that accidents do *not* have accidental impacts on any socio-technical development. Their impacts are rather directly depending and interconnected with the previous degree of flexibility of the system's expectations.

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