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The Titanium Dioxide Case

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Introduction

Technological determinism has had a strong position in social sciences and philosophy.[1] But there has always been voices against this view. Much empirical research the last 20 years have shown that technology is formed by as well as forming the society. Class relations, government procurement, technology as a tool for dominance, conflicts around technology, all have had some influence on the development of technology.[2]

Cultural studies have also shown the influence on technology. Spengler claimed Western technology to be formed by the Faustian man, who is dominant in the western culture. The will to rule the nature was strong.[3] In a similar way, Mumford appreciated the cultural influence. The technologies were developed elsewhere, but it was Western civilization that carried them to a point which no other culture had reached.[4] In a more recent study, Jamison sees the science and technology policy of different countries as formed by national styles.[5]

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[1] See Winner, 1977, who discuss the autonomy of technology.

[2] A good summary of some of this research is collected in MacKenzie & Wajcman, 1987.

[3] Spengler, 1988, pp. 98 - 107.

[4] Mumford, 1962, p. 4.

[5] Jamison, 1988 a.

A third point is the rise of new social movements. These movements do, as the old ones, fight for influence upon decisions and they are often concerned with science and technology. The anti-nuclear movement fights against building of nuclear power, the peace movement against inter-continental weapons, the female movement against male dominated technology.[6] And as to technology, these movements also seems to be influenced by cultural traditions or "National Styles".[7]

The issue to be raised here, and which is related to all the three different claims or traditions is: Does the environmental movement have any influence on development of technology and how does the interaction between movement and technology work in different cultures? If technology is a social construct, it seems logical that from social conflicts and controversies, a different type of technology would rise, compared to a situation of no conflict. In a study of such a conflict, it should be possible to see the impact of technology, or determinism, and to see whether the technology as such form the outcome. In a similar way, different political cultures would give different interactions between a movement and a technology. The way groups maneuver in the political arena and where they put the pressure would be different. And thirdly, does the new social movement represent a base for a shift of both technological and social system, which some claim?[8] When technology plays such a dominant role in our societies, a shift, whether it is just around technology or in society as a whole, should be manifest from the technology which the movements try to change.

In this article I will describe the conflicts around the titanium dioxide industry. This branch of industry has met pressure from authorities and especially from environmental groups. The industry have gone through big technological changes, even if the product remains the same. The conflicts have also taken place in different national context. Here I will mainly be concerned with what happened in Norway and the Federal Republic of Germany.

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[6] Brand, 1985.

[7] Cramer et al. forthcoming, and Brand, 1985.

[8] Offe, 1985. 819 - 820.

In the end, the findings will be related to a theoretical apparatus, in order to frame the questions raised above.[9]

Possible Influences of a Movement

The rise of the new social movements have been analyzed in different ways. As mentioned in the introduction, some find them representing a major shift in the whole political system.[10] This is in the leftist tradition, that sees the shift of the society coming from movements underneath. The labour movement changed the capitalistic system toward a system where the state became strong and dominant. The new social movement fight against both, state and industry.

But on the other side, also in a leftist tradition, the new social movements are seen as stabilizers of the system. The movements give the system warnings about where faults or errors appears. The system can therefore try to ease on these problems and make the situation acceptable. The protest will calm down, and the system will be intact.[11]

Leaving this debate for a while, let us try to break down the problem and move toward the micro level. Here we can make some postulates on possible influence of an environmental movement, which may seem reasonable.[12]

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[9] This study is part of a work on a PhD, where the view on technology from the environmental movement in Germany and Norway, both in theory and in practice is to be studied. This case represent the practical work on technology from the environmental movement. The case is chosen because it has been one of the hottest issues in both the Federal Republic and Norway and environmental organizations have found the work they have done toward this industry as important. It represent a case where at least something changed during the pressure from the different groups.

[10] This is maybe most strongly articulated by Touraine, 1982, p. 13 - 23, and 1986, pp. 25 - 29.

[11] Haffner, 1978, p. 84. A representation of this view is Enzenberger, who saw and still sees the whole ecological debate as a new tactic of the bourgeoisie. Enzenberger, 1973, 1988.

[12] This points is a compressed version of the possibilities of influences as Brand sees them. Brand, 1983, p. 41.

First, the environmental movement may change the general assessment of values, and through that generate an increased and different assessment of problems. We can see changes in such values, both with respect to technology and environment during the last twenty years.[13] However, to find the connection to the environmental movement is difficult, but we can see that environmental groups working on specific projects have achieved such changes. They have had particular susccess in changing values that will give a different consumer pattern.

Second, the movement may bring changes in the scientific community and among experts. The influence could be in terms of changed norms and valuation of problems, but also in mobilizing experts with critical and new arguments. Often such activities open scientific and technological processes to a wider public, because they show that the processes are not exact and with more than one solution. There is different ways of solving the problems, and some are more agreeable environmentally than others. Experts have different meanings and it may be the strength of their arguments and how they are capable to present it that will be the crucial, rather than the "facts" of science.

Third, the movement can often be a strong support for local activities, such as blocking large technological systems or polluting industries. A strong and important movement may also legitimize civil disobedience.

Fourth, the movement may influence the activities of the authorities. Authorities may find it wise to change their environmental policy as a respose to pressure from a movement. They may also reallocate some of their resources, for example put more money into research on alternative energy.

These four points are of course woven together. An environmental group does have one type of policy for their support to local activities and an other for the mobilizing of critical scientist. But often an activity on a specific field have influence on others. The Greenpeace offensive to protect the whales, may have given a different consumer pattern and maybe even a changed attitude toward man's use of animals. Scientist have been mobilized, in this case maybe more as a critique toward Greenpeace.

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[13] Fredricks, 1986.

Greenpeace have supported local activities and governments have reduced their quotas for the hunting of whales, if not forbidden whale hunting.

But this example also shows how an activity may have different outcome in different contexts. Greenpeace has found stronger support of their activities in countries which have no whale fleet. Values are given in then commandments. They are different in different settings. For a society which has been dependent on the hunting of whales, their main concern is how to use the animal for their own benefit. In such a society, respect for the life of an animal or the need to save a species, will meet with greater resistance. Also, a country which has a whale-hunting fleet, will necessarily have scientist which are involved in this activity. And most likely, these scientists are in favor of whale hunting, just because it gives them their profession. A critical voice will be much more difficult to raise inside this community.

As a support of civil disobedience Greenpeace's activities may also work out differently according to how the authorities react upon the activities on the ground floor. An open political system will easier calm a rising opposition, because it is capable of involving some of the critique in the policy making. This have been shown to be the case in the building of nuclear power plants in France, Sweden, United States and the Federal Republic of Germany. Stronger confrontations where found in France and the Federal Republic, two countries where the political system is more closed than in Sweden and the US.[14] Especially in Sweden, the government was capable of adapting the argument from the anti-nuclear movement. One of the main demands of the anti-nuclear movement was a referendum, and the Prime Minister of Sweden, Olof Palme, proposed to agree to that.[15] That was unthinkable in France or Germany.

Important to the activities in the movement is also the strength of the government. Is it able to push a new policy through the system or does it only have a small influence? A weak government makes a shift in the activities from the movement to attack or lean to other actors in the

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[14] Kitschelt, 1986, p. 71.

[15] Jamison, 1988 b, pp. 36 - 37.

political arena. The bureaucracy or the legislature may become more important than the political party[16].

Nuclear power was not developed into production plants in Norway. Infact, the government decided to build a plant in 1971[17] and met with, at first, local protest, and later by a more nation-wide organization, "Aksjon mot atomkraft".[18] Unlike most European countries, Norway is capable to satisfy its large consuption of energy through hydroelectric power, and among researcher and planners there is still the view that many more rivers can be used for energy production. A industry involved in the construction of hydroelectric power and many rivers to dry down did help the organizations to reach their goal. So also geographical factors seem to play a role in the success for the opposition.

