After the individual in society: lessons on collectivity from science, technology and society.

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Abstract. Les sciences sociales ont invente toute une serie de concepts pour surmonter l'opposition entre action individuelle et collective. Un des apports de l'anthropologie des sciences et des techniques (AST) est de montrer que cette opposition ne constitue qu'une des configurations construites par l'action et sa distribution. Pour restituer la diversite de ces configurations l'AST a elabore quatre principes. Le premier affirme le caractere heterogene du social. Le deuxieme conduit a considerer que toute entite est une realite assimilable au reseau des elements heterogenes. Le troisieme affirme que les entites sont a geometrie variable et qu'elles reorientent l'action dans des directions imprevisibles. Le quatrieme propose que tout arrangement social stabilise est a la fois un point (un individu) et un reseau (un collectif). L'analyse sociologique, si elle veut surmonter l'opposition entre individualisme et holisme, doit donc se donner pour objet l'etude de ces differentes configurations hybrides.

Resume. The social sciences have devised a series of strategies in order to overcome the division between individual and collective action. However, science, technology and society (STS) has shown that this distinction is only one possible configuration for action and its distribution. In order to investigate other possible configurations, STS proposes four principles: that the social is heterogeneous in character; that all entities are networks of heterogeneous elements; that these networks are both variable in geometry and in principle unpredictable; and that every stable social arrangement is simultaneously a point (an individual) and a network (a collective). If sociological analysis is to overcome the individualism/holism division it should attend to the range of hybrid configurations. "For at the intersection of all these fields we sense that the same basic message is being conveyed -- a message that seems indeed over the course of the centuries to have almost attained the status of an accepted truth. This is the assertion that reality -- all reality -- can be conceived of as a construction that one should be able to lean on, and as something that must be manipulated. Arts and wisdom, as the Chinese conceived of them, should be devoted to the strategic exploitation of the propensity inherent in reality; they should be designed so as to cause a maximal effect." (Francois Jullien, La Propension des Choses, Paris: Seuil, 1992, page 15)

Introduction

Many cultures manage perfectly well without it. For instance, those of the Papua New Guinea Highlands (Strathern 1991) -- or, perhaps less exotically, that of the Japanese. Indeed, the very translation of Euro-American social thought into Japanese is extraordinarily difficult. For the whole idea of the "individual" and "society" is foreign to Japanese culture. There is a fascinating story to be retold about the conversion of these terms into Japanese neologisms -- the ugly neologisms needed to import Euro-American social science and its problems into Japan. And another equally interesting story to be told of teaching about the distinction between the individual and society to eighteen-year olds in Japanese universities -- students who tend to come from places which perform continuities between the collective and the personal, rather than divisions or dualisms. (2)

Are the Japanese disadvantaged? Perhaps. But perhaps not. For maybe what appears to be a Japanese problem is really one of Euro-American making. And one that should be treated as a burden, indeed an unnecessary burden. Such, at any rate, is the thesis that we explore in this paper. That the Euro-American distinction between the individual and the collective--current since at least the Enlightenment, though no doubt preceding this by many centuries -- is unsatisfactory. And that the space created by the division and the intellectual games it generates are unnecessary, perhaps even sterile. For since the Enlightenment many of the struggles of Euro-American social science have been about how the division might be bridged. Or, perhaps more recently, about how it might be transcended. These are struggles that run through many disciplines. Duesenberry caught an important truth when he wrote: "Economics is all about how people make choices; sociology is all about how they don't have any choices to make" (Duesenberry 1960). So the social science games have been those of bridge-building. In economics Herbert Simon's notion of bounded rationality was an attempt to set homo economicus within a context of intermediary objects such as procedures and routines. And within sociology the various interpretative sociologies have chipped away at the high social ground occupied by such catch-all structural concepts as norms or institutions, instead arguing that the collective is endlessly performed in local interaction.

So disciplines such as economics and sociology have worked in the space created by the collective/individual divide. And they have created hybrid objects which try to describe the simultaneous constitution of the collective and the individual, concepts such as rules, conventions, tacit knowledge and apprenticeship. But -- or so we want to

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argue -- such concepts simply displace the problem. This is because, even after they are mobilised, the same questions are still there. Shifted. Re-formulated. Seemingly blunted. But still performing a logic of dualism. For instance, are rules an emergent product of individual strategies or decisions? Or do they exist independently, acting both as a resource and a constraint for agents? In such questions -- questions which reflect contemporary social theory--the old problem of the individual and society has not gone away. Instead, it is the vocabulary that has shifted. The dialectic of the subject and structure has simply been displaced.

