NORTH-HOLLAND

Technological Forecasting & Social Change
5522 (2002) xxx–xxx

Technological Forecasting and Social Change

Sociotechnical relations and development assistance

Thomas Grammig

185 rue Ordener, Paris 75018, France

Received 8 November 2001; received in revised form 5 July 2002; accepted 8 July 2002

Abstract

Process research is increasingly used to assess and monitor the implementation of development projects. In natural resource management and agriculture, the results have contributed to consensus building amongst village groups, agricultural extension and other governmental agencies, NGOs, and donors. This paper draws on Latour's science studies programme to compare these results with process research in industrial development projects. Process research should reflect sociotechnical relations. Latour's definitions of sociotechnical relations thus allow us to describe the context of development projects and add to the theoretical framework of process research. Ethnographic methods reveal the insider perspective and implementation logic of development interventions also in industry. An interpretation of the ethnographic results according to the layer of sociotechnical relations is proposed.

Keywords: Sociotechnical relations; Development project management; Process monitoring; Process research; Institutional development; Appropriate technology; Ethnography

1. Introduction

The label 'White Elephant' is often used to describe technical equipment financed with development aid that then lies unused or is inefficiently operated in developing countries.[1] Recently, a different category has appeared. Sophisticated technology from in-

E-mail address: trgram@compuserve.com (T. Grammig).

[1] A 'White Elephant' is recognizable by its isolation from its social, cultural, and economic context: it results from ignorance on the part of development experts. This observation is often simplistic because it denounces a rather implausible defect, a blindness to local conditions.

0040-1625/02/$ – see front matter © 2002 Published by Elsevier Science Inc.
PII: S0040-1625(02)00321-9

dustrialized countries has been used successfully, e.g., satellite telephones in villages in Bangladesh [1]. By freeing them from social and cultural boundaries, these telephones enhance the economic activities of village women. Albert Hirschman's classic observation—that developing countries are much better at aeroplane maintenance than at road maintenance—long ago challenged the assumption that technology's adequacy to a social, cultural, and economic context is understood. If we know little about the social impact of the introduction of telephones to industrialized countries, how could we then understand what telephones do in Bangladeshi villages? Had sociologists studied the social dimension of technology in industrialized countries in more depth, the conceptual framework for context adequacy would have emerged.

There is an alternative route, which might produce some elements of context adequacy, and this route is explored in this article. After 40 years of experimentation with aid administration, development agencies are increasingly employing 'process' approaches to managing development aid. These management approaches can entail a large number of learning steps, internal feedback loops, and consultations with all social groups concerned. Through such methods, an adaptation or transformation of the hidden social components of technology becomes possible. After sufficient experimentation, specific process management approaches for particular technologies might appear, e.g., a type of process management for irrigation systems, another for health care, and a third for manufacturing industrial machines. When process management reaches a state where it becomes specific to a sector of the economy (or a field of technology), then the components and tools of that process management approach can reflect the hidden components of technology. In other words, the operational reforms of development assistance can reveal social dimensions of technology.

This route is rather speculative and implies that learning in development agencies can lead to elements of the social dimensions of technology that one cannot isolate by looking at individual technologies in a specific context. This is not as far-fetched as it appears at first sight, assuming that a 'technological style'[2] is the product not of firms or individual organizations but of sets of institutions such as schools, universities, firms, and governments in a particular region or country. In that case, the evidence for a technological style appears on an aggregate level. This article starts with such a speculation and attempts to pursue it further. Later, the concept of 'appropriate technology' can perhaps be replaced with a concept of 'appropriate organizations for technology,' where appropriateness consists of addressing the sociotechnical relations that an organization can attain. First, it must be shown that process management, as it evolves in some development agencies, indeed uses management tools and variables that are specific to a type (or layer) of sociotechnical relation. Demonstrating this here, I hope that much more empirical evidence can be added so that this induction can gain solid ground.

[2] A technological style is embedded in institutional complementarities among education, firms, and administrations in a country or economic sector. These complementarities are possibly more influential than natural resources and factor prices. Many institutional theorists refer to Max Weber's sociology to explain different industrial development patterns.

2. Comparing process management approaches

Development assistance is in a state of constant reform since the early 1980s. Two general trends are evident, i.e., the decentralization of operations and the regionalization of policy and projects in some development agencies. Many agencies were structured according to professional disciplines such that the agriculture department was responsible for agriculture in all regions, the energy department was responsible for energy in all regions, and so on. In the 1980s, agencies like GTZ (German governmental agency) and the World Bank were reorganized so that regional departments (comprising one to around five countries) are now responsible for all projects in their region and the former agriculture department is reduced to a service organ for the regional departments. The same is also true of the departments dealing with energy, water, health, etc. A second trend is related to this one; development agencies increasingly transfer operational responsibilities to their respective country representatives. These country representatives call on services from the headquarters at their discretion, thereby adapting operations to the local context. Whereas before the agriculture department started its policy and planning from agronomic data on productivity, for example, and then imposed technocratic improvements in standard projects, after the reorganization, a country department starts from the local context, firms, and administrations, and concentrates on the 'process' of a development intervention. 'Process management' thus concerns how organizations cooperate, who contributes what insight, who defines objectives, how to monitor and evaluate, who is responsible, and so on. These two trends were preconditions for specific process management approaches to appear.

However, it seems that agencies are not yet at the stage where different process management approaches are sufficiently defined.[3] Nonetheless, we can compare two proposals for process management from different fields of development assistance to see whether the relationship between technology and social context in one field is distinguishable from that in another field. If process approaches in agriculture in different countries resemble each other, then they are specific to the agricultural knowledge and not to countries. On the other hand, if they are only specific to the respective countries, then they reflect first of all political conditions. At the end of this article, we will see that the specificity to the field, e.g., irrigation or industrial sectors, appears more important. This would imply that informing process management with sociotechnical relations can be crucial to bring the process management innovations from different countries together and consolidate them.

The first proposal described here is by Mosse et al. [2], concerning agricultural aid projects. The second one is my own [3] proposal on process management tools for industrial technical assistance. The basis for a comparison of the two is the science studies programme endorsed by Latour [4], amongst others. I first introduce Latour's hierarchy of sociotechnical relations, describe process management in agriculture and in industry, and then assess

[3] Often they reflect the conditions inside a development agency rather than conditions of the field where the agency operates.

whether the differences correspond to Latour's conceptualization of sociotechnical relations. The first objective is to see whether this comparison is feasible. As yet, no process management approach in development aid is sufficiently advanced, or its sociological analysis consolidated, for us to be certain of a correspondence between unknown social dimensions of technology and process management tools. By linking process management efforts to the science studies programme of Latour, we can enrich and advance the definition of 'process.' The level of abstraction necessary to describe sociotechnical relations allows only to verify whether such process management is coherent with theory, but not to predict or guide how it could evolve.

Such a comparison of process management has to consider that these are the results of ethnographic fieldwork. Applied anthropologists use participant observation to work in and on development assistance. This imposes a problematic conflict between the fieldworker's methods and the cultural distance/power in development discourse and development practice [5]. Comparing process results is therefore also a comparison of the utilization and exploitation of ethnography for development agencies' objectives. This comparison complements ethnographic evidence with social theory in an original direction. Strengthening the theoretical basis of ethnographic results is important to 'defend' their quality with respect to agencies' agendas and to encourage more process research through participant observation. Such a comparison is not strictly empirical; one has to account for the fact that process research cannot be generalized.