As discussed above, many factors are important to shape activities. Thus, conflicts and the outcome of conflicts should be taken to be different when some of the factors become more important or different. I will now go into the case of titanium dioxide industry in Germany and Norway, and discuss the differences which may have caused a different way of interaction with the environmental movement and, finally, led to a different selection of technology.

The History Behind the Production

Titanium dioxide was discovered as early as in 1791 by an Englishman William Gregor. In 1795 it was discovered independently by the German chemist Heinrich Klaproth in Hungary. He named the compound Titan, taken from Greek mythology. The Titans were the first Gods in the beginning of time. The compound Klaproth found was so bright, that he meant that the word Titan would suit it. But as early as in 1795 there was no economic use of the mineral. The industrial consuption did not start until the beginning of

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16. Kitschelt, 1986, p. 68.

17. Andersen, 1980, p. 298.

18. Action Against Nuclear Power.

this century.[19] As in the case of the discovery, it also came up independently in two different countries to make it industrially useful.

The ore where titanium dioxide is most commonly found, is rich of iron. And it was the search for iron which later led to the production of titanium dioxide. In 1860 an English company bought the mining rights in the end of the Jøssingfjord, close to Egersund in Norway. Here, a large amount of ilmenit was found, which contained both titanium dioxide and iron. But the company had problems in extracting the iron from the ore economically and they went into bankruptcy after nine years.[20]

On the other side of the Atlantic, a French chemist August-Jacques Rossi, worked with similar problems; to extract the iron from the ilmenit. This work lead Rossi to focus on the titanium dioxide, and in 1908 he was able to seperate the compound from the ore. He found that the Dioxide with its brightness was very useful as a pigment.[21]

In 1911 Rossi went to the Patent Bureau with his method. At the same time, two Norwegian researchers, Peder Farup and Gustav Jebsen, patented their method. They had in 1908 been comissioned by the Norwegian Government to find a profitable use of the mine which was left by the Englishmen. They tried to roast the ore to get out the iron, and in this process they came up with titanium dioxide.[22]

The method which was developed, could be used industrially. November 23th 1916, the company Titan Co. A.S. was founded in Fredrikstad.[23] Titan used the ore in Jøssingfjorden for their production. This ore was and still is the main European supply of TiO_2. The production started independently also in an other context at the same time. The American company Titanium Pigment Company began to produce titanium dioxide close to Nigara Falls. The

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19. Kronos Titan, 1987, pp. 86 - 91.

20. Kronos Titan, 1987, pp. 86 - 87.

21. Kronos Titan, 1987, p. 86.

22. Kronos Titan, 1983 a, p. 87.

23. Kronos Titan, "Velkommen til Kronos Titan".

production was based on the patent of Rossi and his later partner Barton.[24] Both the companies were unable to produce pure titanium dioxide. Small amount of calcium or barimsulphat was found in the product. But the basic process was the same as the one of the process which is still in use to day; the sulphat method. With modifications, the methods have lived for almost 80 years.[25]

Pigments to paints and colors have been used since the antique. Greeks and Romans produced white lead and used it for decoration.[26] But white lead is poisonous and may in time change color. This is not the case with titanium dioxide. Normally, the compound does not mix with chemical solutions. That makes it non-aggressive and non-poisonous .[27] Also, the refraction index is high, even higher than in diamonds. The crystal form anatas of titanium dioxide has a refraction index of 2.5, the form rutil 2.7. The index for diamond is 2.42.[28] These are important factors to the success of the compound.

Naturally, the new product was met with interest from producers of white lead. White lead was the most commonly used pigment in the beginning of this century as well as in the antique. National Lead Company, the biggest producer of white lead, got the majority in the Titanium Pigment Company in 1926, and one year later they also had the control in Fredrikstad of Titan Co. A.S.[29] National Lead Company then also got the majority in a TiO_2 producing factory in Germany, which was started in cooperation between Titan Co. A.S. and IG Farbenindustrie in Leverkusen in 1926. This factory was in 1928 able to produce pure titanium dioxide.[30] Now, TiO_2 became a common pigment.

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24. Kronos Titan, 1987, p. 87.

25. Kronos Titan, 1983, p. 33.

26. Kronos Titan, 1983, pp. 23 - 25.

27. Kronos Titan, 1987, p. 11.

28. Kronos Titan, 1987, p. 12.

29. Kronos Titan, 1987, p. 87.

30. Kronos Titan, 1987, pp. 87 - 88.

Two Different Processes

Titan is not a scarce element. The surface of the earth contents 0.6 % pure titan. Crystals of titanium dioxide like rutil can be found naturally. But this natural rutil can not be treated with sulphuric acid to produce pure titanium dioxide.[31] With only one producer of ilmenite in Europe, the mine at Jøssingfjorden in Norway, it seems like this has been an initiative to search for other methods. One other process, different from the old sulphuric method has been found: the chloride process. This process was first developed by IG Farben during the Second World War.[32] The method was forbidden by the Allied Forces, and the American company Du Pont, developed it further on. The process was commercialized in 1952.[33]

Todays managers claim other reasons to develop methods than to find a way of using new raw materials. According to Charles Maston, director of Du Pont Co.'s White Pigment and Mineral Products Div., the other now commonly used method was developed "to solve the inherent pollution and cost problems of the sulfate process".[34] Whatever reason, the chloride process have steadily been taking a bigger part of the production of titanium dioxide, to more than 40 % today.[35] And it is more environmental acceptably, at least environmental groups have demanded a shift to the chloride process, as we shall see later.

The sulphuric method, which is still the most commonly used process, was in its basic form patented in Norway as early as in 1911. The most common argument for the use of the method, is that the technology is well-mastered, the raw materials are easily accessible and that both the building of the factory and the running of it is relatively cheap.[36]

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31. Kronos Titan, 1987, p. 37.

32. Letter to the minister Hauff from Greenpeace, 1981, Greenpeace archive.

33. Lazorko a.o., 1989, p. 39.

34. Lazorko a.o., 1989, p. 39.

35. Lazorko a.o., 1989, p. 37.

36. United Nations, 1987 b, p. 2.

The production runs through several steps. First the ilmenite has to be milled. The ilmenite contains about 20% TiO_2. After milling, the content has risen to approximately 45 %. This raw material consist of a lot of different metals. They are extracted with sulphuric acid. The metals are made to sulphats, and can be removed from the ore. After the removing of sulphats, the compound is dried and cooled. In this process the iron is taken away as green salt.[37] After this step, a titanium sulphuric solution is left. Water is added to, and it is boiled several times and reduced to a titanium oxid hydrate. The waste is taken away in the so-called thin acid. The hydrate is then heated and made into pure titanium dioxide in either the anatas or the rutil crystal structure.[38] This process produce large amounts of waste, mainly as green salt and thin acid. It delivers about 13 tons of solid and liquid waste per ton produced TiO_2. The other method, the chloride process, produce only 1.7 tons of waste per ton TiO_2.[39]

The raw material for the **chloride process** is either natural rutil or enriched ilmenite. By the sulphuric process the materials are treated in a liquid phase. In the chloride process they have to be treated in a gas phase. This makes the construction of the apparatus more complicated. In the process, the titanium ore together with petroleum coke are lead into a oven. In this oven, chloride gas at about 1000 degrees C is pumped. The ore is made to titanium tetrachloride. The tetrachloride is cleaned in several steps through condensation and distillery and then treated with oxygen and processed to titanium dioxide. The chloride gas which comes out of this process, is recycled into the process. The waste is then the metals which was in the ore from the beginning of the process, but now bound to chloride. Since the ore from the very start is much cleaner than in the sulphuric process and since the chloride can be re used, this process becomes much less environmental dangerous.[40]

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37. Kronos Titan, 1983, p. 33.

