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## **THE SOCIETY OF ARTS AND ITS FRENCH COUNTERPART. APPROACHES TO THE ORGANISATION OF SCIENCE AND INDUSTRIAL RESEARCH, 1850-1914**

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Michel Letté<sup>1</sup>

The aim of this paper is to compare two views of the processes which drove industrial progress at the end of the nineteenth century. These two views were advanced by two national institutions, one in London and the other in Paris, which were concerned with the development of relationships between science, industry and economy. These organisations were the "Society for the Encouragement of Arts, Manufactures, and Commerce", better known as the Society of Arts and the "*Société d'encouragement pour l'industrie nationale*" founded respectively in 1754 and 1801. Thus this paper examines how these two institutions approached the task of stimulating industrial progress and changed in response to the needs of the Second Industrialisation.

Broadly speaking, the Second Industrialisation is situated between the second part of the nineteenth century and the First World War. The German sociologist Max Weber had defined this turn of the century as the rationalisation movement of the western societies. It was mainly concerned with modern state's needs to justify its increasing role in the public sphere. In this case, rationalisation meant an attempt to reach efficiency in all fields of social, political and economic progress through a collective organisation and bureaucratisation.

As a means of material organisation, this notion of rationalisation provided several models for the resolution of problems associated with the increasing scale and scope of modern industry. Hence the history of the relationship between science, technology, industry, economic performance, and the role of the State is widely seen as critical to the understanding of the rationalisation movement. This point is associated with an increasing specialisation and professionalisation of scientific activity. Furthermore, the state's chief role mainly consisted in defining ways of professionalising scientific activity through the creation of academic degrees, protective patents, awards, honours, jobs and so on. The result was a gradual transformation of scientific activity from individuals' occasional pursuit of

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science to full-time professionals. This rational change had radical implications for the organisation of scientific, industrial production and education in relation to the economic process. All these changes had to be considered by both the Society of Arts and the Société d'Encouragement but at different times and with slightly differing models and from distinct point of views.

## **Collective organisation of scientific industrial research in Paris**

The *Société d'Encouragement* (that is to say the SE) was created in 1801 under the influence of Napoleon I and modelled on the Society of Arts (that is also to say the SA) which had been founded 50 years earlier. The major aim of the former was to promote development in all fields of industrial activity and arts. Indeed, as in the case of the Society of Arts, its French counterpart intended to distribute premiums, prizes and medals to selected individuals considered as major contributors to progress. These awards were mainly given to inventors. Thus the Parisian institution followed the British approach by contributing to national economic progress by the promotion of the main contributors of the time.

The first president was the chemist Chaptal at a time when he was also in charge of the *Ministère de l'Intérieur* (Home office). He occupied the position until his death in 1832. During this period, the Council consisted of bankers, civil servants, members of the government (including Napoleon Bonaparte himself), lawyers, engineers, scientists (both amateurs and members of the *Académie des Sciences*), architects and various artists.

Thénard kept the position of president until 1845 when once more another chemist, Dumas, succeeded him. Throughout the period of the latter's presidency (between 1845 and 1884), the individual inventor, or the amateur scientist, were still encouraged as the crucial agents of progress. However, the academic orientation was central and the SE was mainly defined as an academy of applied sciences. Dumas himself simultaneously held the prestigious office of President of the *Académie des Sciences*. In a way, this pattern of promotion of scientific and industrial achievements by focussing on the gifted individual or the "genius" scientist was an utterly romantic vision. It was also an approach which was in accordance with the prevailing liberal view of the organisation of the economy.

Up until 1884 the engineer, the industrialist and the professional scientist had become the crucial agents of industrial change. A reorganisation was thus carried out. It was decided for instance that the president would be elected every three years. Above all, a debate took place

at the end of the 1890s about the best way to use the Society funds. By 1902 the Council had decided to devote its resources exclusively to the organisation of practical industrial or scientific research. Basically, such new ideas involved a complete change in thinking about the relationships between science and industry and ways of stimulating its development. The new vision was essentially based on the promotion of the "industrial science". Indeed, the point was to contribute to the collective production of the scientific materials useful for industry.

Let's now describe how the French institution mainly orientated its resources towards the organisation of industrial science research and why it could be considered as responding to the demands of the Second Industrialisation and at last why the SE, as an academic institution, eventually became more professional.

## **The Role of the Chemist Henry Le Chatelier**

Since its origins and until the 1880s, the SE mainly was and might remain an institution devoted to the individual liberal agent of progress. These tasks were not to carry out practical research but only to discuss, evaluate, judge and sometimes reward and protect inventions. Nevertheless, the SE was changing. In 1884, the engineer, and especially the state engineer, was the main figure who had become one of the essential agents of industrial organisation in France. They were also the most active proponents of change inside the SE.

