Ethnography of a “High-tech”Case

– about Aramis –

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Summary

The first task of the anthropology of techniques is to establish a common ground between those who study traditional techniques and those, called sociologists, technologists, historians of technology or economists, who study modern, central or high-tech pieces of machinery. But even once this common ground is established, the main problem of this type of anthropology remains: how can we understand the social construction of artefacts together with the technical construction of society. To be sure we know that the two extremes –technical constraints and social relations – and the dualist explanation they entail are now useless. We are also aware that “dialectic” is a word that points to the problem but not the solution of this problem of the co-production of society and things. So we must now confront the problem head on and develop a vocabulary and methodological tools that will enable us to follow this co-production of what I call, after Serres, quasi-objects, that is projects that *cannot yet* be qualified as either social relations or things.

The case I have chosen to work with is sufficiently complex to serve as our laboratory. It is a high-tech subway system, the last of the Personal Rapid Transportation devices (PRT), known as Aramis. The case study is the object of a whole book, but here I will concentrate on one aspect only: the project failed because the dozens of interest groups linked by it could not agree on what Aramis was supposed to do; but people could not agree on the Aramis project because the technical difficulties of this PRT system were so great that no two interests stayed long enough to solve them. Objects exist or not depending on the ability of humans to gather around them, but humans gather around objects whenever those objects have the ability to reconcile them. The article is focused on the backbone of the Aramis story, that is a table of the 20 different Aramis that associated groups were

simultaneously trying to build. These sets do not intersect. The interpretation of the case study is reinforced by a naturally occurring blind test, the VAL, another high-tech subway in Lille, built by the same company and the same engineers, and which is a relative success. It is the parallel lives of these two cases that the article explores in an attempt to account for the way humans and things **articulate?**.

This account does not deal with the social aspects of a modern technique – dualist paradigm – but with the technical entities themselves – monistic paradigm. And since this account is set within a framework which is symmetrical – the outlook would be the same were we to study a primitive society –, it offers a **platform>framework, basis?** for discussion of other articles in the volume that deal with different types of links between "the social" and "the technical". Many conceptual tools of anthropologists and technologists are biased by asymmetrical notions according to which modern high technologies are more efficient or less social than stone tools and other implements. I hope that this article will correct this bias and offer a more balanced view of the social construction of our artefacts and of the technical construction of our social ties.

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Prologue: a cultural shock

To attempt an ethnography of a "high-tech" case without visiting the places and the times where the techniques are fabricated is like doing armchair anthropology. Since tropical ethnographers may not be familiar with air-conditioned field studies in modern science and techniques, it might be useful to start with the cultural shock any student of rationalized, efficient, productive machines gets when he or she enters the workshop where they are planned and devised.

In March 1988, I was in the middle of an ethnographic study of a revolutionary subway system planned in the south of Paris when one of my informants presented me, at last, with an overview of the whole project.

_"Il y a du monde là dedans, hein? (Lot's of people in there, huh?!)" he said, unfolding the master plan of the Aramis system (figure 1).

Lots of people indeed, but only very few of them were anthropomorphic. Actors called "doublets" had to travel independently along a track ("la voie"); these actors were to be emptied of any human agency and had to be endowed with movement, thought, and a decision-making process of their own. To obtain such a result, a great number of skills had to be delegated to them under the name of "on- board shunt" or "switch". This however was not enough to guarantee a smooth flow of "doublets". Other skills had to be shifted to the track, which was transformed from a longitudinal, continuous ribbon of steel into a highly ritualized discontinuous transversal code of behavior. The track plus the doublets, however, were kept in check by another delegated and delegating entity called "unité de gestion de tronçon et de station" (UGT) (section-station management unit); this entity was immobile but endowed with thought, with the ability to send and receive messages, and with the authority to approve, rubberstamp and sometimes to overrule decisions taken by the "doublets"; this entity itself was dominated by a fourth level of organization called the "Poste de Commande Central" (PCC) (Central Command Post); this PCC was fairly powerless, since the "doublets" and the "UGT" had to take most of the decisions themselves – and fast –, but the PCC could overrule them all, trigger alarms and bring the whole system to a halt. Anthropomorphic humans were to be positioned inside the PCC. But for now they were only humans-on-paper.

The puzzle of this four-tier system became much more complicated when I realized that none of the entities, from the doublets to the humans, were endowed with a complete program of action. Instead of being like Leibniz's monads, unfolding their worldviews independently of everyone else and preharmonized by God, their theology was much more like that of Malebranche, except that there seemed to be no God. They had to fumble, negotiate, discuss, alert, touch, see, tell, read, proof-read, encrypt what each other was and wanted. To be able to do this, they had to be equipped with various senses and antennas (document 3).

Position of Figure 1

I was used to do the ethnography of scientific microsocieties; I knew how to map out instruments, credibility, translations, modalities and papers, and to follow long, thin networks of exchanges and relations among scientists and among the things

for which they claimed to speak. This, however was different. The whole principle was to do away with anthropomorphic humans altogether and, instead, to populate the setting with *membra disjecta,* some of which clearly came from a classic repertoire of human action (thinking, authorising, encrypting), but most which did not not (actuators, tracks, engines, antennas, ultrasound, ultrafrequencies, calculators, videos). Were the methods of ethnography, and especially of the ethnography of science, applicable to a subway system? Could I add notions such as "representation", "symbolic", "social roles", "values" to a technical substratum of efficient action and mechanical behavior? To answer this question I had to turn to ethnographers.

A meeting with timid and not-so-timid ethnographers of machines

Truth, Efficiency, Profitability are the three sisters who have bewitched all those who have tried to apply ethnographic methods to modern science and technology. Paradoxically, it is Truth, in spite or because of Her long philosophical past, who has been first to go. Ethnographic studies of scientific practices, (Collins 1985; Latour & Woolgar 1979; Knorr 1981; Lynch 1985; Pinch 1986; Pickering 1992), reversing common epistemology, have swept over the weak programs of the sociology of knowledge and made Truth the *result* and not the cause of the stabilisation of scientific controversies. The solidity, robustness, beauty and originality of scientific facts are still there, but so are their artisans, factories, human and non-human allies, accusations and instruments who make these facts hold (Latour 1987). Instead of being naked, Truth is now warmly clothed. Since scientific Truth together with Her retinue resemble *more* and not less the sort of objects traditionaly studied by anthropologists of parascientific, pseudoscientific, prescientific, or ethnoscientific societies, the Great Divide between ethnographers of Modern worlds and the others has ended (Goody 1977; Horton 1982). The anthropology of science is now a respectable – if not respected – subfield of anthropology (Shapin & Schaffer 1985; Traweek 1988; Latour 1991).

It is not Truth who limits the anthropology of techniques, since it deals with artefacts no one denies are human-made. But Efficiency, in the case of traditional techniques, and Profitability, for the more modern ones have taken over the guardian role. Most of the so-called social studies of techniques apply to the artefacts the same *dualism* that marked the earlier studies of facts. Their essential intellectual resource is a balanced use of the trope "not only... but also". "In addition to" technical factors, which are due to the resistance or constraints of matter, to the relative efficiency of human gestures and to the profitability of the technical system, "there exist symbolic, social and cultural factors *as well*". For instance, one will say that pigs, "in addition" to being a protein source for the Bimin Kuskumin of New Guinea, "also" have a ritual value; or that "in addition" to being dictated by wind tunnels, the aerodynamic shape of Concorde is "also" influenced by political factors such as de Gaulle's quest for prestige or the Green movements' lobbying; or that relativity theory has been shaped "not only" by cognitive factors, "but also" by Einstein's

intellectual milieu in turn-of-the-century Switzerland. Exactly as in earlier studies of science, the study of techniques has become a cocktail recipe weighing and mixing *factors* of various origins, resulting, for the same reasons, in just as disgusting a brew.

The problem with "factors", in science as in technique, is that we, anthropologists, are asked to take for granted that we are able to decide *what is* a cognitive, ritual, symbolic, economic, efficient, material factor to begin with. We are asked to decide for ourselves when a Kuskumin is using his stone adze as a cutting instrument and when it is a ritual implement, when an engineer of the Aérospatiale company is dealing with aerodynamic equations and when he is fighting with government lobbies; when Einstein is thinking over accelerated frames of reference and when he is a revolutionary who wants to overthrow the order of things. Even if we are granted that there is no clear dichotomy, we are nevertheless requested to see any mixture as a combination of *pure* forms. Instead of letting the actors themselves make these divisions, and many others, we force on them a definition of "purely" efficient action or of "purely" disinterested truth the purity of which is precisely what is in question. As far as science and techniques go, most anthropologists, no matter how sophisticated they may be on other subjects, practice the crudest form of ethnocentrism. They regard ethnosciences as the carving out through social categories of what Nature is "out there", without realising that our (ethno)sciences are doing the carving out of this very Nature, of its unity, of its otherness and of this bizarre notion of "carving out categories"; as for ethnotechnologies, they are seen as so many specific marks *added* by cultures to an efficient action on matter, as if the definition of matter, action and efficiency were not the hallmark of our (ethno)technology! Worse, the only way to prove that culture is at work is often to see it as an "arbitrary" or "conventional" decision added to the "necessity" of efficient action.