38. Kronos Titan, 1983, pp. 33 - 35, and Letter to minister Hauff, 1981, Greenpeace archive.

39. Kronos Titan, 1983, p. 42.

40. Kronos Titan, 1983, pp. 37 - 39, Letter to minister Hauff, 1981, Greenpeace archive.

The Pollution Problems

For the production of TiO_2 by the chloride process, natural rutil is preferred. But this material can not be delivered to the need of the producers. The raw material must be supplied with the use of enriched ilmenite and high grade TiO_2 slag.[41] The difficult access to resources had been one of the main argument against a shift to the chloride method by the producers. "Mangelnde Zuverlässigkeit und Preisstabilität in der Erzversorgung könnten eine vollständige Umstellung zu einem unkalkulierbaren Risiko werden lassen."[42] The high investment which is needed, is also one of the factors behind the dominance of the more polluting sulphuric process. So if lack of raw material was one of the reason to start research on a new method, this lack has now become a barrier to shift to this method.

The large volumes of waste is not easily handled by the companies. To get rid of it is a costly process, whatever solution taken. For each ton of TiO_2, approximately 4 tons of the green salt are left. The other 7 tons of waste, consist mostly of thin acid. To find an application of the waste would therefore be an economic benefit for the companies. And some solutions have been found. In the 50s, the green salt was mixed with ammonia, and then sold as a fertilizer. But it came to over-production. The steel industry also started to use it waste for fertilizing. They could sell their product cheaper, and the marked was lost for the TiO_2-industry.[43] Since the end of the 50s, the green salt became waste again.

For the other waste, it have been difficult to find a marked. The companies which produce TiO_2, have mostly been interested to get rid of it as easily as possible. Because of large volumes, it is very difficult to store it for a longer period of time. Therefore, the waste has been sent into rivers or dumped at see. The first factories which were build, were place on a river

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41. United Nations, 1988 a, p. 3.

42. The unstable delivery and prices of the ore could make a shift in the process to a real risk. Kronos Titan, 1983, p. 54.

43. Kronos Titan, 1983, p. 45.

shore, so the waste could be dumped easily. To dump the waste directly into rivers, is still common. The factories in East-Europe, England and Spain dump both green salt and thin acid into rivers.[44]

But it has been problematic to the rivers to handle such large amount of waste. So according to the companies themselves, the dumping at see became a more commonly used method, in order to prevent storing at land and to save the rivers.[45] In 1948 in the US and from 1962 in Germany, producers started to separate the green salt, the thin acid and the other rest compounds from the production. They were then either dumped at sea or reused at land.[46]

In Europe, the first dumping was done outside the coast of the Netherlands by the German company Sachtleben Chemie in 1962.[47] Kronos Titan planned a new factory in Nordenham,[48] and they also wanted to dump the waste from the factory in Leverkusen. The German and Dutch authorities searched the North See for a suitable area for dumping. A place was found North of the island Helgoland, where it was supposed to be little fish. The area was not used by fishermen, and conflicts with them could be avoided.[49] In 1966 Kronos Titan started the preparation for dumping from the factory in Nordenham, which should start the production in 1969. The dumping area was investigated by "die Biologischen Anstalt Helgoland, die Bundesforschungsanstalt für Fischerei"[50] and "Deutsche Hydrographischen Institut",[51] and permission was given. So in 1969 both the factory in Leverkusen and Nordenham started the dumping.[52]

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44. Umweltbundesamt, 1982, p. 46.

45. Kronos Titan, 1983, p. 11.

46. Umweltbundesamt, 1982, p. 47.

47. Umweltbundesamt, 1982, p. 37.

48. Nordenham gives easy access to the sea. It is therefore good for two reasons: easy to dump the waste and easy to have the raw material transported from Jøssingfjorden in Norway.

49. Kronos Titan, 1983 b, p. 14.

50. The Biological Institute of Helgoland, The Federal Research Institute in Fishery.

51. The German Hydrographical Institute.

52. Umweltbundesamt, 1982, p. 37.

Regulating Pollution

The dumping of waste into the sea, became a political problem after the growing environmental concern in the end of the 60s. Not only because of the titanium dioxide. Several other industries use the sea to get rid of chemicals and metals. But the TiO_2 industry is one of the biggest polluters and have been treated separately at an international level.

Among the first initiatives toward preventing dumping, was the two conventions from 1972; the Oslo Convention and the the London Convention. The London Convention, signed in 1972 and active from 1975, gives a general prohibition of several materials and chemical compounds into the see. Some of the waste from the TiO_2 production, is totally prohibited. However, it can be applied for a permission to not to follow the rules. This is decided by the country, that has the territorial rights for the area where the dumping finds place.[53]

The Oslo Convention, which only deals with the North Sea, covers the same problems as the London Convention, but gives more specific rules for the TiO_2 industry. A own working group for the TiO_2 industry analyzed the specific problems, and made rules to regulate the dumping. The convention was ratified in 1974. The Federal Republic of Germany and Norway have signed both conventions, but they where not obliged to follow them.[54] Each contries own laws are supreme toward international conventions.

In Japan, the dumping of waste from the TiO_2 industry has been banned since 1970. Several factors seem to have lead to this decision. Opposite to Europe and US, a marked had been found for the thin acid in Japan. The building techniques in Japan require gypsum. By mixing thin acid with limestone, gypsum can be made and used in the cement and clinker production. Application of this method of waste disposal gives a large economic income to the TiO_2 producers, and the handling of the waste has never been such a

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53. Umweltbundesamt, 1982, pp. 150 - 151.

54. Umweltbundesamt, 1982, pp. 151 - 152.

problem in Japan as elsewhere.[55] The building industry in Germany uses about 5 bill. tons of gypsum per year, where 4 bill. is taken from natural sources. If all the thin acid from the TiO_2 producers in Germany was used for gypsum, it would be a minimum offer of 4 bill. tons per year. But the titanium dioxide industry have not tried to compete with the natural producers, and no government incentive have pushed them to do so.[56]

Also EEC has regulated the TiO_2-industry, and it is the only industry with its own specific directive.[57] In 1975, a draft for a clear cut in the waste disposal was given to the Council. Article 8, Paragraph 3, July 18, 1975, said: "as of January 1st 1978, the total pollution by existing industrial operations after processing shall be less than 70 % of the total gross population before processing ... as of January 1st 1985, this figure shall be less than 5 % ..."[58] According to the technical report following the proposal, this result was technical feasible. But the final directive from 20. February 1978, was much vaguer. In the directive, contries are obliged, before July 1, 1980, to submit programs aimed at gradually reducing discharge levels.[59] Even if the EEC put strong efforts on the TiO_2-industry, they limited themselves to give directions for ways of solving the problems, no strong regulation.

Therefore it have been each country's job to find a proper way of solving the pollution problem. In Germany, the waste dumping was regulated in 1977. A new law demanded permission for the sea-dumping. In that way the authorities could control the waste flow out to the sea, at least formally.[60] Norway, a non EEC country, has used normal regulation of industrial pollution in the case of the TiO_2-industry.

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55. United Nations, 1988 b, p. 19.

56. Umweltbundesamt, 1982, pp. 91 - 92.

57. Umweltbundesamt, 1982, p. 156.

58. I.W.T.: Titanium Dioxide, Greenpeace archive.

59. United Nations, 1988 a, p. 5.

60. Umweltbundesamt, 1982, p. 39.

More severe environmental protection legislation was introduced in the US in the period between 1980 1985, which effected the TiO_2 industry. This regulation may have had some effects on the production. National Lead Industry closed a factory in 1978 in St. Louis and in Sayervill in 1982. But it seems like this decisions were more effected by the low profitability in the production,[61] and as we shall see later, they where also met with environmental protests.

