INFLUENCING TECHNOLOGY: DESIGN WORLDS AND THEIR LEGITIMACY[1]

Ibo van de Poel and Cornelis Disco
Twente University
The Netherlands

Introduction

Design is accomplished in design worlds, relatively closed specialist 'worlds' interfacing with environments via production of designs/artifacts and consumption of resources -mainly money, knowledge, and legal/normative legitimations (e.g. about the scripts/effects of the artifacts they produce and how they produce them). Design worlds produce artifacts and effects which particular groups of outside actors may consider dangerous, threatening, or otherwise displeasing and these may try to mobilize pressure to change practices in the design world - concretely to change the composition and outputs of specific design regimes. In this article we analyze how outside actors influence design worlds by examining the process in three pertinent cases: changing coolants in refrigerators, deflecting a trajectory of fixed-dam building in river estuaries to realize a tide-maintaining semi-permeable 'storm-surge barrier,' and influencing the design of housing systems for laying hens. In addition we want to assess the quality of such attempts at influence and to

---

[1] An earlier version of this paper was presented at the 1994 Annual Meeting of the Society for Social Studies of Science and at the 1995 COST A4 international workshop "The role of design in the shaping of technology." This paper is a revised version of the latter presentation.

identify modalities which are more socially durable than the *ad hoc*, intemperate, and often polarizing contestations which now surround the introduction of technologies considered undesirable by particular groups. Though even bitter conflict by no means rules out success in influencing 'offensive' design regimes, opponents and proponents of design regimes often get stuck in moralizing trench-warfare and such antagonism may block sustainable improvements in the quality of design. We shall frame our critique of attempts at influence and the formulation of conditions for improvement in terms of one of Max Weber's basic categories of sociological analysis: the legitimation of 'rational' social action. Building on Weber's idea of goal-rational action, we develop the notion of constructive normative games, in which mutual learning prevails over antagonistic rivalry. One way to bring about such constructive normative games is to integrate the normative discourse on conflicting values with a technical process of developing alternatives technologies, which satisfy all parties.

Design worlds contain one or more 'design regimes.' These are characteristic alignments of preferred goals (particular functionalities) and preferred means (heuristics, knowledge, standards, test facilities, etc.) which command some part of the total resources of a design world and are often embedded in particular actor networks within them. Design regimes have fairly predictable outcomes based on prevailing choices of technical goals and prevailing choices of means to achieve them. The technical *goals*: e.g. producing durable and safe road surfaces, producing a toothpaste that tastes good and prevents caries, shortening coastlines by closing off river estuaries from the sea, housing laying hens in an economic and labor-saving fashion; are basically voiced by actors outside the design regime and are accorded priority in accord with their needs. As long as design regimespursue goals which are utilities for other actors, the basic condition for commanding resources are met and - barring major problems - they will tend to persevere along a particular trajectory. The appropriate technical *means*: e.g. automatic asphalt-laying machines, knowledge of enzymes and their effects on the ecology of the human mouth, measurements and simulations of tidal currents, knowledge of the nutritial requirements of laying hens; are generally chosen by designers themselves inasmuch as special expertise is required to mobilize the means appropriate to achieving particular goals.

Design regimes have various sorts of effects on their environments. These may be roughly classed as primary and secondary effects. Primary effects are the explicit technical goals which designers seek to achieve in the configurations and compositions of artifacts. Utilities for outside actors are tied to particular properties and scripts and it is these which designers consciously pursue. In almost all cases, however, these primary effects (the explicit goals) are surrounded by a halo of secondary effects. These are unintended and sometimes, at least for some groups, unwanted effects related to the working of the artifact itself in particular sociotechnical contexts. A prosaic example is the automobile which, though primarily designed to satisfy an articulated hierarchy of consumer needs (mobility, ostentation, economy, safety as primary effects) also has a halo of unintended secondary effects (pollution, drive-in theaters, sunday driving, greenhouse effect, suburban living, danger, etc.).
A particular class of secondary effects are those associated with the choice of technical means. Though the primary effect of technical means is to facilitate the design and production of the artifact in accord with the hierarchy of goals native to the design regime, particular means may also have unintended and perhaps unwanted secondary effects. These effects are often only internal to the design regime as, for example, the organizational and personnel consequences of abandoning physical hydraulic modelling for computer simulations. In some cases, however, secondary effects of particular means are also felt outside the design regime as, for example, in the use of recombinant DNA methods to design bacteria for the production of particular biological substances. In such cases outside actors may feel pressed to object against the employment of particular *means* while the goals themselves (e.g. production of insulin) are considered unobjectionable.[1]

Our stories are about what happens when outsiders object to specific goals or their secondary effects or to the secondary effects of means and

---

[1] Note that there are in some cases special allergy problems with rDNA insulin, but that the objection is not against rDNA insulin as such but against withdrawal of porcine insulin from the market.

try to influence design regimes accordingly. The problem is that such outsiders (almost by definition) are neither managerially powerful enough nor technically competent enough to enforce the kinds of changes they want in a direct way. They can neither command designers to pursue different goals nor suggest appropriate technical means to realize them. Hence they must find some way to mobilize leverage on specific design regimes so that powerful and knowledgeable actors within them will feel compelled to transform their design activities, that is, to pursue different goals and/or mobilize different means and thereby develop artifacts which satisfy criticisms.

But how to mobilize such leverage? Design worlds persist by virtue of a stable access to resources, such as capital, knowledge, and legality. They are vulnerable to resource deprivation, in particular to economic pressure and legal sanctions. The first can be achieved by increasing the costs of particular design options and materials or by limiting market access. The second can be achieved by legislation banning or taxing particular goals/artifacts or technical means. However, it is very difficult for outsiders to effectuate such measures, among other things because they require the mobilization of large numbers of allies, e.g. for consumers' actions or to exert political pressure. One effective strategic detour is, however, almost always available: the mounting of rhetorical and ideological campaigns to discredit particular technological outcomes and processes as *morally illegitimate*. The hope is that once this definition is accepted it will alienate consumers and/or stimulate lawmakers to declare the goals/means legally illegitimate as well. This is a relatively low-cost option which, when played well, can nevertheless have devastating effects on the survival chances of a design regime. Our empirical examples show something of this.

Rhetorics of *technological legitimacy* effectively couple the technological goals and means prevailing in specific design regimes with underlying social *values*. They do this by comparing the primary and secondary effects of technical goals and/or the possible secondary effects of chosen means with cherished signposts in the landscape of moral and social legitimacy. These signposts are denoted by labels like 'safety,' 'environment,' 'efficiency,' 'reliability,' 'natural order,' and others. Actors rally around such labels because they define what they feel is good

and desirable in life. Claims and counterclaims in such discourses are about the degree to which the effects of specific artifacts and processes violate - or, alternatively, effectuate - these various signpost values.
Typically, critical outsiders will try to argue that what they experience as negative effects resulting from the goals and means pursued in the design regime are illegitimate with respect to the specific hierarchy of values they espouse, while design-regime insiders will argue that their own hierarchy of values legitimates prevailing technological outcomes. What results is a contest, manifestly moral but implicitly also economic and political, for the commitment of publics - either to the existing design regime and its normal outputs or to movements seeking to change the regime and its outputs.

To analyze discursive contests we have recourse to Max Weber's analysis of types of social action, particularly focussing on his two types of 'rational' social action, *Zweckrational* or 'means-ends' rationality and *Wertrational* or 'value-rational' action. We argue that when shorn of their 'methodological individualist' bias, Weber's categories provide both a model of 'rational' progressive design as well as insight into why both proponents and opponents of specific design regimes can get locked into antagonistic moralizing games where mutual labelling and positioning take priority over shared learning. Weber provides the basis of a model of rational design in his notion of means-ends rationality, entailing first of all a choice of technical goals on the basis of articulated needs and secondly a choice of technical means to achieve those goals in relation to possible secondary effects. When reformulated as constructive normative games whereby a multiplicity of actors try to achieve transparent priorities in technological design rather than as individual agonizing over particular means and ends, this category can function as a touchstone for rationality in engineering. He also shows that while one can act'rationally' in relation to absolute values (in the sense that the values can be shown to legitimate particular actions) commitment to absolute values instead of pragmatically articulated needs can introduce 'irrational' elements in design. In our cases we show this to be true both for choice of technical goals (what kind of artifact is desirable and why?) and for choice of technical means (how should such artifacts be designed and built and why?). While we concede that 'irrationality' in this Weberian sense, whether as a 'fetishism of ends' or a 'fetishism of means,' can still generate social solidarities and sustain movements to transform design regimes (as it can also help to sustain them), we note that often such 'irrationality' result in moralizing trench-warfare. In our analysis, however, such antagonistic moralizing games are not primary the result of the (irrational) attitudes of the actors involved, but of the interaction situation in which the actors find themselves. We suggest that only a durable change in such interaction situations may bring about so-called constructive normative games that result in sustainable improvements of the quality of design.