We are looking for context adequacy of technology. What are the social and cultural conditions of technology that make it useful, meaningful, or developmentally effective?[4] Scholars such as Denis Goulet and Galtung [6] suggested in the 1970s that 'underlying technology, there is a certain cognitive structure, a mental framework, a social cosmology, serving as the fertile soil in which the seeds of a certain type of knowledge may be planted.' Their metaphor was on track, but the cognitive structures assumption leaves open the naturalization of unknown social knowledge characteristics, and thus the metaphor turns the wrong way. Klitgaard [7][5] suggested that social scientists should attempt to change cultures themselves just as agronomists study soil composition, a suggestion that leads to a behaviourist programme. There are no essential soil nutrients of cultural phenomena in humans to which to tailor development projects. Until today, there is little insight on what technology is adequate for a particular development context.

[4] Arguably, the economic adequacy of technology, the relative prices of inputs and outputs, are not a sufficient condition for appropriateness. In some cases, even economically inappropriate technology can be shaped to local economic conditions and institutions by ingenious reverse engineering or policy modifying factor prices.

[5] "After collecting such decentralized sociocultural data, the task is to study their connections with local development outcomes, such as indicators of economic development, loan repayment rates, success of family planning programs, educational outcomes, and so forth. The result might in turn suggest experiments to local people, perhaps abetted by external assistance as they try to take their symbolic soil conditions into account." He then recalculated the correlation between Social Soundness Analyses and project success, but these suggestions have not been further pursued.

3. Layers of sociotechnical mediation

Latour's humanist programme of studying science and technology is built on refuting the dualism between the natural (or material) and the social. Instead of treating technology on one side and then adding some independent social dimension, Latour shows constantly that only a hybrid object of analysis, containing human and nonhuman elements (a symmetric anthropology), allows to understand how humans create technology and what they do to themselves in the process. He reconstructs the hybridity, the nonhuman relations transformed into human ones and vice versa, in all his empirical cases, first for research in biology at the Salk Institute, to his latest case, the Aramis transport system in Paris [8]. Using the diversity of his reconstructions of hybrids, he derives types of these transformations, as instructions, translations, enrollments, and displacements between human and nonhuman elements. This diversity spanning basic science, up to simple artifacts in everyday life, needs to be stressed here because that range is important in order to show the applicability of his programme to the range of process management in development.

To transcend case studies of actors and networks sustaining scientific facts and technologies, he introduced a hierarchy of 11 distinct layers of sociotechnical relations, each with a type of 'crossover' where human parameters are transformed into nonhuman ones and vice versa [9]. This hierarchy is a new departure; instead of defining these transformations, it classifies the objects (social and material) these transformations bring together. Each layer corresponds to a type of sociotechnical relations and the crossovers consist of the change from one type to the next type of sociotechnical relations:

> Each of those crossovers results in a dramatic change in the scale of the collectives, in its composition, and in the degree to which humans and nonhumans are enmeshed [10]... For each layer of meaning, whatever happens happens as if we are learning, on our contacts with one side, ontological properties that are then reimported to the other side, generating new, completely unexpected effects [11].

For simplicity, I present these layers more descriptively, referring readers to Latour's analytical presentation. As these layers alternate between human and nonhuman relations, the uneven ones are human and the even ones are nonhuman in Latour's convention.

At the highest (11th) layer, Political Ecology, nonhuman conditions such as climate change or ozone depletion are interpreted into human relations (obligations of OECD countries to stop squandering global commons, for example). Such interpretations, the 11th–10th *crossover*, can take place at international negotiations and in the mass media. Latour labels these nonhuman conditions Technoscience, the 10th layer, the fusion of industry and science. Technoscience constitutes the origin and the options for the planet. This constitution thoroughly mixes up the contributions and interests formed at the ninth layer, labelled Networks of Power [12], comprising global organizations running vast economic structures such as the electricity grid or the global food trade. Their organizational logics create the input into Technoscience. This 10th–9th *crossover* is the one where washing machines, powder, clothing, and electricity meet, and where telephones, TV, and computers converge and create the modern consumer choices. Unfortunately, this ninth layer is not a pure power

game because these organizations are conditioned by factories that constitute their nonhuman constraints. This factory level, the eighth, is labelled Industry by Latour. The ninth to eighth *crossover*, from Industry to Networks of Power, is the matter of entrepreneurs and financial markets, for example. At the eighth level, industrial engineers are at their best organizing human actions to operate machines and automates. The human conditions constraining the engineers are education systems, labour, or transport infrastructure—the seventh layer, called in allusion to Mumford [13], the Megamachine. The Megamachine is made with administrations, accounting, political organizations, and cities. The eighth to seventh *crossover*, from the Megamachine to Industry, consists of much legislation and demands on industry's products (this crossover concerns the process research in industry described later). In this crossover, British coal capitalists once argued that only children could work in the mines (in the 18th century) because adults were too tall. The change in that crossover is radical; nowadays, educating children to become mining engineers is more productive. Below, at the sixth layer, lies the Internalized Ecology—agriculture and the domestication of animals; the exploitation of the biosphere, villages, and farms necessary to the Megamachine's functioning. Therefore, the seventh to sixth *crossover* consists of local trading, medicine, or nutrition (this crossover concerns the process research on irrigation described later). For space, I stop this description here, "at this level we pass beyond the gates of history and enter more profoundly those of prehistory, of mythology" [14]. The fifth layer corresponds to Society and social order; four is Techniques such as the plough; three Social Complication where humans rely on other humans' use of tools; the second is labelled the Basic Tool Kit; and the first concerns Social Complexity at the level of primate groups (Table 1).

New phenomena such as the Mad Cow disease call for complex revisions of different crossovers and sociotechnical relations on different layers. Their novelty can challenge age-old political and social alliances, and rearrange sociotechnical relations between the layers. The disease originates in the Megamachine, whose economic rationale can rearrange

Table 1
Layers of sociotechnical relations

State of social relations	Crossover	State of nonhuman relations	Developmental objects adequate to a Layer
Political ecology	← 11–10		climate mitigation (JI, CDM)
	9–10 →	Technoscience	?
Networks of power	← 9–8		e.g., technological momentum of cogeneration insufficient
	7–8 →	Industry	?
Megamachine	← 7–6		e.g., reification of irrigation management
	5–6 →	Internalised ecology	perhaps many health projects
Society	← 5–4		possibly 'sectorwide' projects
	3–4 →	Techniques	possibly 'livelihood' projects
Social complication	← 3–2		
	1–2 →	Basic tool kit	
Social complexity			

industrial conditions but much less the systemic conditions of rural communities, where the unintended and new nonhuman condition appears nonetheless. Possibly, the disease can be prevented either on the sixth or the seventh layer, or between them.