Protest Raising

But pressure toward the industry did not only come from public officers.[62] A big conflict between the industry, local citizens and fishermen rose in Italy in the beginning of the 70s. The biggest chemical company in Italy, Montecatini Edison, had decided to build a new factory for the production of titanium dioxide in the small town Scarlino. The product should be made by the sulphat method and the waste should be dumped at sea. This was now common in Germany and the US. The central government was in the beginning not positive to the activities to Montecatini, especially after a report which pointed out the danger of the waste dumping. But in march 1971, the company was allowed to dump under special conditions.

The local governments were more restrictive. They would not give permission for production for the factory which was finished in October 1971, and they went in court with their case. The claim was that Montecatini had already from the beginning of the planning promised a recycling unit for the sulphuric acid and to reuse the iron salts. The court found a provisional solution, saying that Montecatini could start to dump, but it should in two years build a recycling and reuse unit. The company started their production in March 1972. The local government did at the same time start a research commission. This commission stated already in July 1972 that the dumping caused serious problems. And this may be the case, since during the summer of 1972, dead whales was found at shore of the island Course. The dumping

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61. United Nations, 1988 b, p. 11.

62. The material for the Italian case is taken from Umweltbundesamt, 1982, pp. 156 - 161.

area was used by the fishermen from Corse, and they now began to feel the problems with the dumping. The sale of fish went down by almost 90 %.

Now the protests started. First a bomb was detonated in the town Bastia at Corse, then a threat to bomb the factory came, followed by a big demonstration in Macinaggio in February 1973. When the Italian government did not react and the harbour commandant in Livorno gave a new permission for the dumping, the actions were intensified. Several harbours at Corse were blocked, and higher officials from Bastia was taken as hostages. Now the French government intervened in Rom and demanded research on the consequences of the dumping.

Local initiatives by the authorities in Scarlino was made again. They went into court, and this time they succeeded. They got the permisson to confiscate the dumping ship. First when Montecatini had promised to neutralize the waste, the ship was given back. And Montecatini kept their promise. Since the beginning of 1974, they have taken away the green salt and the thin acid. The acid is neutralized with burned chalk or soda, and the dumping area is moved further north. Much less waste was then dumped and in an area which was not used by the Corsian fishermen.

In Italy things changed quite rapidly. In the Northern part of Europe, it took longer time for changes to appear. Here the conflicts were different, but also the technological base for the companies much stronger. We will now move first to Germany.

The Greenpeace Initiative

In the end of the 70s, Greenpeace decided to start a campaign for the protection of the oceans. As is normal in the work of Greenpeace, they wanted to find one subject to draw attention to. This subject should be such that it could be used effectively in the media to get public support. The choice in this case became the titanium dioxide industry after a study of the actual industries.[63] The TiO_2 industry was chosen, because it was very polluting, it is placed in several countries and it had been meat with

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63. Hillgaard, Interview.

protest earlier.[64] Also the fishermen would probably support Greenpeace in their actions against the Industry. Another reason, although not mentioned by Greenpeace, may have been that the TiO_2 industry is relatively easily to study and get an understanding of, both technically and with respect to ownership.

But Greenpeace was not alone in putting pressure on the industry. The first actions were initiated in Rotterdam, where the Dutch organization "Natur en Milieu"[65] together with Greenpeace protested against the dumping of thin acid from the companies Bayer and Kronos.[66] The blockade of the ships which were used for the dumping lasted three days. It was stopped because Bayer demanded 250.000 DM per day the blockade lasted in compensation, and also threathened to dump the waste directly into the river Rhine. "Natur en Milieu" also went to court, trying to get an order that would judge the dumping illegal. The complaint was rejected in August. But a Dutch minister said in Dutch television that a new permission would not be given to Bayer when the old one expired in March 1982. Bayer responded that they were not able to aquire the necessary technology, and that they would apply to the Beligum or German government for permission to dump until 1985, the time which was needed to develop recycling techniques.[67]

At the same time, the ships in Nordenham and the pier in Leverkusen to Kronos Titan and Bayer were blockaded.[68] Also the authorities were hit. At the "Deutsche Hydrographische Institut", Greenpeace dupmed sick fish at the stairs to the building. Greenpeace wanted all the dumping to be stopped during 1982.[69]

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64. The Italian case.

65. Nature and Environment.

66. Letter to minister Hauff, 1981, Greenpeace archive and Umwelt, 1/86, p. 70.

67. Greenpeace, 1981, s. 19 - 20.

68. Letter to minister Surlien from Greenpeace, 30.10.84, p. 13, SFT archive.

69. Letter to minister Hauff, 1981, Greenpeace archive.

In june 1981, Bayer said that they would not go on dumping from March 1982. New technologies would be used 3 4 years earlier than the previous schedule.[70] The waste from Bayer came from several different activities, not only the TiO_2 production. Unlike the other producers of TiO_2 in Germany, Kronos Titan and Sachtleben Chemie, Bayer itself uses sulphuric acid in different chemical processes. Already in the 50s, they had developed a method to extract thin acid from the TiO_2 producing process and used it for other needs of the company.[71] Profitable applications of the waste were easy for Bayer to find and the knowledge needed to extract acid was well known. The shift was not so difficult to fulfill for Bayer as for the other two. So the protests went on, both against Kronos Titan and Sachtleben Chemie.

The protests came from several different parts. In Nordenham, the local citiziens organized into a "Bürgerinitiative"[72] against Kronos. Mostly, this was farmers, who earlier had protested against the company Preusser. Preusser was putting out lead from their chimneys, which fell down on cultivated land. When the danger to the fish became known, the farmers also went against Kronos, although Kronos did not poison the farmer's land.[73] The women in the "Bürgerinitiative" was particularly active. Many of them were wives to the workers at Kronos. They went to the wives of the workers of the factories in Leverkusen and Homburg (Sachtleben Chemie), to inform them about the danger of the production, in which the men where involved.[74]

A support for the protest came from the authorities. The organ, which gave the permission to dump, the "Deutsches Hydrographisches Institut" published a report, which stated that cancer had been found among fish in the dumping area. Although the report was heatedly discussed, it was seen as a support of the environmentalist's and the fishermen's view.[75] The fisherman Heinz Ostman went to court against Kronos in 1981 and was pictured in the

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70. Greenpeace, 1981.

71. Lazorko et al., 1989, p. 39 and Umweltbundesamt, 1982, pp. 114 - 118.

72. Citizen Initative.

73. Jütting, Interview.

74. Jütting, Interview.

75. Wiborg, 1984, p. 1.

Hamburger newspapers with dead fishes in his hands. Greenpeace went for the dumping ships. In October 1981, they prevented the dumping from the ships by letting divers swim in the dumping area. Kronos could therefore not dump the waste without endangering human life.[76]

The protesters did not want to go into technical discussions. Rather than speaking with the engineers and leaders at the factory, Greenpeace went around and spoke with the workers to inform them about the activity in which they were involved. In the same way the women from the "Bürgerinitiative" operated. But it was impossible to protest without some technical knowledge: "Greenpeace muss zeigen, dass sie technische Sachen diskutiren können, wollen aber nicht die Hintergrunden kennen".[77] Especially in the interaction with the authorities, Greenpeace tried to state that they were sufficiently competent technologically to protest and to show that other alternatives existed.

But Greenpeace in particular used methods where no technical knowledge was needed. One example is the 6 meter high pillar of dead fish which they build outside the old "Reichstag" in Berlin in June 1983. The Oslo convention was seated in their 9th yearly meeting, and Greenpeace wanted to get the media to focus on the seating.[78] Not only to put pressure on the authorities, but also to show that there were already quit strict laws dealing with this kind of pollution. In general, the conventions have been stricter than the laws of each country, and one of Greenpeace demands has been that the signing countries should follow the conventions which they have previously accepted.[79]

The final large manifestation against the dumping came in February 1984. Greenpeace and 52 fishing boats joined together and blocked the harbour in Nordenham.[80] After this blockade, the protesters and authorities spoke

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76. Umwelt, 1/86.