What, then, is to be done? No doubt this question can be answered in many ways. For instance, the Japanese might do well to ignore the dualisms created by Western social science. Perhaps then, in due course, they could teach us something of the benefits of a monistic social science. But in the meanwhile perhaps we might make some efforts of our own. Indeed, the argument of this paper is that we already have a powerful resource at hand. This comes from a sociology of science and technology which has abandoned the individual/collective dualism in recent work. For instead of asking about the origins of action (a question which usually leads to a version of Western dualism) it asks, instead, about how knowledges or devices are distributed or disseminated. And this--at any rate in the way it has been practised in part of the sociology of science and technology--implies the end of great divides. Divisions between human and non-human, subject and object, and agent and structure--all of the dichotomies generally mobilized to explain the collective have disappeared (Callon & Latour 1991, Latour 1987).

This, then, is an essay of explication and exploration. It explicates some arguments in the recent sociology of science and technology by using brief descriptions of exemplary cases studies. And it explores their implications for the collective/individual dualism.

1. The Heterogeneity of the Social

Stage one. The argument is that the social is materially heterogeneous. This is an argument made in many ways. But to make it we'll go to one of the myths about the social life of primates. (3) This claims that primates -- in particular baboons--draw only on somatic resources when they interact and cooperate. And that when they are left (as the phrase puts it) to their own devices they rarely make tools. An implication is this: if you want to be leader in baboon society (a position generally occupied by big males) you cannot mobilize walls, rifles or social security numbers. You cannot send letters to your baboon colleagues. You have no secret police. All you have is your own body. If you want to be chief, you have to be there in person in order to reproduce your authority. Domination depends entirely on face to face confrontation. The use of the body. Or, perhaps, the use of someone else's body. (4) This is Shirley Strum's argument in her magnificent study of baboon society: that the collective is built by naked bodies alone. No other materials are involved. (5) There are no texts or artifacts, and no money circulates. The social glue is somatic, and somatic alone. (6) All of which suggests that methodological individualism works just fine in the society of monkeys that wander about on the high plains in Kenya. But perhaps only in the society of monkeys. For--this is the argument--human societies are different. They are made up of heterogeneous materials. So this is the first principle of the new sociology of science and technology: that what we like to call "the social" is materially heterogeneous.

Of course everyone knows this. Everyone knows that societies involve technologies, texts, buildings and money. But what to make of it? Often in practice we bracket off non-human materials, assuming they have a status which differs from that of the human. So materials become resources or constraints; they are said to be passive; to be active only when they are mobilized by flesh and blood actors. But if the social is really materially heterogeneous, then this asymmetry doesn't work very well. Yes, there are differences between conversations, texts, techniques and bodies. Of course. But why should we start out by assuming that some of these have no active role to play in social dynamics? The principle of material heterogeneity says that there is no reason to do so. Instead it says that all these elements and materials participate in social ordering.

2. Entities are Networks of Heterogeneous Materials

Scientists and engineers are bricoleurs. They work by linking bits and pieces together. Heterogeneous bits and pieces. Human and non-human. For instance, they write and revise texts, modify instruments, and redefine social groups. They practise what is sometimes called "heterogeneous engineering." (7) But pushed to its conclusion this claim has a profound and counter-intuitive consequence. This is that there is no difference between the person and the network of entities on which it acts. Or (the real point) between the person and the network of entities which acts through the person. Network and person: they are co-extensive. Such, at any rate, is the argument of the sociology of science.

For instance, work by Bruno Latour shows that Pasteur was nothing more than a network of heterogeneous elements (Latour 1988). This Pasteur-network was made

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of a lot of bits and pieces: laboratories, domesticated strains of bacteria, notebooks, statistics, and even--as Gerald Geison has treacherously suggested -- vaccines chemically treated by his colleague Joseph-Henri Toussaint. And one could add many more: the farm at Pouilly le Fort where sheep lived and died in infected fields; the journalists who witnessed Pasteur's spectacular experiment on the farm; the French electors Pasteur sought to convince; and so on, and so on. The argument is that Pasteur was not a single entity, not just a body and a soul. Or rather it is that he was much more than a body who interacted with other bodies. That, instead, he was a combination of a great number of different elements which produced Pasteur-the-great-researcher. So the argument is also that outside this network
Pasteur-the-great-researcher did not exist at all. To put it simply, Pasteur was a network.