In reaction to this dualism, the last ten years have seen a flurry of research treating Efficiency with the same resources and with the same principle of symmetry that proved to be so powerful for the treatment of Truth (Bijker &Pinch 1987; MacKenzie 1990; Callon 1989; Bijker & Law 199**X**). The principle developed from ethnomethodology by Lynch (1985) according to which the only social explanation is to be found in the specific technical resources used by the actors themselves, and that the only metalanguage to use is their language, completely dissolves the "pure factors" which until now were the ingredients used to cook up an explanation of science and technique. Recent anthropologists of technoscience are never faced with the task of allocating what, in a given complex of action, is due to symbol, to religion, to rite, to passion, to politics and what is due to efficiency, material constraints, basic needs and natural forces as Leroi-Gourhan had to (Leroi-Gourhan 1964). Instead of choosing alternatively from the two lists of human and of non-human ingredients, the anthropologist is now interested in how many lists actors make – and there are rarely only two (Descola 1986)! Instead of knowing in advance what the social and the natural worlds are made of, she follows how all the actors – including those of our societies who have been placed on a level with all the others – invent monstrous hybrids very few of which will look

like either humans or non-humans. The loose expressions of "seamless web" (Hughes), "actor-network" (Callon), "heterogeneous engineering" (Law) or "socio-logic" (Latour), all have in common that they erase the Great Divide, reject the dualist explanation, and dethrone the three sisters all at once without allowing anyone of them to exert a new hegemony. Even the exit out of the radical relativism thus embraced is left to the actors' own devices – actors clean up their own mess, so to speak, and solve for the analyst the problem of establishing asymmetrical *relations* with one another.

Two completely different research programs are thus now housed under the same label of ethnology and technology. The dualist program *starts from* a list of factors taken from nature, matter, ecology and society, and then goes to a specific setting to *weigh* the relative influence of these factors in shaping artefacts. The other research program *starts from* the distribution and allocation of categories, labels and entities, in a specific setting, and obtains as a provisional and local *achievement* resulting categories, some of which *may* resemble natures, matters, ecologies and societies of old, or may not look at all like any of the labels we use to order *our* world. This program could be called "monism", as long as it is clear that is a heterogeneous and distributed form of monism.

For example, in the first program, the Kukusmin's azde might be seen as made up of at least two aspects, one of them being efficient action on matter – it is made to cut wood and fibers – and the other being a ritual and symbolic aspect – it is male and it is to be used only to cut woods for building initiation houses. In the second program, the complex categories used by the Kukusmin themselves are used to make sense of this very problem of techno-logy (that is the science of techniques as Leroi-Gourhan called it). They have their own sociology of technics, they have their own techno-logy as well as their own epistemology. Indeed it happens that one of their divide does imply a difference between *profane* implement – which for that reason may have since been replaced by non-sexually marked Western steel axes – and all the others that are more sacred – and which to this day are made of stone. If we now take seriously the metalinguistic resources of the Kukusmin, will the category "profane use" be coextensive with that of our definition of efficiency? Yes, in the first research program, but no, in the second. For the latter, "profane use" is a *coded* category as much as is a male ax or a exchange cowry, and so is our definition of "efficiency" and "material force", which emerges in Europe between the 17th and the beginning of the 19th century. There is no direct translation between the two. In the second program, we are not allowed to use a recent European scientific definition of "action of force on matter" to reconstitute the world on which the Kuskumin act, no more than we are allowed to consider cowries as being a local type of "money" (Polyani 1975).

In the first program, everything happens as if all the social marks were added to a *substratum* that is unproblematically defined as part of the material, or natural, or ecological world. In the second program *there is no sub-stratum*, except when traveling observers and scientists "place beneath" , as the eymology of substratum ("under-cover") implies, the categories

of those they wish to explain. In the first program, society is embedded unproblematically in a material world, and thus the sociology and history of the social and natural sciences that deal with that very world and with that very work of embedding are irrelevant for technology. In the second program, any embedding of society in a material world, including the European one, is to be accounted for, and thus the sociology and history of all sciences, *including* anthropology, are an essential part of any technology. No ethnographer can use notions like "matter", "force", "nature", "world", "arbitrariness", "convention" without studying how they have come about in her society/nature and without taking into account, reflexively, how she has come to confront her world with those of other societies/natures. This is why it is no accident that most sociologists of techniques come from the sociology of science. If sciences are not made part of the picture, the second research program recedes into the first, and the Great Divide together with the dualist explanation it entails is reinforced instead of being dissolved.

A symmetrical anthropology of techniques

The aim of the second research program is to end the partition between materialist and culturalist accounts. This partition is visible in the literature dealing with modern industrialized techniques as well as those dealing with non-modern or non-industrialized ones. Sociologists or semiologists will have no problem in studying the symbolic meaning consumers attach to video players or to cars, but it will be for other scholars far removed from them to study the "substratum" to which the meaning is attached, that is the drafting rooms, the laboratories, the scale models, or the corporate strategy producing the video players and the cars. Similarly, ethnotechnologists will write an account of the material culture of the Kukusmin, where the fifty types of arrowheads will be listed as well as the taro gardens, and the dozens of categories of axes, all being accounted for by transhistorical and transcultural Western categories such as efficiency, impact, force, protein source, energy consumption…; and later they or other scholars will *add* the symbolic, ritual, sexual and cultural meanings that supplement this basic economic infrastructure, all of it being accounted for by equally transhistorical and transcultural Western categories such as symbol, rite, religion, society, myth, convention, arbitrariness.... No matter if they study modern or non-modern practices, they will first describe the video player *as* a machine and the pig *as* an animal, and then will print, paint, mark and ascribe social meaning to them.

There would be nothing wrong with this perfectly reasonable dual research program if it did not make our own techniques and societies entirely opaque – and probably those of the non-modern societies as well. What is a video player? Probably not a machine. At least we should not impose such an a priori crude, unreflected unproblematic category on its manifestations. As for the zoological Westernized pig, it is such a latecomer to the series of actions done by "pigs" that it is a very unlikely substratum for meaning. If anything, we should consider the machine-like video player and the zoological pig as two new recent meanings

extracted from a substratum much more bizarre than these two latecomers. To use a cliché from the debates over relativism, the zoological cassowary is not the substratum out of which the Karam make it a Yakt (Bulmer 1967). *Inside* the London zoological collections, 19th century taxonomists make the cassowary part of the Birds neglecting thousands of other properties the "cassowary" had elsewhere. The objective substratum is no longer the unproblematic matter onto which cultures add their view, *it is another view,* a highly localized and particular view within scientific institutions. As suggested in figure 2, when the practice of extraction *is added to the study*, the very notion of "social meaning" fades. It is here that the anthropology of technoscience takes on its most radical meaning: objectivity, objects, natures, efficiency, profitability, truth are shifted *from the outside* (left side of the drawing) *to the inside* of another network of practice whose peculiarity becomes studiable (Star & Griesemer 1989; Latour 1990). Instead of two literatures and two descriptions – one materialist the other culturalist –, there exists only one that, in addition to all the others, takes into account the practice, movement, institutions and societies of the zoologists, anthropologists and other miscellaneous empire builders.

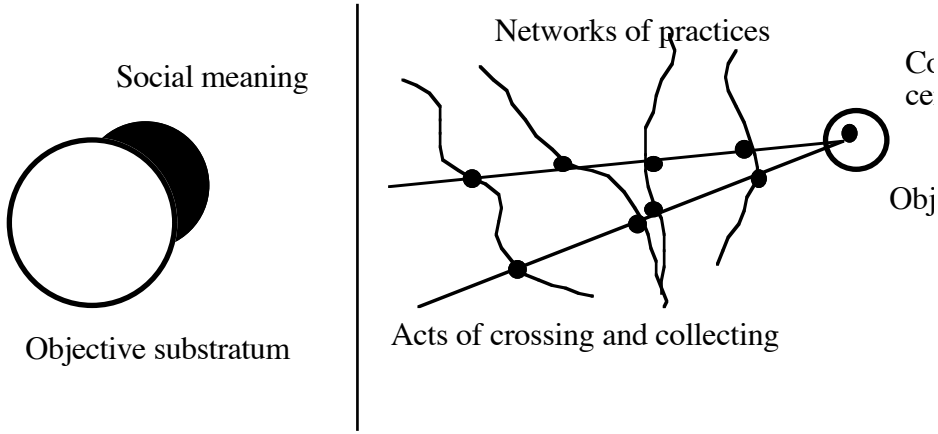


Figure 2

By relocating the work of producing truth, efficiency and profitability, it is not only the non-modern societies but our own world as well that take on a new aspect. To begin with, *our own world stops being modern* because it does no longer differ radically from the others (Latour 1991). The cassowary made a Bird inside the London Natural History Museum is not absolutely different from the Koptby made a Yakt inside the Karam territory. It is only *relatively* different. The zoological pig in the Jardin des Plantes is no longer ontologically different from the Kukusmin pig; moreover, the Paris zoologist pig is also relatively different from the pigs on a farm in Britanny; and better still, the Kukusmin pig that can be eaten only if it dies accidentally is also relatively different from the sacred pig no one is allowed to eat at all. In place of the One a priori

unstudiable Great Divide, appear numerous small divides all of which are empirically studiable. Instead of having two literatures, one about the Savages and the other about the Civilized, one about the Non-modern and one about the Modern, *there is only one anthropology* of science and technology. "They" have many sorts of bizarre pigs, "we" have lots of very queer sorts of pigs (Digard 1990). Then, what we have in common is this bizarre distribution of hundreds of actors whose distribution, diversity and attributes are very poorly accounted for by the invention of this substratum: "the-objective-pig-to-which-cultures-arbitrarily-add-particular-meanings".