This hierarchy of sociotechnical mediations is admittedly speculative, but as Latour always insists, there is hardly an alternative to avoid the essentialisation in opposing society to technology. Such a typology is required to say something about the translation of material conditions into social relations, and this is what development aid often claims to be about. Despite the empirical complexity, the social reality of using technical knowledge in another society than the one where it was created should resonate in science studies. This social reality comprises the professional habits of development experts and volunteers, the individual and institutional discourses, the planning practices, management approaches, and other rules of the ''development industry.'' The question as to which aspects of development aid are most directly connected to sociotechnical relations is theoretically difficult, but even more so empirically because the social reality of aid is sparsely documented. The huge amount of grey literature in development agencies contains perhaps sufficient evidence to define the change of human and nonhuman conditions articulated by development practice. But this literature is not accessible and its analysis is an equally immense undertaking.

Introducing sociotechnical relations to development theory should reduce the modernization ethos (and myths) in development more readily than in science policy. On the nonhuman layers as much as in the human layers, technology and the social context are mutually dependent and causal. A development intervention that mobilises technology triggers changes in the sociotechnical relations embedded in technology and in the sociotechnical relations existing in the local social context where the intervention occurs. This could be the key contribution, as the technical knowledge transmitted by the development intervention should be described with the same concepts as those at the local context. In place of ''appropriate technology,'' the analysis concerns the differences in sociotechnical relations, a type of sociotechnical relations preexisting and another type introduced from outside. For example, a technology created in a social context, where sociotechnical relations of the Megamachine-type exist, contains these sociotechnical relations in embodied form, but these sociotechnical relations change when the technology is brought into another social context. In addition, the new social context can be dominated by a different type of sociotechnical relations, say Internalized Ecology.

Little is known of these sociotechnical relations (and development policy makers would reject them anyway, being ''afraid of mob rule'' as Latour qualifies the authoritative dismissal of anything else than the one objective reality known only to the expert), but the implementation of a development intervention should nonetheless lead to evidence for changes of sociotechnical relations. Improving our understanding of the extent of the unknown can be an advance for development theory. If, despite the theoretical speculation involved, the evidence resembles the speculation, additional insight into the matter of process monitoring/research can appear, at least. At most, there is simply no alternative to the assumption that particular social structures facilitate the accumulation of skills and technical knowledge in a different manner than other social structures, which made Galtung to assume undefined cognitive structures. Latour's ambition of a symmetric anthropology certainly

suggests an application of his theory to the organizations dealing with the historical heritage of the asymmetry (the alterity between the colonial power and the peoples dominated) from which the discipline anthropology came about. Introducing sociotechnical relations into an analysis of development practice is in fact addressing both asymmetries at the same time, the asymmetry between north and south, and the asymmetry between human and nonhuman conditions.

4. Process documentation and monitoring in agricultural development

Mosse et al. have produced a comprehensive overview of research approaches subsumed under the heading of process monitoring/research. It is the result of a decade-long research mainly at the Overseas Development Institute (ODI) in London. Mosse et al. resume the most influential process management innovations from sociology and anthropology of development of the last 20 years. Most prominent amongst these sources are the works of David Korten [15] in the Philippines and Salmen [16] in urban Latin America. Korten showed that development interventions need to be flexible and iterative as the social context is too complex for 'blueprint' projects (where project inputs and outputs are only assumed to be causally linked). ODI appears to exert more influence on the aid policy debate than university departments specifically created for development research.

Mosse et al. expands on Korten and Salmen's results and proposes six more specific purposes for which process management approaches are being tested: to include new and more complex objectives in development efforts, to innovate development policy, to improve evaluation and impact studies, to facilitate the collaboration between development agencies, to understand the institutional conditions in development efforts, and, finally, to expand the political roles of development interventions. These six purposes are not all compatible and sometimes conflicting. Mosse et al. show thereby that the process management currently tested can expand in different directions. A process management approach can be specific for one or two of these purposes. ''Different process monitoring approaches need to be used selectively, the type and timing of work being dictated by objectives, circumstances, and the type of development work involved'' [17]. This implies that a process management approach can be specific to an economic sector, which we need for the comparison with Latour's theory. For Mosse et al., the type of development work involved corresponds first of all to the specific developmental organizations, different NGOs, or governmental administrations. Later on, we will relate the type of development work to sociotechnical relations and see whether the latter allow to qualify the type of development work not according to the specific organization but to these organizations' role in the economy. This also serves to qualify the six purposes of process management approaches that Mosse et al. suggest.

The most detailed process information is produced from village-level participant observation by long-term resident researchers. Less intensive research can use routine meetings of project staff or other events in the context of the development interventions such as village meetings. Process management comprises the use of the information gained, the medium used to distribute the results, and the reactions and interpretations of the concerned people to the

results. 'Process' refers also to the systemic conceptualization of the information matter treated. 'Management' comprises everything related to the production and consumption of process information—by whom, when, how it is being used, analysed, and then applied. The conditions of participant observation as research methodology are obviously central to achieving this systemic conceptualization. Mosse et al. do not suggest which conditions of participant observation are most important.

Most of the research results Mosse et al. described discuss how social structures are affected by development interventions. Sometimes these results themselves are useful without a corrective measure to the development intervention, possibly by preventing counter-productive activities. In other cases, the organization of project implementation was modified, e.g., by creating different structures for different castes represented in an Indian village [18]. The research results have sometimes been useful below the project level, at times at that level and on the national level. In both countries where most process researches described by Mosse et al. have been used, Philippines and India, the results obtained have also led to important changes in agricultural policy nationwide. Water Users' Associations have become new actors and local and national political bodies attempt to nurture and empower these associations, replacing governmental administrations.

The relation between development intervention and process research is complex. The research methodologies shape this relation as much as institutional interests and ideological differences among NGOs, governments, villagers, and researchers. For this reason, it is often difficult to draw a general conclusion from the results. Since process research seeks to reveal the unique dynamics of the development intervention, the specificity of the local context and the adaptation of the technical packages involved are important. As the research objective is the unique character of the intervention, the quality of the research results is unique as well.

The potential mutual benefit between the development intervention and the research activity is to advance both understanding and change. The economic reality of the caste relations being modified by the development intervention is that researchers can observe the social relations being opened up, something they would not have been able to speculate about without the intervention. On the other hand, the development intervention attains a reflexivity that is only possible from scrutinizing its implementation. The mutual benefit is also highlighted by the conclusion that the process research is more effective when there is a better-defined developmental intervention, e.g., an irrigation system, as a defined technological package comprising machines, water flows, and maintenance. When the intervention is less well defined, such as in small-scale farming systems, process research results are less salient [19]. One possible cause would be that the impact of the development intervention is less separable from other economic activities of the project participants. Another potential cause is that the irrigation intervention involves knowledge and skills that are more salient in the local context, not more or less linked, but more prominent in whatever social changes are occurring at the time. This invites an examination of sociotechnical relations as a way to assess this prominence.

My hypothesis is that process research is more successful when the development intervention uses a technical modification of the economic activity that corresponds to the social relations underlying this activity. Agricultural production is one arena where power and

income in the village are determined. The development intervention targets the resource efficiency of this production system and, thereby, one arena where social relations in the village are determined. I speculate that the changes to the local social relations are not intrinsic to the irrigation technology used (water harvesting, percolation tanks, and other systems). Therefore, the process research can reveal opportunities to use the development intervention to shape changes in social relations. By offering villagers the potential to shape the social impact of the development intervention via the application of technological knowledge, these social changes become feasible. This does not necessarily require appropriate technology or creating new irrigation methods. The complexity of irrigation systems creates choices in making a system socially meaningful without altering the instrumental core of the irrigation knowledge (its physical properties, the nonhuman relations in Latour's terminology). Feenberg [20] describes the potential of using technology for different social purposes than the original ones as "subversive rationalisation." The instrumental core of the irrigation knowledge is available even for contradictory ideologies. Different ideologies are quite present in development interventions, and process research might be an approach to such subversive rationalizations.