Let's press this counter-intuitive logic one step further, and say that it works just as well for technical artifacts: for instance (another empirical story) for a military aircraft. It was in 1955 that the British Royal Air Force (RAF) decided that it needed a long range tactical strike and reconnaissance aircraft (called the TSR2) that could fly into Eastern Europe or defend the outposts of the British empire. (8) It needed this new aircraft because the Russian "threat" had changed. Now there were anti-aircraft missiles, but to escape these the aircraft would have to fly very high at Mach 2, and just below the speed of sound at 500 feet or less. And since sophisticated air bases would be destroyed in a nuclear war, it would have to take off and land on short airstrips.

The "threat" was a heterogeneous mixture: political, strategic and technical, all of these were mixed up in it. But so too was the design of the aircraft itself. This was a complex interaction between the laws of aerodynamics, the experience of teams of engineers, the capacity of British industry, and so on and so on -- the list is endless. For instance, a short take-off run suggested the need for powerful engines and long slender wings. But against this, swept wings would be best at high altitudes and high speeds, and short wings would work best at high speeds and low altitudes. Which means that the TSR2 was not (simply) an aircraft. Like Pasteur it was a network of heterogeneous relationships. Or, more precisely, it was a network that traced a compromise between different concerns, considerations and actors. Technicians, politicians, industrialists, different kinds of metal, metal fatigue, the production capacities of companies, wind-tunnels and budget restrictions, all of these were built into the TSR2 network and helped to give it shape.

People are networks. Devices are networks. But so, too, are texts:

DIVEMA ... is a synthetic anionic polyelectrolyte, which ... initiates a wide variety of physiological responses including interferon production, macrophage activation and tumor regression. ... We have tested DIVEMA in three different molecular weight ranges as a potential modifier of the pinocytic uptake of two substrates. (Law 1986a)

This is an extract from a scientific article published at the beginning of the 1980s. There is nothing remarkable about this article -- it is like thousands of others. We're interested in it because it can be analysed in the same way as Pasteur or the TSR2: like these, it is heterogeneous. Thus these few words draw on a web of technicians, instruments, rats, computer print outs, funding agencies, comments by colleagues, and other scientific articles. They even draw on the reader -- she is written into the text when the authors tell her what DIVEMA is. So this is a further claim: texts also reflect, are produced by, and help to create, a teeming world of entities (Callon et al. 1993).

So the sociology of science and technology makes this argument. Entities -- human, non-human, and textual -- aren't solid. They aren't discrete, or clearly separated from their context. They don't have well-established boundaries. They aren't, as the jargon puts it, distinct subjects and objects. Instead they are sets of relations, for instance in the form of networks. (9) And they are co-extensive with those networks. Such, at any rate, are the assumptions which have started to guide the work of many sociologists of science and technology. As they follow scientists in action, the creation of scientific statements, and the construction of technical artifacts they explore the elements that are brought together. And they look at the way in which entities -- people, technologies or texts -- come to summarise of the relations that make them up. This, then, is second principle, one which states that entities -- human, technical and textual -- are compound realities, the product of a process of composition. (10)

3. Entities with Variable Geometry that Redirect Action

We've said that matters are heterogeneous. This is the first principle. And we've said that entities are networks, or network effects. That is the second principle. Now we move to the third principle. This says that the bits and pieces in the networks are not given in the order of things. Instead, they are relational effects. This means that their form, their content, and their properties are not fixed. Rather their identity emerges--and changes--in the course of interaction. The methodological lesson is this: that objects--for instance people and texts--are processes of transformation, compromise or negotiation.

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But the same is also true for devices. For instance, the British wanted an aircraft to counter "the threat." But how big should it be? The RAF said that it wanted a large aircraft; this would be safer with two engines rather than one. The Royal Navy said that single-engined aircraft were perfectly safe, and could fit into aircraft carriers. Indeed, they were already building just such an aircraft -- and adapting this for the RAF would be cheap. But the RAF said no. The Navy plane was slow, its range was small, and it simply wasn't powerful enough. An industrial contractor came up with a compromise. Why not create a small but powerful aircraft with a single-engine and a long-range? Then everyone would be happy. But no. It turned out that no-one was happy. The Navy said it would not be in service for years, while the RAF said the single engine was too risky. This was a big debate through much of 1957 and 1958. Sometimes the big aircraft was on top. At other times, especially when the Treasury was involved, the smaller Navy aircraft had the upper hand. And then there were moments when the contractor's compromise nosed ahead.