Among those few engineers who had decided to initiate a radical change, the chemist Henry Le Chatelier appeared as a particularly motivated and ambitious reformer. He was just 34 years old in 1884 when he joined the Council. He was then a state mining engineer coming from the *Ecole polytechnique*. He was also Professor of Chemistry at the *Ecole des Mines* in Paris and became later Professor of Industrial Chemistry in 1887. He also was appointed Professor of Mineral Chemistry at the *Collège de France* in 1898 and Professor of Chemistry at the *Sorbonne* in 1907. Le Chatelier was at the turn of the century an emblematic figure among the scientists and engineers who were proponents of a stronger connection between science and industry, but also of a technocratic model for the organisation of society based on the rationalisation of its social, economic and even moral forces. He developed the notion of "industrial science" and devoted his career to pursuing this goal by reforming higher scientific education, the organisation of research and industrial production. More generally he developed thinking about the rationalisation of relationships

between scientific and industrial production. The SE could be seen as an arena for pursuing this theoretical concept to stimulate industrial progress at a national level. Le Chatelier was the main member of the society to implement change.

Even a cursory reading of his reports shows that he quickly became engaged in a campaign. He shifted towards a discourse that centred on the defence of a scientific approach as the only useful contribution to industrial production. He considered that the Council should confine itself to the production of precise experimental measures devoted to industrial interests; and in general, to scientific data about all aspects of industry. By the 1890s, Le Chatelier never ceased to stress the necessity of focussing on the use of experimental data and scientific method in order to replace the pragmatic but approximate ideas of contemporary industrial practice.

In practical terms, Le Chatelier tried to impose systematic experiments in order to verify results provided by the candidates for the awards. Consequently, one problem was to make available instruments, equipment, and materials to manage the required experiments. Fortunately Le Chatelier was one of the directors of the chemistry laboratory at the *Ecole des Mines*. As a consequence he was able to take the opportunity to use this laboratory as an extension of the SE's work. Nevertheless the connection remained unofficial. It could be achieved only because in addition to Le Chatelier there were a few other members of the Council who were also professors at this school. Another opportunity for practical experimentation arose when he was able to ask engineer members of the Council who were also directors of a private company if they could lend their laboratories or workshops for this use.

### **The phasing out of premiums**

In spite of this, the SE continued to promote industrial progress mainly through prize giving, although a change could be noticed in the formulation of the premiums. This transformation showed that the Council would have liked to increase its control over the orientation of research, the method used, the type of studies and who could be considered as serious award candidates. Previously the remits for awards tended to be general guidelines. The spirit of the prizes had previously been to appeal to the inventor and his genius. In 1889, new series of completely different remits for awards were suggested. The new awards were explicitly aimed at professional scientists. The subject was also precisely defined. These awards explicitly required the use of the experimental method. They were aimed at recognising the production of accurate quantifiable data used in

general industry like figures, coefficients, universal constants or physical features measured under well-defined conditions. So everything became specified and even the profile of potential candidates. In short, these awards made a major contribution to the disappearance of the pragmatic approach, in use in industrial production which still depended upon irrational, imprecise and expensive trial and error. The result was a major contribution to the standardisation of industrial research. However, the awards remained as a reward for completed research and not as a financial contribution to proposed work.

In fact, it was only in 1902 that the Council admitted that these awards had not kept pace with industrial changes. As can be seen on the figure below, the trend by 1890 was at any rate one of a progressive decrease of all sorts of financial awards, prizes, medals and so on.

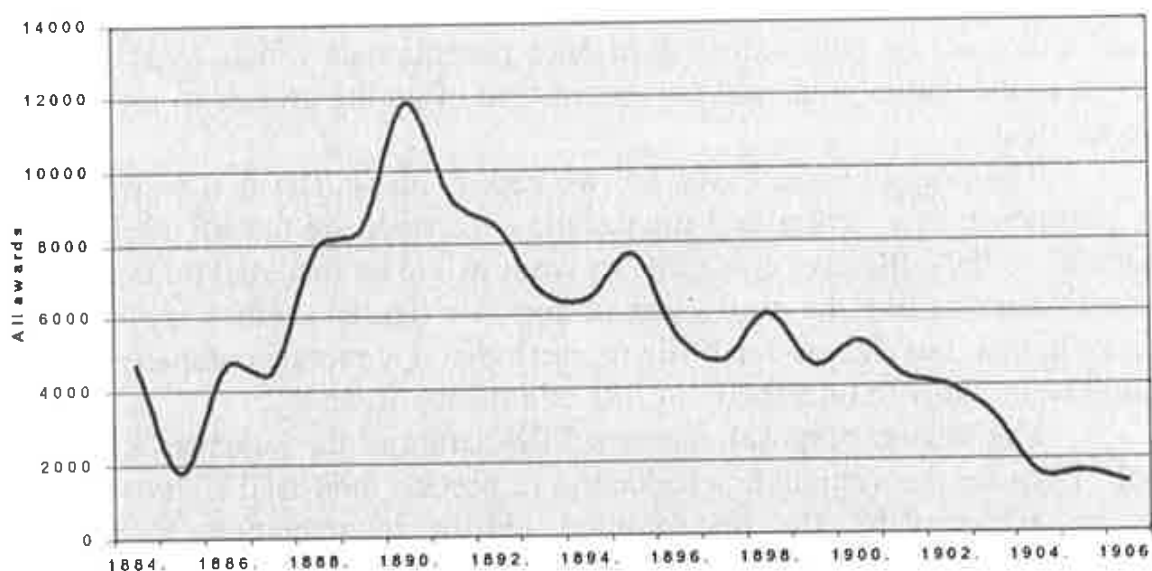


Figure 1: Yearly totals of all awards given between 1884 and 1906 in £

### Programs as a substitute for awards

But the real change was coming. After a proposal coming from the committee of chemistry in 1890, a special commission was appointed to study ways of stimulating industrial and applied science research. The Council then decided to continue with the experimental principle behind the new awards.