Three stories

Story 1: a refrigerator without CFCs[1]

The first story takes place in Germany and recounts the development of a new type of refrigerator using an environmentally benign coolant: isobutane. This so-called *Greenfreeze* became popular so quickly that within a mere two years the entire German refrigeration industry adopted isobutane as a refrigerant. At present it has, at least in Germany, totally replaced HFC 134a, itself the result of more than ten years of research

---

[1] The first story is based on empirical research carried out by Ibo van de Poel and Hugo Verheul, who is at the University of Delft, the Netherlands. Part of this research was financed by the SEER programme of the European Community (DG XII). Main sources for this story include: National Wildlife Foundation, 1989, 'Du Pont Freon Products Division', case study prepared by Foest Reinhardt.; Östlund, S. & R. Larsson, 1991, 'The Greening of Strategic Alliances', Paper to presented at The 11th Annual International Conference, Strategic Management Society, Toronto Canada, October 23-26, 1991; various articles from the *International Journal of Refrigeration*, *AMBIO A Journal of the Human Environment*, *the New Scientist* and from the newspapers *de Volkskrant* and *the Guardian*; information from Greenpeace; interviews with representatives of Greenpeace, Bosch-Siemens and DKK Scharfenstein. A short description of the case can also be found in Verheul, H. and Ph.J. Vertragt, 1995, 'Social Experiments in the Development of Environmental Technology: A Bottom-up Perspective', *Technology Analysis & Strategic Management*, 7 (3), pp. 315-326.

effort in the wake of public and political pressure to ban its ozone destroying predecessors, the CFCs. Although still touted as late as 1992 as 'the first step into a new age of refrigerants'[1], HFC 134a itself soon became suspect due to one of its secondary effects: global warming and thus paved the way for the introduction of the environmentally innocuous isobutane.
The chronology of these successive replacements runs as follows: In June, 1974, Rowland and Molina published their now famous article in *Nature* about the potential degradation of the ozone layer due to CFCs. This publication and Rowland's and Molina'ssubsequent presentation before the *American Chemical Society* launched a public and political debate about the use of CFCs. Although new computer simulations in the early eighties suggested that the degradation of the ozone layer was not proceeding as rapidly as had originally been assumed, the discovery of the hole in the ozone layer in 1985 immediately restored the ozone issue to the international agenda. In 1987 the Montreal Treaty was concluded, calling for a substantive reduction in the use of CFCs. Subsequent international conferences recommended yet tougher measures and by 1992 the European Community was moving toward a complete ban on CFCs as of January, 1995. It should be noted that, prior to 1985, policy measures and campaigns against CFCs focused primarily on their use in aerosols; other typical applications like refrigeration, insulating foam and the cleaning of electronic devices, did not get much attention in this period.

CFCs had been widely used as refrigerator coolants since they were originally synthesized in the thirties. This eminently stable technology became severely delegitimated only in the wake of the debate on the hole in the ozone layer from 1985 onwards. The most radical critique came from a number of environmental groups which raised the fundamental question whether the world really needed as much cooling capacity as it then possessed. In 1989 Director Gac of the International Institute of Refrigeration (IIR) reacted to these attacks as follows:

---

[1] Preisegger, E. and R. Henrici, 1992, 'Refrigerant 134a: The first Step into a New Age of Refrigerants', *International Journal of Refrigeration*, 15 (6), pp. 326-331.

> *"[T]he question I am often asked, and that is considered to be embarrassing for the IIR Director, concerns the chlorofluorocarbons ... I am asked what the refrigeration engineers will do in order to reduce and control chlorofluorocarbon emissions ... In fact this is an excellent question: the CFCs emissions are one of the best means we have at our disposal today, to remind us today that the refrigerating machines, which are very reliable, offer numerous and valuable services. ... If a decision had been made, at an international level, of forbidding immediately any CFCs emission, it would have created such troubles in the supply of perishable goods that not only would the cost of living have increased suddenly and dramatically, but also underfeeding and malnutrition would have worsened, notably in the countries already underprivileged".*[1]

As this quote clearly shows, the legitimacy of the hegemonic design of refrigerating apparatus was under so much public and political pressure that Gac felt obliged to articulate the legitimacy of the refrigerator design regime by connecting it to a generally held value: 'offering numerous and valuable services' to society. According to him, this value was so important that immediate measures against CFCs were unacceptable. Institutions like the IIR continued arguing against CFC measures until it became clear that they could not prevent governments from passing tighter measures.

For many years, CFC 12 had been the coolant of choice for household refrigerators. When CFCs in household refrigerators came under serious attack, the chemical industry - the producer of CFC 12 - and the household refrigeration industry - one of the users of CFC 12 - investigated various alternatives to CFC 12. A number of technical specifications that a new refrigerant was to fulfil quickly crystallized. Apart from being not harmful to the ozone layer, a new coolant had to have good thermodynamic properties, and to be non-toxic, non-flammable and chemically stable. The resulting alternative, HFC 134a, indeedhad these properties. It was, however, also chosen because it did not disrupt the relations between the refrigerator industry and its key suppliers. Since new coolants usually require changes in compressor design and lubricants, developing a new coolant requires careful coordination between the refrigeration industry, the compressor industry and the chemical industry (the latter as supplier of both coolants and lubricants). The chemical

---

[1] *International Journal of Refrigeration*, 12 (5), 244.

industry quickly evinced a marked preference for HFC 134a because it was easily patentable and relatively expensive. Moreover the automobile industry, which was a major market for refrigerants, also opted for HFC 134a as an alternative coolant for car air-conditioning. Most compressor companies followed this lead by adapting their compressors to HFC 134a. Finally, this innovation was also fuelled by government-sponsored research programs specifically devoted to HFC 134a.[1]

The choice for HFC 134a was thus as much the result of the CFC ban, and the consequent formulation of certain technical specifications (good thermodynamic properties, non-toxicity, non-flammability and chemical stability) as it was the result of existing supplier-customer relations.

HFC 134a was well on its way to becoming a new standard technology by 1990, when this technology was also confronted with attempts to delegitimite its use. While HFC 134a was not harmful to the ozone layer, it had another negative secondary effect: it contributed to the greenhouse effect. For this reason it met opposition from environmental groups like Greenpeace. In 1990, when Greenpeace was in the midst of an intensive campaign against HFC 134a, members of Greenpeace accidently met doctor Preisendanz, who had been involved in the development of an environmentally friendly coolant for the refrigeration system of the Dortmund Institute of Hygiene. Together with Director Rosin of this institute, Preisendanz had successfully developed a mixture of the hydrocarbons propane, butane and cyclopentane that could function as coolant.[2] Greenpeace immediately recognized the mixture as a means to prove that environmentally benign alternatives to HFC 134a actually did exist. After

[1] It should be noted, however, that some governmental programs also involved other alternatives than HFC 134a and tried to enlarge the scope of coolants to be chosen as alternative to CFC 12.

[2] The idea to use hydrocarbons as refrigerant was not entirely new. As a matter of fact, hydrocarbons were a common coolant until CFCs became popular in the thirties. Since the beginning of the century, it was well known that hydrocarbons have excellent thermodynamic properties. Moreover, they were cheap. Their main disadvantage was their flammability.

the meeting with the German Doctors, Greenpeace tried to find a German refrigerator manufacturer to commercialize the mixture. However, none of the refrigerator firms showed interest. One of the reasons was that tests, carried out in 1991, showed that a refrigerator using the Dortmund mixture consumed 38% more energy. Despite the fact that Greenpeace disputed the outcomes of these tests and that also Professor Gorenflo who participated in carrying out the tests disassociated himself from the results, the refrigerator industry considered the mixture too energy-consuming. There were also two other reasons for the unwillingness of the refrigerator firms to test hydrocarbons. One was the flammability of hydrocarbons. Since the large-scale introduction of CFCs, flammable refrigerators were seen as out-dated for household applications. Another reason, named by professor Lotz of Bosch-Siemens, was that Rosinand Preisendanz wanted to keep secret the exact composition of their mixture. This made it impossible for the refrigeration industry to test the mixture in their own labs.