So what should we make of this? Our answer is that we're looking at a variable geometry aircraft, one that changed its shape as the weeks went by. Two engines, then one, straight wings and then swept wings, these transformations reflected complex processes of interaction between industry, government, engine characteristics, aircraft carriers and the laws of aerodynamics. Each state of the aircraft was a network, and the shape of that aircraft reflected the form of the network and so of the interactions out of which it was composed.

So the aircraft was shaped by its network. But -- equally important -- the aircraft also acted upon the network. That is, it shaped the projects and the actions of other entities in the network. For instance, we have mentioned that the TSR2 was supposed to be able to operate without large air bases. Indeed, if it could fly from clearings in German forests it would be simple to hide it from the Russians. But this would be much easier if it could take off and land vertically. Was this possible? It turned out that the answer was, not really. On examination it appeared that a vertical take off aircraft would rapidly become a huge monster with limited range and huge fuel demands. Here, then, it was the aircraft that acted rather than the specification. It was the aircraft that shaped the requirement, rather than vice versa.

The conclusion, then is that entities may have variable geometry -- but not all variations are equally feasible. But also, that what is feasible and what is not is decided in interaction. For, as in this case, there is often no way of being sure how entities will behave without trying it out in practice. How could anyone know beforehand how a project for a vertical take-off aircraft would evolve? What form it might take? Whether it was going to act like a real agent, resist, and modify the actions of others? Or whether, on the contrary, would it simply conform with the projects of others, and so be rendered passive?

We've made the argument about the malleability of entities for a technical object. But the same applies to the shape of human beings though the vocabulary of analysis is a little different. It is about the malleability of goals, projects, preferences and identities, and the ways in which these reflect -- and shape -- the heterogeneous elements that they associate. There are many case studies of the instability and reworking of identities in English language sociology. (11) And there is a substantial French literature, inspired by Boudon, Crozier and Friedberg, which brings out the contingent character of the goals and decision criteria, which vary depending on context, concrete action system, and position. For instance Friedberg argues that individuals do not have stable goals, strategies or preferences. Instead these are constructed locally in the course of interaction, and goals and interaction alter together (Friedberg 1993).

Such sociological studies are important. But they are also somewhat limited. This is because they take it for granted that the capacity for action is a human attribute alone. This means that they try to explain change in identity by looking at personal cognitive, interpretative or strategic resources. They are committed to methodological individualism--like Shirley Strum's baboons. But the lesson of the sociology of science is that this is an unnecessary restriction.

For instance, Langdon Winner is the author of a famous article that has been so often cited that by now it almost has the status of a cliche. Called "Do artifacts have politics?" (Winner 1980), it tells of Robert Moses, the New York City planner between the two world wars. Moses designed a parkway between New York and Jones' Beach State Park on Long Island. But Moses was also racist, and wanted to keep blacks out of the Park. But how should this be done? Moses' answer was to invent an architecture of discrimination in the form of low bridges. When he designed these he made sure that they were high enough for cars, but too low for buses. Which meant that if you were rich enough to own a car, then you could use the parkway get to Jones' Beach, but if you depended on the bus then you couldn't.

This story is certainly alarming. But it also shows how the identity of a social group may be constructed and varied in a process of heterogeneous engineering. At the beginning there were two actors -- Moses and an indeterminate New

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York population, perhaps best imagined as a set of individuals unrelated to each other. But by the time the Parkway was built a network of heterogeneous identities had been created. Moses, bridges, buses and cars: these were all involved. But so too were new social groups: for instance, that of poor-people-and-generally-blacks-that-cannot-get-to-Jones' Beach. And it was a group that was relatively stable. Indeed, this is the point of Winner's argument. It was stable because it was materially heterogeneous. For in these interactions freeways, the shape of bridges, and the height of cars and buses are just as important as Moses with his racist politics. (12) And since the bridges are durable, they still tend perform Moses' politics though Moses himself has gone. But only tend. Because more people can now afford cars -- which means that the social group made up of those denied access to the beach has tended to dissolve. So the group is stable, but only relatively so. And the argument is that the individual and collective identity of Harlem blacks varies. And that it varies in interaction with the other components in the network.