A crucial text was then issued and distributed by Le Chatelier to the Council's members. "Proposal suggested by the *Comité des arts chimiques* to the Council of the *Société d'encouragement* at its secret committee meeting on 13<sup>th</sup> December 1890" was the cornerstone of the reforms and focussed on the organisation of practical industrial science programmes. In this text, Le Chatelier mainly expressed the opinion that the majority of the SE's revenue had actually ceased to be spent in the interests of industry and was convinced "that instead of using annual funds in order to add to the embellishment of an already excessively sumptuous building which immobilises a capital of £240,000 plus the annual expenditure, the Society should rather use the funds by commissioning scientific research on industrial matters". "To commission scientific research on industrial matter", that is an eloquent summary of the proposal. The report was mainly focussed on the passive and academic attitude of the SE. It had failed to keep pace with the needs of industry. Le Chatelier suggested that the SE could undertake its own industrial science programmes which would be of service to the whole industrial process instead of giving awards to inventors and amateurs.

The proposal was based on two central ideas. The first insisted on the pertinence of a centralised organisation managed by the SE itself as a protector of the collective concerns. Its work would be focussed on issues of general interests like the production of accurate figures useful for all kinds of production, but also on scientific research that one private company alone would be unlikely to undertake for fear of assisting its rivals.

The second proposal concerned the nature of the industrial science itself. Because the systematic production of precise industrial figures could not be achieved by the uncontrolled pursuit of invention, a certain standardisation of research was required. It meant first a complete rejection of the amateur and the inventor as the main agents of industrial progress.

The first program of industrial science research carried out was devoted to a scientific study of the industrial gaseous fuels used by processes in the production of glass, iron and steel, and lighting gas. The process of the research was agreed and planned, the program precisely defined. Even though the goals, rules and method were fixed, the SE had not yet decided to invest in equipment in order to run the program inside its own walls. The practical aspects of the project were still required to be contracted out. Le Chatelier then suggested that the successful candidate would be welcome in the laboratory of the *Ecole des Mines*. The proposal could not be refused. First the SE's president was the director of the School, also Le Chatelier and another professor of the same school a member of the SE Council were still both directors of the laboratory.

The last but not the least important point concerned the candidate's status. The candidate was a civil engineer. He was an well-educated scientist and a qualified scientific worker. In short, he was a professional scientist. Above all, as a candidate for the industrial science programme, he was an employee and would have to do what he was told. In other words, he was committed by contract to the SE. He was paid instead of in receiving an award. These achievements were the real result of the transformation of the SE into a professional institution.

At last the industrial science programmes had adopted a professional pattern removed from the award system and its academic model. And it was successful. The reforms continued and moved on to a more collective form of organisation.

### **Direct practical contribution to industrial research**

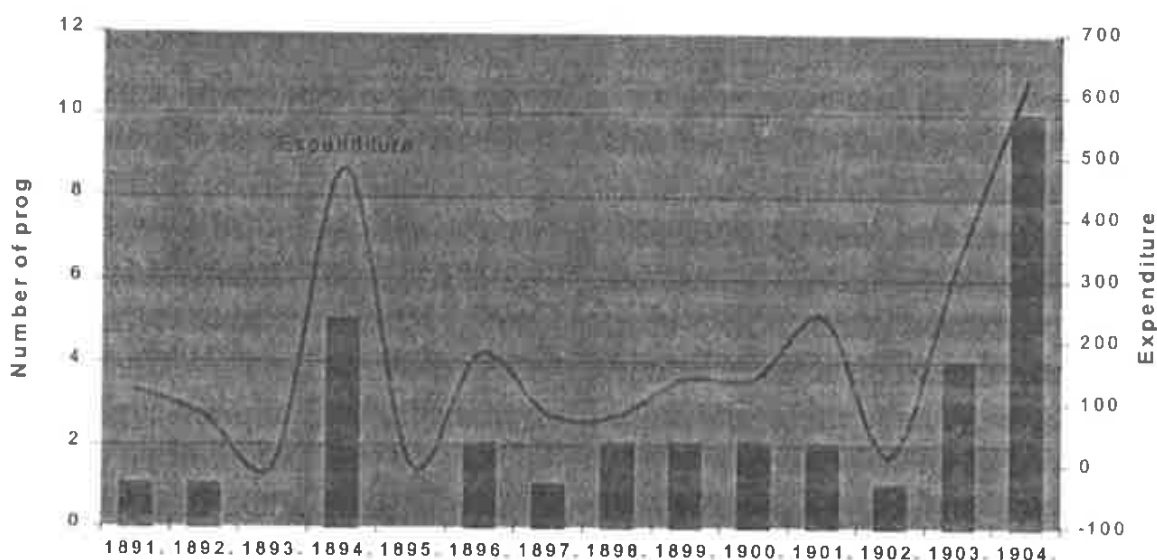
For instance, two committees were created and put in charge of the organisation of specific industrial studies. One was focussed on alloys. The other was concerned with glassmaking and ceramics. In some cases, private companies directly contributed to the financing of the programmes. Many different laboratories, all outside the SE, were commissioned to carry out research at the same time. All results were published and put at the disposal of the whole industry.

