HOW TO WRITE '*THE PRINCE*' FOR MACHINES AS WELL AS FOR MACHINATIONS

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Expanding *The Prince* to redefine democracy

Machiavelli, a republican at heart, established the foundations of democracy in his ***Discourses on the First Decade of Livy.*** In spite of this he is often taken as a dangerous and amoral cynic because he wrote ***The Prince***. In practice, however, the two works are one and the same: if democracy is to be stable the harsh realities of power have to be understood. For Machiavelli the duplicity does not come from his own analysis or even from the hearts of the princes he is analysing, but from the historians who distinguish virtues and evils in an arbitrary way. For instance Hannibal was able to maintain united an army made up of many races and nations: "For this, his inhuman cruelty was wholly responsible. It was this, along with his countless other qualities, which made him feared and respected by his soldiers. If it had not been for his cruelty, his other qualities would not have been enough. The historians, having given little thought on this, on the one hand admire what Hannibal achieved, and on the other condemn what made his achievements possible" (p.97). In his book Machiavelli offers a set

of rules which go beyond the distinction between good and evil made by moralists, citizens or historians. These rules can all be deduced from this paramount one: how to maintain power for a little longer in spite of ennemies and adverse fortunes. Once this rule is clearly understood what appeared until then as bizarre or shocking exceptions are considered as different tactics or strategies to achieve one single goal. For example acting virtuously should be neither the rule nor the exception but one possibility among others: "The fact is that a man who wants to act virtuously in every way necessarily comes to grief among so many who are not virtuous. Therefore if a prince wants to maintain his rule he must learn not to be virtuous, and to make use of this or not according to need" (p.91). Although this sentence did a lot to harm Machiavelli's reputation it is, from his point of view, the only way to increase the chances of morality and not an easy way out of it. His books aims at offering a position in which the margins of negotiations of the virtuous democrats is at least as great as that of the blood-thirsty tyrants. If you want to be virtuous, he says to all republicans, you need much more than your self-righteous sense of morality, you need many more allies, many of whom will betray you. Instead of contenting yourself with ethics, enlist allies, fight ennemies and beware of all.

For all its cunning, passion and generosity, Machiavelli could not anticipate the duplicity of today's Princes nor could he anticipate the pusillanimity and self-righteousness of today's democrats. The machinations he described are based on passions and manipulations of other men. The only non-human allies that he explicitely adds to the *combinazione* are fortresses and weapons, the former because they slow down the taking over by enemies, the second because "there is simply no comparison between a man who is armed and one who is not" (p.88). Apart from these —not to mention supernatural allies that he ironically sets aside- Machiavelli builds his plots by keeping men in check through the handling of other men who are in turn kept in line by other men. Thus his world is a social one. To constantly repair the decaying social order, social forces are, if not the only, at least the main resources.

