For historical reasons, the Ecole des Mines has always been closely connected to industry, thus concerned with the problems of safety, risks, and risk and crisis management. First of all, mining, especially underground mining, is a very dangerous activity for both those working inside and the public outside. The intense industrial development of Europe -- Great Britain, Central Europe, France -- relied upon the availability of both energetic and non energetic mineral raw materials. All the activities connected to mining -- geology, prospection, mining engineering -- were thus "boosted" in that period in such a way that mining was a privileged area for pioneering developments in most technologies, for example, the steam engine (with its applications to railway transportation, rock mechanics and ground stability), ventilation, electricity, etc … Also very important were economy and social sciences, since mining is a capital and labour intensive industry. Gilbert FRADE described in Part I how the Ecole des Mines trains engineers prepared to face risky situations in industry, including mining. Now I will discuss how the Ecole des Mines trains industrial inspectors with regard to matters of risk and responsibility.

One of the characteristic features of France is the strong interaction between the public administration and society, especially in the economic sector. This dates back to the Ancien Régime, was reinforced under Napoleon, and remains an integral part of French Culture. Although recent evolutions linked with globalization and the creation of the European Community have introduced more liberalism, the historical tradition is still present.

This means that the missions of the State include both traditional "regalian" prerogatives (defence, foreign policy, collective and individual safety) and the management of the "intérêt général" (general or public interest). The area of natural resources is one important focus of both of these State missions. Optimization of the use of natural resources, whether renewable, like water or environment, or limited like mineral ores, is quite often in tension with the pursuit of private interests and "what is good for General Electric is not necessarily good for the U.S." In France at least, this justifies that such matters are taken in charge by the State. Clearly, the State must rely on a highly competent, multidisciplinary staff in order to achieve these missions. Everybody knows that such a requirement can be fulfilled only if the State is able to attract top people. Happily, for complex reasons, the State has managed to do so. The people attracted for this mission are not hired to be
"actors", but to be "inspectors." They are paid for elaborating and implementing public regulations which aim at protecting the citizen against spoiling natural resources, misappropriating public money, building systems which may be dangerous for both the public and those who are in charge to operate them. They have also a more positive approach in helping through public aid, local economic development of industry. One specificity of the French system is that "inspectors" are trained in the same institutions as "actors" and, until 1955 at the Ecole des Mines, in the same programs.

1. HISTORY

During the 18th century, France was the most powerful nation, at least in the Western World, but was strongly challenged by Great Britain. Based essentially on a rural economy, France was not as strong in industry. The reason for that relative lack of strength was that France lacked resources in energy and metallic ores. (Incidentally, the assumption was that the Creator had uniformly distributed useful substances and that France was backwards only because of its lack of interest and competences in the field, which, unfortunately, was only partially true !) The problem was really urgent, because the development of steel-making had very seriously damaged the forests and thus it was no longer possible to rely only on charcoal. Surface coal had been indentified a long time ago, but it appeared that significant resources could only be exploited through underground mining.

A conflicting situation arose immediately: is the owner of the surface estate, the same as the owner of the underground? Where does the surface end and the underground start? For metallic ores, especially non ferrous metals, it had been recognized for a long time, they were the King’s property. This was extended in the middle of the 18th century to coal, with much more serious consequences, since coal ores are sedimentary, and thus occupy a much larger surface. The King had to hire civil servants in order to implement this decision. Once the resource had been identified, it was imperative to first find competent and reliable operators who commit themselves to spend a minimum of money during a specified period of time; and second (but no less important), negotiate with the farmers the conditions of expropriation and compensation. Two people were appointed: but the only existing engineering school at that time being Ecole des Ponts et Chaussées (founded in 1747), they were asked to attend the courses there. In parallel, because of the lack of competent operators, it was decided to open Ecole des Mines de Paris in 1783. But the times being somehow agitated, the situation changed considerably during the French Revolution and the Napoleonic Empire and stabilized only in 1816. The major pertinent facts were these:

- the creation in 1794 of the Agence des Mines, which was responsible for recruiting, training, and managing this group of civil servants in charge with the mining problems for the Government,

- the creation, the same year, of the "Ecole Centrale des Travaux Publics" which was designed, at first, as an Institute of Technology.