The first program began in the Artillery laboratory of the French Navy. This was an opportunity for Le Chatelier to claim that the SE could have undertaken such an industrial science programme more rapidly. The reason was that the British Institute of Mechanical Engineers had undertaken a similar successful collective project on the topic. Le Chatelier thought it was the perfect model to adopt. Then, a Commission was appointed in charge of the organisation of a similar programme in France.

These kinds of collective projects were rather original and ambitious. Originally, because the project involved a group of scientists rather than one individual, and because some private companies were directly interested in the project. Other companies allowed the use of their laboratories and workshops or even provided materials and equipment for achieving the results.

These projects were also ambitious because the topic was not only based on a single and precise study but on a major class of industrial products, here steel alloys. Eventually, the commission centralised all the results and issued a complete compilation of reports.

The approach was at this time completely defined and confirmed a more and more rational approach to programmes, with the SE acting as a professional institution. The success of the collective organisation encouraged the Council to pursue experiment with this model. The following chart gives a picture of the whole:



*Figure 2: Correspondence of programmes and expenditures between 1891 and 1904*

If not negligible, the total number of programmes actually carried out was not enormous compared with the total of the SE's revenue. Yet Le Chatelier still claimed that the reforms did not go far enough and proposed that all income should be devoted entirely to industrial science research. Despite the success of the industrial science programmes, the main problem was not yet resolved.

### **The impact of financial difficulties**

Actually, the SE's revenue was hardly sufficient to cover expenditure on the industrial science programmes.

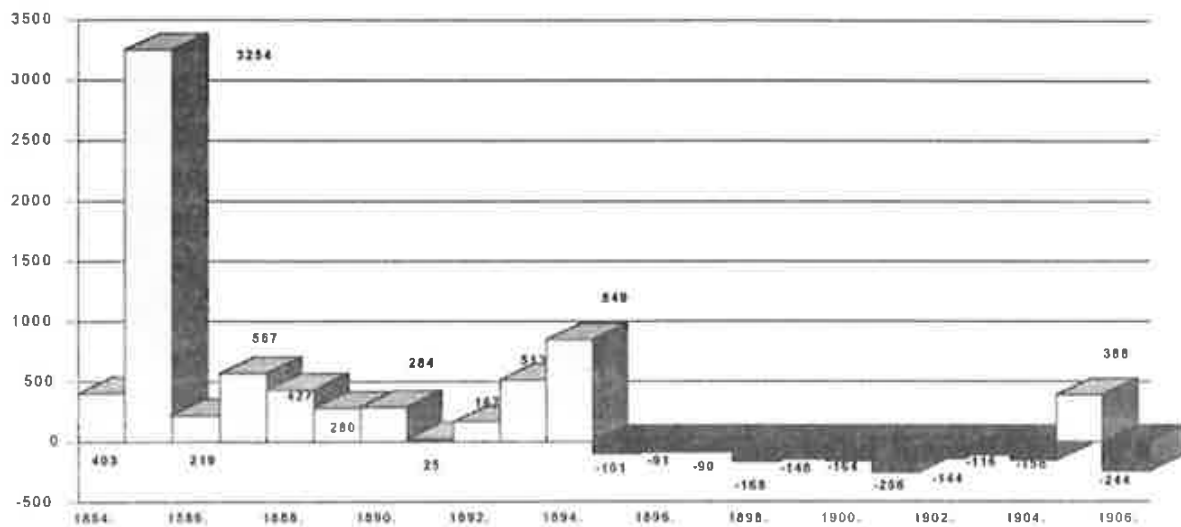


Figure 3: Budget surplus and deficit between 1884 and 1906 in £

In fact, by 1895, the SE had met a chronic budget deficit and according to the annual financial statement, the programme had to be restricted. A special commission was appointed to look into ways to find new income. Unfortunately, the Commission was unable to set up new rules and the SE remained a mixture of a professional and academic institution with reforms not fully achieved.

As a national institution devoted to the stimulation of industrial economy, it can be concluded that the SE succeeded in responding to the demands of the Second Industrialisation, focussing on a rationalisation of the relationship between science, technology and industrial production. The SE particularly took into account the need to contribute to the professionalisation of research centred on the industrial science programmes.

To start with, the process was not driven by invention or discovery but by the scientific production of materials for testing, the control of quality, and the production of figures and scientific explanations about industrial phenomena. These were considered as the basis for concrete improvement, and then as opportunities for further innovation. Above all, the contribution of the SE had moved from the end of the innovative process towards the beginning.

Concerning the place where industrial science research could be carried out, the SE did not invest in equipment or in a laboratory for experiments. But it proved possible to find materials, instruments and laboratory, most of the time among public institutions (*Ecole des Mines*,

Artillery of the Navy, *Sorbonne*, *Conservatoire des Arts et Métiers*) or even, but less often, among private companies. In a sense, the programmes were externalised and disseminated in several places, even though this scheme resulted to some degree from the need for flexibility due to the lack of financial support for the programmes.