In February, 1992, Greenpeace finally found a company willing to try hydrocarbons as coolant: DKK Scharfenstein, a refrigerator firm from the former DDR. Before the unification of Germany, DKK had had a monopolistic position on the East German market for household refrigerators, but in 1992, after the unification of Germany, the economic position of the firm had become deplorable. It was feared that the company would go bankrupt. In these circumstances the offer from Greenpeace - to pay the development of ten prototypes with hydrocarbons as coolant - was seen as a mercy. The development of a more environmentally benign refrigerator was considered a means to enlarge the market share of DKK. Technically, however, the use of hydrocarbons as refrigerant was received with mixed feelings. On the one hand, DKK had problems with the implementation of HFC 134a. One of the problems concerned the compressor. DKK produced its own compressors and was not (yet) able to modify its compressors optimally to HFC 134a. Perhaps, hydrocarbons could offer a solution to these problems. On the other hand, the use of *flammable* coolants was received very skeptically at DKK. Nevertheless, in a relatively short time, DKK succeeded in developing a refrigerator with propane and butane as coolants. The Dortmund mixture, however, was not used because it was very difficult to produce commercially a mixture of three gases in the right composition.[1] In July, 1992, DKK claimed to have achieved energy parity between propane/butane and CFCs. Nevertheless, the other German manufactures of fridges, organized in the ZVEI (The Federation of Electrotechnical and Electrical Industry in Germany), continued to disapprove hydrocarbons. The seven largest refrigerator firms sent a letter to retail trade in September 1992, wherein they insisted that hydrocarbons resulted in too high an energy consumption and that their use as coolants was anyway unproven. Despite this 'official' reaction, the German refrigerator manufactures in their own labs started testing hydrocarbons as refrigerant. Some of them even invited Greenpeace to discuss the issue.

In the end the *Greenfreeze* - as DKK's refrigerator was called - proved to be a breakthrough, not in the sense that it implied radical technical innovations, but because it showed that hydrocarbons, or more generally formulated: *flammable* coolants, could be safely used and were accepted by the consumer. When Greenpeace started in August, 1992, a publicity campaign the result was that, in two weeks, 50.000 orders were placed. As a result, DKK decided to start the serial production of the *Greenfreeze*. Then, in December 1992, the *Greenfreeze* acquired the safety approval from the TÜV (the Technical Certification Institute in Germany).[2]

Now that it became clear that refrigerators with hydrocarbons were not only technically possible, but were also safe and appreciated by the consumer, the other Germanrefrigerator manufacturers quickly developed their own refrigerators with hydrocarbons. Already in February, 1993, Bosch-Siemens, Liebherr and Miele presented a refrigerator with isobutane as coolant at the Domotechnica in Cologne. Other companies like AEG did not want to switch to isobutane, because they were

---

[1] To a lesser extent, this is also true for a mixture of two gases. Using only one coolant, isobutane for example, required, however, more adaptations in the compressor. Adaptations that were difficult to achieve for DKK. Later, when the difficulties with the compressor could be solved, DKK switched to isobutane as refrigerant.

[2] The *Greenfreeze* also acquired the European safety certificate 'EC Standard for Electrical Equipment 72/23/EEC'.

convinced that refrigerators using hydrocarbons consumed more energy. These firms argued that the total greenhouse potential of refrigerators with isobutane was higher than that of refrigerators using HFC 134a. However, they did not succeed in convincing the public with this argument and, fearing a negative public image and declining sales, they also have decided to switch to isobutane as refrigerant. As HFC 134a, the *Greenfreeze* was the result of the delegitimation of the existing - within the regime generally accepted - coolants. In the case of the CFCs this delegitimation had had little effect until CFCs were legally banned. For the *Greenfreeze* to become successful, a prototype had to be actually built and marketed since such a 'real' alternative made it possible to translate the rhetorical and ideological pressure that had been built up by Greenpeace into an economic pressure, that was more directly felt by the refrigerator firms.[1]

[1] The popularity of the *Greenfreeze* was probably not only due the Greenpeace campaign, but also to the David and Goliath-character of the quarrel between DKK and the other refrigerator firms. The defaming of the *Greenfreeze* by the ZVEI can said to have had averse effects: it moved public sympathy to the side of DKK and Greenpeace. Moreover, DKK was a firm from the East of Germany fighting to hegemony of the Western German firms. Especially so-called 'Ossies' were for this reason willing to buy the Greenfreeze.

Story 2: A barrier with holes[1]

To tell the second story we have to move from Germany to Holland and to go back to the fifties. In the last night of January, 1953, the South-West of the Netherlands was attacked by a huge storm flood. Higher water levels then 'ever' were the result. Many dikes were destroyed. Large parts of the provinces of Zeeland and Zuid-Holland, which are below sea-level, were flooded. 1835 people died; more than 72,000 people had to be evacuated.

After the flood disaster a plan was conceived to protect the southwest of the Netherlands from this type of disasters: the Delta plan. This plan, which was based on shortening the coast line, implied that a number of major inlets would be closed by barriers. It was recognized that this would require major technical and organizational innovations, since there was almost no experience - in the Netherlands or elsewhere in the world - with building barriers on such a scale and in such difficult circumstances: tidal inlets with strong currents. Therefore, the Delta plan was organized as a learning process, starting with the smallest barrier and ending with the largest. In this story, we concentrate on what was intended to be 'the crown of the Delta plan': the Oosterschelde barrier. The Oosterschelde is one of the largest tidal inlets in the southwest of the Netherlands. The closure of this inlet was scheduled to start in the beginning of the seventies and to be finished in 1978. However, from the end of the sixties onwards, the Oosterschelde closure was heavily criticized for its negative ecological consequences. As a result of this criticism, it was decided to build a semi-

---

[1] Main sources for the story include: Antonisse, R., 1985, *De Kroon op het Deltaplan*, Amsterdam/Brussel: Elsevier; Dibbits, H.A.M.C., 1950, *Nederland-Waterland; Een historisch-technisch Overzicht*, Utrecht: Oosthoek; Ferguson, H.A., 1988, *Delta-visie. Een terugblik op 40 jaar natte waterbouw in Zuidwest-Nederland*, Den Haag: Rijkswaterstaat; Haan, H. and I. Haagsma, 1984, *De Deltawerken; Techniek, Politiek, Achtergronden*, Delft: Waltman; Leemans, A.F. and K. Geerts (1983), *Doorbraak in het Oosterscheldebeleid*, Muiderberg: Dick Coutinho; Rijkswaterstaat, 1976, *Eindrapport Stormvloedkering Oosterschelde*, Den Haag: Rijkswaterstaat; Rijkswaterstaat, 1976, *Analyse Oosterschelde Alternatieven*, Den Haag: Rijkswaterstaat; Westerheyden, D.F., 1988, *Schuiven in de Oosterschelde*, Enschede: Universiteit Twente; *Driemaandelijks Bericht Deltawerken* and a number of interviews with relevant actors.

permeable barrier in the Oosterschelde. This so-called storm surge barrier was finished in 1986.

The main goal of the Delta plan was safety for the inhabitants of the southwestern part of the Netherlands. It was, however, from the beginning recognized that the closure of tidal inlets had a major secondary effect as well: it would frustrate salt water fishing and ruin the existing oyster firms. Nevertheless, this disadvantage was accepted, especially since another secondary effect - the disappearance of salt water from the sea - would be beneficial for agriculture.

From the sixties onwards, however, another disadvantageous secondary effect of the closure of especially the Oosterschelde was articulated: the loss of a piece of ecologically unique nature, i.e, the Oosterschelde estuary. The congress of the Zeeland Council of the Sciences in April 1967 is mostly named as the starting point for the protests against the closure of the Oosterschelde. At this congress, four hundred proponents and opponents of closure, from varying disciplines (ecology, hydrology, economy, agriculture, fisheries, recreation etc.) met.