Anthropology of science and technology, which deals jointly with the pre-modern and non-modern worlds, is the study of that distribution and of that diversity – and also the study of the efforts of some professions and institutions to unify, limit, extract or purify meanings and natures. Essences have been redistributed back to the networks of actions that shape them through trials.

What is an object? A quasi-object. The case of VAL

What is a high technology in this new symmetrical and "monistic" framework? A shifting network of actions redistributing competences and performances either to humans or non-humans in order to assemble into a more durable whole an association of humans and things, and to resist the multiple interpretations of other actors that tend to dissolve this association (Law 1987). Techniques are not something around which there is a society. It is society considered in its obduracy. It is society *folded*., society made durable, society made complicated in order to resist more tensions by enrolling more non-humans. We seem to get techniques on one side and social relations on the other only only when we believe that social or human relations are enough to hold society together. But this is impossible except in very few aspects of a very few cases of some primate societies (Strum 1987; Strum & Latour 1987) where the whole pattern of social relations depends on social skills and "Machiavellian intelligence" (Byrne & Whiten 1988). In human societies skills, competences, obduracy, are shifted down to non-human actors to which or to whom are delegated the task of fulfilling parts of the programs of actions (Latour 1992). Ironically, they are called *human* societies because the enlisted *non-humans* render them slightly more stable. So every time we are faced with a more *durable* social link, we are in effect faced with techniques (Latour 1992). No observer of human collectives, for at least the past two million years, has ever been faced with a pure social relation, and none of course, *especially* in high-tech modern settings has ever been faced with a pure technique.

Although this folding, this detour, this shifting down, this embedding is clear in anthropologists' accounts of exotic technologies, it is not so obvious in modern high-tech cases. And because it is not clear in our modern technology, it seems that in exotic ones it applies only to the *meaning* of the artefacts

not to the artefacts *themselves*. But this is only because high-technology examples are not studied in detail while they are still *projects*.

Take for example the case of the VAL, the main rival of Aramis (Latour 1992). In the 1970s, in the northern French city of Lille, where a new town was being built, city planners, inhabitants, developers, started to *talk about* a public transportation system for the new town. At first VAL was a statement, it was an argument, it was a dream that captured or not the passions, interests, worldviews of the people of Villeneuve-d'Ascq. It was like a game: "what about playing at being an automatic public transportation system?". The question now is to follow the trajectory of this dream-passion-interest-game-plan. The first idea of the developers was to make a small public transportation system for the new town alone and to experiment with a new cheap automatic system ("New towns are laboratories for new systems"). But if you want a new automatic system you need to enlarge the group of people who think, pay and are interested by innovations in transportation (at the time there were no automatic subways except as prototypes). The argument, or the token, or the quasi-object is now sent to a larger network of people, the Urban Community of Lille: "are you ready to help us with our system so that a New Town can be equipped with new attractiive high-tech transportation?". Is the token going to be accepted as it is, abandoned or transformed? This question, we know, is the first principle for all studies of sciences and technologies (Latour 1987).

In this case, the statement is completely transformed. "Yes, say the Urban Community we are interested, but not if it is limited to your town, only if it becomes the starting point of our Lille Subway". The quasi-object now becomes the focus of interest for the whole conurbation. Are the promoters going to quit because their initial plan is so deeply transformed or will they be able to *renegotiate* their plan so that it *accommodates* people from Villeneuve-d'Ascq as well as from Lille? This is the crucial question for an ethnography of modern technologies. If the promoters are able to redesign what was a local "bidule" (gadget) into a new subway for Lille, their quasi-objects will now bear the interest of hundreds of people instead of a mere dozen. If they prove unable to tackle so many conflicting interests and to shift them down to the project, they will stick to their local arrangement, but will have to transform it so that they do not need the help of the Urban Community. They might turn to the Government, to the Institutions in charge of promoting innovations in transportation. But then it will be another object, something that will look like a laboratory experiment – it will make the innovators happy, but will it transport the inhabitants of Villeneuve-d'Ascq? In the case of VAL, the promoters did all of that at once. They redesigned the project so that it could interest the whole of the Lille conurbation (it was a real subway), so that it interested the Government (it was a major new development away from Paris in a region that needed help); it fascinated the engineers and the laboratories looking for new systems (it had to be fully automatic) without losing the parochial interest of Villeneuve-d'Ascq (it used the patents and

know-how of the local university specialised in automatisms); it remained simple enough to be built in time for the opening of the New Town; and it interested a company, MATRA, new to the world of transportation, but specialized in automatism and military weapons and that was seeking to diversify.

Notice that in following the redesign of VAL and the list of interested groups I am not practicing *two different* interpretations –one about the nature of the artefact and the other about the meaning it has for social groups. *It is the same task to define the artefact tying together the various groups or the groups tying together one artefact*. This similarity is all the more visible as the artefact does not yet exist. It is still an argument to which is now added a thick file of drawings, rough calculations, letters of intent, patents and lists of specifications. Each time a new group is recruited, the list of specifications is extended, rewritten, or written off. For instance, as long as it was a local project, the subway was to run along a circle which allowed the cabin to be irreversible (with a head and a tail), and that in turn made the system cheaper and simpler. When the Lille community requested it become a subway line, cabins had to be made reversible, complicating the design and increasing the cost. The reversible cabin is not a piece of machinery "onto which" one could then add a meaning given it by the Mayor of Lille. It is to enlist the Mayor and keep him happy that the cabin "folds" itself and is made more complicated and reversible. Conversely, my analysis is not a social determination of the artefact by the interests of the mayor since there is no direct resemblance between "happiness of the mayor" and "reversibility of the cabin". It is the clever cunning of the engineer and promoter of the project which *translates* "happiness" into "reversibility". This translation is neither obvious, direct nor simple.

At first VAL was not an object, it became so only when, in 1984, VAL was opened and began transporting inhabitants from Lille. Even then it was not an object but a lash-up, an association of humans and non-humans, an institution, parts of which are delegated to pieces of machinery (the cabins, the automatic pilots), parts of which are delegated to collective persons (MATRA, VAL) and parts of which are delegated to humans (the users, the inspectors, the maintenance engineers). As long as it was a project it was *not yet* an object. When it was finally realized it was no longer an object but a whole *institution*. So when does a piece of machinery become an object? Never, except when extracted portions of the institution are placed on view inside technical museums! An idle, isolated and useless VAL cabin inside a museum is an object that at last begins to resemble the idea that some people have of a technique isolated from its social context. But even this is still inaccurate, since the display is now part of the museum institution and could not survive long without the assemblage of curators, texts, leaflets, inventory numbers, sponsors, other nearby prototypes, visitors, that keep activating it. It is only once on the scrap heap, when it begins to be dismembered, that a technical object finally becomes an object... Even there it is an active entity. No, it is an object, a real object, only when it has disappeared beneath the ground, relegated to oblivion and

potentially ready to be discovered by future archeologists... A high-technology object is a myth.

The essence of Aramis

Inside the lobby of MATRA headquarters in the suburbs of Paris, Aramis is already on tis way to a museum display and is beginning to resemble the mythical object of epistemologists. It is a beautiful, idle isolated white cabin, but no engineer is working on it and no passengers are boarding it. There is no rail and no electricity, no engine and no electronics. Only the nicely designed outer shell is present in the lobby as part of the landscape. Aramis started like VAL, as an argument, as a quasi-object, triggering the enthusiasm of many people. But unlike VAL, it went from being a quasi-object to being a piece of decoration in the lobby of the MATRA firm, whereas VAL became the profitable export product of MATRA-Transport and the indispensable routinized transportation system of a million Lille residents.