None of these components is inflexibly given in the order of things. The new social group of blacks-who-cannot-go-to-the-Long-Island-beaches cannot be deduced from the isolated individuals that existed before. But neither does it follow from Moses' racism. To move from isolated individuals to blacks-excluded-from-Long-Island-beaches we need to add bridges and freeways. Which means that the new identity of the actors maps onto -- and is indistinguishable from -- the material heterogeneity of the network of relations. And the new entities are created in ways that cannot be predicted beforehand.

4. Distributed Entities that are Also Points

The argument is that subjects or objects don't have fixed boundaries or attributes: aircraft, human beings, texts, social groups, or organisations: these are distributed through, a product of, and enact a range of materials and elements. But -- and this builds on what we have learned in the Moses example -- sometimes, despite the endless flux and indeterminacy, networks of heterogeneous materials become more or less durable and achieve a degree of stability.

Another example: the case of the electric car, the vehicule electrique (VEL) (Callon 1979, 1981). In 1970, before the oil crisis, EDF (Electricite de France -- the French electricity utility) announced the end of the internal combustion engine. According to EDF, cars running on petrol were noisy, polluting and spoiling the urban environment. But drivers were ready to give up the charms of the motor car in favour of more functional means of transport: for the consumer society was under attack. Which meant the electric car, which had been shelved at the turn of the century, was the way to go. It would be small, silent, non-polluting and highly efficient. The driver in a post-industrial society would use it as an matter-of-fact way for getting from A to B, and not as a form of conspicuous consumption.

Like the TSR2 and the Harlem blacks, the VEL was heterogeneous. At different times and in different versions one finds fuel cells, platinum electrodes, chassis, town councils, ministries and automobile manufacturers. But as the project developed the associations tended to stabilise. Indeed, they tended to stabilise to the point where potential customers might visit a car showroom, look at an object, and hear about energy consumption and performance -- and they might choose between the two-door or the four-door version. In short, as it stabilised it moved to the point where the VEL was nothing more than a black box. Electrodes, catalysts, the financial arrangements between EDF and Renault, town council bylaws, or the standards imposed by the Environment Ministry -- all of these were contained within the VEL. For the vehicle was the product of heterogeneous interactions and socio-technical compromises. But, once they held together and were integrated into a set of coherent technical choices and materials, the VEL was (also) a single product -- a simple "car" with batteries that needed recharging every fifty kilometres.

This is the argument: that a network which is relatively stabilised also tends to become an entity, a black box, a black box that (as the sociology of science sometimes puts it) translates the various materials that make it up. It translates them by co-ordinating them, by fronting for them, and by standing for them in a simple and coherent form. This means that for the moment the fronted network acts as a single unit. It does not fall apart. And (again for the moment) that it can be distinguished from its environment, distinguished as an object with its own consistent identity. So -- to the extent that it is stabilised -- the VEL represents its network. It represents its network in the same way that a trade-union leader speaks for "the workers" or a president for "the country." For the argument is identical in form. Humans, objects and texts alike: if they are successful such entities have mobilised, represented and taken the form of the networks of entities which lie behind them. (13) And this is the point of the fourth argument. Actors are both networks and points. They are both individuals and collectives. The VEL is both. A text on DIVEMA is both. And so, too, is Pasteur. For when journalists and officials visited the farm at Pouilly le Fort,

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they watched sheep dying of anthrax, while others happily grazed in infected fields. Pasteur said: the dying sheep have not been vaccinated, whereas the others have. And since the sheep did what Pasteur said they should be doing -- since there were no dissident voices in the network -- Pasteur was able to speak as Pasteur-the-great-scientist. For the moment he represented a network. He punctualised it. (14) Which is more than can be said for EDF -- for the VEL project lasted only a few weeks before it started to decompose.