There seems to be no pattern in process research results regarding the field of development intervention. While most process researches started in irrigation development efforts, these research approaches have been demonstrated for forestry, aquaculture, small-scale savings, and other finance projects, all in rural areas and all in south and southeast Asia. An exceptional case is described by Rew and Brustinow, who stretched the process research methods to the limits when they worked on the privatisation of Soviet-style collective farms in different regions of Russia [21]. Rew and Brustinow define the process research outcome as an 'institutional resolvent' where conflicting visions of the development intervention can be addressed. Whereas in the irrigation cases, the process research aspires to allow local social groups to influence the development intervention, as "it is all too easy for outsiders to misinterpret events or to draw conclusions insensitive to the positions of key actors" [22], process research on farm privatization appears to rest more on the credibility of foreign sociologists and ethnologists who can provide insights in local social realities in a former command economy. One might investigate whether the process research outcomes are shaped by context-specific opportunities for institutional resolvents (the Water Users' Associations being another example). Process research would consist of the capacity to detect and foster such a resolvent. However, process research could well comprise more diverse outcomes than new institutions or new institutional functions. An enlightening parallel with the work of Law [23] on social ordering and, in particular, on modes of accounting provides an interpretation of process research suggesting a more versatile diversity of process research outcomes.

Law's anthropology of management information systems in a nuclear physics laboratory presents a typology of organizational syntax.[6] He opposes empiricist and instrumentalist

[6] Law's and Latour's science studies are of course part of the same research programme. Law used similar ethnographic means as Latour in the Salk Institute, but whereas Latour concentrated on the research objects and experiments, Law studied the laboratory management. Both assume that either focus brings them to the relations between human and nonhuman parts of scientific work, its hybridity.

information systems with a poststructuralist one. The first two generate subject–object distinctions that lead to control regimes; manpower (in the case of the laboratory) is transformed into an object of control. The accounting tools have inherent capacities that determine the status of the subject controlling and the controlled object. The format of documenting how much time researchers spent on a particular project and the analysis of this information assumes that the "true cost" of a laboratory project can be determined and managed. A poststructuralist system implies a different subject–object relation. Law demonstrates this by analysing agendas and minutes of meetings. Individuals and activities in agendas appear in an open relationship. "So in this politics, a politics of involvement rather than command, the very character of subjectivity is linked to the appropriate performance by the subject as an object" [24]. "Which implies that subjects endlessly turn themselves into objects—objects of the rules and procedures which, for instance, take the form of the standing orders or conventions which are performed at meetings. While, at the same time, objects are similarly constantly turning themselves back into subjects so that they may judge whether or not the rules have been properly followed" [25].

This research applies well to the process approaches of Mosse et al. Each exercise in process research should be definable in terms of subject–object transformations. While these are in flux, a process research exercise corresponds to a new twist of these transformations. The periodical process reports, pivotal in many cases described by Mosse et al., contain post-structuralist information elements, for example, by providing attributed space of the reports to concerned groups, assuring everyone that the groups' textual product is not edited. Likewise, the agenda items of meetings evolve over time in process research. Consolidating process research with Law's classification of management information systems cannot be pursued here but it should be evident that this will provide much headway. Process research should not be subsumed into science studies because the developmental knowledge has specific characteristics regarding the political context of north–south relations. The objects feasible in development interventions must obey strategic interests from trade, geopolitics, and humanitarian aims, and these are not negotiated in the same manner as a scientific object definition.

5. Process research in technical assistance projects in industry

My work [26] on aid project management in industry reconstructs the relations between local and foreign participants. The content of the social processes observed during project implementation in industry can be compared to the information content of agricultural development interventions. The purpose of this article is to explore whether differences in these contents reflect differences between sociotechnical relations in agriculture and in industry. Contrary to a first assumption one might have, project implementation in industry and the communication between local and foreign engineers are very much determined by cultural factors and differences in perceptions about the knowledge involved in the development intervention.

In case studies from Mexico on power plant construction and from Chad on manufacturing in the informal sector, the implementation resembles a continuous misunderstanding of the

interests, objectives, and competences of both local and foreign project participants [27]. Rather than an arena where strategic interests are negotiated, the implementation is closer to a labyrinth, where the participants never manage to gain a sufficient understanding of the developmental knowledge, the actors present, and the different logics that animate them. All projects studied were funded by the World Bank, whose clients were local government agencies, and the technology experts employed were formally equals. The projects were in a stage where the decor and the script are never quite known. When the curtain falls on the stage, after several years of implementation, what is left is the participants' impression that they have not been treated honestly, and that they still do not understand what the skills and needs of the other side (local/foreign) are. Nonetheless, the case studies reveal that the participants appreciated that there were no direct conflicts of interest as the economic parameters of the technologies were in line with the interests of all parties. The cogeneration power plants would have created more work for the US consultants and increased Mexican oil exports. Similarly, the agricultural implements manufactured in Chad would have replaced imports, freed foreign exchange, and created more business for the French NGO and the Chadian artisans. Something else than the immediate (technical) objects was at stake in project implementation and should be process management matter.

The differences in the economic and historic situation of Mexico and Chad are as big as they could possibly be. The resemblance of some communication mechanisms between foreign and local participants leads to the hypothesis that these reflect the deficits of the state-of-the-art in management of industrial technical assistance, rather than the economic and historic context. Three latent processes are responsible for the dynamics of project implementation in Chad and in Mexico and each latent process dissolves a paradox [28] currently appearing in evaluations and other outside assessments (from journalists or international relation writers). The first paradox lies between the outside observation of the participants' confrontation on technology and their agreement over its adequacy (content process); the second paradox is between the observed accuracy and the irrelevance of their products (exchange process); and the third paradox is between the participants individual intentions and their effects (interface process). The paradoxes are due to the idiosyncrasy of project implementation. The participants cannot render their logic understandable to outsiders, planners, and evaluators. All three processes are intrinsic to implementation, latently reproduced anew by the participants in each development project. The organizational and managerial deficiencies result in the resemblance of implementation even in these rather different contexts.

The comparison of the project ethnographies yields the following definitions of latent processes. The content process was created by the participants presenting sociocultural ends of technology as context-independent and intrinsic to the technology because they could not themselves explicitly express the professional habits in the organizations where they had gained their experience. This misrepresentation became a vicious circle, creating misunderstandings between locals and foreigners. In Chad, this circle was enacted almost daily. For example, the French asked the Chadians whether they preferred scale drawings, full-size gauges, or section drawings, and were pleased that the Chadians' choice confirmed their own opinion that gauges were best. Both sides actually used the same reasoning for preferring

gauges but they could not question the other side's reasoning and so ignored that this reasoning was context-independent. Concerning other aspects, the Chadians qualified some solutions as "too ugly" for certain customers, and these obviously sociocultural criteria were treated between French and Chadians in the same manner as the choice of gauges.