The "distributed monism" I have advocated should be able to tackle symmetrically the failure story as well as the success story. It would be against our principles to say that VAL was more efficient, less costly, more socially accepted, and better technically designed than Aramis, since all of the former's qualities and all of the latter's defects are *results* and not *causes* of the existence of VAL and of the lack of existence of Aramis. An explanation in terms of social forces (pushing VAL and pulling Aramis) or in terms of technical trajectories (mature for VAL and premature for Aramis) are also excluded, since they would be asymmetrical or dualist. And naturally it would fly in the face of the whole field of technology studies to try to explain only Aramis, since it has been a failure, whereas VAL has turned out to be a success (Bloor 1976 [1992]). Such an attitude would be still more asymmetric since it would look for social explanations only when something goes wrong – the straight path of happy technical development being, in contrast, self-evident and self-explanatory.

As a quasi-object, Aramis ties together many interests. Exactly as for VAL, these interests do not exist independently of the Aramis project. They are all bent, seduced, induced by Aramis, which modifies its specification, that is its essence, to tie them all together. Let us read the first page of the specifications written in 1987, a few months before Aramis was dismantled.

Document 1:

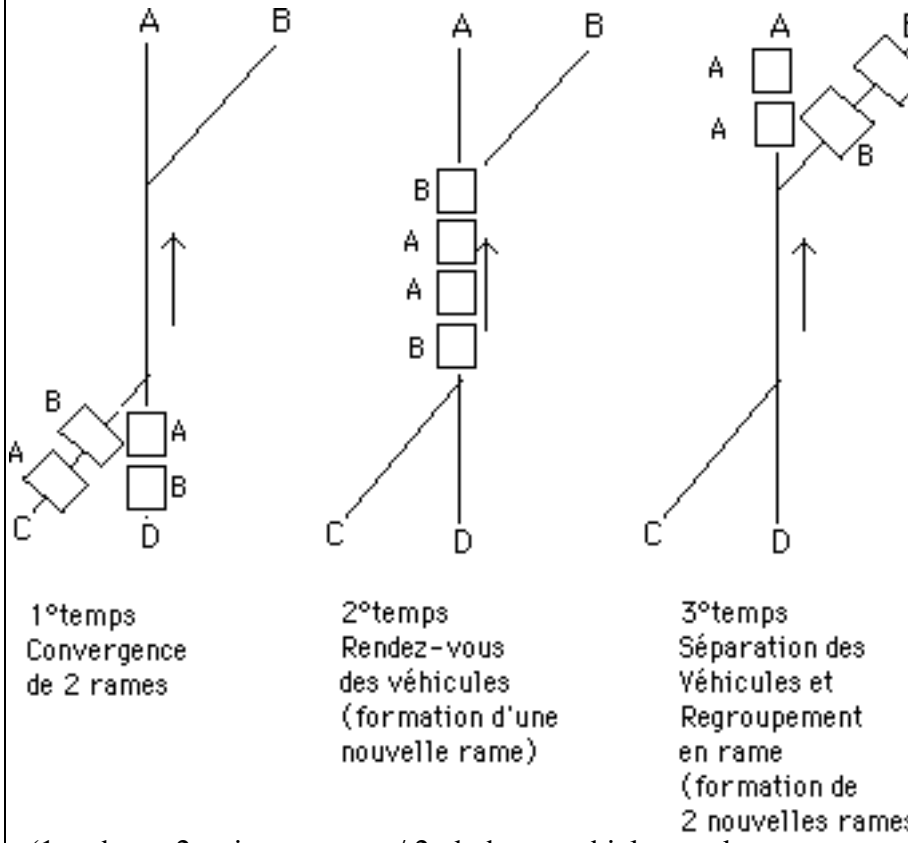
> "2.1. Basic principles of the Aramis system
>
> Aramis is an entirely automated personal rapid-transit system. The elementary unit of transportation is composed of two cars of limited capacity (ten passengers, all seated) which are mechanically hooked together and which are called "doublet**s**".
>
> Those doublets can be merged into in variable trains by means of an electronic coupling that allows their association and dissociation at intersections, change of direction being effectuated by an on-board shunt."

Aramis is the last descendant of the Personal Rapid-Transit movement launched in the United States in Kennedy's day. The

idea was to invent a cross between public transportation and the private car in order to decrease air pollution, traffic congestion and to irrigate loosely populated suburbs with a system that was not too costly. This is a typical case of innovation by hybridization or metaphoric displacement. In the specific Aramis system devised by Matra, the notion of guided systems on tracks was retained from the subway, tramway and train, while the private car contributed the idea of small comfortable vehicles going to the precise place desired by the consumer. Rigid lines imposing a given path on everyone was dropped from the train paradigm, while private ownership and idiosyncratic driving was abandoned from the car paradigm. But in order to abandon the notion of lines, cabins should be endowed with the ability to join a train and to *leave it* at the desired shunt; and in order to abandon the notion of driver, these intelligent cabins should be automated. As a result, the whole work of driving has to be *taken over* by the cabin and by the track, while the whole work of owning, distributing, allocating, cleaning the cabins has to be *taken over* by the public system of transportation. In principle, every automobile driver, every urban planner, every politician should dream of such a system of transportation that would combine all the advantages of individual mobility with none of its dangers and costs. In practice it has become more complicated.

Document 2:

> The specific phases of the Aramis system are illustrated in figure 2.1.



(1st phase: 2 trains converge/ 2nd phase: vehicles rendez-vous and form a new train/ 3rd phase: Vehicles separate and reform 2 new trains)

– "rendez-vous" of two trains coming from two convergent roads and merging in order to compose one single train along the common trunk line;

– separation at the intersection of the doublets going to different destinations and reconfiguration of homogeneous trains in each of the two branches.

This principle of making trains of variable length and composition allows:

– to easily adjust the length of the trains to transportation demand, while keeping a good quality service during off-hours by running short but frequent trains on all the branches;

– to exploit connected networks without the user having to change transportation systems or make connections ("rupture de charge"). This system maintains short intervals on all the smaller branches of the system and may thus provide a fine irrigation of suburbs;

– to offer, in the most sophisticated version of the Aramis system, direct or semi-direct systems by using stations off the main line. Some doublets are thus allowed to short-circuit some stations and to go directly to their destination without intermediary stops."

This is the core of the Aramis project, it is because of this "electronic coupling" or "immaterial tie" that many engineers are so enthusiastic about this innovation, since it allows them to do away with connections ("ruptures de charge") and to let the passenger reach any destination of the network without being bothered with intermediary steps. It also allows them to make public transportation as light and small as cars, since a given vehicle does not have to bear the weight of the whole train. But someone has to think. First the engineers designing the system; then the designed system, which has to allocate destinations, manage the flow of cabins, let the cabins merge into a train, then reshuffle them at each intersection, then come back in order to meet the fluctuations of the demand. The problem is that no mind and no central computer is able to govern a system which, at least in the first project, included 2200 cabins and, in the last one, 660. So most of the functions have to be delegated locally to the cabins themselves. It is they that must do most of the thinking: checking where they are going, where they are, making sure that their speed is finely tuned with the other cabins ahead and behind, deciding when to activate the "on-board shunt" to switch at an intersection, and when to open the doors to let the passengers in and out.

Document 3:

"In addition to the specifications described above, two main specifications should be stressed:

– the small size and the easy insertion into most urban sites, the minimum turning radius being 10m without passengers and 25 m with passengers;

– the very short interval between trains.

Urban designers are also interested by Aramis because it is much smaller than a normal subway and, since it is made of

independent cabins not of trains, it can take steep curves. Ideally it should be able to fit in everywhere in a city and, although it needs a specific track ("site propre"), civil engineering is much less costly than for a subway. The cabins themselves may be made as light as a car, since they never touch or tract each other.

The essence of Aramis is thus to gather about a revolutionary innovation all the people concerned by city congestion and air pollution, all the drivers who want the comfort of their private car but who would prefer not to own and pay for a costly private vehicle, all the city planners and urban engineers who want to implant public transportation without major civil-engineering works, all the companies and scientists interested in furthering automatism, all the big urban networks who wish to do away with unionized and well-paid drivers, government officials who are looking for ways to modernize the world of transportation and discover high-technology export products.

Yet, the ink on the above specifications had not dried when the number of people behind the projects fell to some 50. A few weeks later, in December 1987, only a dozen or so people lamented the interruption of the project. Since then, I am about the only one left who cares about Aramis. A project that was to excite millions of people was left to the study of one lone ethnographer. I had to dig for the remnants of prototypes, tracks, documents, much as the technologist of traditional technologies lost in the night of time. The half billion francs (50 millions £), the 15 years invested in the project, was not enough to make Aramis real, that it is to turn it from a quasi-object into an institution. On the contrary, it turned it from a quasi-object into a prototype in the south of Paris, and from there into a museum piece, and from there, alas, into an object, lying on a scrap heap.

Agreeing on an object

After 50 interviews and a year of work, I had gathered not only one explanation but at least twenty.

