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Introduction

How can one give an account of the interaction between people and technical objects without falling into the symmetrical traps of 'technologism' and 'sociologism'? The former position involves considering technological development as being above all determined by the existence of technical resources and constraints, whose interaction is sufficient to explain the form taken over time by various technical objects. Accordingly, there are two possibilities: either technology succeeds in spreading and proves capable of imposing a form of social order[1], or it runs up against non-technical (social, cultural, economic etc) obstacles to its diffusion and there is no other way of getting round these than by reforming people, by freeing them from their prejudices and taboos[2]. Although it is the diametrical inverse of this position, 'sociologism' merely repeats the

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1 This position is illustrated, for example, by Langdon WINNER's article, "Do artifacts have politics?" in The social shaping of technology, Donald MACKENZIE and Judy WAJCMAN (eds), Open University Press, Philadelphia, 1985. His point of departure is the fact that technologies have a political and moral content, in that their functioning involves a certain imposition of order on the world. He affirms the popular dictum that "democracy cannot go through the factory gate". This affirmation denotes the existence in a single society of separate spheres whose mode of functioning rests on different and incompatible principles. For him, the problem is to know whether, inversely, the factory does not for its part go through the doors of parliament house - that is to say whether it is always possible to maintain the separation between industrial and civil society. In other words, he wants to know whether certain industrial decisions do not, in the very form of the technical objects that support them, impose a social order which acts to limit to an unacceptable degree the freedom of each citizen and their global capacity to decide their own future. His conclusion is not a trenchant one. It distinguishes between two types of relations between technology and civil society. On the one hand, he finds some technologies that are highly compatible with certain forms of social organization but whose political effect depends on the particular circumstances of their establishment. On the other hand, he locates technologies which impose social order in their own right. The archetype of this latter genre is nuclear technology, which because of the risks that it places humanity in - the possibility, amongst others, of appropriation of the basic materials for making bombs by terrorists - implies the setting-up of a police state, which completely penetrates civil society and renders the normal functioning of democracy impossible.

2 The literature on technology transfer to developing countries is full of this kind of analysis, which simultaneously explains the failure of the technology being looked at and renders it irreversible. Thus, for example, the paper by Pierre AMADO, entitled "Une pompe solaire dans un village tribal du Bihar" (*Scientific News from France, the CEDUST Bulletin* - New Delhi, Jan./Feb. 1984). According to this view, if some technologies are refused by target populations, it is because their use is hindered by local prejudices or taboos, because they threaten the social hierarchy or even de-structure the societies in which they are implanted. This model implicitly presupposes that traditional societies are completely rigid in their work organization, social hierarchy, technology etc and that no one element can be modified without causing transformation or deformation leading to a possible collapse of the social edifice. Under these conditions, the introduction of technology from the outside imperils the equilibria that the existence of the societies under consideration depends on. If the technology is taken as unchangeable, the task is then to adapt individuals and communities to it. Accordingly, there is often

distinction between technology and society that 'technologism' depends on, while inverting its 'sign'. Thus it is considered that a given technology can only spread successfully if it satisfies the exigencies of the immutable social order[1]. Further, the form taken by technical objects is directly linked to the social conditions which gave rise to them[2]. The case of developing countries, which are characterized by a maximal distance between the context in which the technology supply is developed (since technologies are in general conceived in industrialized countries) and the context of the demand, permits us to see the limitations of these two approaches. Anyone who has traveled in these countries cannot fail to have been struck by the astonishing heterogeneity of the technologies used. In a single village, even within a single family, there can be found the most primitive technologies, in particular in agricultural and domestic implements, side by side with sophisticated industrial technology (radio, generator, mobylette etc). How, then, can we explain from the 'technologist' perspective the fact that the same villager who is completely indifferent to technological progress in the form, for example, of photovoltaic cells to drive a pump, is open to buying an electrical generator allowing him to run that same pump? Inversely, if we take the 'sociologistic' point of view, how can we account for the use of industrial technologies in developing countries. That is to say, how can we account for the miraculous matching of a technology designed by and for one particular social organization to a radically different society?

The principal flaw of these analyses, which can in fact give a good description in specific cases of the process of the conception and integration of technologies, is that they both rely on an a priori separation between the social and the technical. In fact, we only have to look around us at our most familiar objects to see that their form is always the result of a composition of heterogeneous elements. In another article, I looked at the example of the chassis of cars[3]. The

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talk of precautions, discussions, dialogue, efforts to convince - the whole panoply of social ways of painlessly integrating modern technologies and traditional societies.

1 In the field of technology transfer to developing countries that we looked at in the previous footnote, this position is illustrated by the promoters of so-called 'appropriate' technology. The point of departure for their analysis is the idea that obstacles to the spread of technology in developing countries are not inherent to the form of traditional societies but are in part linked to the incapacity of engineers and technicians to analyze societies and their needs correctly. Thus the recommended procedure is to attempt to encourage active participation by end users (who belong essentially to the most disadvantaged sections of the population, these being the priority target of appropriate technologies) in the process of the conception of technologies. Thus, for example: GUEYE, MADON, "Etude de cas: le programme foyers améliorés au Sénégal", *Revue de l'énergie,* n°356, Juillet/ Septembre 1983; JEQUIER (Ed), Appropriate technology, Problems and promises, OECD, Paris, 1976; AGARWAL, "Diffusion of Rural Innovations: Some Analytical Issues and the Case of Wood-burning Stoves", *World Development*, Vol.11, N°4, 1983.

2 See, for example, the work of Eda KRANAKIS, Social Frameworks and technological cultures: Comparative Studies of France and America in the 19th century (to be published). She performs a comparative study of two innovators, one French and the other American, who constructed the first suspension bridges in their countries of origin. She relates the characteristics of each type of bridge to the context (social origin, eduction, professional activity, political and social structure and so on) in which the two innovators conceived their plans.

3 "Comment décrire les objets techniques", *Techniques et Culture*, n°9, Paris, 1988.

strength of the materials used is in some relation to the expected violence of the impacts they might be exposed to. These impacts are related to the speed of the vehicles, which is in turn the outcome of a complex compromise between “purely” technical elements such as the performance of motors and social elements such as speed limits, ways of enforcing them and the values attributed to different individual behaviors. Already in this small example, we can see that a given technical choice appears to operate within the framework of some very diverse constraints. Further, many studies of innovation process show, on the one hand, that the success of many innovators is linked to their capacity to work in both dimensions simultaneously, to constantly shuffle back and forth between the technical and the social, and to operate translations between these two registers[1]. On the other hand, they also show that the stable definition of what is social and what is technical is one of the major *outcomes* of the innovation process[2].

Given this, how can we represent the interaction between people and their technology in all its richness and complexity? If we want to understand properly what machines "do", then we have to put ourselves into a position where their usage is not yet or is no longer standard. This latter term is evocative. What we are looking for is a place where the division of labour between machines and people is not yet completely stabilized (or rendered inaccessible). This book offers a whole range of solutions to the problem of obtaining this "distancing" effect. For example, one can follow the archaeologist or the historian and look at technical objects which have lost their initial users. One can also, with the ethnologist or archaeologist, examine societies very distant from our own. In this case, it is the observer's viewpoint, from outside the culture, that permits us to achieve the analytically necessary separation between technical objects and their uses. Finally, we can follow the sociologist and chart the progress of projects of technological innovation or technology transfer. This enables us to see the object/user couple progressively take shape.

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1 See, for example, R.V. Jenkins, Images and Enterprise: Technology and the American Photographic Industry, 1839-1925, Baltimore, Johns Hopkins University Press, 1976; (Bell laboratories, Kodak, Pasteur). For our purposes, the most spectacular example is provided by T.P. Hughes in his study of Edison in Networks of Power: Electrification in Western Societies, 1880-1930 (Baltimore, Johns Hopkins University Press, 1983). Edison, who has often been presented as the prototype of the mad but brilliant inventor proves on closer analysis to have been the total opposite of his image of the solitary hero. On the one hand, he knew what he wanted - to build an electrical system capable of supplanting other forms of energy distribution, notably gas. On the other hand, he knew how to achieve these ambitions. He began by using strident press campaigns in which he announced his ambitions. These allowed him to influence public opinion at the same time as he tested the water. He surrounded himself with the most brilliant scientists of the day from a great range of disciplines. At one time, he managed to forge an association with a peerless entrepreneur who negotiated on his behalf with various financial institutions, all of whose secrets he knew. Finally, he himself lent a hand in that he did not preclude any mixture of types that might lead to a solution to his problem. The example of the incandescent lamp is characteristic of his procedure. In his notebooks there are a series of notes and calculations which inextricably mix laws of physics with calculations of costs. These permitted him to infer the necessity of developing a lamp with a highly resistant filament if he wanted to supplant the gas lighting systems then in operation.

2 See Michel CALLON, “Pour une sociologie des controverses technologiques”, *Fundamentae Scientiae* , 3/4, 1981, 381-399.

We will adopt this last procedure. It is only valuable if a major methodological principle is adopted: the sociologist must not make any a priori distinction between what is technical and what is social in what is being observed. Further, s/he must not have any preconceived theory about the composition either of the society or of the technology in question. Unless we adopt this principle, there is no way we can find what we are looking for in this study - that is to say the way in which technical objects participate integrally in the constitution of our culture and of the world in which we live. We therefore need to rigorously respect the categories that the actors use to describe their own situation, and to follow them step by step in their work of producing differences. This principle will be our central guide in our attempt to "historicize" the case we look at below. We suggest that the reader enters directly into the subject, without worrying for the moment about the representivity of the case. This way s/he will avoid deciding the ins and outs of the story too early and will be as far as possible in the same position of uncertainty that we have adopted as our principle[1].

The framework of the Buena Vista Project

Preliminaries

Unlike the many projects for transferring energy technology to developing countries that have been more or less parachuted in according to the "political" exigencies of the donor country, the Buena Vista project resulted from a long-term process of cooperation, and operated according to carefully worked-out criteria. Thus it was not a prey to the chance outcomes of short-term projects. The plan was to give host countries the means of developing their own national energy policy. The idea was then to offer to implement pilot projects following the guidelines laid down in this phase of information collection and consideration of the various alternatives. This would allow them to test the fit between the new technology and the specific context of the countries they would operate in.

From the start, the program operated at a regional level. There were two aims. The first was to enable information pooling between the various Central American countries by establishing channels for exchange such as by organizing joint seminars. The second was to find a wide audience for the pilot projects carried out in a particular country, since this would facilitate their transfer to neighboring countries and make it easier to obtain funding from international banks. In order to bring the different Central American countries - at that time riven by national political

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1 I do not want to engage here in a discussion about the role of the sociologist, since the latter only discovers the role the actors assign him or her in a piecemeal fashion. I would like simply to point out the the sociologist cannot be considered as holding a privileged position. S/he is like a detective or a journalist, or even like a laboratory scientist (cf the findings of sociology of science).

problems - together, the AFME (Agence Française pour la Maîtrise de l'Energie) enrolled a regional partner, the OAS (Organization of American States). This latter took responsibility for liaison between the projects' various host countries.

The first goal of the program of cooperation was to gather in one place the relatively scattered available information about the environment, the socio-economic context and the organization of the agrarian system. The idea was to come up with a diagnosis of energy problems, which could be used when in the planning and implementation of actual projects. In fact, in all the countries involved in the program, these studies encouraged the accumulation of knowledge in the field and fostered the widespread adoption of several energy planning tools.

The idea of experimenting with a gazogene in the context of rural electrification came from two observations. These were the existence in several regions of unused forest potential and the fact that at the same time there were in these regions, and doubtless would continue to be for many years to come, a host of non-electrified villages. However, the decision about the actual implementation and the site of this experiment was taken by the French part of the program even before the Costa Rican partners could consider the question of the opportunities presented by such a project[1]. The village chosen, Buena Vista (1938 inhabitants), met a certain number of criteria[2]:

- easy access from San Rafael de Guatuso, a large town and "municipal" center, with various advantages (electricity, telephone, tarred roads to the capital, San Jose, and so on);
- existence of a demand for electrical energy prior to the development of the project (there was already a generator supplying a group of houses);
- location of abundant biomass resources nearby;
- existence of a very active Association for Integral Development (AID)[3];

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1 The very detailed report put out by the OAS contains a complete chronology of all relevant events. We draw on it in this report. This chronology is in the form of a table with three columns - date, activity and comments. Opposite the announcement of the French decision to finance the operation, one finds this comment: "equipment bought before the project was fully discussed". This remark indicates the Costa Rican feeling that things were rushed.

""Planta de generacion electrica con gasification de leña en Buena Vista de Guatuso, proyecto piloto", informe final, Proyecto Plurinacional de Cooperación Técnica, Producción de Energía y Alimentos en el Istmo Centroamericano, Janvier 87.

2 It is difficult to know now whether these criteria were elaborated before the choice of the village, or if they are an a posteriori rationalization of a choice made for a different reason. In particular, it has been suggested that political pressure by some inhabitants of the village was the main determinant of the decision. We favour a compromise between these two solutions - that is to say that Buena Vista had some natural advantages over other villages, and that political influence might have finally tipped the scale in its favor.