This, then, is the core of the argument from the sociology of science. Stable social arrangements are both individual and collective. They are necessarily possessed of a double nature. Sometimes it is useful to talk of individual entities: to imagine that they are discrete objects in an environment. But it is equally appropriate to treat them as collective effects -- as patterned networks. And to explore the character of that patterning -- a patterning that transcends the division between the individual and the collective. And, indeed often, this becomes necessary, since the patterned stabilities of translation are eroded, and the components that make up the network decompose into an uncoordinated cacophony of different voices and actions. The argument, then, is that the division between the individual and the collective is an effect. Or, to put it another way, that if homo clausus was a (temporarily workable) fiction created at the time of the Enlightenment, then so too was that of entitas clausa.

5. Working Collectivities

We've built an argument that refuses to distinguish between humans and non humans. Or it distinguishes between them, but only as outcomes or effects. But this is controversial. It sounds antihumanist and amoral. So what should we make of this?

First, note that the materials that make up humans and non-humans are similar. Pasteur-the-great scientist includes non-humans (sheep, microbes) -- while TSR2 contains humans. So the fabric of the networks is much the same in each case. The difference is rather in the spokesperson or representative: sometimes this takes human form, and sometimes it does not. But even this division is not straightforward, for there are endless marginal cases. When does an embryo become a human being (Casper 1994)? At what point is abortion a form of murder? When is it proper to turn off a life support system? These are real enough questions. And they embody decisions -- or negotiations -- about what it means to be human. Sometimes this has to do with moral capacity and responsibility. (What does it mean to accuse dogs but not cars of "attacking" children? What should we make of the many animal trials that took place in the eighteenth century?) Sometimes it has more to do with intellectual and cognitive skills. (What of children born with severe handicaps? Or of those persons that are said to be "insane" and hence debarred from witnessing -- or responsibility -- in legal proceedings?) Sometimes the question is theological (all those born of woman are endowed with an immortal soul, whatever their other attributes). And yet again, sometimes it is a medical matter (for instance to do with genes or immune system reactions (15)). So the division between human and non-human is often unclear in practice. There is no universal answer.

But what happens if we move away from the margins, to entities that we would all agree are human? To humans that have goals, intentions and strategic abilities. The question is: where do these come from? Or better, where are they located? Here is another story.

Andrew is director of a large British laboratory. He is an entrepreneur -- active, commanding and energetic. He is, or so those who know him would agree, an actor. So what does he do? He talks with his subordinates, gathers information. He periodically visits "Head Office" to see what is going on. He travels to London to exchange intelligence and compare malt whiskies with his contacts in the corridors of power. He negotiates with other members of the laboratory before flying off to visit the European Community Directorates in Brussels. Everyone knows that it's a hard life being a lab director! And Andrew is no different from Pasteur. He tries to combine elements, heterogeneous materials, and get them hold together. But what would happen if we tried a thought experiment? What would happen if we were to drop Andrew into baboon society?

Imagine, then, what would happen if we were to take away Andrew's fax machine and telephones. If we blocked the reports and messages that flow across his desk. If his secretary were to disappear. If there were no longer planes or trains to Brussels. If his email account were closed, and his personal computer taken away. If the members of his laboratory began to ignore him -- or, started to treat him as a porter or secretary. Would Andrew still be a strategist? Would he be capable of enrolling, linking, calculating, decision-making? The answer, or so we'd suggest, is no. Andrew would no longer be a strategist.

Let us give Andrew his fax machine and his secretaries back. He has called a meeting of his management team. There is a crisis looming. The laboratory is working on an important "flagship" project that is vital to its future. But he feels that things are not going as they should. In front of

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him he has tables of figures which count the "man years" devoted each project. (16) These figures haven't dropped out of the air. It has taken a lot of time and effort to create them -- to invent the set of procedures, routines and machines which is called the "manpower booking system" in the vernacular of the laboratory. But now the system is working: scientists fill in forms, and these are checked and coded by administrators. And the result is the figures on Andrew's desk. But today these are troubling. What they suggest is that insufficient manpower is being devoted to the "flagship" project. And, though it hasn't started to show yet, it is likely that this will fall behind schedule. Andrew wants to take decisive action, action before it is too late. But he is only able to do this because of the manpower booking system. For the laboratory has been converted into a panopticon and it has created a centre of control -- the place where Andrew sits with his colleagues and worries about the dismal manpower figures (Latour 1987, Law 1994), a place where Andrew and his colleagues can take remedial action.