The essential point was that industrial science programmes definitively replaced the inventor and his invention as a means of contributing to industrial and economic progress. Following this, a comparison with the Society of Arts' approach to supporting industrial innovation could be attempted.

### **Reconciling tradition and reform**

In 1754, the SA's aim was the advancement and application of all aspects of science connected with the arts, manufacturing and commerce. To this end, the founders decided to reward those who had competed for a prize. The selection of suitable subjects for the offer and the adjudication of awards constituted almost the sole business at the Society's meetings for many years and continued until the 1850's. The British paradigm was followed not only in France but also in many other industrial countries by means of the setting up of institutions devoted to the stimulation of economic progress through similar awards and discussion.

Since its foundation, the Council had been mainly drawn from the aristocracy with diplomatic, political, military, administrative and industrial interests, along with professionals such as scientists, engineers, artists and industrialists. The structure did not change significantly after 1850. As in the case of the SE some individuals often held a strong interest in certain topics. During 1884 for instance, active scientists such as the chemists Abel or Perkin, ensured a permanent concern for science. The Duke of Albany (Leopold George Duncan Albert), advocated the cause of scientific and technical education and the movement for the extension of university degrees. But whatever their particular emphasis, aristocrats, captains of industry, artists and scientists all shared the conviction that they had an essential role to play in the organisation of British society by voicing their opinion in the arena of the SA.

At the time of the Great Exhibition of 1851, Britain was the home of the Industrial Revolution. It was also the home of an apparently triumphant bourgeoisie and a new industrial elite rivalling in importance the traditional aristocracy. Originally, the SA was responsible for the Great Exhibition, and undoubtedly contributed to the image of British industry as a force for renewal in British society. But the Second Industrialisation

required a revision of the approach to stimulating progress adopted more than a century earlier. The SA decided to reconsider its aim and ways of reaching it. It is this change and its association with the Second Industrialisation movement that should be compared with that of the SE.

Like the SE, the SA was still convinced in the 1880's that industrial progress was due to the cumulative effect of successive inventions. Rewarding inventors had for a long time remained the preferred way of stimulating research. But after 1851, the SA had gradually abandoned a focus on the inventor in order to take into account a larger spectrum of the agents of economic progress. The SA had also undertaken a large diversification of its activities. But the leading principle of stimulating individual effort was still liberally applied. The SA had never really considered practical research or more generally supporting a project from its beginning. The system was still based on the principle "do it yourself" and the SA will reward the results.

### **The Society of Arts' basic role : providing premiums and rewards**

At this point the main function of the SA remained the distribution of various awards. In 1856, prizes were awarded in 216 subjects, but this had been reduced to only 120 in 1864, after which the system began to disappear. However, such a list of awards was enormous compared with its French counterpart. For instance, the SE was content to set up only 87 awards in 1856. Basically, the details of the wording showed that the underlying concerns and the criteria for awarding prizes were very similar. Actually, the SA gave up the system of giving prizes 30 years before the SE did. That was a difference between the two institutions with the consequent saving of money. In London, questions were raised about the efficiency of the awards system when the International Exhibition in Paris in 1867 revealed that other countries were able to surpass British achievements. This awareness provoked the need to reconsider the way of improving the British economy. A wave of reappraisals raised doubts about the value of the influence of the SA. It was found that the most effective reward for an inventor was to give him the opportunity of publicity. Hence the SA initiated the pattern of holding ordinary meetings at which papers were presented and discussed. Few participants received a medal. An average of only fourteen per year was distributed between 1877 and 1906.

In short, the SA did not challenge the principle of competition and awarding the individual inventors but did doubt its efficiency through prize giving. Prize giving meetings were turned into invitations to read papers followed by discussion.

Following a similar principle, the Albert Medals had been organised as a way to mark the distinction of a person for his achievements in promoting progress. The first medal was awarded in 1864 to Sir Rowland Hill, the inventor of the penny postage. The second was awarded to Napoleon III in an honorary capacity for the signing in 1860 of the free trade treaty between France and Britain. However most of the people designated were British scientists and engineers like Faraday, Siemens, Cole, Thomson or Perkin, but also a few foreigners such as: Liebig, Chevreul, Pasteur, Dumas or Helmholtz.

### **Maintaining continuity : the Cantor lectures**

By the second half of the nineteenth century, the SA also became a visible place where lectures of high quality were held. The movement achieved a sort of climax with the Cantor lectures. These lectures originated in 1863 with a bequest from Theodore Edward Cantor who had cultivated a great passion for reptiles and died in 1860. From 1864, the sum left had been used to set up courses on general industrial and artistic topics, to pay the top specialists to give lectures and to arrange an effective advertising campaign. The first lectures were given in 1864 by the chemist Crace Calvert on the application of chemistry to the arts. The following years the Cantor lectures quickly met with sufficient success to lead to the extension of the system. Then the lectures covered an increasingly wide spectrum of themes.

However, the SA did not appear concerned that its activities should be directed towards the concrete organisation of research or even towards funding technical expertise.

Obviously, the papers, discussions and debates showed how interested the SA still was in the scientific topics but only at a theoretical level. As an illustration, a chemical section was set up in 1874 to discuss subjects connected with practical chemistry and its applications. At least six meetings were held during the annual session and usually focussed on only one specific theme. Nevertheless, the meetings did not draw enough people to justify the SA maintaining the system. The section was discontinued in 1887 under the belief that the resources and the influence of the SA might be better applied in other directions.