3 The "administrative network" in Costa Rica is still fairly tenuous. The municipalities, which represent smaller units within this organization, nonetheless cover wide areas. The AID's, which are a

- relative distance from the central electricity network;
- village not included in the second plan for rural electrification;
- representative of other villages in the region and the country.

Enrolling the Actors

In March 1985, six months after the first site identification mission and three months after the decision to carry out the experiment, the gazogene - bought for Buena Vista by the AFME - set sail for Costa Rica. When this was announced, hasty measures were taken in that country. A commission was set up to supervise the project. This included representatives of several institutions: OEA-France, the Costa Rican Electricity Institute (CREI), the Forestry Commission (FC) and the Regional Energy Secretariat (RES). This latter presided over the new, "Buena Vista", commission.

The **RES** housed the permanent secretariat of the Energy Council, which was the body that managed the negotiations between the various actors in the energy field (Ministry of Energy, electricity companies, petrol companies etc.). It was also charged with managing coordination within those projects that required the intervention of several institutions (whether energy-related or not). Given the scope of its activity, it was chosen to coordinate the whole "OEA-France" program, from the pilot studies up to the Buena Vista project.

From the **FC**'s point of view, the protection and maintenance of the potential of the forests - considered throughout Central America to be a national priority - entailed its exploitation for productive purposes. The gazogene was one of the various schemes for making economic use of the forest. With respect to the Buena Vista project, the FC's task was to provide expertise for everything to do with this resource. It evaluated the potential value of the forests in the region and current wood use, set up the planting program, chose the species to be planted and gave the villagers seedlings to plant.

At first, the **CREI**'s[1] contribution to the "Buena Vista" commission was its technical expertise in constructing networks. It was asked to install a network which would provide the villagers with the electricity produced by the gazogene. There was a problem, in that the budget that France had allotted for the project did not include the funding of this operation. Under pressure from its partners, the CREI finally, unwillingly, agreed to finance the network out its own funds.

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national federation, were therefore given official encouragement with a view to supporting the development of smaller-scale projects at the village or hamlet level.

1 The CREI holds a semi-monopoly of electricity production - it accounts for 90%. Distribution is undertaken by 7 different companies, of whom by far the most important is a 95% CREI-owned subsidiary. A program of restructuring that has been under way for several years should lead to a complete integration of distribution within the CREI.

Once it had been set up, the commission made contact with the **AID**, the association which represented the village of Buena Vista, in order to set up procedures for following the project on the spot. In fact, at the time when these discussions began, the members of the commission already knew "everything" about the village, thanks to an enquiry that had provided a wealth of information about its climate, land use, population (age, origin, professional activity, income etc) and "energy" consumption. The report's authors noted the existence of significant conflicts within the village. They attributed these to the great disparity of socio-economic conditions. Aware of this fact, the commission hoped that electricity would act as a catalyst capable of defining a "general interest" which would marginalize these disagreements. But it took particular care that the village organization set up for the project would be able to keep the enthusiasm that the villagers had expressed at the idea of being given electricity alive.

It is interesting to note that at this stage, the only factors that were seen as possibly causing problems were social or economic - the technology itself was above suspicion. The project's technical definition was produced in France, without there being any active information transfer between the two countries (with the exception of an estimation of demand, from which they deduced the equipment's requisite power).

The installation of the gazogene: first technical hitches

The gazogene arrived in Costa Rica in May 1985. While the customs formalities were being completed, the CREI undertook construction of the network. No budget had been set aside to cover the costs of the plant's installation. The OAS released an emergency fund and oversaw the operation:

> *The machine came too soon. It was put in a field, and we had to build a shed around it. People weren't prepared. In October 1986, the motor got stuck in the mud! That shouldn't have happened. All this because no budget had been set aside!*

On June 3, the manufacturer's representative carried out some tests and set the installation going. It was inaugurated by the Costarican Minister of Energy on June 7. When he returned to France two days later, he left behind him a non-functioning plant. It became apparent right away that the gazogene could not operate with the wood being supplied, because of its high degree of humidity (40%-50%). There were two possible ways of resolving this problem. They could modify the gazogene so as to render it compatible with local operating conditions or modify the wood so as to render it compatible with the French gazogene. The first possibility was never seriously considered - a priori, the construction of a wood drier constituted a simple solution to this unexpected difficulty. We should note that this unexpectedness was a result of the strict separation of tasks between the actors in the two countries. The Costa Ricans had carried out a very complete survey of the geographical and social milieu in which the gazogene had to operate. In particular, they had collected information about the climate which should have put a flea in the ear of those responsible for the project's technical definition. We will return below to the question

of how the technology achieved the status of being above suspicion of failure and a priori applicable everywhere.

A first drier was built, but it did not work and it was followed by a second model, which began service in December 1985 - six months after the inauguration. Unfortunately, this was only a provisional stage along the path to getting the plant going. There was a continual succession of problems, until the project stabilized to some degree in the last three months of 1986. The different partners engaged in the process believed that the gazogene had finally become operational. Around this time, the experiment's so-called "final" report was written. Although they remained cautious, its authors displayed some degree of optimism. They continued their retrospective chronology (which went up to November 1986) with a prospective chronology predicting the construction of a furniture factory in February 1987 using energy from the plant, and the end of technical surveillance of the project in June 1987. Given the abundance of problems that cropped up in 1987, the furniture factory was pushed back to April 1988 at the earliest. At the time that we carried out this study, the Costa Rican actors seemed to be overcome by a lassitude. Two and a half years after its installation, the plant's operation remained hit and miss.

At first, there was a fair degree of consensus about the project for gasifying Buena Vista (a consensus that was arrived at, it is true, under the pressure of events). The "environment" seemed to be known - it had been analyzed in numerous studies. The technology seemed to be workable. The gazogene's installation and the various attempts to make it work confronted the promoters of a well-designed project buttressed by scientific knowledge and official support with a confused and profoundly disconcerting reality. As one of the project workers in Costa Rica said:

> ***We couldn't get on top of anything to do with the technology, or the village, or people's reactions*** [1]*: for example, as soon as we changed something in the installation, that changed other things all over the place, because it was a whole. There were times when I had to fight to convince people not to change anything else, and to say to them: "that should work as it is"* [2]*.*

The Buena Vista story can be seen as one of the impossibility of forging permanent links between the various technical elements, and between the people and the technology. The form of the OEA report is eloquent: its very size - it is much longer than those normally submitted - translates the non-summarizable nature of the project, and the attention that was paid to each detail must be interpreted as a consequence of the actors' inability to decide between different possible "versions", to decide what was important and what was not. As for any "official enquiry", they needed to compile as much information as possible in order to reach their decision (which in

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1 Our stress. It is significant that these were almost the first words our interviewee spoke to us.

2 OEA

fact they constantly postponed making) transforming some into damning evidence and eliminating irrelevancies etc.

In fact, in the face of the difficulty in finding out what actually happened, the various protagonists ended up little by little developing their own interpretations of what happened. These allowed them to put a little bit of order and reason into the crazy turn of events. In an uncertain situation, each of them could fall back on these positions, present their version of the facts as the only true one, and as much as say that no-one had the right to deprive them of it! In this kind of situation, the sociologist faces an arduous task. S/he has to untangle the mess without adding one more accusation to those that the actors have already made. And at the same time, this is what makes the Buena Vista project exemplary. What happens when nothing stands in the way of an interpretative frenzy? How far can we go in looking for new witnesses or suspects? The case of Buena Vista demonstrates if we want to follow through a "simple" technological project we have to go a long way. The villagers' identity is at stake. Are they to remain rural or become city dwellers? So is the CREI's policies, and the definition of "public service". Given this propagation of causal chains in all directions, we have decided on a "centrifugal" presentation, that is to say one starting from as close to the machine as possible and working out. It will go from the "internal" or technical relationships between causes to those associated with technology and the "local society" (that is to say the actors explicitly involved in the project) and finally to "general" causal explanations, which describe the events from the viewpoint the macro-actors concerned and which relate to the general political scene. At each stage along the way, we will thus be able to pose our initial question - that of the forms of interaction between technical objects and social actors. And we will follow these latter in their efforts to stabilize the relationships between themselves and with the machine.

First level of interpretation: proliferation of the gazogene

The chronology: modifications to the gazogene

We have already seen that the first problems met with in getting the gazogene working were attributed to a single cause: the wood's degree of humidity. However, far from closing the debate, this explanation merely set it going. The patient could not so easily be encapsulated in the narrow definition of its functional disorders that the doctors tried to impose. Specialists trooped past its bedside, each one uncovering new symptoms, proposing new remedies which each in turn proved to be as useless as the one that came before. Faced with a recalcitrant disease whose origin they did not know, the "relatives" came to wonder whether it was all perhaps the fault of the "environment". We will see this in the second part of our presentation. But first of all we have to be able to understand how they "got into this mess".

Simplified chronology (adapted from the OEA report)[1]

June '85 Inauguration on the 6th. The gazogene does not work; the wood's humidity is blamed.

August '85 A drying oven[2] is built.

Oct. '85 Despite the oven, a number of operational problems persist. *Cavities* develop in the gazogene - that is to say, the carbonized wood accumulates above the hearth, creating a vault, and this prevents wood from descending from above, and so prevents combustion and thus gas production. Further, there are *problems in lighting* and an *instability in the frequency* of the current distributed and various *problems in the distribution network*.

Nov. '85 Since its installation five months earlier, the gazogene has been in operation for 150 hours, the motor for 50 hours, and there has been electricity for 10 hours. During his visit to the plant, the manufacturer's engineer introduces a certain number of modifications: changing the cone and heatproof cement, repairing the doors, installing a wood-level monitor and modifying the lighting system.

Further, France supplies various extra items of equipment which had been lacking: a tool box, an electric saw for sawing the wood into pieces of the right size for the gazogene, a hygrometer (for measuring the humidity), a battery recharger.

Dec. '85 A new drying oven is constructed. Being more powerful, it enables the complete curing of 30 kilograms of wood per hour (as opposed to 70 to 100 kilograms/24 hours before) and makes fewer demands on the operator.

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[1] It should be noted that this chronology was drawn up at the time of the report's drafting, that is to say well after the events that it dates and discusses. Furthermore, the person involved insists on the difficult of the task, given that like any historian he had to juggle with heterogeneous sources (notes, letters, reports, personal recollections). Here we are witnessing a process in which history takes shape, and this process can only intervene when the set of events and interpretations to which they have given rise form a meaningful set. There is an a posteriori rationalization involved in ordering what was at the time merely sound and fury. "Logically" (with respect to our tenets) we should have presented this chronology at the end of the piece, as De Certeau did in his book La possession de Loudon (Collection Archives, Gallimard, 1980), which gives us a biography of Jean of the Angels, one of the principal protagonists of the story of the possession, as a conclusion to the book, as a result of the history and not as an explanation of it. While accepting this, we are in a different position to the extent that we do not have access to the whole range of material (the act of archiving is not so closely linked in the present case to the story itself) and that we have no other way of showing the reader the complexity and the confusion of events that took place than by reproducing the narrative of some of the actors - whose goal, moreover, was identical with our own.

[2] The terms underlined represent new technical elements brought into play, or suggested or actual modifications. The terms in italics represent symptoms identified by experts or the plant's operators.

Jan. '86 During this month, the motor works for 173 hours, but subscribers only receive 25 hours of electricity; there are frequent power cuts. In light of the various difficulties encountered, the project's commission had in December sought the opinion of two groups of Costa Rican experts. Their reports come out in January.

The first group says that the *motor* is *dirty, the lighting timer not regulated* and the *electronic command difficult to adjust*; they suggest regulating the incoming air flow.

The second group discovers *lighting problems, frequency oscillations, sudden losses in power of the motor*. With respect to gas production and filtration, they note the *formation of cavities* and *major kinks in the filtration chain*.

Feb. '86 The plant operates for 66 hours and produces 500 kWh. There are many difficulties: *major kinks* and *excessive heating of the filter chain, the motor breaking down, large frequency oscillations*. The project's commission requests France to send a team to evaluate the installation.

March '86 A French engineer (who has been working in Polynesia on new forms of energy) comes to carry out the evaluation requested.

His diagnosis comes down to three central points: 1) the plant is not in proper operating condition *(very dirty filtration chain and motor)*, 2) various *incorrect operating and maintenance procedures* are followed, 3) Certain modifications and repairs are needed before restarting the plant.

From the basis of this analysis, he sets out a certain number of recommendations: improved recovery of pyroligneous fluid, installing an interchangeable cone without heatproof cement, adjustment of the furnace door, exhaust valves on the exit pipes, doors for filter maintenance, measures be taken to prevent motor going too fast, installing a gas purity monitor on the entry collector, appropriate reconstruction of the hearth, improved drying of the wood, installation of resistors to increase the charge and to ensure operation at a minimum of between 15 and 20 kw[1], improving the security conditions of the operators, obtaining missing documentation from the manufacturer.