It is tempting to say that "Andrew is a strategist." But this is a shorthand that is dangerously misleading. For like all the other actors that we have described, Andrew-the-strategist is a heterogeneous network: Andrew + fax + fellow managers + secretary + head office + trains to London + his PC + the work of scientists and engineers + the memos that circulate + the time slips filled in by employees -- it is this combination that creates the possibility of strategic action. So Andrew-the-strategist cannot be detached from this arrangement of materials. It is, of course, possible to point to Andrew and insist that "this is where the action is located." And to point to all the other materials and insist that they are part of a passive support system. It is possible to distinguish in this way. But it is misleading. It misleads because the capacity for strategy is an effect of a more or less stable arrangement of materials. Not something that grows, as it were out of one alone.

So our argument is that strategic action is a collective property -- not something undertaken by persons in the collective. But the fact that we focus on strategic action should not mislead. For strategic and reflexive action where agency is attributed to a single individual is only a single possibility. There are all sorts of other collective configurations. As is obvious, there are also collectivities -- such as nuclear power plants -- which act (or so we hope) like predictable automata. And in between these two extremes there are all sorts of other possibilities. For instance, Karin Knorr-Cetina shows that the collective created by high energy physicists depends on the presence of the material universe of their experiments (Knorr-Cetina 1991, 1992, 1995). This, to be sure, is what we would expect given our argument about heterogeneity. But what is striking about this is the way in which the "knowing individual" has disappeared in this collectivity. Instead, the scientists participate in experiments in which their contributions can no longer be distinguished from those of the particle detectors. It is no longer possible to draw a line between human beings and technical apparatus. As a result, scientists no longer attend conferences to present their own experimental results. Rather, the team or collective designates a reporter to present its work, and this may be someone who played no part in the experiments at all. To use the jargon, subjectivity, agency, and responsibility -- all of these are being eroded in the new forms of heterogeneous collectivity that are being invented in part of big science. Here, then, the physicists are ahead of the sociologists: they have learned to transcend the division between the individual and the collective.

6. Towards a Sociology of Hybrid Collectives

"The Japanese problem," or so we have suggested, is not a problem for the Japanese, but rather a problem of our own making. The distinction between individual and society is unnecessary. Indeed, it is seriously misleading. For the sociology of science and technology shows that the idea that society is a set of relationships between human actors is a misunderstanding. Instead it suggests that it is better understood as a collective association of human and non-human entities. But this implies that we need a quite different theory of action. And what we've tried to show in this paper is that this theory comes in four parts:

1. Non-humans are not simply resources or constraints. Though they sometimes act passively this doesn't have to do with their inner nature, but because they have been made passive. And, putting extreme cases on one side (cases which are the product of systematic enrolment, alignment and domestication (Callon 1986)) non-humans intervene actively to push action in unexpected directions. The theory of action that is recommended thus makes no distinction, in principle, between the human and the non human. The distinction is a consequence or an effect, not primitive to action itself.

2. Entities are interactive effects -- for instance networks. Pasteur, a warplane, or a scientific paper, these are all associations of the human and the non-human. So to claim that "Pasteur has developed a vaccine to cure rabies" or "TSR2 alters the balance of power between the West and the Soviet Union" is to take a convenient but deceptive shortcut. In fact the actions of Pasteur or TSR2 are the effect of a multitude of heterogeneous entities. And, just as important, these constituents do not fundamentally differ

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from one other: each contains both humans and non-humans.

3. Action is both a relay and it is unpredictable. For entities are inscribed in pre-existing chains of actions and they relay those actions. But these are not simple relays, because each of the entities brought together is also an indefinitely complex network of relations. Thus TSR2 propagates an endless series of actions inscribed, and reinscribed, within the RAF, the Treasury and the rest. Which means that it is dynamic and continuous. That it is variable. And that it unpredictably acts to transform what it brings together. And itself. (17)

4. This means that action cannot explained, in a reductionist manner, as a firm consequence of any particular previous action. For instance, we may guess that the prejudices of Robert Moses were articulated successfully not because of their content, but rather because of the specifics of their material form. A series of billboards saying: "Freeway forbidden to underprivileged blacks" would not, perhaps, have worked at all. The bridges were more effective. But this didn't necessarily have to be so. With appropriate policing the billboards might have worked. And with special low buses the bridges might have failed. The success, or otherwise, of an action is irreducibly specific.