Indeed, the decision to keep away from the practical matters was rather in accordance with the role of the SA since its foundation. The Second Industrialisation had generated specialisation and then institutionalisation of the specific technical or scientific fields. For instance,

if the improvement of agriculture was one of the very objects of the SA, it gradually left the Royal Agricultural Society to fulfil this role after it was established in 1838. The case with chemistry was similar. When several societies were created in order to organise the professional and academic community of chemists and to take charge of the promotion of scientific and industrial research in chemistry, the SA had to take into account division of labour between these organisations. In general the main issue was less about how to keep a prominent influence in each specific practical branch of industry than about focussing its concerns on the interests of the British economy in the widest sense.

### **Organising exhibitions**

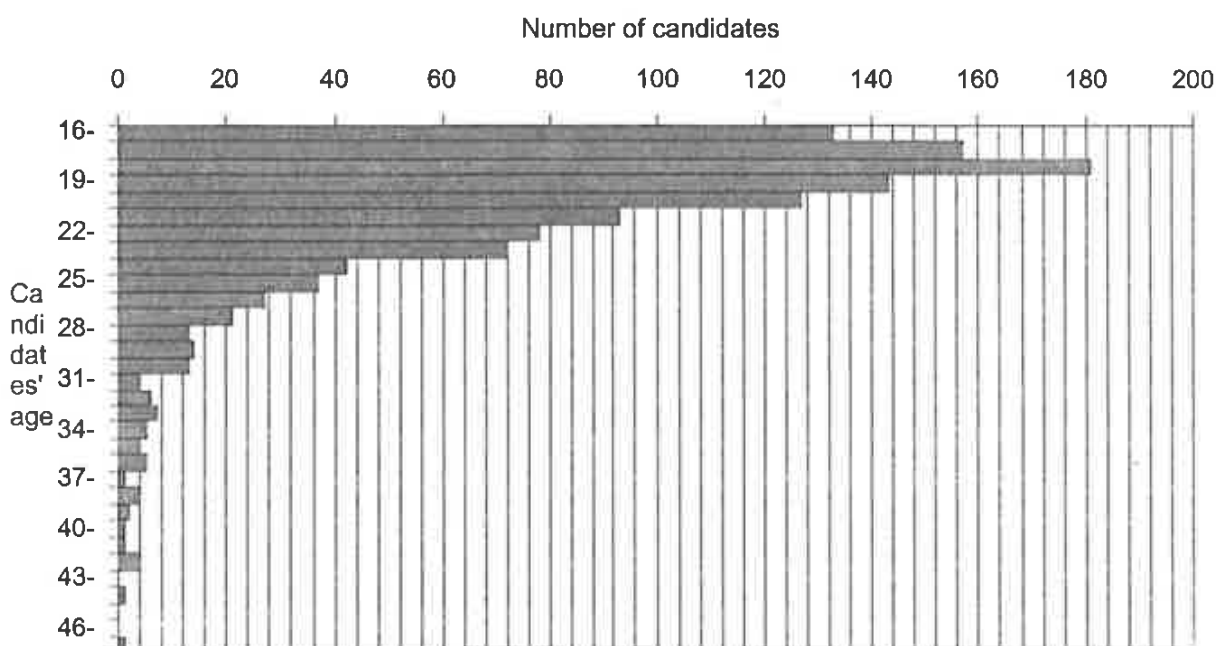
Another important activity has to be mentioned. Since the success of the 1851 Great Exhibition, huge importance had been attached to the holding of exhibitions. They were considered as a one of the most efficient ways of directly promoting invention, technical improvement and the development of skills. Following this, the SA reported various events more systematically, and whenever possible took a direct part in their organisation. An example of this was the International Health Exhibition held in London in 1884. The SA also was for instance commissioned as the Royal Committee for the Chicago Exhibition in 1893. This concern with exhibitions was in line with its tradition of promoting the results of progress rather than achieving progress itself.

### **Keeping pace with the public examination movement**

The SA's most important contribution was undoubtedly the setting up of a national public examination system, and especially relating to the education of those connected with industry. From the 1850s the belief had grown in Britain, in both academic and public life, that open competitive examinations would remove favouritism, reward hard work, encourage good sportsmanship, discourage patronage, and finally offer improved avenues to upward mobility. The SA was largely involved in this debate and had developed its own public examination system. At the turn of the century, a wide range of examinations at all levels bore witness to their enormous social prestige and professional importance. The SA played a potent role in this and, as a private agency, received wider power and influence. By the end of the century it had become one of several national examination centres .

The public examinations system came into being in 1854. It was based on a competition that credited those who were able to answer a defined set of questions. The logic behind this development was in tune with a theme of the SA since its foundation: competition and reward. The first assessment was by general examination and included 18 subjects<sup>2</sup>.

The examinations were held annually on a similar programme, through the agency of local committees established for the purpose. They were opened to any candidate. As can be seen on the chart below, the examinations attracted mainly people between the ages of 16 and 23.