April '86 The commission meets and agrees to a certain number of modifications and adjustments.

May '86 Translation of the operating and maintenance manual written by the French expert during his trip.

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1 The villagers only need between 8 and 10 kW, but this makes the plant operate too far below its normal level; further, the charge varies enormously, and this is prejudicial to the installation's functioning.

June '86 On the manufacturer's initiative, one of his technicians comes to Buena Vista. He installs a modified hearth and carries out the modifications and tests the equipment. After he leaves, the problem of the *instability of the generator's voltage* persists (it had cropped up during earlier tests). The CREI undertakes to resolve this problem. It installs a backup generator.

Aug. '86 The problem with the voltage stems from the *regulator*, which is changed.

Sept. '86 Visit from one of the manufacturer's technicians, to oversee the training of local technicians and to carry out new tests and supervise the "final start up" of the gazogene (an *incident with a damaged lighting circuit*).

Oct. '86 The distributor is changed.

In order to complete this chronology, we should mention that 1987 was peppered by further incidents (problems with the motor and the control panel, the alternator "burning out") and by further modifications consequent on an evaluation by a second French expert (in particular changing of a filter, setting up control mechanisms for detecting the encrustation of filters). The following anecdote gives a clear indication of the state of uncertainty of the various technicians who were managing the project. In October the CREI, which came in to repair the gazogene, took out the motor's cylinder head, and since it was severely encrusted took oil samples. The analysis produced astonishing results: the oil was composed 70% of tars, 5% of ashes, and had a pH of 5. All the technicians concerned were dumbfounded, but did not deny that such results were possible. Thus, for example, one from the CREI commented:

> *This is the first time that we have analyzed the Buena Vista oil. Perhaps a pH of 5 and 70% tar are normal for motors fueled by a gazogene. But this is the first that we know about it We have no experience, and nor does the manufacturer, in my opinion. Maybe it's normal.*

The French expert thought that these figures were insane:

> *The figures they have given me are incredible. I had a telex saying that there was 70% tar in the motor's oil - that is impossible. In one fairly pathological case we took samples from a motor which had been operating for 100 hours and found 0.80% tar. Already at this level viscosity is clearly affected. That is why I wrote them to get confirmation, because I thought that it was 0.70%, which is already high enough to be a problem - I thought they had forgotten the decimal point. They maintained their figure. I don't know, I've never seen anything like it. What I'd give to see oil with 70% tar!*

This is where we are, then, three years after the gazogene's installation. We are in a state of complete disarray, to the point where the technicians are incapable of judging the likelihood of an analysis, and of discriminating between the normal operations of the machine and a simple

measurement error. Contrary to what is generally the case when an experiment gives abnormal results (by a factor of 100!)[1], it is easier here to blame the machine than the technician who performed the analysis. The chronology brings out a clear disproportion between the proliferation of symptoms and the relative lack of an interpretative framework for finding their exact causes. This highlights the fact that this episode occurred after a long series of erratic diagnoses that left the Costa Ricans completely uncertain, to the point where they doubted the most basic facts when trying to apply them to this "infernal" technology.

Diagnostic difficulties: the bottleneck in the attribution of causes

The very fact of not succeeding in establishing a reliable and stable diagnosis was an extremely strange experience for the actors, and it must be looked at in detail. Overall, the various Costa Ricans involved came to the same conclusion. For them, the Buena Vista gazogene was not "technological" in the sense of comprising a series of mechanisms whose interrelationships were ordered and stable. This same idea, however, was interpreted differently according to the type of competence brought to bear.

For the villagers, there was something almost diabolical about this machine, which succeeded in undoing all the predictions and ridiculing the specialists. One of them gives the following humorous account:

> *I haven't really made up my mind: there is something here beyond human ken. The other day they took out the cylinder head ("cabezote"). But they couldn't see exactly what the problem was. The next time it will be something else. The 'cabezon'!*

A 'cabezon' is a stubborn person, someone pigheaded - and this is a fair description of the villagers' perception of machine's obstinate persistency in breaking down.

The OAS representative's interpretation was not very far from that of the villagers. Thus, for example, he gave the following account of a problem with the lighting system. The manufacturer's technician had been in Buena Vista for two weeks. On the last day of his tour of duty, he realized that the connecting part, which had been there since the installation had begun operation, was bent out of shape and that this deformation was the cause of a lot of the problems. The piece was replaced, but began immediately to get bent out of shape again for no apparent reason. No-one could explain this strange phenomenon.

Elsewhere, he proposed a slightly different interpretation, one which involves the manufacturer's very human know-how - which being non-formalizable into procedures as should

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[1] The CREI engineers were perfectly well aware of how far this was from the norm. They were used to working with diesel motors - indeed this was one of their basic duties.

be the case for reliable technology, was not transmissible. It was not a case of "magic", but rather artisanry. A feat of dexterity did the trick. Unfortunately, given that such skills are not easily verbalizable, they entail a long period of apprenticeship and patient observation. This was not possible in the context of the technicians' short tours of duty:

> *Something rather amusing happened with the French specialists who came. They came, stayed for a while, and the machine worked. The day after they left, the machine would stop again. It was like that every time. Doubtless there was some little thing that the French did which stopped the machine from breaking down, but either they did not communicate it to the technicians or the technicians could not learn it.*[1]

The CREI engineers had a more "technocratic" viewpoint[2]. For them, there had been a misjudgment about the technology's stage of development. The gazogene was still in fact at the R&D level, and should not have been distributed as a mature technology. As a result, it seemed to them essential that further research be carried out and experience accumulated. Only at this price, they believed, would they succeed in some day controlling this infernal machine.

Implicating the Actors [3]

We should stress that various attempts were made to give a functional description of the gazogene. During his visit, the first of the two French experts wrote a manual describing the operation and maintenance of the machine which ran to no less than 50 pages. It gives details of the general working of the installation, the analysis of symptoms, the methods for attributing these symptoms to technical causes, procedures to observe in order to remedy the observed malfunction, and finally a timetable of the various checking and maintenance procedures to follow. This document was in fact adapted from a similar manual written for the Bora-Bora gazogene in Polynesia, a gazogene which had been constructed by a different firm from the Buena Vista one.

The OAS report includes a table of "*causes, consequences and corrections of the principal operating problems* [4]". This table, which attempts to summarize the manual's information, has four

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1 OAS

2 One which was echoed, moreover, by many institutional actors including the OAS. This point of view rejects all the other kinds of interpretation given. Caught between the French and the Costa Ricans they "globalize" Costa Rica, as it were.

3 In the French original, to call into question is "mettre en cause", and there is a play in this title and throughout the article which we can perhaps render in English with "implication", which holds the double sense of accusation and the relationship between cause and effect. (Translator's note).

4 The italics signify that these are terms actually used in the report.

columns. These are, from left to right, problem, cause, consequence, correction. In fact, if we put ourselves in the position of an operator confronted with some breakdown or other, the table reads non-linearly. What is "seen" (whether as a result of direct experience - such as not being able to start the motor, or reading an instrument - such as finding the gas to be at too high a temperature) comes under *consequences* in the table. From there, he can work his way back to the *problem* (which is, in fact, the cause of the *consequence*). The *problem* is in some sense what the machine "sees" locally[1]. Next, he goes back to the *cause,* that is to say what has led to the sequence of effects "perceived" by the machine and then by the operator. Finally, *correction* consists quite simply of suppressing the *cause.*

We can make three remarks about this table:

- The table's non-linearity for the operator is incomprehensible, or at least very strange. The overall organization becomes clear when one realizes that the table was written not from the point of view of an actor put into a position like that of the operator, but from the point of view of the machine itself. In fact as soon as we put them in their correct perspective, the table's various columns follow logically from left to right. As we have said, the left-hand column, problem, describes anomalies perceived locally by the machine (a cavity in the hearth, tars etc). It is followed by the column cause, which represents the problem's "local" reason, that is to say the reason which is internal to the machine (the wood is too humid, for example). Next we find the consequence, which is, as we have said, the surface manifestation visible to the operator. Finally, there is the correction, which takes the form of an injunction to the operator to suppress the local cause that is disturbing the machine.

- The causes of a single problem which induce the same consequence can be diverse and highly heterogeneous. For example, the clogging up of the motor or of the chain of filters stems from the existence of tars produced during gasification. These tars may be due to over-humid wood (the resource), insufficient electrical tension (the village), or to faulty construction of the hearth (the machine) - "for example, wood instead of carbon in the hearth[2], or a space between the grill and the partially or totally empty hearth ...".

- Finally, a single consequence (impossible to start the motor, for example) may be due to several distinct problems with different causes. In the case of the motor that does not start, there

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1 To give some examples, we find in the "problem" column such elements as the "formation of cavities in the hearth", "production of tars", "production of scoria", "overheating of the filter chain" etc. These represent local phenomena "perceived" by the machine in the sense that they induce "abnormal" behavior in it. This behavior in turn leads to "surface" manifestations which the operator can see. It may be that the "problem" becomes visible directly via a measuring tool. This is the case for the existence of a kink in one or several of the filters - this can be read on a manometer (we will see below that in fact the manometers that were chosen did not render anything visible, but this "detail" was unknown when the manual was written).

2 That is to say that pre-combustion is incomplete.

might be a door or valve that has not closed properly, a hole in the generator or in a filter, too much ash in the filtering stones, a dirty metal grid in the expansion chamber, the pipes between the gas generator and the expansion chamber might be partially clogged, the hearth might be clogged with scoria, the water level in the cork filter might be too high, the cork filter might be dirty, the micronic paper or the foam in the last filter might be dirty, the motor's spark plugs blocked, the platinum screws may have snapped, or the firing mechanism be off. From this, it follows that even the most complete attempts at rationalization leave the installation's messages to its operator profoundly ambiguous. These messages might mean so many things that they remain uninterpretable without further decoding.

We have given a long list of possible *causes* for the motor's failing to start. On perusing them, we might ask the following question: what are the "final" causes? Why do we not go on and ask why the filters are dirty, or the spark plugs clogged or a door badly closed? The answer to this question is given elsewhere, in the maintenance manual. Each final cause can be attached to an item of operation or maintenance covered there[1], and in some sense is its negative image. The operating and maintenance manual as a whole constitutes a description of the normal and necessary relationships between operator and machine, both being assumed to be "honest". In other words, these manuals can be read as a contract that the machine and the operator have signed. The operator does what s/he is supposed to do and in exchange, the machine will do the work it was designed for. From this point of view, the fact of making the kind of diagnosis that the table just analyzed does amounts to the machine accusing the operator of voluntarily or involuntarily having not fulfilled his or her part of the bargain, there being no distinction made between careless mistakes, stupidity and bad intentions.

Moreover, this interpretation is confirmed by the last line of the table, which at first sight appears very strange. If we take the left hand column, *problem,* and read down, we have in turn:
production of tars
entry of air into the system
low quality gas
regulator of mixture admission off
etc..

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1 Even the "hole in the gas generator or one of the filters", which might appear mysterious to the neophyte, can be found in the table along from the corrective measure: "perform regular mechanical maintenance". This total homogeneity of the "causes" is an amazing limiting case. In general (and you only need to look at a car's maintenance manual to convince yourself) the attribution of responsibility is much more symmetrical. It is assumed, for example, that a piece can be broken without there being any maintenance flaw. It is implicit that the length of life of a given item depends on too many independent and uncontrollable factors for it to be worth the trouble of prescribing a replacement operation before the thing itself gives some signal. No-one would change their starter motor, alternator or battery before they had serious problems with them. It is the fact of breaking down itself that enables a consensus to be arrived at between specialist and user, the latter often suspecting the former of "forcing" him or her to consume.

and in the last line:
operators insufficiently or badly trained.

This *problem* is put down to the *cause* "badly designed training" which has as its *consequence* "bad operating procedures, an incapacity to analyze and repair breakdowns, and bad maintenance procedures (frequency, nature)". The first thing to note is that this last analytical series is "signed" differently from the preceding ones. In effect, the machine cannot see, as in the other cases, the *problem* (badly trained operators). It only sees what is considered to be the *consequence* (bad operating procedures). Thus here we have a reversal of the perspective, very probably due to the authors of the report's using different manuals, written by experts. It is as if having realized the accusatory nature of the work of formalizing diagnostic methods, they wanted to pull their punch at the very end. Even if all breakdowns and malfunctions are due to operator error or negligence, these latter are not moral faults since they are non-intentional. They are the simply the outcome of lack of a suitable training which would allow the operator to tell Good from Evil, correct procedures from incorrect ones.

With this table, which a priori appears to be an atemporal, delocalized analysis of the gazogene, the OAS discretely invites the reader to reinterpret Buena Vista's history. If there are both recurrent breakdowns and diagnostic methods that aim to discover the fault underlying the symptom, then the operator is always to blame. The OAS does not contest these facts, but exculpates the operator by accusing the educators.