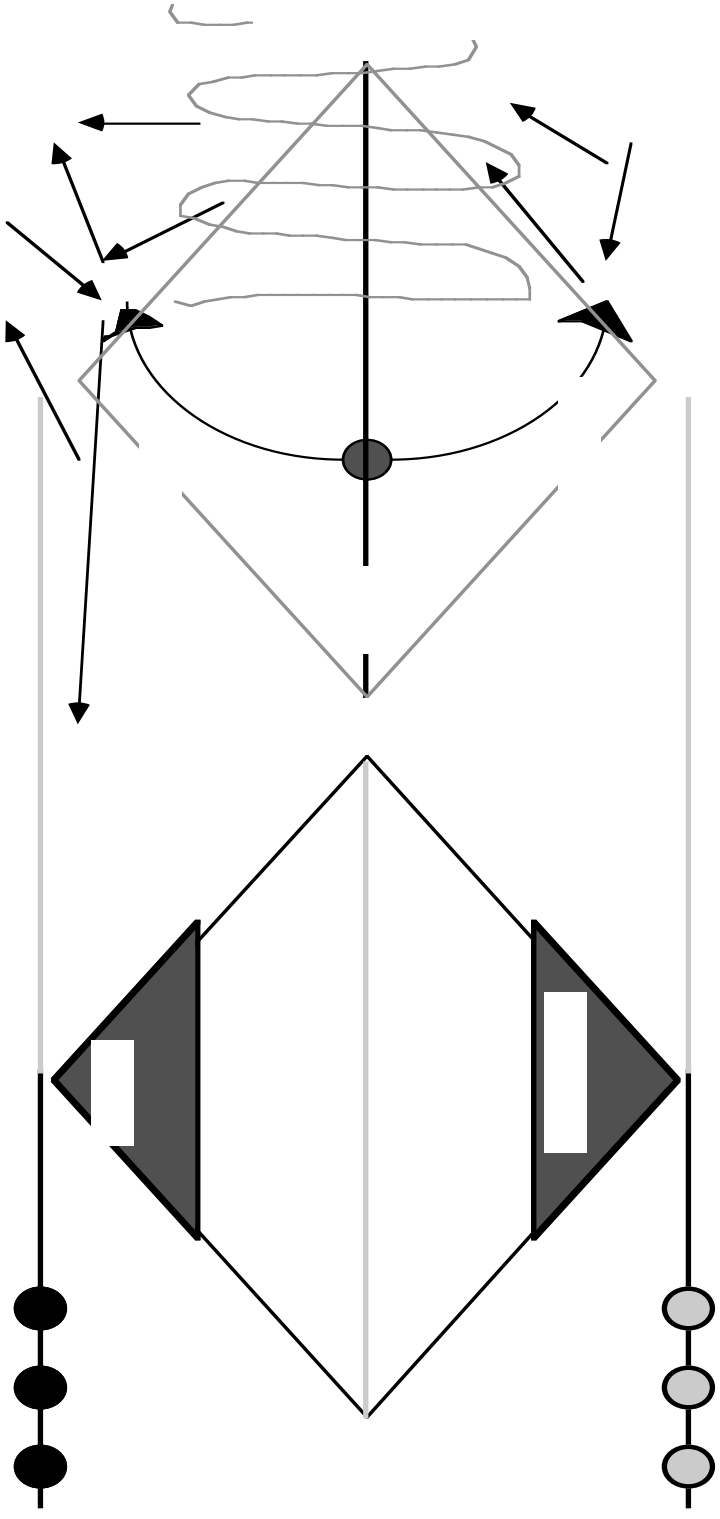
This is no longer the case today and this is why Machiavelli's world, no matter how troubled and bloody, appears to us, by contrast, a fresh and easy one to understand, and why his astute stratagems seem to us disarmingly naive compared to those we have to entangle today. The duplicity we have to understand is no longer in Princes and Popes that break

their word, but in the simultaneous appeal to human and non-human allies. To the age-old passions, treacheries and stupidity of men or women, we have to add the obstinacy, the cunning, the strength of electrons, microbes, atoms, computers, missiles. Duplicity indeed, since the Princes always have two irons in the fire: one to act on human allies, the other to act on non-human allies. In brief, threatened democrats who had to fight for centuries against machinations, have now, in addition, to find their way through machines. This paper explores the ways in which ***The Prince*** might be expanded so as to describe at once machines and machinations, techniques and society.

Technology and society are two artefacts due to analysts' duplicity

As in Machiavelli's time the duplicity is first of all in the analysts' own interpretations. Instead of following at once the Prince weaving his way through human and non-human allies, they transform this disorderly crowd into two homogeous sets: one is made by pairing humans with humans; the other by lumping together all the non-human elements of the strategies they have to explain. The South African apartheid system is less unnatural than this segregation that implies a policy of separated development for social ties on the one hand and for techniques on the other. It is impossible to grasp the modern forms of power if we do not first understand that what is called 'society' and what is (wrongly (1)) called 'technology' are two artefacts created simultaneously and symetrically by analysts who have too narrow a definition of power to track down the powerful. This transformation of the Prince's cunning into two parallel lines that never intersect each other has as much meaning as separating Hannibal's prowess from Hannibal's cruelty, or preparing a battle by putting at one end of the field all the paraphernalia and, at the other end, all the naked men. It is as if Thomas Hughes (1979) in his exemplary study of Edison had put on one line all the technical elements (lamps, power stations, transformers...) and on the other all the social ones (organisation, finance, public relations...), and had later tried to establish some connections between the two sets! If the history of Hannibal is made obscure by historians' moralism, what should be said of the history of the socio-technical imbroglios that we often have to read?