- The transformation by Napoleon into a military school Ecole Polytechnique, for recruiting highly competent military (and a few civil) officers.
After Napoleon had been defeated, the Restauration had to make decisions on what to do with the new institutions created by the Republic and the Empire. It was decided to keep the École Polytechnique and the École des Mines de Paris. But under the influence of LAPLACE, a famous mathematician who happened to be a royalist, it was decided to build an interesting system based on the following principle (inherited from the "Siècle des Lumières"): mathematics is a construction of the reason and is reason’s principal tool when trying to understand the surrounding world. At the extreme, natural sciences could [should?] be considered only “applications” of mathematics.

This is the reason why École Polytechnique was transformed from an institute of technology into an "école de mathématiques" providing students to "écoles d’application", among which École des Mines.

École Polytechnique students were recruited from all over France and completely taken in charge by government, since they were considered as government employees when admitted. Originally, the majority of the graduates were supposed to work in the Army, but from 1816 on, a certain number of non-military positions were offered to graduates, and these attracted the best students who joined the "Corps Techniques de l’Etat" including Corps des Mines, Corps des Ponts et Chaussées, etc … These people were in charge of both economic development and public protection against risks inherent in those activities.

The system has undergone obvious evolutions: but, strangely enough, the general frame is still the same and, although constantly questioned, seems to be rather stable.

2. PRELIMINARY COMMENTS

First, it must be emphasized that the individuals recruited are top-level people, at least in mathematics. However, most of them can also be very good in many other activities, including, sometimes, artistic activities, especially music. They can adapt to a lot of various situations and thus have access to many different positions.

This situation has some noteworthy logical consequences.

- Some of these state « inspectors » are strongly motivated by science and completely uninterested in industry or administration. They have passed successfully through the selection process by their scientific capability and for prestige [JACQUES: it’s not clear in English what you mean here. I think you mean this: «...They have passed successfully through the selection process because of their scientific capability and because of their prestige as graduates of EP], but with no special ability for the jobs they will hold. Some arrangements
must be made to deal with this mismatch, and most often are. Interestingly, some of the top French mathematicians and scientists belonged to the "Corps des Mines" : one example, Henri POINCARE.

- Most of the inspectors are very ambitious, but working as an inspector for government is not really satisfactory, especially from a financial point of view. This explains why a large number of « Ingénieurs du Corps des Mines » quit administration for industry after the legal 10-year period. This temptation to leave was less of a problem when the majority of big industrial firms were either government-owned or very close to the government. Even now formal ethical safeguards guarantee that no "inspector" is hired in a firm that he has inspected during the past five years. This prohibition is probably the most efficient asset contributing to the attractiveness of the Corps des Mines.

- It is rather difficult to understand how a young graduate can reasonably become an inspector after having just left the University and without having any experience as an engineering actor. In order to answer this objection, emphasis is put on practical aspects during the training period [Jacques : is this training period after the person is hired as an inspector or at the end of his or her university training ? Please clarify.] Finally this appears not to be too much of a difficulty in their beginning professional life.

- Although it has drawbacks, this inspector system is very positive in that, in France at least, most industry leaders have a strong technical and scientific background, as do most important public decision-makers in industrial matters. They also have a good understanding of the constraints of public administration, which is useful everywhere, particularly in Europe. Last but not least, there exists an efficient network (which is obviously criticized ! ...). [Jacques : this phrase -- « an efficient network » -- needs a bit of clarification. An « efficient network » of what?] More generally, it [Note : it’s not clear what « it » refers to] may explain the high level of interest of young people in France in scientific studies compared to other Western countries.

3. THE TRAINING PROGRAM

3.1. Recruitment

Future inspectors are recruited by the government through a competitive recruitment procedure from among the graduates from the Ecole Polytechnique, the Ecole des Mines de Paris, and the Ecole Normale Supérieure. Graduates from the first two institutions hold an engineering degree, while those of the third one hold a scientific degree (usually a PhD in Science). The number of positions open [each year ?] varies between 11 to 16, depending on the government's policy.

3.2. Program

The training program is a vocational one, preparing the graduates to do inspection jobs. However, for the reasons developed above, the program is much
broader considering the range of job opportunities they may have during their careers.

Until the 1950's, the training program was almost entirely devoted to science and technology. But it was found more relevant to insist on economy, law, social problems, and management. The direction of the Ecole des Mines decided to devote more than a half of the 3-year program to practical experience in France and overseas. Trainees spend their first year in a production firm where they are appointed as beginner engineers. It is very important to identify a personal supervisor who does not belong to the host company and reports to the direction of the Ecole. [Clarify: does the student have to recruit a supervisor or is the supervisor assigned to the student?] The role of the supervisors is even more important when the student is in a foreign country for 10 months in the second year of the training program, where it is difficult to arrange person-to-person contact. The main goal is to help the student have a lucid look at what is life in industry, not too critical, not too obliging, and get the maximum out of this first experience. Finally, the third year includes courses in economy, administration, law, all containing material relevant to industry. Third year trainees also take seminars, e.g., on risk and crisis management. This is completed by a final year of research project. The topics "hot" subjects, for example:

"Steel today"
"The megafusions"
"Research environment"
"Generic drugs"
"Relations between start-ups and big firms"
...