77. Greenpeace has to show that they has competance in technical discussions. However, they will not know why things developed the way they did. Jütting, Interview.

78. Umwelt 1/86.

79. Hillgard, Interview.

80. Letter to minister Surlien from Greenpeace, 30.10.84, SFT archive.

together. Now the authorities could calm down the protesters by pointing to new regulations directed toward the industry. They would not give permission to more dumping of green salt from January 1st 1985. The dumping of thin acid should stop by the end of 1989 at the latest.[81] This decision came after Kronos themselves had presented a plan for the reduction of the waste.

The Kronos Initiative

In 1983, Kronos officially presented their waste reduction plan. It should be the biggest investment in the history of the industry.[82] Some have claimed this investment to be caused by the pressure from the environmental organizations. The conservative newspaper Frankfurter Allgemeine stated that "Diese Aktionen haben zweifellos einen Denk- und Handlungsprozess beim Unternehmen selbs beschleuningt."[83] The industry themselves have argued that their environmental concerns date back long before the protests came, although they also did value the interest form the public.[84] But economic factors seem to have been very important also in this case. The cost of dumping in 1982 was 18 millions DM for Kronos Titan. This represent a large expence for the comany. The trade for the Kronos Titan Group in Gemany was 530 millions DM in 1982.[85]

Already in 1948 Kronos started to work on methods to recycle acid.[86] In 1955 they started to work on the chloride method. In the 50s they also had a marked for the green salt, which later was lost.[87] In 1968 they had build a prototype in technical size for the chloride methods which was expanded to a real size prototype in 1978.[88] For the problems of the green salt, the

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81. DHI permission 8020-01.IV/2284/83 Z1, SFT archive.

82. Kronos Titan, 1987, p. 89.

83. The actions have with no doubt accerelated the search and research activities in the companies. Wiborg, 1984, p. 1.

84. Kronos Titan, 1983, pp. 42 - 43.

85. Kronos Titan, 1983, pp. 16 and 67.

86. Kronos Titan, 1983, p. 41.

87. see p. 10.

88. Kronos Titan, 1987, p. 90.

company made a research group in 1973 to find an application for the waste. In 1974 this group had found a marked an a reduction could start.[89]

What the initiative offered to the public was a new factory in Leverkusen. This was to bring half of the production over to the chloride method. The acid from the other half of the production should be recycled together with the waste from Sachtleben. In Nordenham, Kronos would build a unit for recycling of acid and roasting of the salts. The dumping of green salt from both factories would be stopped by the end of 1984.[90] The original plan said that Kronos should stop the dumping of the thin acid by 1991, but this period was shortened to the end of 1989 after the permission from DHI.[91]

And Kronos has fulfilled their plans. The green salt is now widely used as a cleaner of municipal sewage systems.[92] The dumping of thin acid stopped already by the summer of 1989, earlier than demanded. One reason for this seems to have been the pressure from the public, especially after the death of seals in the North Sea in the summer of 1988.[93]

The Problems in Norway

In Norway, the company in Fredrikstad applied the authorities for permission to construct a new factory in 1962, after NIVA had investigated the area in 1961. The new factory for production of 25.000 tons of TiO_2 was started in 1966. Here the waste was dumped directly into the river Glomma.[94] In 1968 NIVA was again asked to investigate the dumping of the waste. Kronos had to apply for a new permission. The investigation came out positively for Kronos: "Forsøkene viser at man ved det anlagte utløpsarrangement kan oppnå

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89. Kronos Titan, 1987, p. 89.

90. Kronos Titan, 1987, pp. 89 - 90.

91. Wiborg, 1984, p. 2.

92. Kronos Titan, 1985.

93. Jütting, Interview.

94. Miljømagasinet, No. 2, 1988.

en fortynning som tilfredsstiller de krav man bør stille til forurensingskonsentrasjonen i elvevannet",[95] and Kronos got the permission.

But protests came, first from the sports fishermen. "Fredrikstad Jæger og Fiskerforening"[96] complained that the waste destroyed the smolt which was put out. Also a new NIVA report noted harmfull effects on plankton and fish in laboratory tests.[97] The reactions were not unheard in the ministries. The government wanted to put a stronger pressure on Kronos. In 1974, when Kronos was given new permission for waste dumping, "Statens forurensningstilsyn" (SFT)[98] stated that they wanted a reduction of 95 % of the waste in the next 10 years.[99] But the company did not have their own R&D unit to do research and development on their own processes. They relied on developments in their sister companies.[100] So when Greenpeace started their activities in the beginning of the 80s, Kronos Titan in Fredrikstad was still pumping their waste out in Glomma, both green salt and thin acid.

The dangerous effect of this became more and more evident. NIVA published a new report in 1980 where they stated that especially the dumping of the iron sulphat, the green salt, is alarming.[101] This was something Greenpeace already knew, and they wanted the industry to know that too. In April 1982 Greenpeace Denmark visited Kronos Titan in Fredrikstad. They met the director of Kronos and two of the production leaders. At the meeting was also one researcher from NIVA. Kronos wanted to discuss the danger of the waste.[102] Although several reports have shown that the waste from the industry was dangerous, Kronos could claim that the resulrt of these investigations were ambiguous.. Since there were so many different opinions,

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95. The investigations show that the arrangement for disposal satisfies the demands on pollution in the riwer. Simensen, 1968, p. 11.

96. Fredrikstad hunting and fishing organization.

97. Miljømagasinet, No. 2, 1988, p. 11.

98. State Pollution Control Authority.

99. Press release from SFT, 24.8.84, SFT archive.

100. Letter to "Natur og Ungdom" from SFT, 20.7.84, SFT archive.

101. NIVA, 1980.

102. Hillgaard, Interview.

Greenpeace wanted to discuss the alternatives to the dumping of waste. But Kronos would not discuss this matter with Greenpeace. The director said: "Jeg ser ingen grund til at diskutere dette her. Vi vil tage punktet op med de norske myndigheter inden udgangen af 1982. Inden dette tidspunkt skal vi framlægge planer for, hvordan udslippet af syreaffald skal reduceres til under en trediedel af, havd det er i dag".[103] But it should last longer before that promise could be held.

It is not clear whether the initiative from Greenpeace lead to the rise of the protest in Norway. Clearly, Greenpeace was the first environmental organization to raise the matter of the pollution from the TiO_2 industry, and they were also later used by the Norwegian organizations, especially in the conflict in Jøssingfjorden. However, after Greenpeace visited Norway, the environmental organizations there entered the stage. The organization of the area around Fredrikstad, Østfold Naturvern (ØN),[104] initiated their own campaign to make the river Glomma clean. This campaign was especially directed toward Kronos Titan: "Stopp utslippene fra Titan".[105] Østfold Naturvern, an organization which is more than 20 years old, is s local unit of the Norwegian Society for the conservation of Nature (NNV). They started as traditional conservationists, but in the beginning of the 80s, they changed their strategy.[106] Now, they wanted not only to conserve nature, but also to work directly against the industrial pollution.

The ØN campaign against Kronos started in the autumn of 1984.[107] In the same period Greenpeace again visited Fredrikstad. In October they went into Kronos and climbed the chimneys with banners.[108] Because of these activities

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103. I see no reason to discuss this here. We will discuss this matter with the Norwegian Authorities before 1983. Before that time, we will present plans on how to reduce the disposal of acid to one third of todays amount. Greenpeace, nr. 2, 1982, p. 5.

104. The Nature Conservation in Østfold.

105. Stop the disposal from Titan.

106. From, Interview.

107. Norsk Natur, 1, 1987.

108. Hillgaard, Interview.

around Kronos, the factory became known to a wider public. The mother organization of ØN, NNV, claimed Kronos to be the worst polluter in Norway.