Conclusion

Taking all the preceding events as a whole, we see two distinct lines of interpretation emerging. Each tries to account for the problems met with in getting the installation to operate normally. The first criticizes the technology, which had not reached a stage of development where it could be called "viable", whether we interpret this in the classical sense of the term or in the sense of the confidence that one could have in one's communications with it. It seems as if the technicians were confronted with a wild animal, and were given the job of taming it. This taming involved knowing the animal's "predictable" reactions, its "likes", "dislikes", language etc. This knowledge, accumulated by research, led to setting up mechanisms for making the animal do what you wanted - to "trick" it, before it tricked you.

The second kind of interpretation takes the animal's side and accepts its definition of the masters as clumsy or negligent - whether these attributes are inherent to the masters or a product of their incomplete training.

This second explanation is chronologically anterior to the first. We might hypothesize that it was as a result of a completed training cycle being judged satisfactory by all the actors that manuals were written detailing the installation's functioning and maintenance procedures. The fact that these diverse measures had no definitive effect on the installation's behavior led the engineers to

think that the machine did not give them a "fair chance" as it should have done. Thus further research had to be done before it could be tamed. Since it does not respond to our kindness, let us be more "cunning" than it. The French etymology is useful here, since it brings out the similarity between 'to be cunning' ('ruser') and 'to challenge' (récuser). Originally, the term 'ruser' was used in game hunting to describe the behavior of an animal which changes direction so as to outwit its hunters. That is to say, it manages to falsify any interpretation of its movements by proceeding in a disordered, unpredictable, fashion. It encourages effects to be attributed to some one cause, and then hastens to prove the attribution wrong. To be more cunning (rusé) than the machine means giving oneself ways to challenge (récuser) it - that is to say to get around its accusations by substituting internal causes. There are two possible outcomes to this procedure. Either one can succeed in understanding the animal's actions and thus get it under control, or one concludes that it has an incurable fault which will always render it untamable (unless the flaw can be located in an organ which can then be amputated, thereby changing the nature of the beast). In this latter case, one is in the world of "genetics" - the cause of the machine's technical nature lies in its conception. In the same breath, one opens the way to a new series of accusations, this time of the gazogene's manufacturer.

Three years after the gazogene's installation, all attempts to bring it to reason had proved infertile. People were acted on by the machine more than they acted on it. Given the failure to locate an internal flaw, there was only one possibility - to avoid going crazy one had to look beyond the machine for the guilty party.

Second level of interpretation: the localized social

Essentially, two different paths were followed in this search for external causes. The first was merely a continuation of the path that had been indicated by the machine's designation of the faults committed by those who interacted with it. The second turned towards genetics, and put the whole thing onto the manufacturer, who was accused of being the root cause of the machine's problems.

Which of these two interpretations were chosen depended directly on the position of the actors in question in the project. In theory, the final project set-up left the village (as organizer and consumer) confronted by the CREI (as technical operator). Theoretically, all the other actors should have disappeared from the scene over time. They were only a chain of intermediaries enabling this confrontation to take place by starting electrical production. Today they are still actively trying to disengage from the battle front, without completely succeeding, since the CREI's and the villagers' interest is constantly in danger of being lost as a result of the gazogene's failures. On one side we have the CREI and the village, which are in daily confrontation with each other, and blame each other. On the other side, there is the French section of the project made up of the AFME (which organized the project) and the manufacturer. These two occupy symmetrical positions in the heroic attempt to locate responsibility. The OAS and the RES occupy an

intermediary position between these two groups of actors - intermediary in every sense of the term. They act as relay between the two while at the same time giving a weakened version of the two accusatory modes - that is to say, they nuance interpretations judged too severe, without really exonerating anyone.

Accusation as interpretation: the confrontation between the CREI and the village

The CREI as seen by the village

Before plunging into the details of the quarrel, we should give some overview of the organization that was set up, so that the reader can see what was at stake. The village, represented by the AID (Association for Integral Development) was supposed to manage the daily operation of the plant. That is to say it had to organize the collection of wood. It had to pay an operator (an inhabitant of the village), who took care of all the operations essential to its functioning (preparation and curing of the wood, starting the plant up, checking its operation, shutting it off, and daily maintenance). It had to employ someone to read the meters that have been installed in each dwelling hooked up to the network, to calculate the bills and ensure their collection, and to pay for any fuel which might be needed if the gazogene broke down. The charges were calculated so as to guarantee the financial equilibrium of the AID, by maximizing returns without discouraging consumers by too high prices. In order to do so, charges were based on studies of household income and energy budgets before electrification. Two further principles apart from balancing the budget guided pricing policy: 1) poorer households should not pay more for their electricity than they paid for the same functions before electrification; 2) more wealthy households which were already connected to the mini-network fed by a generator should gain from the use of the gazogene[1]. The idea was to avoid generating further social conflict to what was already there with the pricing system. For this, it was essential that everybody be "accounted for". This system of charges was explained at a public meeting and discussed there. It seems to have been fairly successful in meeting its aims, since no-one had any particular complaints about it. Only one point was contested: the relationship between the local price of electricity and national prices. We will come back to this point below.

The AID was in a twofold relationship with the villagers. It was a "producer", in the sense that it was responsible for providing electricity (this was the object of a tacit contract with consumers in

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1 This procedure led to a very progressive system of charges, with two fixed monthly charges for two consumption thresholds and then a series of consumption levels for which the cost of the kWh increased with consumption.

the form in particular of the system of charges). But it was also the villagers' political representative in their dealings with the outside world[1].

When the plant was not working, the AID could bill consumers, since the meters were not ticking over. It had, however, to continue to pay the operator's salary. It could bring in an emergency diesel generator, but this operation could not help in balancing its budget. The cost of the kWh produced by the diesel generator was twice as high as that from the gazogene, whilst the charges did not take into account the way in which the energy provided was produced. Every day without electricity production from the gazogene, the AID therefore lost money and started to move into the red - not to mention having to deal with the users' discontent at having no lights.

The role of the CREI was to guarantee, free of charge, the heavy maintenance of the plant and to carry out those repairs which the village operator could not deal with. In this context, it is not very surprizing that most of the anger resulting from the plant's malfunctioning was directed at the CREI. Each micro-event served to nourish resentment, and allowed a new, conflictual, interpretation to be made of what had gone on before. This spiralling movement was described by one of the inhabitants of the village who was particularly involved in AID affairs:

> *From the start, little things have happened which showed that something was going wrong. And then, these little things became bigger and bigger and were transformed into a hydra which is attacking us - the CREI. We were cheated ...*

The lack of respect that the CREI showed for its engagements constitutes the first reason for recriminations. "Big men" from the CREI arrived and "with a lot of ceremony" signed the convention that defined their obligations, but:

> *When it came to doing the work, the CREI mechanics, their "muchachos", never showed up. That is what caused our problems.*

There were several interpretations made of the CREI's failure to come through. One of them referred to its organizational structure. The CREI appeared to the villagers to be an enormous, very hierarchical institution, and this hierarchy induced a dissipation of power by "mechanical loss" as you went down the ranks. They accepted the good faith of the directors when they came to sign the agreement, but they learned the bitter lesson of the directors' inability to filter their message down to the base.

Further, they were confronted by the "technical" problem of finding who to talk to as a function of the type of breakdown that had occurred. In the classical electricity network, the technically sustained separation between production and distribution is inscribed in the structure of the enterprise that manages electricity: production and distribution services are virtually unrelated and

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1 Each inhabitant has the right to be a member (if they have paid the minimal subscription fee) and its directors are elected at a general assembly.

the average consumer generally only deals with the latter. In Buena Vista, production and distribution equipment were located in the same place. And only one actor, the village, could signal the alarm in the case of a breakdown - and then they had to deal not with the CREI as a whole, but with the its relevant internal service.

A "lack of interest" in this kind of project constitutes the second kind of argument the villagers put forward in order to explain what they considered the CREI's default on their agreement. More than anything else, they accused it of having lost their good faith - they say were initially enthusiastic, consensual and unreserved in their support.

> *What we have heard from the CREI since the beginning is:"Why do you believe in this thing? It hasn't been tested. They are trying it out here, experimenting". These are depressing things to say. What I say is that I can't prove it. Because if you ask someone, he will deny he ever said it. They said "Keep it to yourself. Don't tell anyone". I think that they wanted to say that only they could provide lighting, That theirs was the only good technology. At the start, they didn't want to participate. It costs a lot of money to construct a network. The project didn't interest them.*

These two attributions of blame, lack of interest and failing to honor agreements, are symmetrically opposed to the villagers' good faith and their ardor for the project. Hearing the villagers talk, you would think that they had believed deeply in the solution that had been proposed - viz that they were the "elect" of all the villages and would usher in the rural world to come. They did not spare any effort - organizing the community, offering their work and their money to construct the shed which would house the plant, preparing holes into which the CREI had merely to insert their stakes etc. They thought that the CREI had not lived up to their part of the bargain - the CREI had dismissed their ambitions right away. Their "ideals" were confronted with egotistical material interest and misappropriation. Little accustomed to the city-dwellers' and salaried workers' way of life, they took umbrage when the CREI technicians asked for receipts for their drinks or their telephone calls: "Imagine that! They didn't come here for nothing". In short, they accused the CREI of having only shown what consideration they did as a result of the mobilization of other interests: the reimbursement of expenses, the possibility of a trip to France[1], or threats of sanctions. The kind of interests that they saw at work and that bothered them were particularly apparent when there were problems with the distribution network:

> *For three months, we had been having problems with the network. One day, one half of the village was cut off, the next day it was the other half. As soon as it started up, one half or the other would go. One day, there was a meeting with the National Apprenticeship Institute. The engineer who had carried out the feasibility study was there, along with people from the OAS and the RES. They wanted to see the*

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[1] For a while there Costa Ricans were sent to France for training. The CREI technicians went first, to the great annoyance of the villagers, who thought that the plant's operator should take priority.

network in action. The next morning, the CREI came to repair the network. We had lights for 20 minutes, Then there was another breakdown. The meeting had to be stopped. They saw that it was not working. They had their demonstration to do. So the RES engineer phoned and got someone to come and fix it properly. He carried more weight than us. There was a faulty connection. It was really easy to see the problem.

The illusion of democracy faltered. The villagers discovered, or feigned to discover, that although all citizens are equal, some are more equal than others. We will come back to this point below.

More prosaically, they accused the CREI of getting involved in village matters, and in so doing of denying the AID's competency and legitimacy. In particular, the CREI shied away from the policing duties that the AID wanted them to perform and that they should have performed. Two families had never paid their electricity bills. For the AID, it was clear that their meters should be taken out. But the meters belonged to the CREI, and it was formally forbidden for the villagers to touch them. Despite reiterated demands by the AID, the CREI did not cut off the miscreant subscribers. According to the AID, this negligence had serious consequences, since it threatened the supposed solidarity of the village. Little by little, shocked by the lack of penalty applied to the non-payers and feeling justified in their attitude by the poor quality of the service, the other subscribers refused to pay their bills.

Let us look at the role of the meter. Normally, it constitutes in some sense both the material inscription and the arbiter of the contract drawn up between producer and consumer. If the producer fails to meet its obligations, the consumer is safe in the knowledge that the meter will not tick over. In the inverse case, the producer can disconnect the meter. Dispossessing the producer of its control over the meter means annulling one of the clauses in the contract (meter disconnected in case of non-payment). The relationship between the two contracting parties then becomes very unequal. The only response to the consumers' act of violence is a return act of violence - cutting off production. For the AID this entails the renunciation of two other contracts, the one linking the operator to the plant, and the other, "moral", one committing them with respect to the other groups that worked on the project (RES, OAS etc). The meter's mediation is only effective within a given mode of social organization. If only a part of its attributes appear in a particular instance, then it cannot work.

After the villagers have had their say, the CREI appears to be the main villain. It proved incapable of keeping the plant technically up to scratch, and compromised its social operation by refusing to play the part of a technical/moral operator. We will now look at the CREI, and see how it defended itself against the serious accusation made against it.

The village as seen by the CREI

We have seen that the CREI attributed part of its problems with the technology to the latter's insufficient maturity. This is not all that they had to say about the matter. The villagers' lack of motivation and solidarity compounded and reinforced these technical causes. The CREI's judgment seems to be all the more reasonable since it could draw on a comparison with other cases that had worked out differently. Several villages at their own request and on their own initiative had developed projects for decentralized electrification similar to Buena Vista's. They had a generator and a distribution network installed by the CREI. They took care of the day-to-day maintenance, of the generator's functioning, of subscriber billing and of the management of the budget for covering the working costs. For its part, the CREI took care of the heavy maintenance work and repairs to the installation.

If you take the CREI's word for it, there is the world of difference between Tortuguero, the showcase village of decentralized electrification, and Buena Vista. Their comparison is based on three main points: the degree of community solidarity, its motivation with respect to the goal of having electricity available and its taking responsibility for the plant and the problems that crop up or are part of its regular operation. In Tortuguero, there was active village solidarity based on the struggle for electricity. This is still maintained and is demonstrated every day. There is no salaried operator there, the villagers themselves take turns in performing the necessary operations for the maintenance and functioning of the plant. In Buena Vista, there was only perpetual bickering manifested by the unkind words that the villagers had for each other overheard by outside witnesses (as it turns out the CREI agents). This is clear proof of the acute, open nature of the conflicts. This lack of solidarity was demonstrated as soon as things started to go less well than had been hoped. The subscribers' refusal to pay was interpreted by the CREI as proof of this lack of consensus. They thought that the village should have formed a united front to face a problem like not having electricity which by its nature was a collective one.