After the congress, more and more groups joined the protests against the closure of the Oosterschelde. Environmental groups feared that an unique ecological area would be lost; organizations of salt water fisher firms feared their bankruptcy; water sport groups feared a loss of opportunities for water recreation. While these various opponents of closure had different reasons for their opposition, ecological values became a focal point for the protest movement: possibly because ecological care is a more generally accepted moral 'signpost' value, and hence has more cogency, than the economic well-being of salt water fishers or the particular pleasures of boaters and swimmers.

Instead of closing the Oosterschelde, opponents proposed to heighten the dikes. The protesters saw this alternative as a more reasonable way to reach the goal safety because they believed that in this way environmental values would be compromised to a lesser extend. In 1972 protests reached their peak. The closure of the Oosterschelde became a national issue. National broadcasts began to pay attention to the environmental aspects of the Oosterschelde issue. Despite these nationwide protests, the responsible authorities, the Department of Transport and Communications and Rijkswaterstaat strongly opposed changes in the Delta plan. However, in the same year the Dutch government was recalled due to an issue not related to the Oosterschelde. After the elections the first progressive government after the second World War came in power. This government decided to install a new committee to reconsider the closure of the Oosterschelde. In this committee, named after its chairman Klaasesz, an environmental expert, a biologist, a fishery expert and an economic expert got a seat in addition to the 'traditional' planners and hydraulic engineers. This broad composition of the committee was typical for the approach of the new government with respect to the Oosterschelde. An approach that was to recognize both safety and ecology as legitimate design values.

On the 1st of March, 1974, the Klaasesz committee came with a creative compromise: a semi-permeable barrier. According to Klaasesz, a semi-permeable barrier of blocks should first be built and later be replaced by a storm surge barrier. The technical feasibility of this option was, however, a problem as Klaasesz himself already recognized. Rijkswaterstaat believed that the 'egg of Klaasesz,' as the solution was quickly called, was technically impossible. Nevertheless, it asked the dredging companies, united in DOS, to investigate the possibilities of a semi-permeable barrier with blocks. The reason why Rijkswaterstaat delegated this feasibility study was probably that it feared not to be believed by the public if it, known as the defender of the Delta plan, considered the Klaasesz solution to be impossible.[1] DOS developed, in collaboration with the Rijkswaterstaat and Delft Hydraulics a new design:

---

[1] In the sixties and seventies, Rijkswaterstaat was heavily criticized for its uncommunicativeness. It was accused of not listening to the public and of forbidding its own employees to criticize the Delta works. Especially the report Rijkswaterstaat published in 1972 infuriated the opponents of the closure, because it left no room for discussion. There seems to be evidence that Rijkswaterstaat indeed was not willing to listen to the public at all. For example, in its own journal on the Delta Works, it did not, until 1978(!), pay any attention to the public protests against the closure of the Oosterschelde. For the imaginary reader, only reading the magazine on the Delta works and having no other source of information, the report of the Klaasesz committee must have come as a complete surprise. Despite this seeming reluctance to discuss other options, the Rijkswaterstaat in 1972 seemed to realize that it had to improve its public image.

a barrier consisting of caissons and with 'holes' between the caissons, later to be replaced by a storm surge barrier.
After the Klaasesz report, Rijkswaterstaat cooperated loyally in searching for solutions to the technical problems. It, for example, did not, formally or informally, try to withhold DOS from generating new initiatives. Later, the Rijkswaterstaat even developed a new technical variation, i.e. a permanent barrier with closable caissons. In its official statements, however, the Rijkswaterstaat stayed skeptical about the possibilities of a semi-permeable barrier. Its assessments with respect to the technical feasibility, the costs and the time scale of alternatives were rather conservative (compared with other actors), sometimes even intentionally.

At the end of 1974, government and later parliament decide to commission a storm surge barrier if in one and a half year it could be shown that: 1) a semi-permeable barrier was technically feasible, 2) the extra costs did not exceed 1.75 billion guilders plus an extra 20% and 3) the storm surge barrier could be ready in 1985.
Now that the technical goals for a design that would serve both the design values safety and ecological care had been fully articulated and was politically accepted, it was the task of Rijkswaterstaat helped by the dredging companies and research institutes like Delft Hydraulics to find the technical means to reach these technical goals. Within one and a half year, the concept design for the storm surge barrier had to be ready. Engel, the new head of the Delta department started working enthusiastically on this task.[1] He was surrounded by a generation of young civil engineers who wanted to prove their ability in coastal engineering. For these youngsters, the development of a technically feasiblealternative was a matter of prestige. Engel fully realized that the development of a feasible alternative required the mobilization of a lot of new knowledge from inside and outside the Rijkswaterstaat. Therefore, he considered it necessary to create

[1] In 1974, Engel was not yet the head of the Delta Department, but he was seen as successor of Ferguson, who was at that moment heading the Department. Moreover, Ferguson delegated all aspects of the Oosterschelde issue to Engel. Therefore, with respect to the Oosterschelde, Engel was the de facto head of the Delta Department. In 1976, Engel officially became the head of the Delta Department.

a new project organization for research on the storm surge barrier. In this project organization also the Department Sluices & Weirs, the Department of Bridges, and the Department of Water Management and Water Movement of the Rijkswaterstaat had to participate. The work inside the project organization was characterized by two developments. In the first place, the generation of a large number of alternatives. In the second place, the rivalry between the Delta Department and the Department of Sluices & Weirs.

In the first instance, the project organization was organized around constructions with closable caissons[1], which was in line with the decision of parliament. However, also other types of solutions were proposed in different working groups. In June, 1975, for example, 324 combinations of possibilities were under discussion. Engel continuously tried to promote the development of new alternatives. For this reason, he was striving for a more flexible project organization. Blokland - the head of the Department of Sluices & Weirs, a department that had played an important role in the realization of the Delta works and had a lot of experience with caissons - heavily opposed Engel's attempts to change the project organization. In the end, Engel won the quarrel. His success was partly due to his better access to the head of the Rijkswaterstaat and the Minister of Transport & Communications and partly to doubts within the project organization about the technical and economic feasibility of a solution based on caissons.

In May, 1976, the Rijkswaterstaat had to report to parliament on the feasibility of a storm surge barrier. At that moment, three serious alternatives were available: pilers founded in pits, which was supported by the Delta Department, caissons founded on sand, supported by the Department Sluices & Weirs, and caissons founded in pits. The main thing known was that for all these alternatives it would be hard, but not necessarily impossible, to meet the conditions that parliament had formulated in 1974.

---

[1] Caissons are a kind of 'pontoons': they are floated to the place of closure and then sunk. Caissons had been used on a wide scale in the Delta project.

In May, 1976, Rijkswaterstaat indeed sent government and parliament a memorandum on the feasibility of a storm surge barrier. In this so-called Blue Memorandum, the three named alternatives were treated. A preference was spoken out for 'pilers on pits', an alternative that was presented as meeting the conditions formulated by parliament. Although the Blue Memorandum in principle answered the questions posed in 1974 with respect to the feasibility of a storm surge barrier, Engel also decided to prepare another memorandum. This so-called White Memorandum made an assessment of different plans with respect to what were now seen as the main design values, safety and the environment, and less important considerations like costs, fisheries, economic consequences, etcetera. In this White Memorandum, three alternatives were compared: a storm surge barrier, an open Oosterschelde (with higher dikes) and closure according to the Delta plan. No preference was spoken out.

In June, 1976, government and parliament had to choose what to do with the Oosterschelde. In April, 1976, an open Oosterschelde had returned to the political agenda because a report, carried out by the consulting engineer DHV by order of variousenvironmental groups, stated that heightening the dikes was technically feasible, much cheaper and quicker to realize than a storm surge barrier. Also two other options, in addition to the storm surge barrier, were on the political agenda: closure according to the Delta plan and building a 'reductor.' Despite the creativity it took to fulfil the financial condition, government and parliament decided to stick with the storm surge barrier, which was eventually finished in 1986.

The storm surge barrier was a 'technical wonder' and, as we have seen, implied major organizational changes. More important was, however, that it also implied the legitimacy of a new design value in the design of coastal barriers: ecological care. The first official recognition of the legitimacy of this value, and other values not directed related to safety, was the composition of the Klaasesz committee. The most clear example of an attempt to optimize both safety *and* ecological care was the White Memorandum.