The theory thus assumes that action is equivalent to specific and materially heterogeneous relations. Or, as we might call them hybrid collectifs. (18) These relations, human and non-human, carry action, they exert it, and they modify it. And since theory works from the assumption that there are no pre-determined structures it also assumes that if we want to characterise action then we might explore the patterns of relations in their specificity. We might, for instance, look at the way in which they are translated from place to place; or from one time to another; or, indeed, from one material form to another. And it suggests that if we want to solve the Japanese problem -- which is, however, our problem rather than that of the Japanese -- we will ignore a priori distinctions between agency and structure or between the individual and the collective. For if action has no identifiable source but is located through heterogeneous patterns, then to describe it will not be to locate it in a particular place -- the human agent; social structure; the divine; or a platonic realm of essences. Rather it will be to find ways of characterising the patterns in the relations of influence -- the patterns that make up hybrid collectifs.

Earlier we identified one specific form of action, that of strategic reflexivity, with its goals and discretionary spaces. And we tried to show that this is a collective product which creates and organises humans and non-humans in a particular way. That is an arrangement which generates the possibility of data-gathering, calculation, evaluation and strategic action. So this particular pattern is like a cybernetic loop. It feeds back upon and seeks to regulate itself, creating and distinguishing its own locus of control, and in some measure drawing a boundary between inside and outside. But as we have indicated, such a configuration is merely one possibility, a strategic possibility, indeed one that is an extremely popular (19) But no doubt there are many others. And that is the promise of this new sociology: that it offers a way of exploring other collective configurations and dispersals, the ways they perform different kinds of actions, and the ways in which they transform themselves -- what Jullien calls their propensities (20) -- as a result of their particular human and non-human configurations.

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(1) . We are grateful to the following friends and colleagues for their contribution to the arguments in this paper: Madeleine Akrich, GeoffBowker, Bob Cooper, Takashi Harada, Antoine Hennion, Bruno Latour, Annemarie Mol, Rolland Munro, Leigh Star and Marilyn Strathern.

(2) . We are deeply grateful to Takashi Harada of the Konan Women's University, Osaka, for exploring these questions with us, and gently reminding us that the divisions and dualisms that we assume in the educated West are forms of provincialism writ large.

(3) . For an analysis of the possible significance of these myths see Haraway (1989).

(4) . The story tells that females frequently use their baby's body as a shield to resist attack and reverse power positions. This serves to dissuade males from continuing their aggression; they turn on their heels.

(5) . See, for instance Strum & Latour (1987).

(6) . This statement needs to be somewhat qualified. As Shirley Strum has shown, the topography of the places where the baboons live, and also the local flora and fauna, enter into in the social organization of these primates.

(7) . See Law (1986b); for a reworking of the notion of heterogeneity see Law & Mol (1996).

(8) . For fuller details see Law & Callon (1992).

(9) . It is possible that some relations are better understood as fluids, flames, or as decentred "partial connections" rather than as networks. Though in the present paper we press the network metaphor, our argument would apply, with modifications, to other metaphors for relationality. On the notion of fluid see Mol & Law (1994). On the importance of partial connections see Strathern (1991).

(10) . This process is sometimes called "translation" in the sociology of science. For further details see Callon (1986).

(11) . Indeed, analyses of formation, dissolution, and interaction of partial identities are widespread in sociology. For a sample from British sociology: Keith & Pile (1993). For variations in primatologists' identities see Haraway (1989). For discursive shifts in the formation of management performances see Law (1994).

(12) . For a less asymmetrical and more general presentation of the argument about the inscription of the social in technical artifacts see Akrich (1992, 1993).

(13) . For more extensive discussion of the diverse character of representation see Callon & Law (1997).

(14) . For a magnificent study of the precarious building of boundaries around bodies and their more or less successful punctualisation, see Outram (1989).

(15) . Both of which, to be sure, are endlessly negotiable, and tend to undermine the possibility of homo clausus. For discussion about the immune system see: Haraway (1991).

(16) . In conformity with laboratory practice we will use this gendered term.

(17) . This double movement, that of relaying and going beyond has been well captured in the concept of mediation. See Hennion (1993).

(18) . For further discussion of this term see Callon and Law (1995).

(19) . For comments on its popularity see Haraway (1991), and in a less critical version, Giddens (1990).

(20) . Jullien (1992). We wish to thank Bruno Latour for

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drawing our attention to this magnificent book.