The second one, the exchange process, appeared when technical knowledge was used to act upon the cultural distance (alterity) between the participants. The exchange dynamics concerns both knowledge and identity. In Chad, the cooperation was an exo-social process [29] because the technical knowledge was used to act upon the cultural differences (alterity) of the experts and to diminish any sociocultural content that it may have accumulated. Technical objects (tools, prototypes, etc.) can be physically destroyed when they become negotiation matter for identities between foreigners and locals in such an exo-social process. The foreign experts found themselves in agreement with the Chadian experts in their judgment of individual Chadian artisans, even though they always avoided discriminating among the artisans. In Mexico, on the other hand, the conditions of the cooperation were endo-social. When the technical knowledge cannot serve to distinguish individual identity, these objects cannot be adapted to the local context. Everything was spoken in Mexico, but the more they said, the less they understood about each other. Both sides appealed frequently to thermodynamics knowledge of an individual expert, for example, but in the end concluded that all on the other side hid something (incorrectly so). The articulation of this second latent process depends on the historical and social context. In a particular project, it can be, more or less, prominent, but the same process should appear in all cases in the same context. The foreigners and the locals, respectively as a group, position themselves by defining their global position as a social identity.

Finally, the third one, the interface process, consists of the failures of the participants' interpretation of their behaviour (Long and Long [30] have established a large body of 'interface analysis' in rural development). Each side developed a folk theory about the others and these folk theories adjusted and rehearsed certain errors so that a degree of misunderstanding could be stabilized after several months of interpretation failures. Afterwards, small shifts in the interface appeared saliently in the discourses.

Process management in such development interventions is concerned with the means and tools for project participants to affect these latent processes determining project implementation. These means comprise the enunciation of sociocultural ends of technology, the linkages between cultural distance and technical knowledge, and their interpretations of individual work. All organizational aspects of implementation can be used to influence these processes: the division of tasks and responsibilities, the format and analysis of data by the project, housekeeping, inventories, salaries, budgets, meetings, the communication of results, and relations with other institutions [31]. The definition of these organizational aspects follows from participant observation during the implementation, and is specific to the dynamics of a group of foreign and local participants. The latent processes as identified above translate into management modifications that the participants can assess and use to shape their relations.

A process management exercise would establish the coherence of these organizational means, and incorporate other economic and political aspects as well. One major difference with the process management in agriculture is the scope of these means. The various factors

of the latent processes are the social and cultural context of development interventions, but these processes are constructed by individual participants. Process management in agriculture concerns the interactions between the development intervention and the social groups in the village concerned, whereas in industry, the interactions between individual participants are more central. This reflects that the technical knowledge involved is recent, acquired by these individuals and not socially interpreted from a wider perspective. A claim that the technical knowledge is 'not symbolically overdetermined' would contradict Latour's programme because technical knowledge does exist outside of social relations. In agriculture, the relations among local government, extension workers, rich and poor farmers, agronomists, local and foreign NGOs, and development donors are the matter of process management. These relations provide the necessary local and historical context. In industry, on the contrary, the Chadian artisans and the Mexican engineers have individually stepped outside of their social networks and interpreted their relations on a larger, mostly national level. Their participation in the development intervention can only be understood in light of the professional socialization of these individuals and general relations between Europe and Chad, and between the US and Mexico, respectively. In industry, the process management, therefore, must concentrate on relations between individual participants and less on information exchanges between the development intervention and the locally important social groups.

We started with the assumption that through the comparison of different process management approaches 'discovered' in development agencies, an alternative route to understanding the context adequacy of technology is feasible. This implies that these agencies experiment sufficiently with different operational means to learn how to adapt developmental knowledge and hidden social components of technical knowledge to the local context of a development intervention. Having presented two different process monitoring/research proposals, we can judge whether this alternative route still appears feasible. Indeed, the process approaches described by Mosse et al. and Grammig contain enough operational variables to allow specificities for countries, economic sectors, and technologies. The case studies from irrigation systems in Mosse et al. contain elements that reflect the caste system in Tamil Nadu, for example. ODI's experimentation over the last 10 years has produced elements of context adequacy of technology. The latent processes appearing in industrial technical assistance also provide many different configurations. The content process reflects experts' professional socialization (the exchange of knowledge was exo-social in Chad versus endo-social in Mexico) and different interface configurations [32]. These different configurations allow to experiment and adapt development interventions. Agencies' general reluctance to admit participant observation on their operations and to acknowledge science studies has prevented process experiments in industry so far, but the empirical evidence suggests that this is quite possible. The initial assumption for the comparison is still valid, both for the agriculture and the industry projects studied.

The concept of sociotechnical relations will allow to pursue this comparison in a different manner, notably in this case the linkages between the individual participants and the technical knowledge treated. Because of these linkages, development interventions engage social processes to which the organizations involved in such interventions need not be related at all.

6. Sociotechnical relations and process monitoring/research

What can process research gain from the hierarchy of sociotechnical relations where each layer has a distinct ‘‘degree to which humans and nonhumans are enmeshed’’ [33]? Process research can depart only from the issues arising during project implementation. Whether it deals with new institutions to resolve conflicts or new monitoring or information channels to document implementation, process research cannot introduce assumptions about sociotechnical relations. However, the issues arising during implementation can be scrutinized as to whether they reflect sociotechnical relations. If this is not the case, nothing changes with respect to the research methods or research results obtained.

A first remark to be made is that development interventions of the blueprint type tend to be presented in apolitical terms, as concerning only nonhuman relations. There would be no actual choices in implementation affecting social relations in an unforeseeable way because the nonhuman component would be ‘natural’ or mechanistic. This is impossible even for the first layers. In fact, purely technocratic interventions often change social relations as much as humanitarian aid. For this reason, process research leads to new development objectives (one of six purposes Mosse et al. put forth) because when development interventions alter sociotechnical relations, each intervention automatically creates new objectives. Focusing on sociotechnical relations, process research can contribute to mending both asymmetries in development assistance, i.e., the order between providers and recipients, and the order between human and nonhuman objects. Perhaps, both have to be overcome simultaneously to knock down the rigid traditions in donor organizations. Both symmetries are axiomatic in science studies.

There are two grounds to establish the comparability of the research areas agriculture and industry: (1) the technologies or other aspects that these development efforts mobilise can be shown to be comparable, and/or (2) the research methodologies that are being used. In both contexts, ethnographic fieldwork is the exclusive method. Participant observation reveals differences in worldviews, beliefs, attitudes, ‘othering,’ related cultural interpretation habits, and so on. While ethnographies often reflect individual research skills, the results are similar in both areas in as far as they reflect social identities and types of education amongst project participants as sources for the differences in the meaning given to development interventions. In both areas, process management helps to articulate these differences and reduce, thereby, the cultural distances. Without implying a unified ‘development discourse,’ the identity formations in industrial and agricultural projects can be assumed to be of similar character. So, we look here at the first ground for comparison, i.e., the technologies, to see how process research reflects sociotechnical relations.