But even if NNV now also went against Kronos, they did not at first accept the strategy of ØN, which seemed too offensive for NNV. NNV had lost more than 40 % of their members after the big confrontation in Alta, where demonstrators protested towards the construction of a hydroelectric power station. NNV did not take part actively in the demonstration, but supported the view of the protesters. The protesters lost their case, their activities judged as illegal and the dam was buildt in the beginning of the 80s. At least in NNV, the common view was that the support of civil disobedience led to the loss of members. Therefore they were skeptical to support similar activities.[109] But the pressure from Østfold was strong, and NNV finally agreed that ØN could go into the factories to protest.[110]

NNV also tried to bring about changes at Kronos Titan, but their actions were traditional. The yearly meeting in NNV stated that the pollution from Kronos must be stopped. The resolution was sent to the authorities, where NNV asked SFT to stop the discharges from Kronos in Fredrikstad.[111] And the authorities responded. In a press release, SFT stated that they would change the permission for the dumping. "SFT vil nå kreve at bedriften snarlig gjennomfører filtrering av slammet".[112]

Now Kronos started to move. In May 1985 they asked the authorities for permission to build a recycling unit for the acid at Fredristad, and at the same time increase their production to 30.000 tons a year. This was dependent on the work on the prototype in Germany. If that was successfull, Kronos assumed that they would be able to build their own unit in Fredrikstad that would be running before the end of 1989.[113]

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109. From, Interview.

110. Norsk Natur, 1, 87.

111. Letter to SFT from NNV, 12.7.84, SFT arkiv.

112. SFT will now demand a filtration of the slam in short time. Press release from SFT, 24/8-84, SFT archive.

113. Letter from Kronos to SFT, 9.10.87, p. 4, From's archive.

But Kronos had some problems in dealing with the salt that was filtered away. They worked with three alternatives. One solution was a cooperation with the companies Borregaard or Boliden. They could roast the recycled acid either in Sarpsborg or in Helsingborg. Another was to roast the filtered solution in Fredrikstad or in cooperation with Kronos in Germany. The third solution was to neutralize the acid and deposit it on land.[114]

The big problem in Fredrikstad was the thin acid. The green salt was no longer problematic, since Kronos had by now started to do the same with it as the Germans: use it for cleaning of municipal sewage water. They had become the only supplier to the city of Stockholm. And after 1985, one year later than in Germany, no green salt was wasted from Kronos in Fredrikstad. One big polluter had disappeared from Glomma.[115] But the thin acid remained. And while all actors, the company, the authorities and the environmental organizations searched and fought for solutions, a new actor appears on the arena with a new idea on how to solve the problem.

The Langøya Solution

The company Norcem used a small island in the Oslo-fjord to produce limestone for their cement production. The company owned the island which is about 1 square kilometer big. As Norcem increased their production, they used more and more of the island. In the beginning of the 70s, the island was closed for other purpuses than industrial. Up till then it had been used as a leisure resort for the population in the surrounding area.[116] For those who used the island for recreation, the new activity with machinery and big craters was not appealing.

But in the spring 1983, Norcem decided to stop the production of cement. The island was now more or less like an empty boat. It had craters with a depth of 50 meters below the sea level.[117] Just to leave the island as it

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114. Letter from Kronos to SFT, 9.10.87, Froms archive, p. 4.

115. Letter from Kronos to SFT, 9.10.87, From's archive, Enclosure.

116. "Aksjon Langøya", Main Document, 12.5.87, From's Archive, pp. 1 - 2.

117. Norcem, Note FH01L1/ET, From's Archive, p. 2.

was, was not acceptable. Then a committee was appointed in order to find new activity for the island.[118]

In the autumn of 1984, the company Borregaard asked Norcem to deposit pyrite ash from their production at Langøya. Borregaard needs sulphuric acid in their production of cellulose. They make the acid themselves. In this process, they are left with pyrite ash. This could earlier be used by the steel industry, but because of their new processes, they was no need for the pyrite ash. So the product became waste, and with an amount of 200.000 tons per year, it was not easy to deposit. With Norcem searching for a use of their "empty boat", and Borregaard searching for a way to get rid of the pyrite ash, the two companies got in contact and cooperation started.[119] Norcem got permission to store pyrite ash at Langøya by SFT, and they could thereby start a new industry at the island. Now Norcem had realized that the island could be used as a waste disposal site, and they started to store slam from a sewage system. Some protested against this. People were afraid of the smell from the slam. But finally Norcem got the permission from the "Fylkesmann" (Regional Commissioner).[120] The deposit of slam did not put Norcem in a positive light in the public. The permission to dump slam was given for one year, but Norcem expanded the period. Although Norcem claimed that the permission could be interpreted that way, some meant that Norcem was handling waste illegally.[121]

Then Norcem got in contact with Kronos during the summer of 1985.[122] Kronos was working with the problem of thin acid, and Norcem looked for something that could increase the activity at the island. Kronos had by that time, together with the Germans, worked out a process to steam the waste acid, so that it could be reused. This would leave the crystallized salts from the steaming process, and Kronos searched for a place to deposit these salts.[123]

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118. Norcem, Note jFH01L1/ET, From's Archive, p. 3.

119. Norcem, Note FH01L1/ET, From's Archive, p. 4.

120. Norcem, Note FH01L1/ET, From's Archive, p. 4.

121. Letter from Bredrup, 3.6.87, From's Archive, p. 1.

122. Norcem, Note FH01L1/ET, From's Archive, p. 5.

123. see p. 21 and Letter from Kronos to SFT, 9.10.87, From's Archive, s. 4.

When contact was established, it was discussed whether to store the salts at Langøya.[124]

But Langøya was still rich on limestone. This could be used to neutralize the acid from Kronos. Norcem then applied to SFT with two different alternatives: Either to store the evaporated salts or to neutralize the acid at Langøya with limestone and the store it there. In the autumn of 1986, they sendt the application to SFT.[125]

Now the parts who had been involved with Kronos Titan also got into the new project. NNV stated in a press report, that they supported a unit for the recycling of acid at Fredrikstad. However, this led to conflict with the local environmental organization around Kronos, ØN. A conflict which had been going on for a while concerning which strategy to follow.[126] ØN was eager as soon as possible to get a "clean" Glomma, and in a letter to NNV they wrote:

> "Man må også unngå å la natuvernideologiske betraktninger føre til at man overfokuserer på muligheten for å gjenvinne ressurser i form av svovelsyre ved det planlagt anlegget ved K-T. Dette synes kanskje som en selvmotsigelse i NNVs arbeid, men det er hensyn til resepienten som teller ikke ideologien. ØN frykter at vi skal få en vurdering av deponeringsstedet og rensetiltakene og virkningene av disse, gjennomført av en komite i Forbundet som er helt fjernet fra realitetene i Nedre Glomma-regionen. En komite som er faglig helt på topp, men er i fare for å rote seg inn i faglige/akademiske problemstillinger som fører til at vi skusler vekk en historisk mulighet til å fjerne alle utslippene fra K-T".[127]

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124. Norcem, Note FH01L1/ET, From's Archive, p. 5.

125. Letter from Norcem to SFT, 29.10.86, SFT Archive.

126. see pp. 20 - 21.

127. A nature conservation ideology should not lead to a too heavy activity in finding a solution to recycle acid at the planned unit at K-T. The most important is the consideration of the polluted waters, not the ideology. ØN is afraid that the committee in NNV would make the statement about the deposit area without beeing awear of the realities of the pollution in Glomma. The committee is technical skilled, but is in danger going into

ØN meant that even with an installation of a unit to a cost of 150 mill. NKr, Kronos Titan would still be one among the 20 30 worst polluters in Norway. The Langøya solution could prevent this. According to ØN, a solution in Fredrikstad would give Glomma 100 tons pr. day of sulphuric acid against 30 with a deposit at Langøya.[128] Kronos claimed the outlet to be 22 tons for the Fredrikstad solution and 14 tons for Langøya.[129]

The local environmental organization around Langøya, Holmestrand NV, said in their comment that they were not against the use of Langøya as deposit for the waste from Kronos.[130] It was more in line with ØN. In their answer to the authorities, NNV stated that in principle they would prefer a recycling unit in Fredrikstad, the most preferable would be a new factory using the chloride method. A solution at Langøya could only be agreed upon, if the demand for the stability of the solution to be deposited became higher.[131] NNV had moved their view toward the local organizations.