*Figure 6: Candidates' age at the 1864 examination*

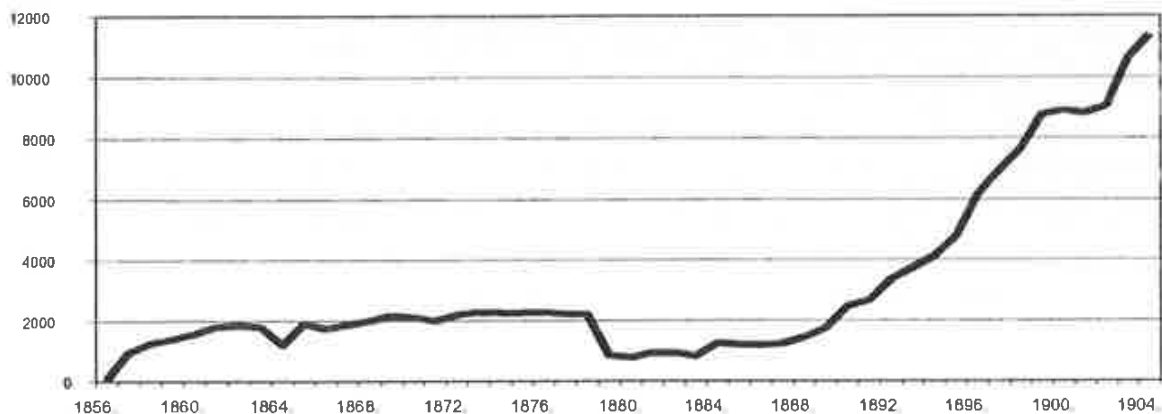
The principle of examination based on a fixed curriculum about general topics and the rewarding of pupils was well accepted. However, the debate raised the issue of the appropriate content of examinations and in particular that of science and technology. When Donnelly joined the SA in 1860 as an inspector for science in connection with the Art and Science Department, and its Council in 1870, he undertook a campaign to persuade people to include technical subjects in the examinations. He proposed that the examinations in science and technology related to manufacturing trades

<sup>2</sup> 1. Book-Keeping ; 2. Arithmetic ; 3. Algebra ; 4. Mensuration ; 5. Geometry ; 6. Mechanics ; 7. Chemistry ; 8. Animal Physiology ; 9. Botany ; 10. Agriculture ; 11. Geography ; 12. Physical Geography ; 13. English History ; 14. English Literature ; 15. Latin and Romance History ; 16. French ; 17. German ; 18. Freehand Drawing

should include basic science as well as practical knowledge. He also devised a scheme for instruction. He adopted the principle that teachers should be awarded certificates on the results of the examinations of their pupils. Prizes were at the same time to be given to successful students. The scheme was in accordance with the traditional views of the SA and in fact had been adopted in part before Donnelly had joined the institution. Thus the science examinations began in 1861. Ten years later, the Council announced that they would discontinue general examinations. The outcry was such that the SA reinstated the original programme and the resolution was adopted that it would set up examinations in technology in addition to its existing system.

In 1879, the question of abandoning the system cropped up again along with this time a demand for examinations of a more elementary character. The same year, at the foundation of the City and Guilds' Technical Institute, the Technological Examinations were handed over to that body. Yet a widely supported reaction had arisen against examinations by the mid-1880s, especially against scientific ones. The criticisms were targeted mainly on the opposition between training and education, between recognised knowledge and original research. If a defining characteristic of research was the disinterested pursuit of knowledge then it was held to be inconsistent with the mercenary pursuit of prizes. But the SA continued to pursue progress through competition and awards rather than through organising and financing its own original research.

Finally, an elementary examination was established in 1897. It was so fully popular that in 1901 an elementary grade was added to the general examinations. By that time the whole system was well established and attracted a huge extra number of candidates each year, as can be seen on the chart below.



*Figure 5: Number of candidates examined between 1856 and 1904*

Besides the management of the annual examinations themselves, the SA had initiated a number of debates relevant to the whole educational system. For instance, the SA organised in 1868 a conference on scientific and industrial education. Another example of this was the Committee on Physical Education appointed in 1884 to consider the question of the physical training of children in elementary schools. The SA also contributed to the foundation of the Association for the Promotion of Technical Education and its inaugural meeting was held in the rooms of the SA in 1887. In 1897, the SA hosted the 4<sup>th</sup> *Congrès International de l'Enseignement Technique* which had hitherto been held in Paris.

The SA's role in setting up an examination in order to contribute to economic renewal might be understood as a response to the need to find a basis for the selection of people for recruitment into the civil service, the military and the professions. It might be that examinations were considered as a means of improving technical and scientific education because there was no other system readily available in Britain to meet the educational needs of the Second Industrialisation. Actually, the institutionalisation of written examinations historically went hand in hand with the development of a rational bureaucratic industrial society to which the SA had contributed.

But through the examinations system, the SA had definitely kept away from the fostering of industrial or scientific research which at least involved the production of new types of knowledge. From this point of view, examinations and original research should be considered as contradictory. As a matter of fact, the SA did not follow the endowment movement of science which emerged in the 1870s. The SA rather reinforced its position as a sort of Gentlemen's institution. The devotion to examinations allowed for instance to validate what knowledge is and then to contribute to its standardisation. With the power to assess, to select and to reward, in all fields of knowledge, the SA's examinations amounted to reinforcing existing cultural and social positions through the validation of common educational beliefs.