The results of the research are presented publicly and some of these studies are published by the Presses de l'Ecole des Mines de Paris.

4. WHAT HAPPENS NEXT?

After graduation, the trainees work for the administration services (former "Service des Mines", now called "DRIRE") in charge of safety inspections and environmental protection. The general rule, to which there are exceptions, is that none of the trainees is allowed to stay in Paris. They either go to the "Regions" or to the EC in Brussels.

Till the end of the 1960's, the essential part of the jobs consisted of applying safety and social regulations in mines. This was especially true in regions where mining was an important activity. But some other domains were covered, because of their connections with mines. For example, the safety of steam engines was extended to
that of pressure vessels. The "Service des Mines" was in charge of supervising safety in all industrial activities using pressure vessels, which means almost all industries. Two surprising examples: car engines and nuclear reactors. At the end of the 19th century, the "Service des Mines" was appointed as an expert for car controls because of their engines. Although strongly modified, the "Service des Mines" still examines every new car prototype, which must be accepted before being put on the market (This is also true for any foreign car or for any modification introduced by individuals on their car). The Service des Mines was also appointed as the administrative unit responsible for safety in nuclear plants, which undoubtedly are pressure vessels. Considering that about 80% of electricity in France is provided by nuclear plants, this mission is really very important.

Finally, let us mention a special type of industrial regulation which classifies plants according to their respective levels of hazard. (The classification results in "installations classées.") For each level of hazard, the relevant procedures of control are specified. [by whom?] As a consequence of a spectacular accident, which took place in SEVESO (Italy) in 1976, with the dispersion of gaseous dioxine, the E.C. issued a "directive" which applies to all European countries. The "Service des Mines", now called "DRIRE," is in charge of implementing the "directive SEVESO" in France.

Obviously, our young graduates are not alone for this mission. A lot of other people, especially technical experts, are involved. But they occupy key positions and play a very important role. They must be prepared to face difficult situations. For each accident, but especially when people are killed, if the inquiry proves that the inspection has not been strict enough, the inspector can be personally in a difficult position, subject to indictment in a criminal court and, if found guilty, sent to jail.

Most of the inspectors spend at least 3 years in public administration outside Paris. Then about 70% of them leave public administration either for the private sector, or for industry, or for research in the public sector. Those of them who are really exceptional – or lucky! -- may get a very high position. In fact, the Chairmen of 5 out of the 40 biggest French Companies graduated from the inspector training program. They have been marked by this first professional experience as "inspectors" and have a special concern for these problems of industrial regulation of risk.

CONCLUSION

What a strange system! France selects outstanding people through a long, efficient, and costly process in order to prepare them to officially act as inspectors for protection of the public safety, of the "intérêt général" (public interest) in the use of limited resources, and for risk evaluation, prevention, and crisis management. The average duration of a trainee’s stay in public administration is between 8 to 12 years, but in inspection per se, only about 5 years. The existence of such a system cannot be understood unless one considers the still very intense relationship between State and society in France. The liberal evolution of the recent years undoubtedly dilutes the relevance of this system. But this is largely offset by several aspects of contemporary socio-technical reality that help explain why the inspectorial system continues to remain relevant:
- First, the ever increasing complexity of technology and technological systems enhances the risks of accident and the potential scope of the disasters;

- Second, the question of sustainable development, in particular in connection with environmental protection, energy and raw materials availability and conservation, is becoming one of the burning issues of the future;

- Third, the need of contemporary society is for high-claiber technical people to protect public safety and the public interest, and, whatever its disadvantages, the inspectorial system has a side advantage in terms of the excellent quality of people it attracts. This is a real asset.

- thanks to its strong connection with both industrial and administration networks, the Ecole des Mines is in a good position to adapt constantly and satisfy the requirements of both as well as the expectations of the individuals involved. [What is it about the Ecole des Mines that enables it to adapt constantly and satisfy these organizational and individual requirements? Is it the specific courses offered? The culture of the institution? The quality of the faculty at ENSMP? or other factors?]