In the hearing before the final decision, NNV arranged an open meeting in Holmestrand. Here the Industry, the authorities, the environmental organizations and the local public were present. At this meeting, a new opposition group was formed as a protest against the planned activities at Langøya. The forming of the group, claimed the protesters, was induced by the arrogant attitude of Norcem at the meeting. This attitude was also brought about by the way Norcem had handled the slam from the sewage system at Langøya.[132]. The newly created committee represented mainly the outdoor life interests in the Holmestrand area. Their main concern was to use Langøya for recreation, and they wanted as little activity there as possible. The good, old days was

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technical/academic problems and generate a mess that will destroy the historical possiblity to remove all the waste from K-T. Letter from ØN to NNV, 28.12.86, p. 2, NNV Archive.

128. Letter from ØN to NNV, 28.12.85, NNV archive.

129. Letter from Kronos to SFT, 9.10.87, From's Archive, p. 10.

130. Letter from Holmestrand NV to NNV, 15.12.86, From's Archive.

131. Letter from NNV to SFT, 21.1.87, From's Archive.

132. "Aksjon Langøya", Main Document, 12.5.87, From's Archive, p. 11.

still in their mind: "Sommer-Langøyas blomsterflor, møkeskrik og stille bølgeslag glemmer vi aldri."[133]

Now the environmental interests were divided in three. In Fredrikstad, ØN wanted the Langøya solution. It would most probable give the cleanest river, and sooner than the other alternatives. In Holmestrand, we had the Langøya committee, representing mostly outdoor life interests. Their aim was to get Langøya free of industry so it could be used for leisure activities. Therefore, they opposed the deposit of the waste from Kronos and wanted Norcem to give Langøya to the public. The third part was NNV, which in principle wanted a recycling unit in Fredrikstad and was critical to the way the waste was to be stored at Langøya.

Norcem hiered the geotechnical company Strømme to investigate the stability of the masses which were to be stored at Langøya. The investigation came out positively. The stability would be good enough, both if salts neutralized in Fredrikstad or neutralized at Langøya was stored.[134]

July 2th came the answer from SFT to Norcem's application: Norcem could deposit the acid from Kronos. The acid should be brought with ships from Fredrikstad to Langøya, neutralized with limestone at Langøya and stored in the craters there.[135] In the decision, SFT said that the claims from both NNV and the local municipalities about the stability had been tested by an independent company and found good enough. This was the report by Strømme.

Now the different organizations tried to change the decision or to make it definitely. At a meeting in the Ministry of Environmental Protection, NNV presented their solution: the minimal waste alternative toward the maximum waste alternative. The minimum waste alternative would be to get Borregaard involved in the process. Borregaard that produces sulphuric acid for their papermaking, could use the recycled acid from Kronos. In that way Borregaard would not need to use the ore at Hjerkinn, which NNV claimed that would last

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133. We will never forget the flowers, the waves at the shores and the screams from the seagulls at Langøya. "Aksjon Langøya", Main Document, 12.5.87, From's Archive, p. 1.

134. Report from Strømme, 19.3.87, From's Archive.

135. Letter from SFT to Norcem, 2.7.87, From's Archive, p. 1.

only 10 12 more years. The maximum alternative would be that the waste both from Borregaard and Kronos was stored at Langøya. But still, NNV could accept this offer as long as the waste was propably stored.[136] And in their final complaint, NNV focused on this issue: The demand from SFT on resistance and physical stress limit was not satisfactory, compared to other norms, especially the United States Environmental Protection Agency.[137]

The Langøya Committee complained that outdoor life interests had not been taken into consideration at all and that they were not asked by SFT before the final decision was taken. Also the consequences had not been probably investigated.[138] NNV and the Langøya committee had cone closer, especially since NNV also raised the question about outdoor life interests in their complaint.

On the other side, the industry tried to safeguard the decision. The processes which earlier had been researched, was now too expensive. The cost of investment of a recycling unit would, according to Kronos, be 333 millions NKr compared to 12 millions for the Langøya solution.[139] "Dersom Langøya faller bort som deponeringssted blir syreregenering med røsting av filtersalter i Fredrikstad den eneste gjenstående mulighet for behandling av tynnsyre. En slik prosess blir så kostbar at den vil gjøre en fabrikk på vår størrelse ulønnsom. Den vil også komme i konflikt med myndighetenes krav om at rensingen skal være gjennomført før 1/1-1990."[140] The new demand 1.1.90, was according to the new Paris convention. Norway had signed on to stop all the dangerous waste dumping at sea.[141]

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136. Minutes, 29.7.87, From's Archive.

137. Letter to the Ministry of Environmental Protection from NNV, 15.9.87, From's Archive.

138. Letter to SFT from the "Langøya Committee", 15.9.87, From's Archive.

139. Letter from Kronos to SFT, 9.10.87, Enclosure, From's Archive.

140. If Langøya could not be used for the deposit, the only possiblity left is recyling and rosting of the acid in Fredrikstad. Such a process is so expencive that it will make a factory of our size unprofitable. It will also be problematic to meet the demands of the authorities to clean before January 1st 1990. Ibid..

141. From, Interview.

Borregaard supported Kronos that the alternative, to use the acid there, was impossible. To roast the salts in the process also was difficult: "Konklusjon er at en slik løsning er helt urealistisk".[142] And finally, Norcem stabilized the solution with more reports from geological and geotechnical consultans.[143]

The Ministry of Environmental Protection was going to make a new decision based on the complaints. SFT informed the ministry about their view. They found the stability good enough. This have been tested by an independent consultant. Also, another way of solving the problem would lead to problems for a shift to the chloride method.[144]

The final decision came February 1988 from the Ministry of Environmental Protection. Norcem could neutralize and deposit the acid from Kronos at Langøya. But some compromises were made, especially toward leisure interests. Norcem had to abolish the protection zone around the island and to clean up the shore so that it could be used for small boats. Also Norcem was obliged to set away 100.000 NKr which should be used for the rehabilitation of the island. The claim from NNV was met in a demand to Norcem to check the stability continuously.[145]

ØN was pleased with the solution and NNV accepted it. The Langøya committee felt that they had been ran over, and threatened to use actions against the activities at Langøya. 100.000 was far to little to clean up Langøya suficently for leisure interests.[146] But this protest were not to come, and from the 1. April 1989, Kronos have been sending waste with the dumping ships from the German factory to Langøya.[147]

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142. The conclusion is that such a solution is impossible. Letter from Borregaard to Kronos, 9.10.87, From's Archive.

143. Norwegian Geotechnical Institute: "Langøya Gipsdeponi - Geokjemiske undersøkelser, 9.11.1987, Strømme: "Gipsslamdepot, Langøya, Geotekniske forhold", 11.11.1987, both in From's Archive.

144. Letter to MD from SFT, 27.11.87, SFT Archive.

145. MD, Press Release, 17.2.88, From's Archive.

146. Tønsberg Blad, 18.2.1988, p. 7.

147. Austrheim, Interview.

The Closing of a Factory in the US

The owner of Kronos Titan, National Lead Industries, also were met with environmental protest in their home country. In January and February 1982, fishermen and environmental organization were protesting the dumping of the waste from the factory in Sayervill.[148] The American environmental authorities called for a public hearing. After this hearing, the authorities decided that National Lead should dump their waste much further away from the coast. National Lead had a surplus of 314 millions dollars in 1981. They were therefore better suited to do something than the fishermen who were loosing their income because of the waste dumping.