The advancement of the design value ecological care also required the involvement of ecologists and biologists in the Delta works. Ecological research in the Delta area and on the ecological effects of the Delta works was, however, already carried out before the closure of the Oosterschelde

became disputed. This research was, for example, carried out at the Delta Hydro-Biological Research Institute (established in 1959) and by the Environmental Division of the Delta Department of the Rijkswaterstaat (established in 1971). This research, however, initially was considered *irrelevant* for the *design* of the Delta works. The storm surge barrier changed this in the sense that ecologists and biologists were needed to formulate the minimal tidal effect that would be needed to sustain the ecosystem of the Oosterschelde estuary. This desired tidal effect was one of the technical specifications for the design of the storm surge barrier.
Eventually, the Oosterschelde project also played an important role in the advancement of an approach that is called 'integrated water management.' In this approach ecological and environmental care are seen as an integral part of the design of 'water infrastructure' alongside with such design values as safety and economics. As this approach is gradually becoming more popular in the Netherlands in the design of, for example, dikes, shores and sewage treatment plants, environmental and ecological considerations are becoming more legitimate and serious design values in the relevant design processes.

Story 3: attempts to change the design of battery cages[1]

The third story is about the design of housing systems for laying hens. In the fifties and sixties, the laying battery became popular as intensive livestock system for laying hens. In the seventies, however, this system was delegitimized as being detrimental to animal welfare. As we will see in the account below, hugh and heterogeneous efforts were undertaken by animal rights groups in the Netherlands and elsewhere to ban the battery cage.

The laying battery is an intensive livestock system for hens. It consists of a number of small mesh cages. In each cage there usually are four to five hens; each hen has an ground area of about 300 - 500 cm^2 at her disposal. The battery system was widely adopted in the Netherlands in the sixties. When this change-over to the battery cage was still under way, the first criticisms of the effects of the battery cage on animal welfare could be heard. The appearance of Ruth Harrison's *Animal Machines* in 1964 is widely regarded as the starting point of the attempts to delegitimite the battery cage. In her book Harrison argued that:

---

[1] This story is mainly based on an article by one of the authors: Poel, I. van de (1994), 'De Wereld van de legbatterij', *Kennis en Methode*, 18 (4), 315-340. Main sources include: Harrison, R., 1964, *Animal Machines; The new Factory Farming Industry*, London: Vincent Stuart; Harrison, R., 1993, 'Case study: farm animals', in R.J. Berry (ed.), *Environmental dilemmas: ethics and decisions*, London: Chapman & Hall, 118-135; Ketelaars, E.H., 1992, *Historie van de Nederlandse Pluimveehouderij*, Barneveld: BDU; Kuit, A.R., D.A. Ehlhardt and H.J. Blokhuis, 1989, *Alternative improved housing systems for poultry*, Beekbergen: Ministry of Agriculture and Fisheries of the Netherlands, Directorate of Agricultural Research, Proceedings of a seminar in the Community programme for the coordination of agricultural research, held at the Spelderholt Centre for Poultry Research and Extension, 17 and 18 May 1988; Schenk, P., 1988, 'Het nuttige dier', in M.B.H. Visser and F.J. Grommers (eds.), *Dier of Ding, objectivering van dieren*, Wageningen: Pudoc, 31-50; Wegner, R., 1990, 'Poultry Welfare - problems and research to solve them', *World's Poultry Science Journal*, 46 (1), 19-30.; articles from the magazines *Pluimveehouderij*, *Praktijk-onderzoek voor de Pluimveehouderij*, *het Agrarisch Dagblad*, *Oogst*, *Poultry*, *Misset World Poultry*, *World's Poultry Science Journal*, *New Scientist*; materials from animal rights groups; interviews with relevant actors.

> *"Most people, especially in towns, tend to be ignorant of the processes by which food reaches their table, or if not ignorant they find it more comfortable to forget. Farm produce is still associated with mental pictures of animals browsing in fields and hedgerows, ... , of hens having a last forage before going to roost, ... , and all the family atmosphere embracing the traditional farmyard. This association of ideas is cleverly kept alive by the giants of the advertising world who realise that the public still associates quality with healthy surroundings. A picture of ... the battery hen cramped in its cage ... would not, they rightly surmise, help to sell their products".*[1]

In the remains of the book, Harrison attacked the drive for efficiency in animal husbandry on the modern farm. As she argued animals on the modern farm are reduced to production machines:

> We have seen that the chief aim of intensive egg producers is to make chicken into a super-efficient machine for laying more and more eggs in a given time, and if, after all, she bears little relation to the chicken as we knew it, who cares?[2]

Harrison's book was also read widely outside of England and succeeded in creating a negative public image for the battery cage and other intensive housing systems by connecting the secondary effects of this system with the demise of the signpost value 'animal welfare.'

As in the case of the refrigerator and the *Oosterschelde* story, the articulated new design value - in this case: animal welfare - had to be translated into more concrete technical goals, specifications and heuristics to become effective. A special role was in this case played by ethologists. Ethology is a branch of biology that studies animal behavior. The disciplinary basis of ethology is the study of the behavior of animals in their natural environment. This 'natural' behavior gives ethologists a kind of reference point with respect to which they can discern 'abnormality' in the behavior of, for example, chickens in battery cages. Deviant or absent behavior can then be interpreted as, for example, failure of the animal to adapt itself to the new environment. So, ethology as a science had a normative standard by which to judge the suffering of animals. One of the

---

[1] Harrison, *op. cit.* (1964), 2.

[2] *Ibid*,, 58.

first occasions for ethologists to use their scientific insights for the formulation of design requirements for more humane chicken husbandry systems occurred only six weeks after the appearance of *Animal Machine,* when the British government installed a committee on animal welfare, also including an ethologist. Thc committees report advanced several criteria for animal welfare in housing systems: 'An animal should at least have sufficient freedom of movement to be able without difficulty, to turn around, groom itself, get up, lie down and stretch its limbs.'[1] On the basis of these kinds of criteria and insights ethologists developed more detailed ideas about technical goals and specifications for more animal benign housing systems. With respect to housing systems for chickens the following kinds of technical goals were formulated: the number of hens per square meter, the possibility for chickens to 'scratch' and take 'dustbaths' (presence of 'litter'); the presence of laying nests (to lay eggs in); the presence of perches. These sorts of technical goals also came to function as heuristics for the development of alternative systems.

The delegitimization of the battery cage and the development of technical goals and heuristics for more animal benign systems was, however, not enough to change the design regime of battery cages. Alternative systems had to be developed as such. One such system already existed in the seventies. Before the introduction of the battery cage in the Netherlands - and in some other countries - chickens were often kept in sheds with slatted floors, a housing system considered somewhat more animal friendly than battery cages.[2]In the Netherlands, this system was in

---

[1] cited in Harrison, *op. cit.* (1993), 120.

[2] It is a point of discussion if 'scratching systems' can really be seen as animal benign. In these systems, seven chickens are held per square meter and the chickens do not have any room outside. The Dutch animal rights group 'Lekker Dier' therefore considered, for a long time, this system as unacceptable. This organization disagreed in the early seventies with the attempts of another Dutch animal rights group 'Rechtenvoor al wat leeft' to bring the scratching egg on the market. Today, 'Lekker Dier' is willing to accept to scratching egg as 'a first step on a long road to go'. For a critique on the idea that scratching systems are animal friendly, see Harrison, R., 1991, 'The myth of the barn egg', *New Scientist*, 30 November 1991, pp. 40-43.

the seventies renamed as 'scratching system' because the system offered chickens the possibility to take 'dustbaths' and to 'scratch.'[1] The scratching system, however, had two major disadvantageous secondary effects: an increased risk of poultry diseases due to the wet litter and an increased risk of cannibalism (chickens killing each other under stress), which is more serious in a scratching system because there are more animals in a single space. Moreover, the production costs of scratching eggs were somewhat higher than of battery cage eggs. Therefore, research efforts were undertaken to develop other alternative systems. Not until the mid seventies, however, the first applied research on alternative systems started. A main reason for this 'delay' was that farmers did not want to pay for research on alternative systems. They believed that alternative systems would lead to a higher price per egg since they believed that consumers would not be willing to pay this extra price they considered such a secondary effect unacceptable. For these reasons, research on alternative systems did not start before governments subsidized it.