Document 4:

> (1) Aramis is technically ready ("au point") for homologation**>approval**;
> (2) Aramis is technically ready, but it is too expensive to industrialize;
> (3) Aramis was almost technically ready, but more studies, and more time were necessary to complete the experimenation before approval;
> (4) Aramis was almost technically ready, and would have been completed if it had not been abandoned by politicians, who could have imposed its mass production, and thus decrease the cost per cabin;
> (5) Aramis was technically ready, but would have been so costly that it would have been unsalable politically;
> (6) The Aramis cabin was technically ready, but the system as a whole was not and would have required much more study;

(7) The Aramis cabin was technically ready, but even if the system could have been developed, it would have been so expensive that it would have been abandoned on the political front;
(8) The Aramis cabin was not technically ready;
(9) The Aramis cabin was not technically ready because Matra abandoned it and instead worked on VAL;
(10) The Aramis cabin was not technically ready because the RATP requested that Matra respect specifications completely unsuited to such an innovative research prototype;
(11) If the RATP had agreed to simplify the specs, it would have become another VAL instead of Aramis;
(12) If Aramis had been simplified and transferred to a region other than Paris, for instance Montpellier, it would have been technically feasible;
(13) Whatever the specs and wherever the prototype, Aramis could not be technically ready because it is unworkable for more than three cabins;
(14) Aramis was not technically ready and may have been technically unfeasible, but portions of Aramis could be used in many other transportation innovations, there are many "spin-offs" ("retombées");
(15) No portion of Aramis is re-usable, no software, no hardware, everything would have to be started all over, but culturally Aramis has useful spin-offs since it helped Paris unions to accept the idea of subway automation;
(16) No portion of Aramis is re-usable, there is no fall-out technically or culturally, it was a false innovation from the start, an unworkable idea;
(17) If the prototype phase had been well managed, it would have been possible to tell whether or not the Aramis cabin, or the Aramis system was technically feasible and technically ready;
(18) It is impossible to tell if Aramis was technically feasible or not, it is a black box, it is unaccountable;
(19) There was a cover-up, engineers played their games with the project and now all trace of goals and feasibility are gone;
(20) The question of the technical feasibility of Aramis should not be raised.

At one end of the spectrum, some actors in the project believe that the specifications above (document 1 and 2) were the true essence of a real object called Aramis, while others believe that if Aramis were to be real it would have to become another smaller case of VAL; at the other end, many informants claim that the specifications are those of an absurd, self-contradictory, false innovation that is unfeasible in theory as well as in practice - others going much further and accusing their colleagues of a cover-up. So much for those who believe that technical trajectories are so rationally determined that Cost or Efficiency or Interests are enough to account for their diffusion or demise. On the contrary, the multiplicity of interpretations is a necessary component of projects that slowly

cease to exist. Interviews on the history of VAL also show a dispersion of answers, but all the various answers are *point of views* about an institution, the VAL, which exists independently of them. There exists an intersection of the set, and therefore I could find the sum of the points of views *about* VAL. I cannot find the sum of the interpretations of Aramis, since there is no common intersection and hence no distinction between interpretations and the object to be interpreted. The distinction between the two has not *yet* been made. Aramis remains a story, an argument, a quasi-object that circulates as a token in fewer and fewer hands - and now it survives only as a case study among technologists and ethnographers of science, another story to make a point, this time not about transportation, but about the mechanisms of innovation.

"Dialectics" of technical objects

Is it because Aramis ceased to exist that the interpretations diverged so, or because the interpretations are so divergent that the project never became an institution, a stabilised thing, the common intersection of all the arguments for it? I could say that it is both, and close this paper by saying that it is a dialectical movement between those who tie their fate to the object and those who are tied by the object. "Dialectical" arguments are often used to further darken what is already obscure and to save the dualist paradigm under the pretence of subsuming it. If I want to maintain my "distributed monism" paradigm I have to be more precise than dialecticians and render fully accountable this twofold move of people assembling around things and things forcing people into assent (Latour, Mauguin & Teil 1992).

The process is impossible to follow if we consider social actors that simply press upon or inscribe their wills on inert passive things - or if we accept to see autonomous technologies pressing their fate and aimless goals upon softer human wills. Non-human actors have to be accepted as such, that is as actors endowed with as much complexity, ill will and independence as humans. But even symmetry is not enough. We also need to abandon the idea that *fixed* human actors or *fixed* non-human actors can simply be taken "off the shelf" and inserted into the process. The process becomes accountable if we follow *translations* of human and non-human competence instead of only following the displacements of goals, intentions and intents of the human actors.

The Mayor of Paris, for instance, had been interested in Aramis because the project intended to re-use an abandoned railway line, the "Petite Ceinture", that girds the south of Paris and could irrigate sections where the subway meshes are too far apart. The Mayor had been convinced to pay for the equipment of the Petite Ceinture. He was thus aligned behind Aramis and he linked its fate to the fate of the project. Or is he? Well, not exactly. Aramis's essence is to do away with the notion of line altogether, since the trains are reshuffled at each intersection. However, the Petite Ceinture is a line, as traditional as one can get. It goes from Boulevard Victor straight on to the "13th arrondissement". The Mayor may have supported Aramis, but it

could also shift to another object, for instance a VAL, provided it re-uses the Petite Ceinture. The Mayor's support is not aligned behind Aramis, but behind a confusing hybrid: "anything that equips the south and stops citizens from those districts complaining about City Hall". Even this translation is not fixed, however. The citizens from the suburbs and from the North of Paris are now complaining so bitterly about the crowding of another line (line A of the RER), that the Mayor soon lost interest in Aramis - or at least lowered the priority of this "thing on the Petite Ceinture".

To be sure, equipping cheaply the Petite Ceinture with a smaller VAL would be possible and would make the Mayor happy – for a while, but the projects' supporters do not agree. An automated subway in Paris would immediately trigger a long strike of the very tough and corporatist subway-drivers' union. They would take it as a long term threat to their jobs - which it is, especially in the wake of a recent series of bitter strikes. But Aramis is so innovative, so small and so different from a subway that the same unions are indifferent to it, or even like it because it gives a good high-tech image of their company. Same thing with the engineers and the technical structure of the RATP. VAL is their direct enemy that was built by Matra, who shortcircuited most of their know-how. Until VAL opened in Lille, RATP engineers were the best subway experts in France. To build a VAL inside Paris would be a provocation. Again, Aramis was so different, so new, and anyway generated so much skepticism that it was not a provocation. It was a good research project on which they could try out new ideas about "immaterial links" and "on-board shunts".

The project leaders inside Matra as well as inside the RATP had literally to take "on board" those various translated interests. The Mayor, the unions and the engineers were behind Aramis, but the first on the condition that Aramis looked like a VAL, the second on the condition that it did not look like the threat of automated subways, and the third on the condition that it would be as different as possible from VAL and as innovative as possible so that they could regain their lead over Matra. We know the general answer to those quandaries: negotiate, go back to the drawing board and redesign the project so that it folds over and "absorbs" or "swallows" the contradictions of hesitant supporters. Then, once the project itself has been modified, it in turn holds in place all the interests that were at first holding it in place. Non-human mechanisms are now visible where social ties and arguments were before. This is what the project leaders did. So that Aramis looked like the equipment of the Petite Ceinture, the cabins were enlarged to 10 seats - 20 per "doublet" - and the flow of passengers went up - on paper - to 10,000 per hour, later to reach 14,000 per hour. But so that it would *not* resemble a VAL while retaining the shape of Aramis, intersections were added to the Petite Ceinture, intersections that no normal subway, even automated, could accommodate without possessing the competence that made Aramis' charm: "immaterial ties and on-board shunt".

Aramis' chips and software were now bearing the whole weight of the complex negotiations of the project leaders.

Nowhere among the lines of program could one read that the unions, the Mayor, the technostructure, and Matra had to be kept happy. Happiness, here as above for VAL, is being translated by programs of action that are entirely different from the original wording. Not that they are hidden, disguised, covered up, but because the unions, the engineers and the Mayor, expect a thing that runs automatically, not words that seduce or please. Negotiation is continuing but this time with non-human actors. Is it possible to endow a cabin, and from there a system of 660 cabins, with the ability to transport in a regular flow 10,000 passengers per hour along a line similar to a subway line, and at the same time to reshuffle all the cabins at the intersection so that a whole network can be irrigated and passengers reach destination without boarding having to make connections. The work of translation has now assumed the shape of **figure 1**. It not only looks technical, it *is* technical. But by saying this we do not mean something *different* from the discussions between Mayors, unions and technocrats, since the programing languages are now in charge of keeping the negotiation settlement between the human actors. But we are certainly not talking the *same* language either, since it is because the human actors could not agree with one another that the discussion was shifted to non-human actors to which was delegated the task of holding the humans together. This is the reason why we use the key-notion of translation. The chips are not reducible to social ties nor are the social ties reducible to the determination of things. *They are new social ties*. They are social ties continued through the active mediation of "physimorphic" actors that are now playing their own part and trying to reconcile the fuzzy, shifting or contradictory interests of the humans.