A development intervention can concern only a nonhuman relations layer, only a human relations layer, only a crossover between two layers, or a combination. What follows from the assumption that the seventh to sixth crossover, from Internalized Ecology to the Megamachine, contains the sociotechnical relations amongst whom Mosse et al. have defined their process research approaches? The Internalized Ecology layer contains the imprinting of society onto large spatial features, infrastructures linking rivers and cities, regional specialisation of agriculture, changes in landscapes, and so on. The stock of natural resources is

being defined by creating production patterns that fit society's needs. Latour sees Mumford's theses as the best description of the Megamachine. On the Megamachine layer, organizational means are employed to expand material techniques. The villagers' history of central government administrative 'straightjacketing' was frequently the obstacle for process research (and the intervention). However, many government officials as well as villagers were willing to cease the established irrigation administration and management and redefine them anew. The process research has helped them to unlock this crossover, and so, the Megamachine is to be weakened against its internal coherence. The precondition for the Internalized Ecology is a social order, where social hierarchies and divisions of labour are elaborated. Irrigation systems represent physical conditions in which human relations exist and these systems are reinterpreted to shape its possibilities for development. Latour calls the crossover from Internalized Ecology to Megamachine human relations a 'reification.' Reification can comprise a radicalisation of social organization over and above what is necessary for the sake of social order. That both the villagers' new Water Users' Associations and the government administrations were able to redefine the irrigation management and give up their older vested interests can be interpreted as reflecting that this reification was felt on both sides as an obstacle to overcome.

The development interventions that Mosse et al. analysed indeed show the difficulties of using features of nonhuman conditions to change parts of social organization that go beyond social order (and for reasons of optimizing physical conditions of production). Process research focusing on the implementation of a development intervention ends up describing how social structures are affected by development activities. Mosse et al. note in their chapter Critical Concerns:

> The positive effect of abandoning external research perspectives and working within existing systems is, therefore, enhanced power to advance development initiatives, to create the necessary consensus, resolve differences and validate progressive change. But there are costs, too. The removal of critical reflection may allow the perpetuation of mis-conceived models, may foster self-serving institutional collaboration or contribute to covering over the gaps between intention and action [34].

The conceptualization of sociotechnical relations indicates that process research on project implementation should inherently reveal social realities as the development intervention comprises irrigation methods that embody elements of social order. Critical reflection is not lost even when one does not elaborate a critical theory of irrigation methods. When Water Users' Associations are being formed and Megamachine-type organizations can endow them with social characteristics for their integration, this crossover cannot contain a misconceived model and still expresses cultural and political choices that are historical and in a flux. Particular sociotechnical relations are embodied in the irrigation methods and other such relations have been produced locally before.

Perhaps the outcome of the development intervention contains limits or deficits of the process research, but this research should never be able to supplant the integration of a Water Users' Association in a new form of administrative straightjacketing. Placing the process research on the seventh to sixth crossover adds a macrolevel interpretation to that research,

beyond its emphasis on the grassroots and participatory policy goals. This interpretation complements the ethnographic ideal of revealing the insider perspective of the development intervention by suggesting that the insider perspective can contain elements of 'reification' between Internalized Ecology and Megamachine relations. Further, it suggests to look for Megamachine functionality in new administrative controls on irrigation systems. The concept of such sociotechnical relations also underlines the observation that the intervention creates choices for making an irrigation system socially meaningful without altering the instrumental core of the technology (the appropriateness of the physical parameters to the context is only a precondition for the intervention).

In the Philippines and in India, process research has been instrumental to establish a national legislation regarding Water Users' Associations. The seventh to sixth crossover should be further assessed whether such a wider application of research outcomes is intrinsic to that crossover. Other organizational means that define the exploitation of natural resources could represent opportunities of producing similarly versatile research outcomes. If this national legislation is considered rather successful, then what was responsible for the success? Possibly, the nonhuman conditions, the efficiency of resource use, or the human conditions—the Megamachine efficiency—are positively qualified, or maybe some groups appreciate the resource efficiency and other groups the human side (and it is an academic question). In light of the stakes involved in irrigation, it is unlikely that change of a crossover itself, as a social experiment for the sole sake of the experiment, could be seen as a positive outcome of this legislation. Seen in the context of sociotechnical relations between the sixth and seventh layer, Mosse et al.'s process analysis gains, justification and methodological reservations (mistaking the reification for a lack of critical analysis), are reduced.

On space considerations, we proceed likewise only with the abovementioned development interventions in industry, the cogeneration project in Mexico. It comprised efforts to change industrial technology, increasing the complexity of production structures and creating a higher (thermodynamic) integration of the energy equipment employed. Such interventions occur on the ninth to eighth crossover, from nonhuman to human relations layer (the same direction as the agriculture interventions). Establishing cogeneration power plants in Mexico changes the nonhuman conditions in Industry (eighth layer), which derive from the Networks of Power layer ('private power development' in the energy policy jargon):

> The extension of networks of power in the electrical industry, in telecommunications, in transportation, is impossible to imagine without a massive mobilization of material entities. Hughes' book is exemplary for students of technology because it shows how a technical invention (electric lighting) led to the establishment (by Edison) of a corporation of unprecedented scale, its scope directly related to the physical properties of electric networks. Not that Hughes in any way talks of the infrastructure triggering changes in the superstructure; on the contrary, his Networks of Power are complete hybrids, though hybrids of a particular sort—they lend their nonhuman qualities to what where until then weak, local and scattered corporate bodies. The management of large masses of electrons, clients, power stations, subsidiaries, meters and dispatching rooms acquires the formal and universal character of scientific laws... the intimacy of human and nonhuman is less apparent in Networks of Power than in Political Ecology [35].

According to the project objectives, the cogeneration feasibility studies produced should have introduced a new type of relation between the Mexican government and the industry groups involved, arms-length guidance instead of command and control. The intervention failed there because the studies only contained engineering knowledge and could not refer to historic conditions of Mexican industrialization. Cogeneration technology is only effective when the private companies and the government-controlled utility enter into a relationship, where they anticipate each others' planning and plant management. Process research did not lead to social structures involved in the development intervention because the technology did not involve social relations at the intervention level. Differences in project outcomes affected first of all the careers of the individuals involved. The three latent processes that shaped the intervention were placed on a higher level of aggregation (economic sector or country) than the intervention. Enabling project participants to seize these processes will only permit them to attain the Networks of Power conditions when they improve their mastery of the technology far beyond what was achieved. Probably, the Networks of Power conditions for industry put even greater demands on process management. More than in the case of agriculture process research, any new communication or consensus formation in industrial development interventions passes via the individuals.

This pegs the question as to whether different sectors would allow to attain Networks of Power-type human relations. In other words, do different technologies, or another sector of the economy, contain interests that facilitate an opening of Networks of Power relations to alter the industrial structures[7] [36]? An answer to this question has to start from the structure of Mexican industry because this capacity cannot be inherent in technology. If other sectors do not allow to affect Networks of Power relations, process research could be limited only to managerial and operational issues relevant to development agencies. Rather than being an indication that process research is not pertinent for the development intervention, this is an indication that the project objectives were too narrow. Hughes describes Networks of Power relations as constrained by the 'technological momentum' produced by the technical conditions in industry. This technological momentum is to be found in the various professional orientations of experts that shape R&D and operational innovation efforts. In order to affect the technological momentum of the power sector in Mexico, a development intervention has to comprise other elements of industrial relations besides technology, such as the legal framework or organizational aspects of the dominant parastatals. This interpretation is coherent with the process research results of the cogeneration project; to affect the latent processes, only organizational modifications changing expert behaviour and interpretations appear feasible. The experts' definitions of sociocultural ends, the linkages between cultural distance and know-how, and their mutual interpretations of individual work are the matter of process research in industry.