Bareham's 1976 development of the so-called 'get-away cage' is generally cited as a starting point for applied research on alternative systems. The get-away cage is a battery cage with special areas for perches, laying nests and litter. These special areas increase the quality of the system from the point of view of animal welfare. In the course of time, however, it became apparent that modified hen batteries had their own disadvantageous secondary effects. The litter in these systems caused problems with respect to eggs laid outside nests and the chickens were more difficult to access and inspect. Moreover, modified hen batteries turned out to be labor-intensive. Hence, other types of alternative systems were developed. One of them is the aviary or, as it is called in the Netherlands, 'volière.' This system is characterized by the use of several levels, on which the chickens can drink, eat and rest. Because of the different levels, a large number of chickens can be held per square meter ground area. On the other hand, the aviary offers chickens the possibility to scratch, take dustbaths, rest and lay eggs in laying nests.

---

[1] The Dutch verb 'scharrelen' means something like 'messing about' or 'scratching'. The later term is used as translation by the 'Dierenbescherming' and will be used here too.

Although alternative housing systems have been developed and are now commercially produced, most farmers do not want to buy and use aviary systems because they imply higher production costs per egg. According to the poultry farmers the system has some other negative secondary effects as well: aviaries are more labor-intensive, produce more dust, which makes the labor conditions worse, and entail a greater risk of poultry diseases due to the litter.

If we look at the earlier stories, there seems to be two ways in which a more general use of alternative systems, and hence an overturn of the design regime of battery cages, can be reached. This first is by creating economic pressure, as was so successful in the case of the *Greenfreeze*. The second is by a political decision to ban the battery cage, a strategythat resembles the successful ban of CFCs and to a certain extent also the political decision to build a storm surge barrier. Both strategies are treated below.

Already in 1972, Dutch animal rights groups tried to bring an alternatively produced egg on the Dutch egg-market, i.e. an egg not produced in battery-cages. This so-called 'scharrelei' (scratching egg) was produced in scratching systems. As noted earlier, this system was still in use by some farmers in the early seventies; however the eggs produced at these farms were not discernable as scratching eggs for the consumer. This spurred Dutch animal right groups to develop a 'label' to be stamped on the scratching eggs as to offer consumers the possibility to choose for 'animal benign' instead of 'cheap' eggs. The 'scratching' egg was a success, despite its somewhat higher price. In fifteen years it conquered 20% of the domestic egg market. However, as things now stand this may remain only a limited success. Eggs used in the egg-based foods industry are not discernable as either battery cage or scratching egg for the end consumer. Moreover, 75% of the eggs produced in the Netherlands are exported and the scratching egg plays only a limited role in this export.
Later also eggs from aviaries ('volière-eieren') and from free-range poultry farms (where chickens have the possibility to go outdoors) came to be specially stamped and sold. However, the market share of these kinds of eggs is relatively small. Hence, there has been only modest economic pressure on farmers to switch to alternative systems.

With respect to political action, the Dutch government, like most West European countries, considered it desirable to wait for EC-legislation, instead of developing national laws that would 'punish' only their own farmers. In 1986 EEC rules with respect to laying batteries were laid down in EEC Directive 86/113/EEC. This directive included minimum requirements, mandatory for laying batteries which would come into use after 1 January 1988 and mandatory for all batteries after 1 January 1995. The requirements were: at least 450 cm^2 floor area per hen, 10 cm trough per bird, 40 cm height for at least 65% of the area and a floor-slope of maximally 14%. In most West European countries, these requirements have become mandatory. These national and international requirements, however, do not prohibit the battery cage. Nevertheless, in a number of countries, there has been discussion on a legal ban to the battery cage. In one country, Switzerland, such a ban has indeed been enforced. In the Netherlands, parliament has decided - after long and heated discussions between farmers and animal welfare groups - to wait with a possible ban of the battery cage until the EC takes positive action. It was feared that the additional production costs per egg - an estimated 0.8 Dutch cents - of the conceived alternative - the aviary - would damage the position of the Netherlands as one of the world's largest egg exporters.

So, neither the sale of specially stamped alternative eggs nor government regulations succeeded in banning the battery cage. This is not to say that nothing has changed in the design regime of the battery cage. Animal welfare has become a more legitimate design value; this value has been translated in technical goals and specifications for the design of housing systems; alternative systems have been developed; alternative eggs are being sold, etc. Nevertheless, the hegemony of the battery cage and the drive for efficient laying systems in terms housing, food and labor has not yet been broken.

Discussion

The three stories described in the preceding section show the durable character of design regimes. Existing design values, technical goals and specifications, types of artifacts actually designed, heuristics, technical models, testing methods and relationships between suppliers and customers were in most cases not easily changed. But as especially the first story made clear, things can change suddenly in a design world. In this story, we saw how in the first instance existing technical specifications for coolants and existing supplier-customer relationships led to the choice of HFC 134a as replacement for CFC 12. However, when Greenpeace succeeded in eroding the legitimacy of HFC 134 and was able to offer an alternative type of refrigerator, which consumers wanted to buy, the existing design world quickly decided to switch over to isobutane and, hence, to a new design regime for coolants.

In all three stories it was *outsiders* that more or less successfully tried to influence existing design regimes by questioning their legitimacy. In all cases, this questioning concerned the secondary effects of the design regimes: destruction of the ozone layer (refrigerator regime), ecological destruction (Oosterschelde regime) and suffering of chickens (battery cage regime). Outsider protests had, in all three stories, strong moral overtones. The protestors tried to show and to convince the public that the existing design regimes were neglecting values that should be held by everyone, and should *for that reason* be seen as illegitimate regimes. The opponents backed these discourses by 'persuasion devices' like books, statements, pictures and happenings. With the help of these devices they tried, not unlike Harrison's 'giants of the advertising world,' to connect the neglect of some absolute value with the activities of the design world under attack, as kind of 'unmasking.'

In the stories, environmental and animal rights groups also accused existing design worlds of a 'fetishism of means and/or ends.' Why is the Rijkswaterstaat only interested in safety and why does it not take into consideration alternatives to the Oosterschelde barrier to reach this safety? Why is efficiency the sole value in the design of battery cages? Why do the German refrigerator firms so firmly stick to HFC 134a as the alternative for CFC 12? As alternative to the 'absolute' values, ends or means held by the design worlds - at least in the eyes of opponents - opponents articulated other values with an almost absolute character: environmental care, preservation of the ecosystem of the Oosterschelde, animal welfare. To a certain extent, the stories can, thus, be understood as a clash of, in some cases deeply rooted, 'absolute' values.

Insiders to design regimes defended their regimes mostly in terms of the intended primary effects like cooling capacity for society, safety for the inhabitants of the southwest of the Netherlands, cheap and high-quality eggs. They argued that they were not striving for such values and the related technical goals for their own sake, or because of an irrational attachment to earlier formulated design goals, but because these were widely perceived subjective needs. In other words, the existing design regime was serving society and it was not the regime insiders who fetishized certain design values, technical ends or means, but the outside protesters, who were so attached to certain 'absolute' values that they neglected widely perceived societal needs.

As the stories make abundantly clear delegitimizing a design regime was not enough to change it. Delegitimization was more or less a rhetorical or ideological detour used by outsiders in the hope at gaining support and mobilizing political and economic pressure. As we have seen in the stories, the translation of alternative design values into tangible technical goals and specifications and subsequently into technical alternatives was a necessary, but not yet sufficient, condition for the creation of political and economic pressure on a design regime. It was around such concrete technical options (with their specific range of effects) that political and economic pressure was concentrated: the *Greenfreeze*, the storm surge barrier, scratching systems and aviaries. Hence, the stories suggest that, at least, three activities are important in the redirecting of design regimes: 1) eroding the existing legitimacy of design values, technical goals and technical means; 2) setting new design values and translating them into technical goals and specifications and 3) developing or mobilizing (new) technical alternatives that meet these new specifications.

Nevertheless, in the three stories the dynamics of normative discussions about the (il)legitimacy of various ends and means seem to explain the (social) dynamics of the change processes we have described to an important extent. But, how does normative discourse exactly order or disorder the actions of actors inside, or outside, a design world? And how exactly does this eventually lead to new design regimes? To answer these questions it is useful to think more fundamentally about the relation between patterns of legitimation and delegitimation on the one hand and social action and order on the other, as it might apply to technical design. Many have preceded us in this endeavor and the resulting welter of claims and counterclaims may explain our urge to consult a primary source on legitimation, namely the sociologist Max Weber.