They play their part so actively, so freely, that Matra software engineers would like to get rid of most of them. Aramis prototypes have become so full of computers in order to endow the cabins with enough competence to manage the intersections and the merging that there is hardly any place left for passengers! As for the costs, they are skyrocketting, every cabin is now as expensive as a satellite. To be sure, some of the functions of Aramis may be nicely simulated, but Aramis has to be as safe ("en sécurité") as trains and subways, as cheap as the automobile industry, and as sophisticated as the aerospace industry! Now the engineers are trying frantically to reconcile three technical worlds as far apart as the unions, the Mayor and the technocrats were. Automobiles are cheap, but their quality ("disponibilité) is very inferior to that required for public transportation; planes are precise and safe but very expensive; subways are safe, but not at the level of sophistication required for cabins moving at 30 km/hr and adjusting their acceleration hundreds of times a second.

Matra engineers would like to simplify the whole mess and fall back onto the world of VAL they handle so well. But they can't. They have signed a contract and every time they try to loosen the specifications, the RATP is there to insist on their making Aramis, not VAL or some erzats of it. When at one point they offered to fall back on an ARAVAL, the contractants recoiled in horror at this monstrous hybrid.

I cannot include all the details of the negotiation (Latour 1992), but the final diagnosis, although paradoxical, may be of some relevance for ethnographers of high-tech projects. It is because Aramis completely isolates the core technical ideas of the project from the rest of the network (exploitation, systems, political vagaries, costs, engineers skills) that it cannot become an institution and is fated to remain a utopia, a UFO. By contrast, it is because VAL makes no such neat distinctions and swallows up in its technical specifications most of the variations of its human supporters that it gains in reality and, from a mad project, ends up as a respectable institution. The various interests behind Aramis do not intersect any more than do the 20-odd interpretations of its demise (see figure 3). An object cannot come into existence if the range of interests gathered around the project do not intersect. Of course, interests may be modified and so may projects. But, if the two-way movement translating interests and modifying the project is interrupted, then the object cannot become real. Thus the real locus of enquiry for the ethnographer of high technology is neither the technical object itself – that will exist only later as part of an institution or will disappear as part of a scrap heap – nor the social interests – that may be translated and that will later be shaped by the stable objects. The locus of enquiry is to be found in the *exchanges* between the translated interests of humans and the delegated competences of non-humans. As long as this exchange goes on, the project is alive and may become real. As soon as it is interrupted, the project dies, and we obtain, on the one hand, a social assembly of quarreling human actors and, on the other, a stack of documents and a pile of idle and rapidly decaying technical parts.

The irony of the Aramis case is that the main engineers behind the project really believed in the epistemological myth of a technology fully independent from the rest of society. They maintained the basic specifications of the system for fifteen years without a single modification. The same engineers during the VAL story applied a completely different social theory of technology and happily renegotiated the core specifications according to the shifting interests of Lille's main actors.

Conclusion: an anthropology of objectivity

Many social scientists share the illusion that social actors share the following illusion: "mere actors" believe the intrinsic qualities of art, religion, and techniques to be what oblige them to agree and comply, whereas it is really the force of society projected onto arts, religions and technoliques that makes them act and possess meaning. Unable to bear the direct brunt of society, social actors are forced to express it through artefacts and beliefs. Fortunately, social scientists are much wiser than mere social actors, and they see through this illusion and reveal the force of society reflected in the fetish of gods, beauty and technical styles. This way of practicing social science was extremely popular from Durkheim until the irruption of ethnomethodology (Hennion 1991).

What those social scientists never explain is the reason why society constantly needs to be projected onto new objects. Is

society so weak that it needs continuous resuscitation? So terrible that, like Medusa's face, it should be seen only in a mirror? And, if religion, arts, styles are necessary to reflect, reify, materialize, embody, society, then are they not, in the end, its coproducers? Is not society built literally, and not metaphorically, of gods, machines, sciences, arts and styles? But then where is the illusion of the actor in the bottom arrow of figure 3? Who are deluding themselves if not those same wise social scientists who have simply forgotten that, before projecting itself onto things, society has to be made, built, constructed? And out of what material could it be built if not out of non-social, non-human resources?

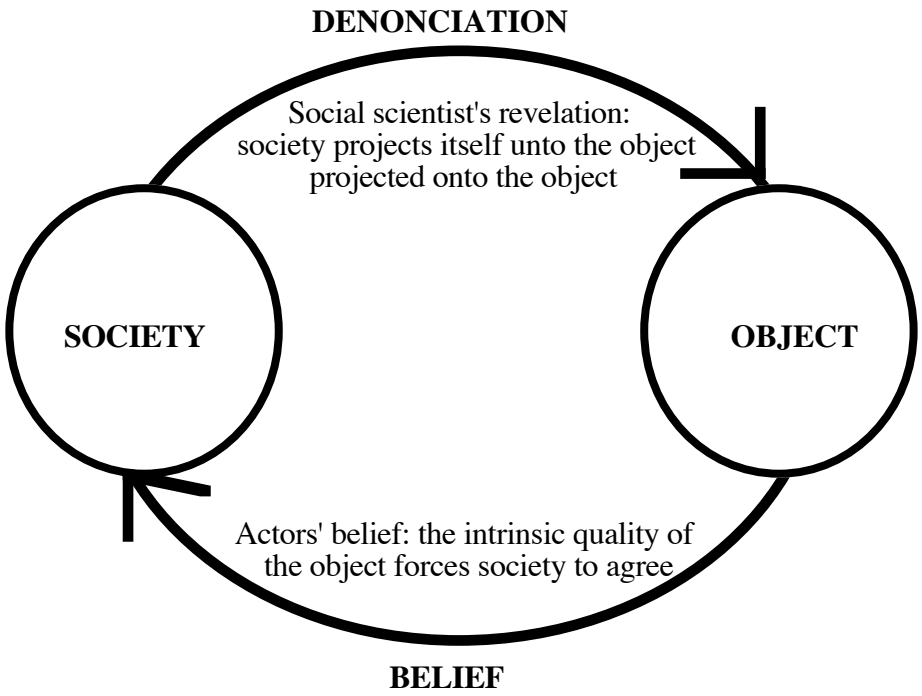


Figure 3

We can now detect the origin of the dualist paradigm I discussed above and which has for so long paralyzed an ethnography of objects. Social scientists used the Durkheimian model on everything *but* science and technology. They use it on religion, on art, on rites, on style, but not on Truth and not on Efficiency. If, in figure 3, you replace the word "object" by the

traditional entities about which social scientists are so wise (which means basically the beliefs they do not share), then they criticise the bottom arrow (the false effect) by unveiling the top arrow (the real cause). If, however, you now replace the word "objet" by "science and technology", then social scientists occupy the same position as the "mere actors" of the former diagram. They do indeed believe that objective facts of science and objective constraints of matter force society to agree. The consensus theory so nice for explaining why we believe in gods, in arts or in stylistical differences, is the horror to be avoided at all cost if Truth and Efficiency are concerned. Moreover, it is now the top arrow that becomes the illusion to be eradicated, the illusion of relativism. It is not because a society agrees about something that this thing comes into existence.

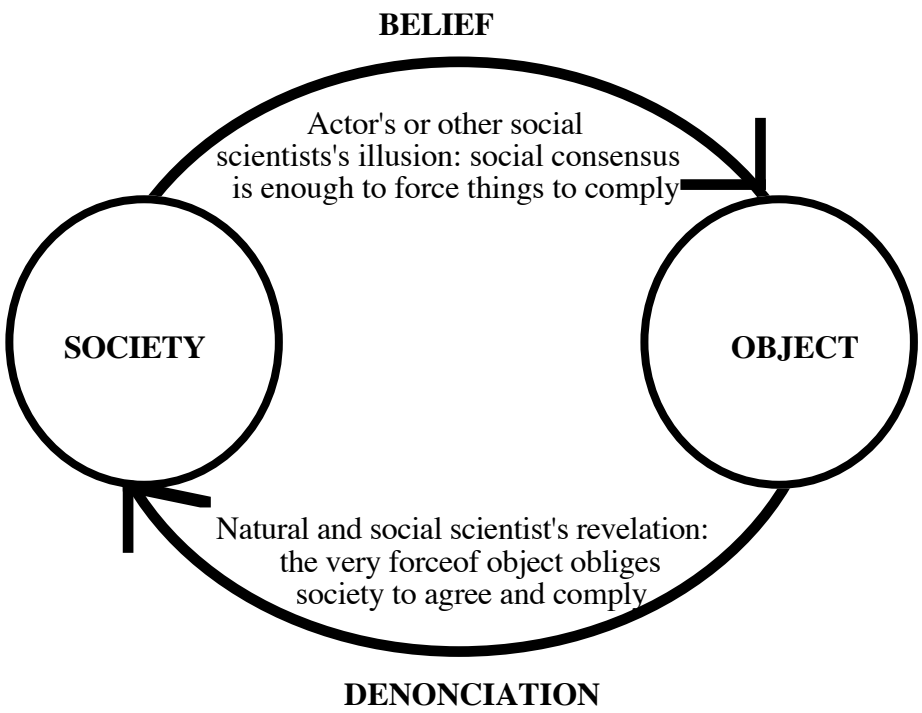


Figure 4

No wonder that the superposition of the two main resources leads to dualism. How could asymmetrical social scientists resolve the difficulty? Society reflects and materializes itself in all the "false" objects that "mere" actors believe to be the cause of society, but *not* in the real objects that do indeed cause society? If such is the case, then society is becoming a very strange beast indeed, strong enough to be *sui generis* and

effectively cause religion, art and styles, but so weak and plastic that science and technology impose consensus on its members without them building any facts and artefacts at all! The result of such a blatant contradiction is dualism. Each object will be divided in two (Figure 5): one part to which the classical Durkeimian model will be allowed to fully apply, as in figure 3, and the other where the no less classic model of figure 4 will be applied. "Secondary qualities", to use the old language of philosophy of perception, are socially explainable, but not "primary" ones. The problem with this dualism is that objects and societies are either too weak or too strong. "Society I" is so strong that it is *sui generis* and projects itself on objects which are reduced to being the screen onto which social categories are played. But "objects II" are so powerful that they are able to impose their force onto the pliable matter of society. Either society is too strong and objects too weak, or objects have too much force and society not enough. In both cases it is impossible to grant objects and societies the right solidity and to see both of them in focus.