It is important to underline that the contextual role of local institutions is rather straightforward from the process research results on irrigation and in electric power

[7] For the energy sector, that would imply a potential change of the roles of Pemex and Comisión Federal de Electricidad (CFE), the two large parastatal companies. Pemex is the national oil company responsible for oil exploration and refinement, and CFE is the electric power utility company. The historical industrialization pattern locked the country's energy industry into a centralized organizational structure and technological pattern.

generation. In other words, both process research results described here allow to delimit the institutional aspects of the development intervention, how the developmental content is relevant to local institutions. This is an obvious conclusion, but one with quite considerable implications. The irrigation technology can be a vehicle for new local institutions; the cogeneration technology cannot. Both concern the transformation between a nonhuman relations' layer to a human relations' layer in Latour's hierarchy, irrigation from Internalized Ecology to the Megamachine and cogeneration from Industry to Networks of Power. This would reflect that the crossovers represent different scales of the collectives between human and nonhumans. Sociotechnical relations embodied in irrigation involved local groups, whereas sociotechnical relations embodied in cogeneration are at a higher level of aggregation than social groups. The difference between these crossovers would confirm that the technical conditions of irrigation allowed local groups to negotiate, whereas the technical conditions in cogeneration were evident to all experts and did not allow any negotiation to take place (economic interests were similar). Parameters of the organizations alone do not reflect this difference while irrigation allows a similar vertical integration than cogeneration; both contain many backward or forward linkages and remain as essential infrastructure systems. Rew stated that process research can lead to 'institutional resolvents.' Perhaps, such resolvents are specific to layers of sociotechnical relations. The Water Users' Associations are so policy-relevant for the governments that process research is politically effective. Obviously, other fields of development aid, which also concern the crossover between the seventh and sixth layer, are candidates for similar institutional resolvents.

The most profound difference between the process research in agriculture and in industry is that in the former, interests were negotiated and the research affected this negotiation. In the latter, the research did not change the negotiation but rather showed the absence of interests, which would make negotiation amongst the participants meaningful for their work. Some Mexican experts decided not to continue working on cogeneration because they judged that the foreign experts had manipulated and dominated the Mexican side, whereas other Mexican experts reproached the foreigners for not having imposed their engineering heuristics instead of adapting to local demands. Whatever was at stake between foreigners and Mexicans and between Mexicans, it could not have been brought to a conclusion with the engineering matter between them. Of course, in both areas, these results only reflect particular circumstances of these interventions. However, these results are conditional on the embeddedness of the technologies. This is also suggested by the observation that the companies involved in the energy technology project in Mexico continue to work together despite the relative failure of their cooperation. Interpreting the development intervention with the ninth to eighth crossover suggests that the research did not miss other social processes concerned. In the failed development intervention described in Mosse et al., the parties involved, USAID, and the local fishery administrations ceased to cooperate. The suggested that cause of this failure was that the technologies involved would have concerned agro-ecological priorities rather than socioeconomic issues [37]. This suggestion is unlikely when the intervention is part of the seventh to sixth crossover because a nonhuman condition in the Internalized Ecology layer can be socially reinterpreted by the institutions involved. There is no difference between agro-

ecological and socioeconomic conditions at the point where the agro-ecological ones are transformed into socioeconomic conditions (new straightjacketing). Another factor must explain why this intervention failed.

7. Conclusions

Understanding the relations between technology and the social context in development interventions requires a complex conceptual approach. Process research produces microlevel results, which can be qualified on a macrolevel by linking them with Latour's hierarchy of human and nonhuman sociotechnical relations. The confidence and scope of both the ethnographic method and utilization of the process research results are enhanced by interpreting them with sociotechnical relations. In order to ascertain this interpretation, more ethnographic results from different countries, sectors, organizations, and technologies are needed.

The operational reforms in development agencies during the last decade will be fostered by consolidating the process management tools and concepts discovered in different countries and sectors. So far, irrigation in India and the Philippines has been the most prominent process experiments. The comparison between process research in rather different sectors and countries has been shown to be feasible. It goes without saying that this is an invitation to agencies to build on the definition of sociotechnical relations to consolidate their process experiences. In order to achieve this consolidation, a theoretical frame that covers a large range of human and nonhuman relations is necessary. The hierarchy of sociotechnical relations discussed appears to serve this purpose. The hybridity among social groups, social interests, other social context, and the technological structures and industrial relations can be observed in situ during the development intervention. This conclusion resembles running through an open door. Doing this slowly is adequate at this stage, in particular, as an alternative to studying how the transformations (instruction, translation, enrollments, and displacements in Latour's terminology and in Actor Network Theory) between human and nonhuman elements constitute this hybridity. Comparing process research with sociotechnical relations is in line with Latour's declared aim for this hierarchy to overcome the endless collecting of ethnographic studies of the local, the complexity, and the indeterminateness of the context.

These comparisons can be pursued by assessing whether development interventions using new technology are more effective the more they affect sociotechnical relations. Process research would then reveal that the necessary organizational means must allow the actors concerned to reassign objectivity and subjectivity in order to achieve changes in sociotechnical relations. The communication tools used in process research described by Mosse et al. have been newsletters and other process protocols. These can be improved by analysing their circulation and the evolution of their content. Similar communication tools and subsequent analysis should be applicable in all fields of development interventions. The comparison of process research we could attempt here suggests when the context is a crossover from nonhuman to human sociotechnical relations, process research is likely to be more dynamic when the crossover is at a lower layer of sociotechnical aggregation (and worse with blueprint project planning). However, this is probably premature. Process research

on a development intervention about Networks of Power relations with more ambitious institutional objectives and communication uses than the cogeneration case can possibly unlock the ninth to eighth crossover as well.

Mosse et al.'s account of the role of Water Users' Associations confirms what the seventh to sixth crossover predicts, the reification of Internalized ecology into new institutions (Megamachine) at the next layer of sociotechnical relations. This interpretation of the process research reduces questions about the possible quality limits of the underlying fieldwork during the development intervention. The successful use of mobile phones in Bangladesh is perhaps another case of reification. Grammig's process results show that on a higher layer of enmeshing between human and nonhuman relations and a higher level of aggregation, the relations between individuals did not include a sufficient variety of interests and institutional entities, so that the negotiation within these relations become meaningful for the sector of the economy (electricity). The higher layer is a plausible explanation for this limited process research result. Some of the cases in Mosse et al. dealt mostly with data production, others more with the evolving relations between social groups defining data. For cogeneration, on the Networks of Power layer, the social identity and relations between individuals completely replace data. This is also the case for John Law's work on the Technoscience layer (the 10th layer). At the end of this first tentative comparison of process research, it thus appears feasible to anticipate the sociotechnical relations layer in the ethnographic work, improving the researchers' participation and observation efforts.