The SA then neglected the professional orientation that would have consisted in organising research in order to produce new knowledge. The SA retained and in fact developed a more complex model based on competition and rewarding with the individual as a major agent of progress, a scheme which differed from the French one.

## **Conclusion**

The main differences between the SA and the SE lay first in the change of the status of the two institutions when they had to meet the needs of the Second Industrialisation. From 1851 already, the SA had begun to undertake its transformation. The point was then essentially to remove the prizes and to replace them with the system of public examinations. Nevertheless, the liberal principle of rewarding an individual for the work he or she had done remained. This scheme meant keeping away from the organisation of original research. Actually, the SA had preserved its academic nature by its theoretical discussion and its judgement. In a sense, it was a conservative change through the competition and the reward principles.

From this point, the SE lagged behind the SA because it only undertook its own reforms 30 years later. This gap could be considered as the materialisation of the distance between two Second Industrialisation processes. Then the SE also abandoned the prizes system and stopped considering the inventor as the main agent of industrial progress. Having originally rewarded achievements, the SE's aim had become the practical production of scientific materials for the industrial innovation process. Actually, the SE had left behind the academic aspects of its origins and had become a more professional institution.

As regards the endowment of research, the specialisation, the professionalisation and generally the rationalisation of the relationships between the scientific and industrial production, it could be said that the SE had responded to the needs of the Second Industrialisation by contributing to the organisation of industrial research, and that the SA failed on this point. Actually the original question was inadequately worded. One can argue that an institution devoted to economic progress and whatever its nature need not shift from academic objectives to more professional pursuits. In the SA's case, it only meant that British industrial society did not need such a transformation. One explanation is that the British industry was still so efficient in using a traditional industrial innovation system that the SA could itself afford to preserve an academic pattern. Then the luxury of dealing with general and theoretical topics keeping away from a more pragmatic concern could be maintained.

The SA's wealth compared with the relative poverty and decline of its French counterpart could in a way explain the difference. The main differences lay both in the origin of the revenues and in the amount of

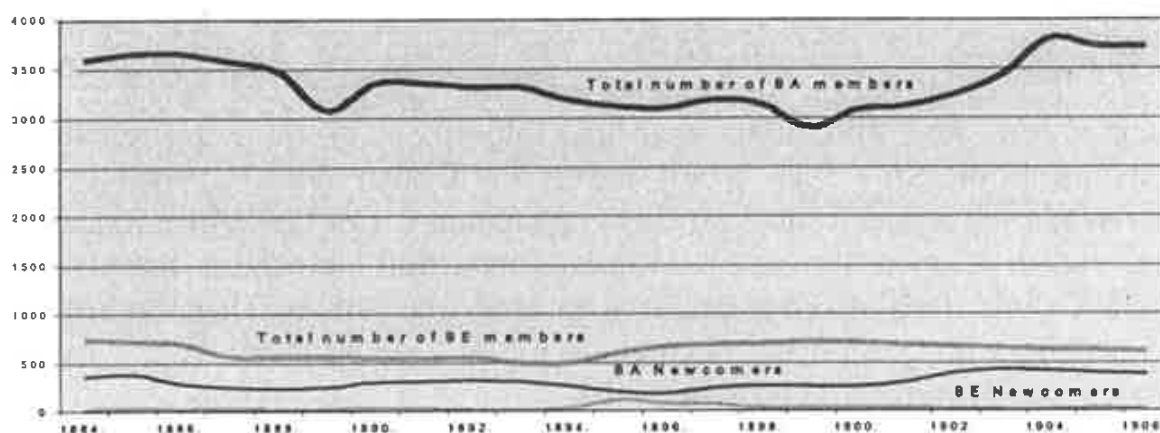
income drawn. As an illustration, the income of both the SA and the SE could be compared for the year 1884. According to the following pie chart (*figure 8: Comparison of the incomes of both SA and SE in 1884*), the SA got its income mainly from its subscriptions, which should on the whole be considered as an indicator of a healthy situation. The French case is slightly different. SE could not pretend to retain membership and attract enough newcomers to cover its expenditure. Then the balance could only be obtained because a surplus from the previous year was included in the income of the next. In other words, the SE was only able to maintain the balance because of restricted activity.

*Figure 8: Comparison of the incomes of both SA and SE in 1884*

SA	SA incomes in £	SE incomes in £*
Subscriptions	6670	1085
Dividends, interests & ground rents	766	3095
Donations	1260	1000
Sales, advert, and fees	1522	192
Others	2363	1141
<b>TOTAL</b>	<b>12581</b>	<b>6513</b>

\* The exchange rate considered is £40 = 1000 FF or £1 = 25 FF (according to the *Journal of the Society of Arts*)

Actually, the SE registered only 23 newcomers in 1884 against 361 for the SA! (*See figure 9*).



*Figure 9: Variations in membership between 1884 and 1906*

But whatever the similarities and the differences underlined, both societies belonged to a group of institutions which constituted a network with a division in labour organisation. The role of both the SE and the SA might be associated with the understanding of the organisation of the whole network. In other words, comparing two isolated institutions could not be restricted to the comparison of two national views about the organisation of relationships between science and industry. To do it without taking into account the other academic and professional institutions would be incomplete.

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