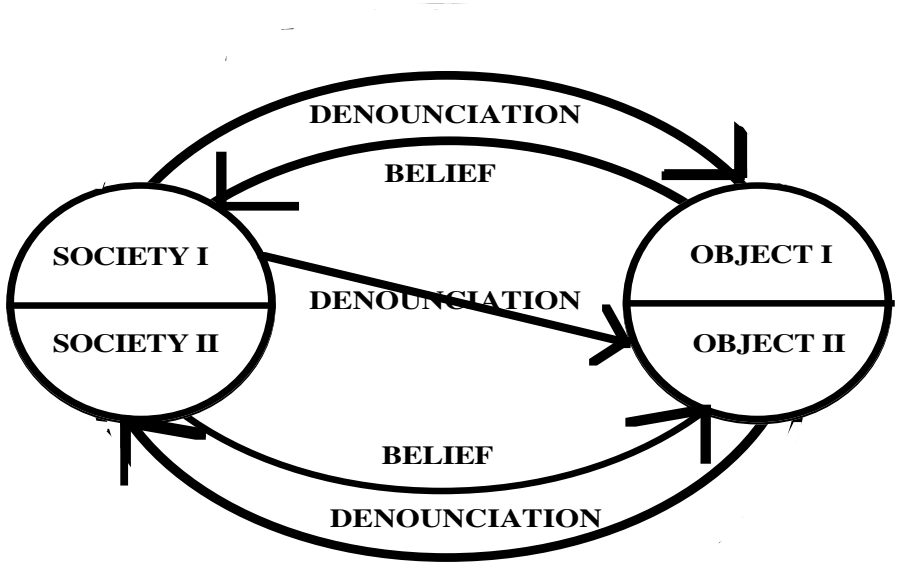


Figure 5

To resolve the dualism is now easy. One simply has to apply the first model to the second in order to break *both* into bits. This transformation has occured in two steps. The first one was to treat science and technology in the same way as art, religion and styles used to be treated by main stream social science. If, taking over the social scientists' mandate, we now consider their denunciation (bottom arrow of figure 5) as a belief which we now denounce (arrow crossing over in figure 5), I extend social constructivism to science and technology. I treat the "object II" as if it were the "object I". What social scientists have rightly said of religion, art and style, we now claim, is even truer for

the facts of science and the artefacts of technology. They are all made by society through and through, and simply express, reflect, materialize, embody our consensus.

But no sooner have we taken this step that the whole enterprise falls apart. There is now nothing left with which to make society ("society I"), whereas society is supposed to make and cause everything else *including* the constrains of matter and the objectivity of facts. By *extending* the denounciation program of social scientists to science and technology, we reveal the emptiness of social constructivism, its intrinsic idealism. The impression that it had a meaning was maintained only as long as it did not apply to hard facts. Social constructivism was protected from absurdity only by the dualist paradigm. On the other hand, although some of my colleagues are trying to prolong its life, the extension of social construction to science and technology lasted only a split second, the time to see how badly built a dualist social theory was.

How can the distributed monism I advocated above provide a better social theory? As I indicated in the case of Aramis, the object is not to be positioned at one of the extremities while the social would be at the opposite pole. Society does not exist enough to occupy the position of a pole, nor does technology. The Mayor of Paris does not know what he wants enough to be able to shape Aramis, but the software engineers do not know either if they will be able to accommodate the contradictory wishes (now translated into the form of specifications) of the same Aramis. Where is Aramis? Not on the left side of the diagram and not on the right side. A technical object – at least as long as it exists – is the institutionalized transaction through which elements of the actors' interests are reshaped and translated, while non-human competences are upgraded, shifted, folded or merged. Figure 6 provides a diagrammatic comparison of the two explanatory models above. There are indeed arrows going from society to technology and back. But these arrows are not the only ones nor do they indicate the most interesting phenomena. What is more important is the *displacement* of goals and properties due to translation – displacements that are indicated by the sharp or shallow turns taken by the lines. Sometimes an element of the social is transposed with very few variations to become a member of the technical world, but sometimes the shift, the metamorphosis, is much greater.

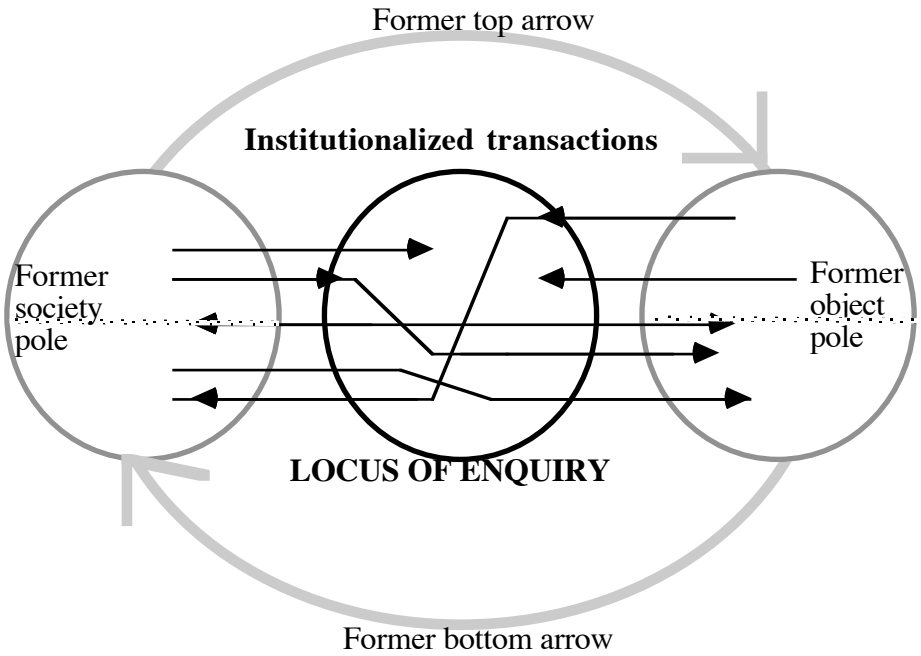


Figure 6

Society does exist, but only as the sum of all the arrows coming from the transaction sites. Technology also exists, but not as the independent entity onto which society could project itself, or which could force society into obedience. When everything is stabilized the smooth transactions indeed give the impression that there exists a technique, faithfully obeying our wishes or coercively forcing us into assent. In times of instability, however, the ethnographer would be wasting her time if she were sitting at either extremity of the diagram, the only viable locus of enquiry being where translations or transactions are effectuated. This focus was entirely missed – or indeed carefully circumvented – by the two main language games of the social sciences, represented here by the gray arrows of former figures 3 and 4. Moreover, trying to link the two arrows and to envelop the two poles by dialectical moves would take the ethnographer *still further* from the locus of enquiry. This is the paradox of dialectics to have so pitifully failed in studying what it claims so arrogantly to reconcile: the subject and the object.

Once again the parallel trajectories of VAL and Aramis are enlightening. VAL remained a site of transactions and has now become an institution. Aramis, unable to maintain the transactions, has drifted into two unreconcilable parts: social interests, on the one hand, techniques on the other. A high technology exists only as long as it remains in the middle part of the above diagram. As in the old disputes about the connection between soul and body, the locus of enquiry I have tried to picture is the *life* of a technique and of a society.

Bijker, W. & J. Law (eds). 199**X**. *Shaping Technology-Building Society. Studies in Sociotechnical Change.* Cambridge (Mass.): Massachusetts Institute of Technology Press.

Bijker, W. E. & T. Pinch. 1987. "The social construction of facts and artefacts: or how the sociology of science and the sociology of technology might benefit each other", pp. 17-50 in, *The Social Construction of Technological Systems. New Directions in the Sociology and History of Technology.* Cambridge (Mass.): Massachusetts Institute of Technology Press.