If the village did not succeed in overcoming its internal differences in order to obtain a collective good like electricity, this was because at base electricity was not a sufficiently valued goal. Otherwise, the villagers would have organized themselves to deal with the non-functioning gazogene and would have found, if necessary from outside sources[1], the money necessary for the extra cost of using the generator. The CREI for its part estimated that it had done more than

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[1] It is worth drawing attention to the difference between the way billing was done in the two villages. We have seen that in Buena Vista, meters governed the billing. In Tortuguero, the subscribers paid as a function of their equipment (so many lamps, a fridge, TV etc). This difference was interpreted by the CREI to be an indicator of the state of consensus. The Tortuguero villagers' solidarity is manifested by the high degree of confidence that a "fluid" billing system entails. Since the relationship between charges and functioning costs is explicit here and not secondary to considerations of social justice with a view to avoiding new conflicts in an already explosive situation, it is probably easier to adjust the prices with respect to the real production costs. Inversely, since the Buena Vista billing system is a "neutral" system around which there has to be consensus, to "throw it open" would mean de-neutralizing the thing holding the agreement together and would risk provoking its collapse.

was necessary in offering two back-up generators. The work that the community had agreed to do at the start in installing the plant (constructing the shed, digging holes for the stakes) was not an expression of a common will and motivation. According to the CREI's interpretation, they were the result of an assortment of the villagers' private interests, interests captured by the payment of salaries to the workers by the project's promoters. Just like the CREI agents who, according to the villagers, were only interested in Buena Vista to the extent that the project allowed them to control new resources, the villagers, according to the CREI, were only interested in electrification to the extent that this interest was paid for in hard cash. Their mutual accusations are rigorously symmetrical here.

The village's lack of responsibility becomes in this context a simple consequence of two initial "flaws" in the village's commitment. Whereas the Tortuguero inhabitants took care of everything (purchase of the diesel, the oil, filters, regular maintenance etc), the Buena Vistans got carried away by their egotistical nature:

> *The village is "concerned", but does not want to pay for keeping it going. Even when the machine worked there were problems. The operator did not keep cutting up the wood as he went along. As a result, there was no dry wood. This is what makes me say that they do not want to work, to make any effort to produce their own energy. We told the villagers: the drying ovens must be kept filled up and there must be a full reserve of wood. I don't know if they decided to do it. We said to them: moisture affects the operation. If you leave the wood in the fields, it will get waterlogged and that will cause problems. We know that there are limited resources, but they didn't display any real interest. There was no initiative on their part, no cooperation.*

The gazogene's operating difficulties here appear to be at least partially a consequence of the social peculiarities of the village of Buena Vista. The humidity is no longer as in the first analyses of the problems an uncontrollable external factor, but the product of the villagers' negligence, which in turn is caused by their lack of interest and their absence of solidarity.

The CREI's slowness in carrying out repairs when there were breakdowns was a consequence of two factors. The first was "external" to Buena Vista. The same service had to deal with half a dozen installations spread over the whole country. This degree of decentralization implied long trips, and since they all had the same degree of priority, everyone had to have the patience to wait their turn. The second factor was due to the villagers themselves. As a result of their lack of interest in the project, they did not take the trouble to gather any information before they brought in the CREI - and this information would have made the work a lot easier and obviated the need for constant trips, costly in both time and money, between the capital and the village:

> *When the people from Tortuguero phone, they say: "The machine stopped under such and such conditions; here are the symptoms". We can analyze the problem and bring what we need. When Buena Vista calls, they say:"The plant isn't working". It's not just a question of instruments, of the fact that they are incapable*

of performing diagnoses. There are gauges of tension, frequency, temperature, motor safety (t°, oil). When the technician comes, the operator is off doing heaven knows what. He doesn't come and look, so he doesn't gain any experience.

It seems as if a collective technical operation requires a certain affective ambience. It does not permit dissensions and incessant conflicts, and shows its displeasure by developing organic disorders. The comparison between the two villages of Tortuguero and Buena Vista is instructive. If there has to be a "social link" (to use a shorthand phrase) for machines to work, then this link can be brought about in different ways, be more or less delegated, embedded in "technical items" (either material or legal ones, such as contracts) or left to the initiative of the social actors. Tortuguero falls into the latter camp. The fact that the machine works well is just a translation of the collective solidarity that existed prior to its installation. Everything else stems from this supposed accord: the organization of turns for operating and maintenance procedures, the "flexible" billing policy which worked on the basis of the number of items of equipment owned etc. There is relative social non-differentiation, in the sense that there is no need to appeal to discriminating notions like equality or inequality to explain what happens. Buena Vista is at the other end of the scale. The lack of solidarity observed by the project's promoters led them to take serious measures (a work contract with the operator, installing meters etc) in order to stabilize the local social link around the machine despite the instability of general social relationships. The meter played a double role: it was a durable form of the contract between producer and consumer and it guaranteed the solidarity necessary for the functioning of a community operation by allowing everyone to remain individualist.

The CREI's message is clear: "Heaven and the CREI help those who help themselves. Construct a social order and you shall have technology". The village, it will be recalled, had their own message for the CREI: "Stabilize the technology and the social order will return!". These two types of causality agree term for term in all their implications. In both cases, the interpretation consists in relating the machine's problems to the unsatisfactory behavior of others. The solution to the problems, from the point of view of each of the actors, could only come from reformed behavior. The machine itself was more or less exonerated in this process. This being so, to the extent that each side maintained its single-minded position it was difficult if not impossible to achieve a truce. For this reason the attitude of the different protagonists might seem suicidal to us, insofar as we consider them to be in a confrontation situation. But in fact these reciprocal accusations only rarely reach their targets: they form the thread of a discourse with third parties - that is to say essentially with those, like the OAS or the RES, who since the beginning have been in intermediary positions. We will come back to this below in order to explain the role this discourse plays in the overall techno-social machine that is set in motion.

Transition: The CREI and the project

Even though the CREI agents use a denunciation of village passivity to explain some of the problems the plant ran into, they did not believe that this was the end of the matter. They were willing to recognize a certain reluctance on their own part to care as they should have for the maintenance of the Buena Vista plant. This withdrawal was seen as a response to the lack of enthusiasm they attributed to the villagers, and was accentuated by the unsatisfactory nature of their relationships with the technology. If you went to Buena Vista, you were bound to be faced with an embarrassing series of problems, both because of the villagers' non-involvement, which made any long-distance diagnosis impossible, and because of the lack of theoretical or methodological tools they disposed of for dealing with technical difficulties.

This second element is related to the very way the project was set up. Being brought "into the game" at a late date - some people go so far as to say as a result of political pressure - they could not intervene in its development. Not only could they not participate in the technical definition of the project, but also and above all since they did not order the gazogene, they had no direct control over the manufacturer. Thus when they asked for more technical information about the installation's operation, the manufacturer systematically refused, claiming "Manufacturer's secret!". Thus their sense of impotent rage with a machine that did not want to talk and that others did not want to talk.

How can we account for the relationship between the various partners? In order to answer this question, we will have to go to the other end of the chain, to France, where both the project and the machine originated. We will then come back to the "intermediaries", the OAS and the RES, so as to see how they operated a synthesis of the various rationalizations they were confronted with.

Implicating as testing: the confrontation between the AFME experts and the manufacturer:

The manufacturer as seen by the AFME

For the AFME, which set up and financed the project, one thing is certain: the Costa Rican actors were irreproachable. They mobilized better then could have been hoped. The villagers' participation was exemplary. Only technological failure can explain the breakdown of the project. This finding is tinged with regret: "Imagine what it would have been like if the technology had worked!".

Gazogenes are a difficult way to go. Recent international congresses have shown that there have been numerous failures and comparatively few successes. The AFME feels reassured here - it was not alone in succumbing to the mirage of the gazogene.

The choice of manufacturer was the major problem, and the AFME judges that it is difficult to excuse the choice they made, to absolve themselves. The gazogene might have caused problems whoever the manufacturer, but with someone else - or rather with *the* other French manufacturer producing plants of the requisite size - the problems would have been resolved much more quickly and easily. What is more, the AFME was not content with making the wrong choice, but it vested more confidence in the manufacturer than is justified in this kind of affair. There was neither a schedule of conditions nor someone to take reception of the material from the factory. From the start the manufacturer was handed the whole thing on a plate, whereas the AFME should have retained some control. The choice of supplier was made after invitations to tender were answered by two manufacturers. The cheaper one was chosen. The AFME only allows itself one "excuse" for its laxity - youthful enthusiasm, which made it believe in the technology's maturity and made it believe the claims of a manufacturer with the gift of the gab.

For details of the trickery that took place, AFME officials involved refer to the experts' analysis. They do not have enough technical competence to be able to judge the technical pertinence of all the technologically very diversified projects that they have to oversee. In the Service for International Action, for which they work, they are called on more for their diplomatic talents, their ability to set projects up, than for their ability to provide expertise. The two French experts sent to Costa Rica were allies who could provide some technical muscle in their controversy with the manufacturer.

The expert's reinterpretation

The second expert, the one who went to Buena Vista in May 1987, was involved in the project from very early on. He was part of the project's pilot study in September 1984, and was considered for the 1986 tour, but being unavailable at that time he was replaced by his colleague from Polynesia. From the time of his involvement in 1984 up until 1986, he had not heard anything further of the project, except incidentally. He knew which manufacturer had been chosen. He worked for a research organization dealing with agricultural machinery in tropical zones. He was part of team which, amongst other activities involving gazogenes, had developed a test site for evaluating the performance of various existing models and those under development. Thus he was in close touch with all French manufacturers in the field.

According to him, the cause of the problems was simple. The choice of manufacturer was the fundamental error which sparked off the catastrophic sequence of events. He is in total agreement with the AFME - indeed he probably helped shape their opinion. His reasoning, however, is much more detailed, and is very interesting for its total reinterpretation of the role of the various actors we have followed above (CREI, the village, AFME), starting with the technical definition of the gazogene. For him, the possible forms of interaction with the machine are

inscribed in the machine itself[1]. All the actors can do is play out a scenario that has already been scripted.

We saw above that humidity was one of the recurrent interpretive factors, and that it was associated by some often fairly "loose" mechanisms to a wide range of negative effects. There was however a conflict about what could be the cause of this persistent humidity. What was the preponderant element in causing it: the climate, inefficiency of the drying oven or village negligence? The expert offered a very detailed interpretation of the humidity, one which brought into play in turn a series of heterogeneous factors, mediated by the machine.

First of all, we will look at what makes the presence of humidity in the gazogene effect the whole plant's operation:

> *I should explain that any gas coming out of a gazogene will always contain soot, humidity and tars. This does not matter very much - except ... - in the case where the gas is used in a burner. However, for a motor it is much more troublesome. It can tolerate a little humidity. But soot will clog it up and wear it down. As for tars, they are OK when the motor is hot. When it is turned off, it cools down and the tars can block up the motor. This is why we put in filters to get rid of them. A manufacturer's commercial agent will always tell you that his gazogene does not produce tars. When a gazogene is functioning properly, it is true that there are not too many problems. When the filtration system is working properly there is a little humidity, very little soot, and zero tar.*

The significance of the parasitic emanations from the gas is directly linked to the use that is made of it. They only come into the picture because they receive differential treatment in a motor for converting the gas into electricity or motor power. The presence of tars, which is the main danger to the motor, is itself linked to the presence of humidity. A gazogene is designed to work with a given flow of air and of combustible material, the relationship between the two determining the rate of combustion and as a result the temperatures within the gazogene, which reach their maximum in the furnace. If the wood is humid, then part of the energy given off by these reactions will be used to steam off the water, and this will lead to a lowering of the temperature. At a temperature of between 600 and 700 °C in the furnace, the tars are no longer cracked and are evacuated as such with the gas instead of being converted into molecules "inoffensive" to the motor.

The expert did not deny the relationship between the climatic particularities of the region and the installation's setbacks. He quite simply read it differently. For him, these particularities were in some sense activated and brought into play by the "limitations" of the equipment's specifications:

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[1] In the broadest sense of the term - not just the physical machine, but all the handbooks, maintenance manuals etc supplied by the manufacturer.

The second problem is the environment. It is true that it is a very humid region and that this gazogene is very sensitive to the humidity of the wood. The manufacturer says that the humidity level should not be higher than 15%. He believed, in his pride, that this was lower than the real limit. But we tested it. It works well at colder temperatures than Costa Rica's at 12-13%. It depends on the filtration system. In France, we carried out official tests and found it could work up to 18% humidity. In Buena Vista, as soon as the wood gets a little wet it gums up; the gas is not clean. And since the filtration system is very inefficient, it gets into the motor.