But the local authorities did not have the same opinion as the central environmental authorities. They gave National Lead permission to go on dumping in the same area as earlier. National Lead had threatened to stop the production and fire all the workers if they had to change their routines of waste dumping. The new practice which the central authorities demanded, was to expensive for them. The local authorities gave NL a permission to dump for five more years. But shortly after this decision was taken, NL sold their factory. Even with the old dumping practice, the factory did not seem profitable.[149]

Changes in Technological Practice

We have seen how the TiO_2 industry have changed their practice with new production methods or other types of waste handling. In the cases described, the industry was under pressure from environmental organizations and authorities. But the way the pressure groups acted was very different in the different contexts. Also the outcomes of the interactions were different. In Italy and at Corse the protesters used quite dramatic methods. This is maybe more common and accepted in the South than in the North. But also the

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148. Greenpeace, Nr.2, 1982.

149. Greenpeace 3 - 4, 1982, p. 5.

Corsian long and intensive fight for independence may have initiated the type of reactions that came up.[150] But not only the fishermen and the Corsians were against Scarlino was not only the fishermen and the Corsians. The local government in Scarlino tried to put pressure on the company before protests arose. And then finally the central government in Italy also acted, by then more because of the protest against Montecatini. The outcome of the conflict was not new technology, but a different technological practice. Both the acid and the green salt was taken away, recycled or neutralized, and the sea was protected from the waste.

In Germany, the protests were also relatively dramatic. The protesters used methods which got the interest from the public because of the form they had. The producers in Germany changed both their production methods and their technological practice during and after the conflict. But like in Italy, the protesters where dependent on the actions from the authorities. And also like in Italy, they put pressure on them in order to act. This is has been different in other conflicts between the environmental movement and technology in Germany. In the protests against the construction of nuclear power, the most common argument was that the government should keep off.[151] This difference may have been caused by the fact that in nuclear power issue the government was much involved and also initiated the construction of the plants, while in the case of the TiO_2 industry the government was a more neutral part.

In Norway, the contact between government and protester was quite good, compared to Germany. No actions were needed in order to establish contact between the authorities and the environmental groups. Most of the actions also went through the government. The government seems to be a medium for the organizations to achieve changes. This corresponds to the view on the Norwegian political system as relatively open and responsive.[152] On the other hand, the wish of the central environmental organization to save resources was not followed. No new technology was introduced.

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150. Umweltbundesamt, 1982, p. 159.

151. Offe, 1983, p. 233.

152. Burns et al., 1987, p. 276. "The Alta struggle, while failing to achieve its specific aims, contributed to a major restructuring of the hydroelectric power planning system".

As we have seen, the changes of technology was not something that was initiated by neither government nor movement. The speed of the implementation may have been changed, but the "new" technology that was applied, was in fact old. Kronos Titan in Germany had done research on extracting thin acid since the 40s and on the chloride methods since the 50s. This correspond to the view on technology as promoted by Giovanni Dosi. Although sudden changes may appear, the most common way of technological change is inside a trajectory. "Technological and organizational changes in each firm are cumulative processes too. What the firm technologically can hope to do in the future is heavily constrained by what it has been capable of doing in the past".[153] The shift in the practice was guided by what the company had done research in. They had achived competence in the chloride method and in recycling acid, a competence which they had been working on for a long period. The research on this field was also constrained or directed by the main activity. It was inititatied by problems that appeared in the method in use. The question then becomes: Could a environmental movement inititate new research which could lead to new processes? Most likely, it would not have done so. The general knowledge on technological changes is "that increasing obstacles to progress within a certain paradigm do not automatically induce the emergence of new ones; scientific advances are often a necessary condition of their development".[154] Just the pressure to change the process because of environmental consideration would not be sufficient.

In the same way as technology follows a concrete trajectory, it also have a search trajectory connected to it.[155] A Dutch study have shown that the activities inside the search trajectory may have a strong influence on the actual technological change. The search trajectory is way in which a company generates ideas for innovation. In Germany, the work from the pressure groups can be said to have been to change the search trajectories. They did not discuss the technological practice in the company, they only had to show that they had competence on it.[156] In Norway the organizations discussed the

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153. Dosi, 1988, p. 225.

154. Dosi, 1988, p. 229.

155. Buijs, 1987, p. 305.

156. See p. 17.

concrete trajectory more. They wanted other solutions where technology and process should be used in order to bring about a better environment. It seems that the efforts in Germany to build public pressure, and then leave the technological solutions to the company was more effective. The organizations in Norway were never able to build their own technological competence in such a way that their alternatives were seriously estimated. Technology generated outside the company have great difficulties to be integrated than what is innovated locally.

Conclusion

The question remains whether the changes were caused by the pressure groups. As indicated above, the groups may have changed the speed of the implementation. But more likely, other conditions have been stronger for the introduction of technological changes. The handling of the waste was always an economic problem for the companies, and it seems like the research on waste handling was initiated by economic considerations. In Japan, the dumping of waste stopped already in the beginning of the 70s. Here there was an economic application of the waste. Also the shut-down of factories seems to have been caused by economic conditions. National Lead Industries sold their factory in Sayervill, rather than to still run it, even if they got the permission to handle the waste as earlier.

The activities of the environmental organizations have also not been independent from the governmental organizations. Both in Italy, Germany and Norway, state organs or commissions published reports that stated the danger of the waste dumping. This both initiated protested and intensified them. In the same way the organizations have been using the governments to put pressure on the industry. Most strongly in Norway, least in Italy. Even in Germany where the trust in the governmental system has been broken down after many political scandals and decisions against the public, the organizations wanted the state to intervene.

Another question is whether the organizations have achieved a more open technological system? In general, it seems like environmental concerns now slowly are flowing into the mind of industrial managers and engineers. Studies have shown that "Umweltshutz wird zunehmend als ein wichtiger

Bestandteil der Unternehmenskultur akzeptiert"[157]. The environmental organizations seems to have been a strong influence of the changed attitudes. But the environmental changes which have appeared in this study have been inside traditional trajectories. Large investments have been done in order to make a cleaner environment. This investment will then later guide the activities in evironmental protection. The technology will become locked-in. It seems like a common view that: "technical progress generally exhibits strong irreversible features"[158] In this way the environmental movement may cause even further industrialization. Environmental concern have made possible the application of green salt to clean municipal sewage water, and this have stabilized the sulphuric process. The waste has become a cleaner.

The shift in process may be solving environmental problems at one place, but may generate new ones other places. The chloride method require pure rutil. Since this is not found in the necessary amount in the nature, ilmenit must be enriched to cover the demand. To enrich ilmenit gives waste, maybe more hazardous than by the sulphuric process. The most heated environmental discussion in Norway the last 3 years has been on the pollution of the ilmenite production in Jøssingfjorden. Here material from the ore is enriched and the waste is send to sea.[159]

We have seen that cultural differences have had effects on the technology. We have also seen that technology follow a certain path which is decided by economic considerations and the research activity in the industry, And thirdly, about the environmental movement, the conclusion made by Huber on whether the environmental movement represent an alternative to the industry seems reasonable: "Die Ökologie ist nicht das Ende der Industrie und zu guter Letzt nicht einmal mehr ein Gegensatz zu ihr".[160] But maybe the

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157. Environmental protections are in increasing rate accepted as an important part of the industrial culture. Wirtschaftswoche, Nr. 20, 1988, p. 70.

158. Dosi, 1988, p. 227.

159. See the book about the conflict: Ambjørnsen, 1988.

160. The ecology is not the end to industry and fortunately not even a contraction to it. Huber, 1982, p. 209.

environmental movement could be a end to a specific industry if it could bring a reasonable alternative to it.

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