Bloor, D. 1976 (1992). *Knowledge and Social Imagery*. London: Routledge(reprinted by University of Chicago Press, Chicago).

Bulmer, R. 1967. "Why is a cassowary not a bird? A problem of zoological taxonomy among the Karam", *Man*, 2: 5-25.

Byrne, R. & A. Whiten (eds). 1988. *Machiavellian Intelligence. Social Expertise and the Evolution of Intellects in Monkeys, Apes and Humans.* Oxford: Clarendon Press.

Callon, M. (ed.). 1989. *La Science et ses réseaux. Genèse et circulation des faits scientifiques. Anthropologie des sciences et des techniques*. Paris: La Découverte.

Collins, H. 1985. Changing Order. Replication and Induction In Scientific Practice. London/Los Angeles: Sage.

Descola, P. 1986. *La Nature domestique. Symbolisme et praxis dans l'écologie des Achuar*. Paris: Editions de la Maison des Sciences de l'Homme.

Digard, J.-P. 1990. *L'Homme et les animaux domestiques*. Paris: Fayard.

Goody, J. 1977. *The Domestication of the Savage Mind*. Cambridge: Cambridge University Press

Hennion, A. 1991. *La Médiation musicale*. Paris: Editions de l'Ecole des hautes études en sciences sociales.

Horton, R. 1982. "Tradition and modernity revisited", pp. 201-60 in, *Rationality and Relativism.* Oxford: Blackwell.

Knorr, K. 1981. *The Manufacture of Knowledge. And essay on the constructivist and contextual nature of science.* Oxford: Pergamon Press.

Latour, B. 1987. *Science In Action. How to follow scientists and engineers through society*. Cambridge (Mass.): Harvard University Press.

— 1990. "Drawing things together", pp. 19-68 in, *Representation in Scientific Practice.* Cambridge (Mass.): Massachusetts Institute of Technology Press.

— 1991. *Nous n'avons jamais été modernes. Essai d'anthropologie symétrique.* Paris: La Découverte.

— 1992a. *Aramis, ou l'amour des techniques.* Paris: La Découverte.

— 1992b. "Technology is society made durable", *Technology, Power and the Modern World.* Keele: Sociological Review Monograph pp.103-130.

— 1992c. "Where are the missing masses? Sociology of a few mundane artefacts", *Shaping Technology-Building Society. Studies in sociotechnical change.* Cambridge (Mass.): Massachusetts Institute of Technology Press pp. 225-259.

— (in translation). *Aramis, or the love of technology.* Cambridge (Mass.): Harvard Unviversity Press.

Latour, B., P. Mauguin, et Teil 1992. "A note on socio-technical graphs." *Social Studies of Science* : vol.22 pp.33-58

Latour, B. & S. Woolgar .1979. Laboratory Life. The construction of scientific facts. Los Angeles: Sage.

Law, J. 1987. "Technology and heterogeneous engineering: the case of Portuguese expansion", pp. 111-34 in, *The Social Construction of Technological Systems. New directions in the sociology and history of technology.* Cambridge (Mass.): Massachusetts Institute of Technology Press.

Leroi-Gourhan, A. 1964. Le Geste et la parole. Paris: Albin Michel.

Lynch, M. 1985. *Art and Artifact in Laboratory Science A study of shop work and shop talk in a research laboratory.* London: Routledge.

MacKenzie, D. 1990. *Inventing Accuracy. A historical sociology of nuclear missile guidance systems.* Cambridge (Mass.): Massachusetts Institute of Technology Press.

Pickering, A. (ed.). 1992. *Science as Practice and Culture*. Chicago: The University of Chicago Press.

Pinch, T. 1986. *Confronting Nature. The sociology of neutrino detection*. Dordrecht: Reidel.

Polyani, K. 1975. *Les Systèmes économiques dans l'histoire et dans la theorie*. Paris: Larousse.

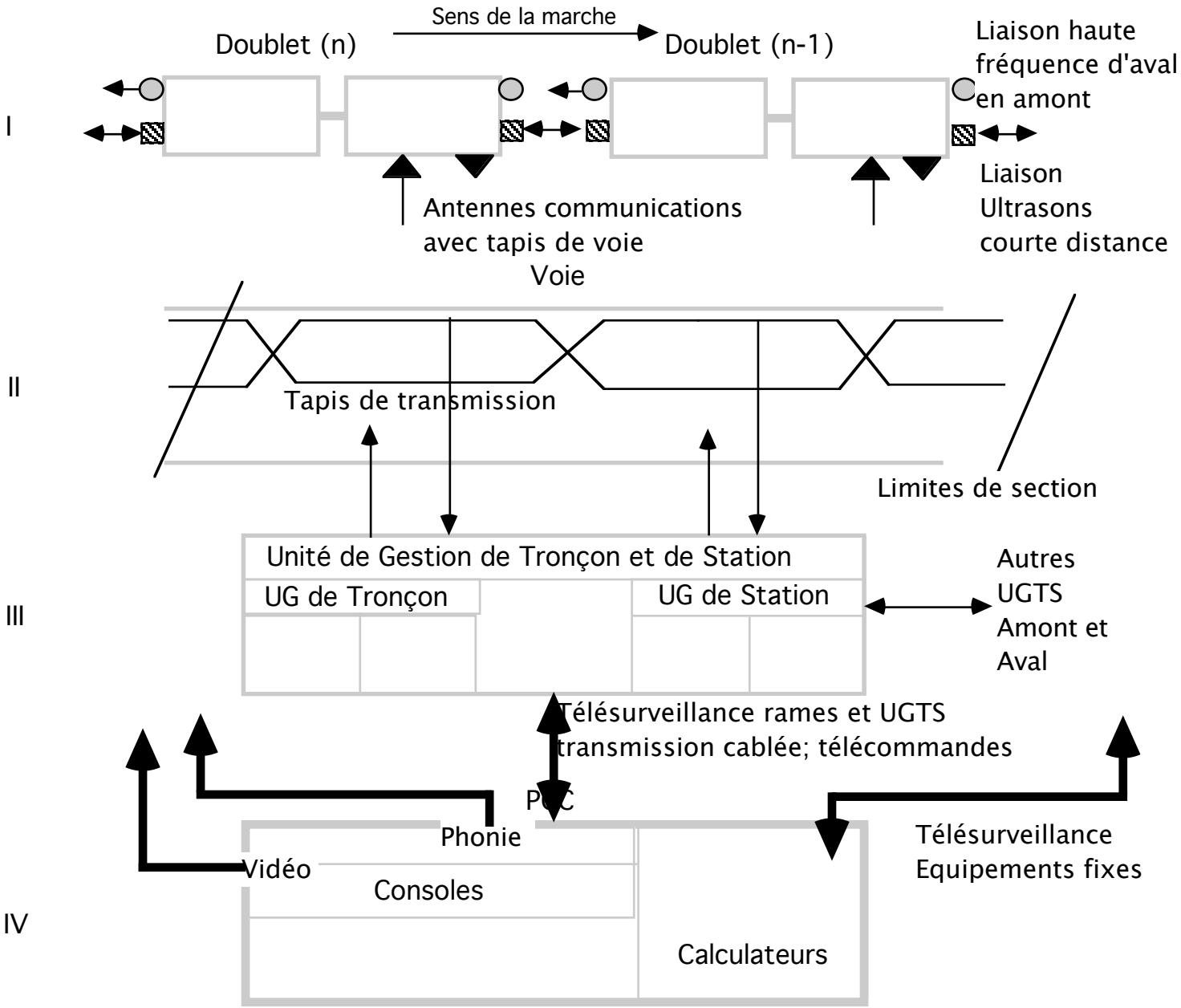
Shapin, S. & S. Schaffer1985. *Leviathan and the Air-Pump. Hobbes, Boyle and the experimental life.* Princeton: Princeton University Press.

Star, S. L. & J. R. Griesemer 1989. "Institutional ecology, translations and boundary objects: Amateurs and professionnals in Berkeley's Museum of Vertegrate Zoology, 1907-39", *Social Studies of Science*,19(3): 387-420.

Strum, S. 1987. *Almost Human. A journey into the world of baboons.* New York: Random House.

Strum, S. & B. Latour 1987. “The meanings of social: from baboons to humans”, *Information sur les Sciences Sociales/Social Science Information,* 26: 783-802.

Traweek, S. 1988. *Beam Times and Life Times, The world of high-energy physicists.* Cambridge (Mass.): Harvard University Press.


Sens de la marche
Doublet (n)
Doublet (n-1)
Liaison haute fréquence d'aval en amont
I
Liaison Ultrasons courte distance
Antennes communications avec tapis de voie
Voie
II
Tapis de transmission
Limites de section
Unité de Gestion de Tronçon et de Station
UG de Tronçon
UG de Station
Autres UGTS Amont et Aval
III
Télésurveillance rames et UGTS
transmission cablée; télécommandes
PCC
Phonie
Vidéo
Télésurveillance
Equipements fixes
Consoles
IV
Calculateurs