Weber regarded social action as chronically in need of justification, especially insofar as it constituted 'orderly' patterns of social interaction: not, to be sure, in the sense that he saw society as a collection of actors constantly justifying their behaviors to each other, but certainly in the sense that actors should, *in principle*, be able to provide such justifications. Weber formulates a number of grounds of 'orderliness' in social action in the form of possible *justifications* for actors' preferences for one course of action over another. At the lowest level is the idea of customs *(Sitten)* which are patterns of social action maintained simply out of habit or ease, but in any case thoughtlessly. More reflexive grounds can be found in notions of 'conventions' and 'rights.' An important category of social action based on these kinds of grounds is 'traditional action.' This type of social action can be justified by explaining how it *reproduces* and *sustains* what has always been so. Because of the relatively inflexible and codified nature of traditional belief systems, this type of action also tends to be highly stable and even ritualistic. The bottom line of traditionalistic legitimation is that 'it has always been done so.'

From the standpoint of designing and the stability and overturn of design regimes, the most interesting category is what Weber calls *rational* social action. As opposed to both traditional and 'irrational' (e.g. emotional) action, *rational* types of social action presuppose that the actor can provide explanations and justifications on the basis of more or less self-referential systems of meanings and values. Among other things, this is clearly the distinctive category of social action of modernity. What is of paramount interest, however,is that Weber distinguishes two types of rational social action, which he calls goal-rational *(Zweckrational)* and value-rational *(Wertrational)* action.

The tenor of this distinction is whether the action is justifiable with respect to a 'means-ends' rationality or with respect to what Weber calls an 'absolute value.' Weber describes means-end rationality as follows:

> *"A person acts rationally in the 'means-end' sense when his action is guided by consideration of ends, means and secondary consequences; when, in acting, he rationally assesses means in relation to ends, ends in relation to secondary consequences, and, finally, the various possible ends in relation to each other. In short, then, his action is neither affectively determined (and especially not emotionally determined) nor traditional."* [1]

Note that Weber is not merely describing a narrowly 'technical' form of action; i.e. one limited to the selection or development of means *given* specific ends. He explicitly includes the choice (and justiciability) of ends, and not only in relation to the primary goal, but also in relation to possible (and possibly undesirable) 'secondary effects.' So social action of the means-end type, or 'goal-rational' social action as it is often translated, involves a heterogeneous variety of legitimating discourses; from considerations on the relative 'utility' of possible ends (also in view of 'secondary effects') to the efficacy of various means for achieving them (presumably also in relation to 'secondary effects' as well). The main point, however, is that this type of action is *teleological*; it is shaped by the will to specify and to achieve some desirable (and legitimate) future state by searching for technically adequate means to bring it about. As far as it goes it is an adequate general description of technological designing as well.

Weber's second category of rational action, namely *value-rational action,* introduces interesting complications. Weber describes this type of action as follows:

> *"An example of someone who acts wholly rationally in the sense of attempting to realize an absolute value is a man who, without any concern for foreseeable consequences, acts out of a conviction based on what duty, honor, beauty, religious doctrine, piety or the importance of any kind of 'cause' seem to him to require. In the sense of the term defined here, an action which is 'rational' in this sense is always performed in obedience to*

---

[1] Max Weber, 'The Nature of Social Action', in W.G. Runciman and E. Matthews (eds.), 1978, *Max Weber, Selections in Translation*, London: Cambridge University Press, 29. The text is originally part of chapter one of *Economy and Society* and is clearly intended by Weber as an exposition of his sociological 'primitives.'

'imperatives' or in fulfilment of 'claims' which the agent believes to be imposed on him".[1]

The 'rational' basis of this kind of action (what distinguishes it from traditional or various kinds of 'irrational' action like emotively guided action) is that the absolute values in question are in principle discursively *retrievable.* I.e. the actor legitimates his or her actions with respect to 'absolute values' which are themselves in principle 'open to discussion,' albeit often entrenched in systems of norms and beliefs. The distinguishingfeature of this type of action with respect to 'goal-rational' action is that there is little or no 'concern for foreseeable consequences' or possibly secondary effects. It is social action, more concerned with the propriety of the means than the value of the ends.

In the stories, opponents as well as proponents of existing design regimes defend their behavior with respect to these regimes in terms of means-end rationality as well as value-rationality. Typically, however, they accused each other of 'fetishm' and 'irrational attachment to certain values' or, in other words, of acting value-rational. This raises the question what the relation between these two kinds of rationality is. Weber himself suggests this relationship between the two types of rationality. After describing full-blown means-end rationality as an ongoing *assessment* of ends in relation to expected utilities and 'secondary effects,' and of means in relation to these ends (see above quote) he describes the case where the choice for ends is based on 'absolute values':

> "*When ... he has to choose between competing and conflicting ends and consequences, his decision may be rational in the sense of being based on his conception of absolute values: in that case,* his action is rational in the present sense only in respect of its means." (italics authors).[2]

But what other basis is there for choosing ends? Weber appears to fall back on Jeremy Bentham and suggests the principle of subjective 'marginal utility':

---

[1] *Ibid.*, 29.

[2] *Ibid.*, 29.

> *"Alternatively, the agent may not take into account absolute values, with their 'imperatives' and 'claims,' but treat the competing and conflicting ends simply as subjectively felt needs and order them on a scale of their relative urgency, as consciously* assessed *by himself, so as to act in such a way as will satisfy them as much as possible in this order. (This is the principle of marginal utility)".*[1]

So for Weber, there is full means-end rationality only when the ends are chosen on the basis of some articulated version of self-interest, which may involve the resolution of conflicts of interest, but which in any case remains *rational with respect to the pursuit of interests and can be legitimated as such.* From this perspective, any other basis for choosing ends (including emphatically absolute values) is more absolutely beyond the pale of discursive contestation, less pragmatic and less reflexive; in short, less *rational*:

> *"There can therefore be various kinds of relationship between the two types of rationality to be found in human action, that based on conceptions of absolute value and that based on fitting means to ends. From the standpoint of the 'means-ends' kind of rationality, however, the other kind is always irrational, and the more so the more it elevates the value by which action is to be guided to the status of an absolute value".*[2]

Weber's conviction that it is more rational to choose (technical) goals and means relative to each other and in relation to subjectively felt needs also seems to shape the behavior ofthe participants of the stories we described in section 2. In many instances, they accused each other of value-rational action and implied that they were themselves acting more goal-rational, i.e. more deliberately choosing technical goals on the basis of 'widely felt subjective needs' and taking into account possible secondary effects.

As it stands, Weber's description of 'goal-rational' and value-rational action and the legitimation of goals and means in these two types of rationality provides some interesting clues for a theory of the routinization of technical goals in design. On the basis of Weber's

---

[1] *Ibid.*

[2] *Ibid.*

distinctions, one could expect a given sort of technical goal to become typical in a given design world when it expresses either, a) a widely shared perception of actors' subjective needs or, b) some 'absolute' design value held in common by numerous actors. Weber would say that (a) was the more fully rational because 'needs' are chosen, and can be discussed, vis-à-vis each other, whereas, by contrast, the very notion of 'absoluteness' entailed in (b) suggests that any weighing of goals against each other is impossible.

Of course, Weber would be the first to admit that in reality these ideal types are only poles on a *continuum of legitimation* of the ends of social action, i.e. a gradient from a fully open discourse of needs and interests, through a relatively closed fetishism of absolute values. Any real-life determination (or legitimation) of ends (including the technical goals of design regimes) is therefore bound to be a mixture of means-end rationality and value-rationality. Nonetheless, Weber's distinction does allow us to identify and isolate what appear to be two major sources of teleological ordering in social action in general and in technical designing in particular.

In general, but especially for the type of social action we are calling technological designing, it would be interesting to extend Weber's ideas on legitimation to the selection and development of *means* as well. On this view it is possible to select (or develop) means either with an eye to maximizing efficacy and efficiency in achieving stipulated technical goals or with an eye to realizing some 'absolute value.' For example, one can pursue the design of a barrier either in a 'pragmatic' way, by developing models, theories, and building techniques to suit, say, a particular site or certain technical specifications; or, one can design according to 'absolute values,' i.e. insist on the importance or inevitability of using particular canonic heuristics, materials, and building techniques which in effect limit the range of ends (i.e. type of barrier) which can be realized. In the latter case, the choice of means (and their *post factum* legitimation) assumes the same kind of dedication to absolute values as Weber sketches above in his description of the *Wertrational* specification of ends. And the result is the same degree of 'irrationality' *with respect to a 'utilitarian' choice of means*, as Weber argued for the *Wertrational* choice of ends. Our point is that design worlds can assume different positions along this continuum through time and that, in effect, ends (i.e. technical goals and specifications and hence also 'secondary effects') can also become fixated as a result of a 'fetishism of means,' i.e. as a result of choosing means on the basis of a commitment to 'absolute values' rather than on the basis of their efficacy and efficiency in realizing desired technical goals.