Summing up, the hierarchy of sociotechnical relations should be tested further. Development assistance brings out the differences between sociotechnical relations in developmental objects (technologies, policies, organizations) and in the local context. The social quality of these objects, hidden in their original context, reappears in international cooperation. The most important benefit of the sociotechnical relations hierarchy so far is to avoid separating the human and nonhuman relations to explain failure. Planners, evaluators, policy makers, and journalists almost uniformly fall back to suspect a failure of technology or project management (as in the USAID fisheries case in Mosse et al., or in the cogeneration case) when, in fact, the development intervention (and the process research) was not ineffectively realized but was only ill adapted to the differences in sociotechnical relations between the developmental objects and the intervention contexts. In most cases, the 'White Elephant' is a hybridity at the wrong sociotechnical relations' layer.

References

[1] D. Schön, B. Sanyal, W. Mitchell, High technology and low-income communities, Prospects for the Positive Use of Advanced Information Technology, MIT, Cambridge, MA, 1999.
[2] D. Mosse, J. Farrington, A. Rew, Development as Process: Concepts and Methods for Working with Complexity, Routledge, London, UK, 1998.
[3] T. Grammig, Technical Knowledge and Development: Observing Aid Projects and Processes, Routledge, London, UK, 2002.
[4] B. Latour, Pandora's hope, Essays on the Reality of Science Studies, Harvard Univ. Press, Cambridge, MA, 1999.

[5] K. Gardner, D. Lewis, Anthropology, Development and the Post-Modern Challenge, Pluto Press, London, UK, 1996.
[6] J. Galtung, Development, environment and technology, Towards a Technology for Self-Reliance, UNCTAD, Geneva, Switzerland, 1979, p. 6.
[7] (a) R. Klitgaard, Taking culture into account: From "Let's to How", Environ. Sustain. Dev. Proc. Ser. 1 (1994) 75–120;
(b) D. Gow, Social Analysis in the Nineties: Case Studies and Proposed Guidelines, DAI, Bethesda, MD, 1989.
[8] (a) B. Latour, Laboratory Life: The Social Construction of Scientific Facts, Sage Publications, London, UK, 1979;
(b) B. Latour, Science in Action, How to Follow Scientists and Engineers through Society, Harvard Univ. Press, Cambridge, MA, 1987;
(c) B. Latour, Aramis, or, The Love of Technology, Harvard Univ. Press, Cambridge, MA, 1996.
[9] (First published in) B. Latour, On technical mediation in philosophy, Sociol. Geneal. Common Knowl. 3 (2) (1994) 29–64.
[10] B. Latour, On technical mediation in philosophy, Sociol. Geneal. Common Knowl. 3 (2) (1999) 201.
[11] B. Latour, On technical mediation in philosophy, Sociol. Geneal. Common Knowl. 3 (2) (1999) 204.
[12] T. Hughes, The title of Hughes' chef d'oeuvre on the creation of electric power grids, Networks of Power, Johns Hopkins Univ. Press, Baltimore, MD, 1983.
[13] L. Mumford, The Myth of the Machine: Technics and Human Development, Harcourt, Brace and World, New York, NY, 1966.
[14] B. Latour, On technical mediation in philosophy, Sociol. Geneal. Common Knowl. 3 (2) (1999) 208.
[15] C. Veneracion, A Decade of Process Documentation Research: Reflections and Synthesis, Institute of Philippine Culture, Quezon City, Philippines, 1989.
[16] L. Salmen, Listen to the People: Participant–Observer Evaluation of Development Projects, Oxford Univ. Press, New York, NY, 1987.
[17] D. Mosse, J. Farrington, A. Rew, Development as Process: Concepts and Methods for Working with Complexity, Routledge, London, UK, 1998, p. 12.
[18] D. Mosse, J. Farrington, A. Rew, Development as Process: Concepts and Methods for Working with Complexity, Routledge, London, UK, 1998, p. 63.
[19] D. Mosse, J. Farrington, A. Rew, Development as Process: Concepts and Methods for Working with Complexity, Routledge, London, UK, 1998, p. 39.
[20] A. Feenberg, Alternative Modernity: The Technical Turn in Philosophy and Social Theory, University of California Press, Berkeley, CA, 1995.
[21] D. Mosse, J. Farrington, A. Rew, Development as Process: Concepts and Methods for Working with Complexity, Routledge, London, UK, 1998, pp. 155–194.
[22] D. Mosse, J. Farrington, A. Rew, Development as Process: Concepts and Methods for Working with Complexity, Routledge, London, UK, 1998, p. 150.
[23] J. Law, Organizing accountabilities: ontology and the mode of accounting, in: R. Munro, J. Mouritsen (Eds.), Accountability, Power, Ethos and the Technologies of Managing, International Thomson Business Press, London, UK, 1996.
[24] J. Law, Organizing accountabilities: ontology and the mode of accounting, in: R. Munro, J. Mouritsen (Eds.), Accountability, Power, Ethos and the Technologies of Managing, International Thomson Business Press, London, UK, 1996, p. 296.
[25] J. Law, Organizing accountabilities: ontology and the mode of accounting, in: R. Munro, J. Mouritsen (Eds.), Accountability, Power, Ethos and the Technologies of Managing, International Thomson Business Press, London, UK, 1996, p. 300.
[26] T. Grammig, Technical Knowledge and Development: Observing Aid Projects and Processes, Routledge, London, UK, 2002.

[27] T. Grammig, Technical Knowledge and Development: Observing Aid Projects and Processes, Routledge, London, UK, 2002, pp. 52–73.
[28] T. Grammig, Technical Knowledge and Development: Observing Aid Projects and Processes, Routledge, London, UK, 2002, p. 103.
[29] K. Ekholm, J. Friedman, Global complexity and the simplicity of everyday life, in: D. Miller (Ed.), Worlds Apart. Modernity through the Prism of the Local, Routledge, London, UK, 1995, p. 162.
[30] N. Long, A. Long, Battlefields of Knowledge, The Interlocking of Theory and Practice in Social Research and Development, Routledge, London, UK, 1992.
[31] T. Grammig, Technical Knowledge and Development: Observing Aid Projects and Processes, Routledge, London, UK, 2002, pp. 165–175.
[32] T. Grammig, Technical Knowledge and Development: Observing Aid Projects and Processes, Routledge, London, UK, 2002, p. 101.
[33] B. Latour, Pandora's hope, Essays on the Reality of Science Studies, Harvard Univ. Press, Cambridge, MA, 1999, p. 201.
[34] D. Mosse, J. Farrington, A. Rew, Development as Process: Concepts and Methods for Working with Complexity, Routledge, London, UK, 1998, p. 50.
[35] B. Latour, Pandora's hope, Essays on the Reality of Science Studies, Harvard Univ. Press, Cambridge, MA, 1999, p. 204.
[36] R. Monteforte, Organization of the electric power sector in Mexico, Util. Policy 3 (1) (1992) 149–157.
[37] D. Mosse, J. Farrington, A. Rew, Development as Process: Concepts and Methods for Working with Complexity, Routledge, London, UK, 1998, p. 41.

After studying chemical engineering in Frankfurt, *Thomas Grammig* spent 6 years as a consultant in development assistance. Following studies in development economics at Sussex University, he obtained a PhD in anthropology at the EHESS in Paris. From 1996 to 2000, he served as academic director with the Leadership for Environment and Development programme (Lead-Europe) in Bonn and Geneva. He is the author of *Technical Knowledge and Development: Observing Aid Projects and Processes* (Routledge, 2002).