There was, then, a way of rendering the humidity harmless: putting in a very efficient filtration system. By contrast, the problems in Buena Vista show the equipment's limitations. It is not capable of transforming gas produced in conjunction with the gasifier and the Costa Rican climate into a gas acceptable to the motor. The motor should not have to know the outcome of the debates between these two elements/actors (the climate and the gasifier). The overly "fine-tuned" analysis of the performances of the different parts of the system is linked to the manufacturer's belief that it exceeds the specifications. We have seen, in the example of the table of "causes, consequences, and corrections of the principal operating problems" how the machine could accuse users, passing a quasi-moral judgment of them. Here, the expert reads the manufacturer's "morality" in the difference between his claims and measurements resulting from the different tests of the equipment (the Buena Vista one being the severest) . His "pride" is inscribed in the size and the form of the filters.

But it goes further than this. According to the expert, the Buena Vista gazogene conspires to produce humidity and tars. The gas that it produces is evacuated by a series of pipes which go the length of the tank. This procedure is often used to allow the wood which is being burned to benefit from heat that the gas can provide when it comes out at a high temperature. The Buena Vista one is different from the other models that use this system of recuperating the heat in that the tubes go to the top of the tank whereas generally they are deflected towards the filters below.

As it goes down the gasifier tank, the wood - which is reheated as it gets closer to the furnace - progressively loses its humidity by evaporation. At the top of the tank there is a cold zone, and a system of gutters that allow the water to recondense and then channel it to the outside. If the pipes go up into this cold zone, they reheat it and as a consequence prevent it from fulfilling its assigned role. The water is condemned to remain in the gasifier and, despite itself, to be a disturbing influence. The gazogene contains its own contradiction. The dehumidifying scenario of the first part of the equipment, the tank, is opposed by a second scenario inscribed in the pipes. This one prevents the proper unfolding of the first. Why did the manufacturer not notice the self-destructive nature of his system? At first, he made gazogenes using wood carbon, while his competitor specialized in wood gazogenes. After a number of mishaps, he decided to invest in his competitor's field, but:

To put it briefly, he drew his inspiration largely from functioning models. But when you copy something that you don't fully understand, there are little things that don't

seem to be doing anything and you suppress them or modify them - and it turns out they were very useful.

Technology pardons no-one. If an upstart wants to use it without making any effort, it applies a ferocious sanction. You cannot rely too much on your allies lest they turn on you and betray you. However, you need someone to come along and interpret this treachery, that is to say to bring out the contradiction between the two scenarios and read it as an inscription of their author's incompetence. For the neophyte, the machine itself has an opaque, reflecting surface which reflects causes and accusations outwards - this is how the Costa Ricans interpret the story of the gazogene.

Working from the machine and its dysfunctions, we have arrived at a "moral" portrait of its author. His pride can be read in the undersized filters. His laziness and impertinence can be read in the "misplaced" pipes. Once you begin this operation of translating technology into the language of morality, a sort of silhouette of a hero is drawn, one who could have constructed an "honest" machine. In this case a flesh and blood actor plays this role - the sole French competitor of our manufacturer.

What the Buena Vista manufacturer has said all along is that anyway his thing works perfectly and does not get clogged up.

His competitor is just the reverse. He visits the site, has good relationships with the people. He says to them: if you have the slightest difficulty, call me and I'll send you the pieces, I'll come myself. He is almost upset in advance at the problems that gazogenes can cause people. To the point where he actively discourages some potential users. He puts in control and follow-up monitors everywhere, to the point where people get afraid that they are dealing with something experimental. The Buena Vista manufacturer has one basic principal: it works. If you have any problems with it, that's because you have made some stupid mistake.

Thus we find an a posteori justification of the interpretation that makes the choice of manufacturer the fundamental error that led to all the difficulties the project encountered.

This analysis leads to an almost total exoneration of the Costa Ricans. So much the more so since unlike his competitor the manufacturer did not give them any way of entering into the black box. He deliberately omitted giving them the smallest tool that would have served to this end - either installation plans or measuring instruments or diagnostic tools. The machine is only dumb for those who do not know its language, or who do not have translators:

There are some basic things you can do to diagnose problems that I realized the manufacturer had never told them about. When I said certain things, I saw the penny drop right away. I said to them: in the morning, when you start it up, there is a way of verifying that there is gas. The flame should keep going. It doesn't have to be too bright, but it should be visible. The operator was trying to get it started with his lighter, and when it went phut he thought that there was gas even when it didn't

light up. It was some other problem; there was probably some gas but not enough. The basic mistake he made was using his lighter - you should use something that stays alight. That helps right off by stopping you from suffocating. Once the light is going, you are at least sure that if the motor does not start, it's not because there is no gas. It might be the batteries or something else.

The flame's color is also a good indicator of the quality of the gas. When the flame is reddish, there is soot in it. When it's blue, the soot has been eliminated. Already, that is a concern for the CREI rather than the operator.

There was no system for saying when the filters needed cleaning. I put pipe gauges on each filter. If the motor stalls, you need to:
(1) verify that there was a supply of gas;
(2) if one of the filters is obstructed, you can see it right away: the water level is higher in that filter, we marked the gauges at the right level. It is very easy to detect a problem with the filter. In a maximum of half an hour the operator can have located the cause of the problem and cleaned the filter. It is elementary. I was astounded ... . The operator wasn't doing anything ... . But what could he have done? The manufacturer had put pressure meters in. It's like using a Formula 1 speedometer to measure a bicycle's speed The meter didn't tell you anything, it wasn't sensitive enough.

Despite the lack of resources at their disposition, the CREI engineers did a remarkable job. They got documents together, went through the literature, did what they could. In a word, they tried to solve the puzzle from the pieces that they could find in articles and books, from the various experts and technicians who visited them, and through the little that they could understand of the machine itself.

The sole external confirmation of the value of this analysis is its simultaneous complete exoneration of users and machine. The test is a technical one, since the expert's interpretation traces equivalence conditions - that is to say necessary and sufficient conditions - between the description of the technical device and the series of events experienced by the actors. The manufacturer's "morality" is the cause of the machine's problems and the Costa Ricans' inability to solve them. So all you need to do is to rebuild the machine so that it is operational and give the actors back their competence. If the suggested alterations to the machine resulting from the preceding analysis succeed in redressing the situation, then the manufacturer will be confirmed as the source of evil, and will bear the brunt of the accusation.

In fact when this study was being written, the controversy was far from over. The expert had made a certain number of changes, which had to be rounded off, if they were to work at all, by a final operation the CREI had to perform. Six months after his departure, the CREI had still not buckled down to the job. They pointed to a reorganization of the section concerned and their agents' lack of motivation (caused in turn by the villagers' own lack). According to the expert, the continuing problems are due to the failure to follow his suggestions. It should be noted that here

there is a reversal of cause and effect. Insofar as the CREI does not do what is required, it risks being designated the cause of the problems. Its behavior brings into play "social" and "moral" accusations, which during the controversy were only virtual histories. As for the machine, it does not wait for the laggards to catch up before casting its history in iron. The failure to carry out the modifications constitutes irreversible damage inscribed into its body. Just as an autopsy can betray human vices, so is the examination of this damage likely to betray the criminal negligence of those who were charged with its care.

The world according to the manufacturer

The position that the manufacturer takes is rigorously symmetrical to that of his detractors. He does not defend, he attacks. He hurls accusations in as many directions as there are actors who can be blamed. The basic presupposition of his position is that there is nothing wrong with the technology. Not bothered by subtleties, he goes straight into high gear - he is the best:

> *I know all the gazogenes on the market and I can tell you that the one with the most advanced design, conception and maintenance system is mine. It's a technical fact that all gazogenes work for 500 hours then stop. I've seen them all. Nothing works - the hearth burns and you can't do anything to stop it. With mine, with 5000 francs [US$800] and a few hours work we can build a new hearth.*[1]

From this baseline, everything else follows. If there are problems, and he still does not explicitly accept this, it is because the project is run by unmotivated administrations, unorganized users with training officers who don't know the field and incompetent technicians.

Governments need to intervene because the "gazogene technology" is still fairly new, it is not fully operational. Private buyers find it difficult to raise the money, and so it tends to be a gift from one government to another. In his view, since neither governments nor users are driven by a profit motive, there is no reason for them to get it working optimally: "they don't give a damn". Now you need to put in a minimum of effort to make a gazogene work properly. You need to cut the wood up, dry it off etc. People are naturally lazy creatures, and unless there is a deal of pressure they will always try to dodge their obligations. When on top of this they are not motivated by the desire to make money, everything conspires to make the work not seem worthwhile, and this damages the plant. According to the manufacturer, the Buena Vista project had an additional handicap, linked to the choice of training officers:

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1 It should be pointed out that the first version of the Buena Vista gazogene had a hearth of the type he is criticizing here. Only after the expert's mission was it changed, as a result of recommendations in the report. This procedure - turning accusations against him into accusations of others - is used frequently in his arguments.

There was no training in Costa Rica. The training officers didn't know the field - they were agriculturalists. That's why things went haywire. They were from the forestry section - they should have dealt with the wood for burning, not the gazogene! That was the mistake. An agronomist can't deal with starting it up! He doesn't know the first thing about it.

Lastly, local technicians are generally incompetent. Since the gazogene field is still a new one, there are few specialists. For this reason, maintenance work is often given to motor operators who, according to him, do not understand the gazogene's particular way of working:

The people don't know the field. In the CREI for example, they know their jobs very well but they don't know gazogenes. Everyone believes that when the motor stops, it's because it has broken down. They take it out and dismantle it, breaking the rocker arms etc, when often it's just that a door hasn't been closed properly, or the wood is in too large pieces. Gazogene motors are always getting clogged up with soot - that's no reason to dismantle them. If you open them up after 50 hours, they are already sooty. But it is self-regulatory.

We can see here a subtle inversion of cause and effect. The motor's getting sooty, which before was seen as a consequence of its not working properly, is normal. It is the fact of opening up the motor - an element of the black box - that is the real cause of the plant's breakdowns. What was interpreted as a symptom internal to the machine was in fact its normal reaction to human negligence or error. If they had carried out their instructions, the "symptoms" would have cleared up.

The manufacturer occupies a "high" strategic ground. He does not get involved in his adversaries' game, but tries to embroil them in his by proposing an interpretation which accounts for the others' actions and positions and give a new meaning to it. He calls on them to prove what they are saying, but he sets down the rules for their demonstration. In particular, he prohibits them from taking the motor as proof. As we have seen, for them the motor is the main measurement device - it is the site of the accumulation of traces (in the form of tars, soot etc.) of what has gone on before. He operates a completely logical displacement of the terrain of confrontation. For him, there is no question of entering into a technical discussion with the experts, since they cannot even agree on the *nature* of the causes. In return, he peppers his arguments with constant threats to sue - this would constitute the legal apotheosis of his quest for human responsibility.

After this examination of the arguments that were used, we find ourselves confronted by two differing positions. They are irreducible one to the other, since they agree neither on the causes and effects nor on the means of proof. Each position can interpret the other in its own terms by a simple transformation. It seems that we can characterize the positions to some extent as a function of the choice of causes or accusations between objects and subjects. The expert gives a description rich in technical detail and in the way the technical elements interact, and only at the end of the day does he re-attribute these effects to a social or moral cause - the manufacturer. Inversely, the manufacturer leaves his black box almost closed and so as to be able to do this he

has to generate accusations of all the human actors around it. The expert tries to construct the gazogene as an object of consensus even if this means excluding its author. The manufacturer tries to preserve his relationship with the gazogene (not to be challenged) by constructing general dissension around it, and therefore implicitly consensus against it. To put it another way, one undoes the technology in order to put it back together and not compromise the social, while the other attacks the social in order to keep the technology intact. "Accusation" is only one of the modalities - notable for its extremely polemical nature - of a more general movement to "implicate" the world[1]. Depending on the nature of the causes that these rationalizations place at the origin, the actors need to use different types of proof in order to validate them. For the expert, the cause of the hitches can be found in the manufacturer's "morality", which comes out in his conceptual errors. He has to be able to show that by freeing the machine from its manufacturer's influence - that is to say by making technical modifications - the problems will cease. Here we are on scientific/technical ground. Inversely, since for the manufacturer the causes are on the side of the users' non-respect for the machine's operating conditions, he has to situate the confrontation on legal ground in order to bring out their responsibility. These two attitudes are only a sub-set of the possibilities of confrontation, which form a continuum from witch trials to scientific experiments by way of the polling booth.