In the cases we described, design regimes were influenced via a legitimation detour. It is the strategic importance of this detour that explains why the debates between proponents and opponents of design regime often had value-rational overtones. Describing your opponents as 'irrationally attached to some absolute value' or accusing them of 'fetishmof means or/ends' and thereby implying that that opponent is neglecting 'widely felt subjective needs or values' was a way to win public support and eventually to build up political and economic pressure, or - in the case of regime insiders - to avert such pressure. But, while antagonism among proponents and opponents of design regimes may be understandable from the role legitimation discourses actually play in the overturn of design regime, it nevertheless may block the interaction between the parties and lead to trench-warfare. In our stories, it was mainly governments that tried to prevent such antagonistic gridlocks. As is abundantly clear from the battery cage and the *Oosterschelde* story, governments tried to avoid the sacrosanction of certain design values and attempted to weigh the different values at stake (e.g animal welfare versus economic efficiency) against one other in order to find a compromise, which would be acceptable to all parties. An important move in this search for a compromise was the funding of research to bridge the gap between conflicting design values. As we have seen in the battery cage story, the Dutch and other European governments stimulated research on, among other things, aviaries, in an attempt to develop a system that was animal benign as well as economically acceptable to the farmers. But the developed system did not resolve the normative conflict; it led to even sharper disagreements between opponents and proponents. Possibly because it showed that a ban of the battery cage was not as unthinkable as farmers thought beforehand.

The role of governments in the battery cage story makes clear that governments may not be able to reach 'goal-rational' solutions to fights between opponents and proponents of design regimes. One might argue that such quarrels are irresolvable as long as the contending parties are not prepared to act more goal-rational. Such a solution would, however, deny the strategic importance of (de)legitimation discourses. The point is often *not* that either proponents or opponents are totally unreceptive for the arguments of the other party. In our cases, regime insiders and criticasters were - in some cases - prepared to discuss the pros and cons of the various options, but often only off-the-record. While the refrigerator firms condemned the *Greenfreeze* in a letter to the retail trade, in the meantime some of them started informal talks with Greenpeace. While *Rijkswaterstaat* after the Klaasesz Report cooperatively searched for alternative barrier designs, in its official statements it was very skeptical about the feasibility of alternatives. While animal rights groups condemned the suffering of chickens in battery cages, some of them were prepared to contribute to the introduction of systems, like the scratching system and the aviary, that are a compromise between animal welfare and 'economic' requirements. These examples suggest that the 'real' problem is not so much the 'value-rational' attitude of the opponents and proponents, but the structure of the antagonistic moralizing games, in which they got stuck and which invokes value-rational behavior. In other words, we need to look for games structures, in which the preferences and values held by the contending parties are confronted in a constructive way. We will denote such games as constructive normative games. Looking for (goal-)rational game structures, instead of (goal-)rational individuals means developing a more truly *sociological* version of goal-rational action than Weber seems to do. Such a version should be based on the idea that design regimes in principle can learn something from outsider protest. Design regimes can, for example, improve their 'performance' by taking into account secondary effects in the design process. Constructive normative games should, therefore, not primarily aim at the containment of conflict, because - as our stories indeed show - 'ideological' conflicts can be an important detourin a learning process about design goals and means. The *Oosterschelde* story shows an excellent example of such a successful learning process. This game started with a seemingly value-rational conflict, but eventually resulted in a goal rational design approach - integrated water management - that is almost universally accepted in Dutch water management. The question now, of course, becomes are there general properties by which constructive normative games differ from moralizing antagonistic games?, and if yes, how can such constructive normative games been brought about in practice? There are clearly no easy answers to these questions and we cannot pretend to offer them in these few pages. But one thing is sure, constructive normative games can only come into being if we take the (sociological) reasons by which actors get stuck in moralizing antagonistic games fully serious. As it seems these reasons are twofold. As hinted earlier, outside protesters seem to choose for an ideological detour if they have no other means to express their concern or to put pressure on design regimes. For one thing then, constructive normative games can only be successful if outsiders in principle can gain a serious role in these games. The reasons why insiders choose for an ideological route seems to be that they fear that the existing design regime, to which they are often strongly committed through all kinds of 'sunk investments,' will be overturned. In a truly constructive normative game, this problems should be avoided, for example by developing 'creative' technical solutions.

Our stories suggest at least one way, in which a constructive normative game *could* come into being. In the stories, goal rational discourse had the best chances when proponents and opponents should give their opinion on the desirability of alternative ways of going on, for example when the pros and cons of different technical options were to be discussed. Thus, in the battery cage story farmers primarily did not consider the aviary a legitimate system for producing eggs because they were convinced this system would bankrupt them, not because they considered animal welfare an illegitimate value in itself. As a practical researcher of the Spelderholt stated: 'Chickens also have to sacrifice something for the welfare of the poultry farmer.'[1] With respect to the legitimacy of designing refrigerators, environmental groups tended to say: 'Ok, it is in principle important to have cooling capacity, but if this leads to a destruction of the ozone layer a lowering of the cooling capacity should be strived for.' Whereas Gac of the International Institute of Refrigeration said something like: 'Ok, CFCs are a serious problem, but

[1] *Publikaties Pluimveehouderij 1991*, 6, our translation.

we should not give up the social benefits cooling has brought us.' Of course, discussions about technical options also may have value-rational overtones and are surely not easy to resolve, but they at least offer the possibility to mutually learn about the *relative* importance of design values, technical goals and technical means in relation to what can be realized in practice. It is, therefore, very important that in this way 'ideological' discussions become more directly connected to technical development and design processes. Development and design processes that are in themselves already learning processes, be it often more concerned with means than with ends. Such development and design processes, however, not only make the trade-offs between different - in principle legitimate - design values more clear, they may also result in an acceptable 'technical solution' for the normative conflict. Note that in the battery cage story (the aviary as a compromise between animal welfare and economic efficiency) as well as in the Oosterschelde story (the storm surgebarrier as compromise between safety and ecological values) such technical solutions were aimed at. In these cases, however, the proposed technical solutions did not resolve the normative conflicts totally. Nevertheless, by changing the trade-offs between conflicting values, these solutions created new terms for the normative discussions, which may enhance the learning process. As the stories suggest, however, such enhanced learning is only probable if the contending parties have at least some *prior* commitment to the search for alternative designs. Poultry farmers lacked such commitment to the development of alternative poultry husbandry systems and interpreted this development as being *only* a step towards a ban of the battery cage. Only when the search for alternatives, in which the different hierarchies of values, goals and means of the parties are to be confronted, is to a certain extent a common *endeavor* can a learning process with respect to values, goals and technical options evolve.

Conclusion

In our cases, outsiders that tried to influence design regimes because they considered some of the secondary effects of these regimes unacceptable chose for a delegitimation 'detour.' They delegitimated existing design regimes by connecting their 'performance' to the demise of certain generally held social values. Delegitimation detours were particularly successful if the newly articulated design values could be successfully translated in design goals, specifications and, ultimately, alternative products. Such alternative products were a major vehicle for organizing political and economic pressure on existing regimes. The potential success of delegitimation detours suggests that, although there does not exist a one to one relation between on the one hand patterns of legitimation and delegitimation and, on the other hand, the occurrence and dissolution of design regimes, is reasonable to consider legitimation as, at least, one of the sources for the stability of design regimes, alongside with such 'traditional' discerned sources for stability such as existing technical concepts, sunk investments, vested financial interests, market structures, technological enthusiasm and government policy.

While a delegitimation detour may be a successful route to influence a design regime, it often invokes value-rational behavior of the actors involved and may eventually lead to antagonistic moralizing games. We have suggested that such trench-warfare might be avoided by creating 'constructive normative games,' which try to attack the causes by which opponents and proponents get stuck in value-rational behavior. One route to trigger constructive normative instead of antagonistic moralizing games is promoting the actual development of new technical options and actively and seriously involving all contending parties in such design processes. In this, a learning process may come about, in which different, and possibly conflicting, design values, technical goals and technical means are confronted in an integrated way.