Implication as negotiation: the role of the intermediaries

The OAS and the RES performed similar intermediary roles in the project. They brought other actors together, and then had to pull out when these relationships were stabilized by the machine. One of the things they had to do to fulfil their role was to maintain, at whatever cost, the relationships that they helped establish. So it is not surprizing that they do not repeat the others' accusatory discourse in all its violence, but present softer versions of it which constitute attempts at compromise. The OAS, and to a lesser extent the RES, offer a detailed interpretation of the project. Since the OAS was the principal mediator, orchestrating operations in Costa Rica and holding a quasi-monopoly over relations with France, its analysis covers the unfolding of the project from its inception. It reckoned that the initial decisions were taken too quickly, that is to say without the AFME having assured itself of ways of controlling the firmness of the engagements that the whole thing depended on. Costa Rica was a priori for it, but without knowing precisely what they were for. There was no precise report or detailed outline program to base their support on. The OAS tried to work within the time constraints imposed by the French, but the possibility of Costa Rican negotiations affecting the project's technical contents were annulled by the speed of events. The main consequence of being presented with a purchase already made was the late and reluctant implication of the CREI. Across the ocean, this excessive haste led to an insufficient formalization of the relationship between the manufacturer and the AFME. There being no

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1 See footnote 3 p.14.

schedule of conditions, or any reception of the material or contract laying down the manufacturer's obligations with respect to training and maintenance, there was no other means of reciprocal control than the supposed good faith of the parties involved. The manufacturer took advantage of this situation, which was favorable to him, to do something other than had been requested:

> *What is unusual in the case of the gazogene is the fact that the manufacturer not only sold his machine; he used the project to do free on-site R&D of it.*

Worse still, he deliberately omitted to provide things that were essential to the proper care of the installation - such as plans, technical specifications etc. This forced the CREI to improvise. Faced with breakdowns, the technicians had to make hypotheses that were difficult to check about the way that the machine worked. According to the OAS, this partial transfer of the technology is the origin of the complexification of the technical problems. The CREI's difficulties were a consequence of the AFME's imprudence in its relationship with the manufacturer.

The CREI itself does not come out of it totally free of sin. The upper echelon's support is beyond question, however at the lower end of the scale there was more reticence - and only a part of this could be attributed to the recurrence of problems which they did not have the necessary tools to resolve.

The same kind of additional complexification which accompanied the transfer of the machine from France to Costa Rica occurred when the machine was transferred to the village:

> *People think that it should be easy, but in fact it is extremely complicated when you find yourself in a little village like Buena Vista. The smallest things, the most minor problems take on massive proportions in Buena Vista.*
> *A case in point: there is no more wood in stock - who is going to take the decision to go and get some? No-one, although the resource is there, there is someone paid by the village to maintain it and so on. But then they notice that to deal with the problem of wood collection, you need to have the tractor of the wealthiest local landowner etc.*
> *Or take batteries going flat. The simplest things become disproportionately difficult in Buena Vista. If the batteries go flat, first of all you have to know that they are flat. Then you need money and someone to take the decision. You need to go to Guatuso to recharge them, to take a car. And you need to be sure that they have been recharged properly.*

There are two types of reasoning here. It is difficult to gain access to resources for the same reasons that the village was chosen for a project of decentralized electricity. The village is distant, and does not have large financial, technical or material means. But the decision was even more problematical in the conflictual context of Buena Vista - a context the OAS does not deny. In order to take a decision for the community, you need do declare yourself its representative and risk being disavowed in your role of spokesperson. In this case, the positions of power are profoundly unstable. Since the start of the project the AID committee director has changed several times, and

the electrification commission set up specifically to manage the project was rapidly reduced to impotence as a result of internal squabbling.

The OAS' working hypothesis that the collective benefits of electricity would be capable of overcoming the villagers' dissensions is threatened by the machine's instability (which was in turn a product of a series of external causes described above) and by village conflicts. Thus there is a vicious circle which can only be broken by everyone accepting their own responsibility.

How can the OAS and the RES calm things down? In this case they cannot exonerate everybody - this would come down to accepting each side's positions, and as a consequence to realizing the impossibility of reconciliation. The act of "implication" takes on a slightly different meaning from before. It was face-to-face in the case of the CREI and the village, for whom it constituted formal notice that their own interest depended on interesting the other in it. Reformulated by the OAS and the RES, it is rather a case of tipping one's hat towards one side's habitual accusation in order to get them to take the other's accusation seriously. In this set-up, implication is the currency of negotiation. The OAS and the RES stand on the balance beam and try to maintain the equilibrium of each transaction. The two principal protagonists, the CREI and the village, play an active role in this process. It will be remembered that their "implications" were addressed not to those they implicated but to the intermediaries. They were, so to speak, pleading their cause before an arbitration commission. The implication has two inextricable consequences. It constitutes the other as an actor (the only reason we can talk about "the CREI" and "the village" is because these entities exist first of all for others). Secondly, in so doing it founds the cohesiveness of the group named (the "we" of the villagers or of the CREI workers as reflection of the outside "them" is the outcome of the process of interpretation, not its starting point). Thus the intermediaries appear as the mediators[1] who produce social differentiation. Without their presence as negotiators - which is in turn confirmed by my position as researcher - this mixture of accusations remains in part incomprehensible, since it is essentially self-destructive.

The negotiation process sets up a second order mechanism. In the case of the CREI/village, the act of implication can be turned into an injunction such as: "Prove to me via the machine that you have my interests at heart". For the OAS, the injunction becomes: "Prove to me via your exchange of accusations that you are both interested in each other via the machine". Thus, for example, after we had carried out this study there was a meeting between the headquarters of the CREI, the RES and the OAS. At this meeting, the latter two obtained a reaffirmation of the interest of the CREI's directors in the project, and the concretization of this interest in the form of an undertaking. This was that in case of difficulties the villagers were invited to phone the second in charge of the CREI. The latter's secretary was told to immediately relay any such communication to her boss. This measure can only be seen as an implicit recognition of the institution's failings, even of a disagreement between the upper and lower echelons and recognition of the loss of

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1 For the theory of mediators, see A. Hennion, Comment la musique vient aux enfants. Une anthropologie de l'enseignement musical, Economica, Paris, 1988.

power as you go down the hierarchy. The message to the villagers is: "Since the Saints are undisciplined, you can have direct access to God". The CREI accepts a part of the accusation the villagers' accusation. In exchange, the OAS and RES expect the villagers to put an end to their internal dissensions and withdraw some of their accusations against the CREI. In particular, they propose subscribing to a new version of the story we told above[1] which the villagers used to highlight the CREI's lack of effort when the network broke down:

> *The villagers did some amazing things. They made connections every which way. They hired a group of musicians for a party. And they connected all their equipment to the same cable. So the plant broke down and they didn't have any lights. They have a lot to learn, they need to learn.*

The villagers' "demonstration" of the CREI's ineptitude is rejected by the RES: "It's you who caused the breakdown and the CREI's delay in responding is only a detail; you cannot use this case as currency in our negotiation". However the effectiveness of this negotiation process depends on the technology's behavior. It too has to agree to negotiate and to stop accusing others.

Conclusion

Throughout the last section, we saw that most discourse about the project's history was accusatory. Attempts at an internal rationalization of the technology failed - the latter reflected the causes back to the outside world. Faced with this, the actors involved began a game of reciprocal implication. This game has to be seen as a trial of strength between the forces involved in the project. In the end, the weakest links were bound to break since the technology had put up a lot of resistance from the start.

The way the project developed depended on the marked geographical separation between technical factors, which the French looked after, and social factors, which were largely a Costa Rican responsibility. The forms of the various accusations reflected this split - you can only blame what you have access to. This is particularly so since accusation is never gratuitous - it constitutes a description of the relationships between the actors and an attempt to modify those relationships. The Costa Ricans implicate social factors in technical malfunctions, and the French do the inverse. The exceptions to this rule can be easily interpreted. The CREI also (but to a lesser extent) refers to technical problems, since as a result of its institutional nature, which situates it in a scientific and technical network (with access to international journals, congresses etc), it engages with the technical parameters. And it was in direct contact with the manufacturer or his representatives when they came to Costa Rica. The manufacturer constitutes a special case wherein the accusation does not represent a means to try to modify the behavior of others, but rather a

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1 see p. 22

defensive strategy aiming to guarantee the immunity of his own position. Put crudely, he doesn't give a damn about whether the technology works or not. For him, the only thing that matters is to have at his disposition an arsenal permitting him to give an external account of the malfunctions, without risking his own being implicated.

The intermediaries provide the linkage between these modes, without deciding between them nor between the two versions that each one is composed of. To do so would put them in a position of upsetting the applecart, in the sense that it would destroy the equilibrium of their position and could only be supported by a series of arguments that the actors qua detractors would regard as false. They employ a second degree of accusation - using attributions of blame as currency in the negotiation.

Interpretation of failure always involves listing ways of avoiding it, of transforming it into success. In this sense, the situation would be much more difficult if there been a state of generalized indifference rather than this incessant spiralling of accusation. Despite the various more or less explicit attempts at reconciliation, there is some doubt about the real possibility of reaching consensus. The actors' capacity to negotiate is not in doubt. The difficulty is the apparent rigidity of the technology, and its obstinacy in doing the unexpected, in tricking humans. Can it be made to be honest, and brought to the negotiating table with the others? This is what is really at stake in the project. However, not all the actors are equally invested in this stake. In the case of a definitive failure of the project, the AFME and those that we have called the intermediaries would probably console themselves by filing away the Buena Vista case as a single instance within the overall context of international cooperation. Then it would only be a marginal failure. As for the experts and the CREI, they are only indirectly implicated and should be able to distance themselves fairly easily from something that was never their central concern. Just the two ends of the chain are left, the manufacturer and the village. The village is in the most fragile position, in the sense that its involvement in the network as a whole is by way of the gazogene itself. We will now see how the village and the manufacturer prepare themselves against the consequences of failure. They have diametrically opposed goals: the village wants to keep the exchange process going despite the eventual failure of the gazogene, the manufacturer wants to withdraw his name from the annals of Buena Vista's history.

Third level of interpretation: the generalization of causes

The manufacturer's paranoia: from machines to machinations

The first French expert's report proposed a certain number of modifications to the plant. But it went further than this and up to a point warned against any optimism that a reading of the

suggestions for significantly improving the gazogene might induce. It suggested taking a radical step: replacing the existing plant by another, more reliable, one. The report's author, after consulting with his colleague[1], even ventured to put forward the name of a competing manufacturer as supplier of this new plant.

The manufacturer was warned by "friends in high places" in the AFME of this threat. He succeeded in getting hold of the incriminating report before its official release, and threatened the AFME with legal action aimed at establishing the experts' incompetence and the existence of a plot against him. The single technical proof he offered was an error in the report about the method of cooling used. For the manufacturer, this sufficed to disqualify the whole analysis. The falsified study of the gazogene became an arm in a attack on him personally. But why was he under attack? His analysis of the politics of gazogenes gives the answer. The whole gazogene milieu, the competitors, the organizations to which the two experts belonged etc was largely funded by the government. He was the only one that had not received this manna. His political impartiality had prevented him from playing the game of financiers whose decisions are based on party politics. And even those who had received a pile of money had not succeeded in constructing a single working gazogene. Thus there was a collusion between these failures against him, since his striking success - he was ahead of everyone in the world - cast doubt on how they had used the funds they had received:

> *Thousands of millions [of centimes] have been invested in Europe in gazogenes, and results are needed. If they had given me even a twentieth of that amount, I could have done something significant.*

The attack against the report's authors bore fruit, in the sense that it paralyzed the AFME. The OAS qualified the report as dubious. Since the two experts worked for the other manufacturer, their recommendations could appear partisan. As a result, the AFME could not follow the report's suggestions without being accused of improprietary behavior with respect to the free market. Here the manufacturer's strategy proves its effectiveness. Having constructed a consensus against him, there was not a single available expert - in France at least - who could not be suspected of being biased against him. However, there was one element missing before the manufacturer's avowal could be fully convincing: a demonstration that his analysis worked.

For the manufacturer, behind every technological malfunction there is intentional human malfeasance. This defense is so much the more unanswerable since it connects up with two other strategies - refusal of joint experimentation and threat legal action. This reduces the others' field of discourse, by continually reinterpreting what they say. "If you accuse my machine, I can accuse you of being the cause, since because I didn't see it, you can't convince me to the contrary. If you accuse me, I will sue you after I have denied you any means of proof. I have a satisfied customer on

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1 The second expert to come to Buena Vista, whose analysis we looked at above.

my side[1] and justification for my behavior - that is to say, proof of sabotage". Indeed, on the sole occasion when there was a trial at the second French expert's test site, something very strange happened. After some hours' operation, the motor began to lose power, and then stopped. On looking inside, the expert found some strange deposits. For the manufacturer, the explanation was crystal clear: someone had put salt in the water tank used for cooling. According to the expert, the incident (which he considered "abnormal") has not been properly explained - perhaps it was an accident. The report that was written following this experiment did not mention this incident, accepting de facto to consider it as having no bearing on the plant being tested. On the other hand, the report did bring out a certain number of other problems, which prevented a final judgment of the plant. From the manufacturer's point of view, this negative result is due to the sabotage that he was the victim of (although in fact of which he was sole beneficiary - since he was the only one to emerge unscathed). This is the argument that he presents to prospective clients who are surprized that his gazogenes do not have any official sanction. It is also what allows him to refuse any other testing of his products. He has a decisive advantage here. His general interpretation permits him to account for more facts, since his detractors cannot explain this particular incident in their way (technically) in opposition to his "social" account[2].

The constructor "cannot be manipulated"[3], since he has a sufficiently strong interpretation of reality to allow him to refuse any negotiation about technical content[4]. A psychological description of this strategy would be that he is "paranoid".[5] He takes others' implications as accusations which are strictly without foundation. With the "incident", he has the means of turning them around, of transforming them into an unquestionable sign of the plot of which he is the victim. In so doing, he removes himself from the field of controversy about the Buena Vista failure by reinterpreting "technical" malfunctions in the machine as simply the result of "social" machinations.

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1 He did indeed install a gazogene which seemed to work well enough in a saw mill in Bordeaux. For the experts, this was not convincing proof, since he went down to fix things up whenever there was the slightest hitch.

2 They give a moral/ironical account of the form "if you play with fire ...". They burst out laughing and say: "My boss at the time reused to take the thing seriously. He laughed it off saying: That really caps it off. They sabotaged his gazogene!".

3 This is what the others say of him.

4 We can not say how long this strategy is tenable for.

5 This is what the other French actors say about him.

Entry into politics

How do the villagers react to the possible future irredeemable breakdown of the gazogene? Confronted with this possibility, the tone of their arguments changes, becomes more detached. The CREI is not exonerated, but its role is articulated differently. Becoming "detached" from the history means making the technology a black box, abstracting it from its actual framework so as to concentrate on its goals - which were lost from view when the means monopolized all the attention. The operation that the villagers carry out is a kind of thought experiment. Imagine that we do not know anything about the gazogene, nor about the electrification project it belongs to. What can we say about our electricity?

> *We pay more for our electricity than people in Guatuso. They have 24 hour service, we get 3 hours a day. I've got relatives there, and they have told me that there are almost never any blackouts. When one occurs, it is only about half an hour before someone from the CREI comes to repair it. We have to wait 8 to 10 days.*

> *The anomaly is this: how does it happen that a family living in Guatuso and which has exactly the same number of appliances as a Buena Vista family pays 50 colones a month when here we pay 300 colones? And what is more they have a constant supply. We knew we were going to have to pay more: that is not the anomaly. The anomaly is that we are always having blackouts of a week or more.*

The plant's problems led to a complete rethink of their interest in the project. The villagers were happy to pay more than others, so long as they believed that as beneficiaries of the project they should feel honored and grateful. That they were being given a lucky break, a chance to extricate themselves as far as humanly possible from a difficult situation. That they would not otherwise have had electricity for ages. Events progressively gave the lie to this.

A more radical accusation of the project consists in referring to the bad conscience that its very existence denoted: "if you reckon you did well to give us electricity without our having asked, this is because you implicitly recognize that we have a right to electricity". Thus they inverse the terms, bringing this "right to electricity" into the foreground. All of a sudden, the differences which earlier appeared normal - with respect to availability, maintenance and cost - become insupportable. This difference is rendered significant by a supplementary translation. This one transforms a simple anomaly between different clients of a single enterprise into a division between town and country, into a discrimination against a part of the population that should have the same rights as others[1]. The pragmatic upshot of this claim is put very simply and radically: we want to be on the electricity network! The villagers are willing to renounce their accusations against the CREI on this condition, and to impute the gazogene's failure to a cause, local humidity, which would exonerate

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1 In this process, all the events that we indicated above as denoting a lack of regard for the villagers are reinterpreted as markers of discrimination.

everybody. This is, then, a different type of transaction from the attempts at negotiation made by the OAS and RES. It brings the worlds of politics and nature into play, whilst before we were only dealing with technology and society.

In the face of this claim, which goes beyond the particular framework of the project and brings in various macro-actors (the city-dweller, the peasant etc), the RES - which here becomes spokesperson for the CREI - introduces other macro-actors[1]:

> *Right now, the CREI is having a lot of problems. Demand has increased much faster than expected. There isn't enough production to meet demand. We need to build a very large dam, and that is very expensive. Costa Rica buys a lot of its electricity from Honduras. But the line to Honduras goes through Nicaragua. Honduras tells us that they have sold us say 100 units and we only get 50 of them because the Nicaraguans steal the current. But we have to pay for the 100. It is possible that next year there will be blackouts all over Costa Rica.*

So the internal politics of Costa Rica are put in the context of regional Central American politics - and thus of a cause that is bigger than them. It is not that we want to continue discriminating against you, it is just that events over which we have no control force us to. A return reference to the contract linking them completes the demonstration: the CREI never agreed to provide electricity regardless of source. The project's sole aim was to explore the possibility of another form of electrification:

> *The villagers consider electricity as a public service. In fact, the project's goal was to explore alternatives, not to provide a public service. The idea was to try decentralized electricity production - and if that worked to set up decentralized companies at the village level*[2]*.*

This declaration at once defines the limits of relevance of the project and indicates its failure, to the extent that it was impossible to avoid reference to classical forms of electrification. The failure itself is interpreted in two steps, which in a sense prove the villagers right. It was not only that the technology was not up to specification that we had a problem. The very choice of Costa Rica may have been the root cause. This country is the most electrified in the area, and for political reasons electricity is ridiculously cheap here. These two factors support a reading in terms of discrimination or of the inequality of the difference between electrified and non-electrified areas. This is what gives us the key for understanding the support for the project from the CREI's directors. Having reached the limits of their system, but still being committed to an ideal of public service, they saw the Buena Vista project as a chance to display their interest in any method that would allow them to redefine those limits from within. It was a low cost solution to the problem posed by the

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1 The villagers heard this at a meeting to explain the impossibility of their claim.

2 OAS.

contradiction between their general mission to provide any citizen needing it with electricity and the absence of means for doing this. Without this kind of response, the problem's resolution would involve more radical modifications of the system - in particular higher charges, which would be opposed by much larger forces. They would need to convince the government of the need for a new pricing system. Even if they succeeded in doing this, they would have to be able to control consumer reaction. When there was a sharp price hike in 1983, there were such protests the following year that the government imposed a price reduction. The village of Buena Vista would not carry any weight in this contest, even if it managed to mobilize all sections of the countryside without electricity .

The CREI headquarters impose a closure of the debate and of the project's future history:

> *While the service is working we will continue to lend our what support we can - but we can do no more than that.*

That is to say they will provide support as long as the villagers agree to having electricity at whatever cost (in terms of breakdowns, price etc.) and as long as the machine is "salvageable" and they can get something out of it. This is a minimal definition of the project, one that reduces its ambitions to nought.

Conclusion

Having completed our enquiry, we would now like to consider the wider implication of this case. We will do so while at the same time indicating the limits of its pertinence. Throughout this text, we have seen actors desperately seeking a way of controlling the series of events they were confronted with. In the face of an ever more intolerable feeling of incertitude, bordering on insanity, they were led to propose an interpretation. That is to say to implicate. This made it possible for them simultaneously to account for what was happening and to attempt to remedy the machine's disorders. The machine implicated the technical/social basis of their project. Since it refused the initial compromise offered (viz that in exchange for dry wood, it would agree to operate normally), the actors were led to cast ever wider nets in order to find what the machine needed and what its features were. This led us, in the same movement, to see the extent of the work of association essential to making a technical object function. It is a matter of constructing the universe in which events take on and produce meaning, and also of finding the universe in which they are shut up, contained, punctualized by a series of determinations external to themselves so that they can no longer escape the limits of their interpretation. Given the exceptional resistance of the sequence of events to any attempt at reduction, we can better understand why it was necessary from the start to impose a principle of agnosticism. If we had prejudged the relative value and truth of the different interpretations to be found, we would have obscured the fact that the actors' problem was precisely one of rendering them non-equivalent, and thus of producing a result that we could have taken as the point of departure for our enquiry. Further, it would make no more sense to see our own work of interpretation as proving the relativity of the different

viewpoints. If this had been the case, we would have concluded with a theory of their arbitrary nature (that one can say anything and everything, since it all depends on one's social position - this comes down to putting the object between inverted commas, to making it a mere pre-text), since any interpretation seeks to account for the totality of the phenomena associated with the introduction of the gazogene, and also for competing interpretations, by showing that their "causes" are merely the effects of a prime cause. In this sense, we are surrounded by controversy ("telling stories" - in particular a story of which the current study is one of the conclusions). The wider the interpretative net is cast, the larger the event itself becomes, since any new interpretation has to incorporate the preceding ones into the phenomenon itself, at the same time as providing an external determination of it.

In the same way, we cannot make any a priori distinction between what is social and what is technical, insofar as it is the indissociable nature of the association between these two terms which raises problems for the actors involved. All their efforts were turned towards introducing a separation between the two. A third term was introduced into the space created by tearing them apart - that of the mediator between the social and the technical[1]. Since the equation to be resolved concerned the functioning of the gazogene, the interpretative chains were clearly polarized. The result was that they interposed generally social or human actors between the actor/interpreter and the technical goal[2]. If it were a question of understanding why, for example, a technical object is used only a little or not at all, we might have seen an inverse polarization. Thus in this configuration, the object plays a special role, in that it forces others to become describers. It challenges them to a decoding competition. It becomes the instrument for measuring these different interpretations, by way of its reactions to the various tests that the actors submit it to in their search for validation. To assert that village conflict was the pre-existing cause of the project's failure is to come down on the side of one of the actors and to take a position in favor of a particular interpretative schema[3]. Above all, it would entail ignoring the fact that in order to be able to describe the village as a site of conflicts, one had to first look at the tribulations of the gazogene. Any description of a technical object is also a description of its environment. The supplementary hypothesis that we will make is that any social description is also the description of a set of

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1 Among the different permutations we analyzed above figure: "machine"/damp wood/villager (for the CREI), "machine"/behavior of the agents/CREI (for the villagers), "machine"/(piping = moral order)/constructor (French expert). By "machine" we mean all the phenomena that take place centered on the installation.

2 In the case of the expert, even if he gives a socio-moral interpretation of the gazogene's breakdowns, he at the same time sees the constructor's "lieutenants" operating in the machine. This renders it no longer necessary to make the constructor act or to act on him in order to make the gazogene work - all you need to do is to attack the piping technically.

3 One which means: 1) that the technical dimensions are but a detail of the story 2) that no project that involved any degree of local support could work and 3) that there is no other way of validating this interpretation than by carrying out a test - for example by finding technical means of doing without village solidarity, and demonstrating that in this case there are no problems with the gazogene.

technical objects in the widest sense of the term (including technology as such and also the legal and scientific domains). Without these latter, the links that attach us one to the other would irremediably dissolve. When these objects are fully integrated and are the object of a consensus, the divisions between the realms of operation and dimensions (social/technical/natural world etc) on which their functioning is based have been completely naturalized. This explains why it would prove difficult and fruitless to try to restitute the richness of the associations that they forge (in this case it would be more effective to argue in terms of economics, mathematics etc, if possible).

There is still a final point to be dealt with. The Buena Vista story has one important characteristic, that of dealing with an experience which, at the moment when we looked at it, appeared to the various actors concerned to be the story of a failure. Given this, the relationships between people and the technical object are particularly explicit, and often take the form of rather strident reciprocal implications. Are these results generalizable?

As a rule, innovators are almost always confronted with uncertainty. They are obliged to adopt a certain number of hypotheses about the actors they hope to mobilize with their projects, and are never completely sure that these actors will behave as they ought. It is not that innovators take their decisions whimsically. As Hughes has amply demonstrated for the case of Edison[1], innovators surround themselves with interlocutors who are supposed to know the desires of those who are to be convinced. Their role is to be faithful spokespeople. For the innovator, the spokesperson is the final term in the series, who hides others at the same time as s/he guarantees their integration to the network provided the innovator interests their him or her[2]. But the innovators' choice of valid spokesperson involves a decision about the causes of their own technical decisions. Given this, there is a very thin line separating cause from accusation. As soon as things develop a little bit differently from what had been expected, the spokesperson - or in other cases those who s/he was supposed to represent - is explicitly "implicated", designated a traitor. In the inverse case there is no difference between representer and represented. Or rather, as the alignment between these two terms is constructed, the object materializes in its form the compromise that has been achieved. Here we have an "objectification"[3] which naturalizes the world described by the successive displacements of the innovation process. In the long run, all we are left with is a given stabilized and consensual division of skills and responsibilities between people and objects. But before the fate of an innovation is sealed, that is to say before the actors concerned agree that it has been a success or a failure, there is no way of deciding between these two sorts of project. This is the reason why we thought it worth devoting a chapter of a book

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1 op. cit.

2 On this idea of spokesperson, see M. Akrich, M. Callon, B. Latour, "A quoi tient le succes des innovations: 1) l'art de l'interessement, 2) l'art de choisir le bon porte parole", Gerer et Comprendre, 11 and 12, 1988.

3 In French there is a play between "mise en chose" - objectification and "mise en cause" - implication, "chose" and "cause" having the same etymological root.

devoted to "technology/society" to the case of an object that allows us to follow a path inverse to that of innovation - one from "objectification" to "implication"[1].

1 See previous footnote.