The first thing that should be done in order to expand ***The Prince*** and render history less opaque is to get rid of these twin artefacts, society and technique. To do so we simply have to place ourselves in the new Princes' own position. This is what Machiavelli did, thus transcending the narrow definition of ethics of his predecessors, and this is what the best contemporary analysts of socio-technics have done (2). If it were possible to summarize the few field studies we possess in one single diagram I will offer this one:



Each of these case studies shifts the attention away from the two artefacts of society and technique (left part of the diagram) and leads us to a socio-technical position in which we see the innovators, or entrepreneurs, appealing from one set of alliances with human actors to another set of

alliances with non-human actors, thus increasing the heterogeneity of the mixture at each turn of the negotiation (right part of the diagram). As Gilfillan wrote in his peculiar style: "men compete with men today not by teeth but by tools, not by thews but by thots" (1935/1963) (p.19). This is what John Law aptly called 'heterogeneous engineering' (1986) or what, in a similar context, Thomas Hughes named 'the seamless web' (1979; this volume). The duplicity is to be seen in the joint negotiation between heterogeneous allies —middle line of the right diagram—, no longer in the segregated development of two estranged communities —top and bottom line of the left diagram. The analyst who draws the lessons from these case studies, instead of being quartered in between technics and society, is now as free as the actors he or she is observing (Callon:1986). Needless to say, this new position is **not** a happy-medium that would carefully balance social aspects with technical ones, no more than Machiavelli's Prince is half honest and half devious. It is a strategical position that makes all the ethical, social and technical definitions subservient to a new goal —that will be defined below.

It is interesting to see that the main result of sociological or historical field studies is also the main thrust of economical and managerial enquiries such as the SAPPHO project aptly summarized by Christopher Freeman (1982). "The single measure which discriminated most clearly between success and failure was 'user-needs understood'. This should not be interpreted as simply, or even mainly, an indicator of efficient market research. It reflects just as much on R & D and design as well as on the management of innovation. The product or process had to be designed, developped and freed of bugs to meet the specific requirements of the future users, so that 'understanding' of the market had to be present at a very early stage" (p.124). This result is confirmed by the studies of innovation we have done (Callon and Latour:1986; Coutouzis:1984; Coutouzis and Latour: 1986) but also by a more managerial litterature (Peters and Austin: 1985). It is not underrating the quality of these studies to say that they are not really surprising from a Machiavellian point of view. This 'Sapphic wisdom' simply stresses that, in a war, the one who wins is the one who relates the soldiers, the weapons, and the logistics to winning over a specific enemy on a specific ground. It is the opposite that would indeed be a surprise ! To take a more pacific example, it is as if someone marvelled at the discovery that to play well at ***Scrabble*** the same player should at once inspect the changing

structure of the board and try out all the combinations of the letters he or she had drawn. Such is the sorry state of our sociology and of our technology that we find these sociological or management studies new and important.

A machine is indeed a machination, but on more than one front

Now that we have rid ourselves of this excess of duplicity added by the flattering analysts of the past to the Prince's cunning, we have to understand this cunning itself. The first question to raise, if we wish to follow our Machiavellian model, is in what sort of fights the Prince is engaged that requires him to appeal to human and non-human allies.

Marx offered an answer to this question which has been so influential that it first stimulated and later stifled analysis of socio-technics. He placed the Prince —renamed capitalist— in a class struggle so that whenever a machine or a mechanism was introduced in the production process, it was to displace, replace, unskill, humiliate and discipline the workers: that is to break their resistance. The tactical rules were simple: if your workers bother you, appeal to machine-makers; if they strike or are undisciplined replace ties among workers by ties among parts of one mechanism (Mac Kenzie: 1984). In this Braverman's new world (1974) each machine is a machination against the workers, and Ludism is, whatever its forms, a resistance to this ploy (the intellectual counterpart of it being what I would be tempted to call 'Elludism').

The main difficulty of this position has been very nicely pointed out by Donald MacKenzie (1984). Whenever the introduction of a machine does not attack the workers, many Marxists are left speechless and start talking about technical factors and other determinisms. When a machine does deskill textile workers they know what to say; when companies create new highly skilled workers they see this as a puzzling exception, or even, in MacKenzie's terms as an "obverse trend". For a century the exceptions have proliferated, but Marxists have moved only reluctantly from this tenet that the only way to prove that 'technology is socially shaped' —their words— is by showing the class struggle at work. The idea rarely dawns on them that a Prince might have more than two enemies —the workers and the other Princes— and that, struggling on many fronts at once, he might from time

to time need highly skilled and independent-minded collaborators to resist, for instance, other Princes. Moralist historians praise Hannibal's prowess but deplore his cruelty; Marxists deplore capitalists' cruelty and have nothing but praise for technics that increases the workers' skills. Same contradiction in both cases. They suppose one single division (good/evil; capitalists/workers) when there exist many among which the Prince chooses according to his one overriding goal. Perceptive when the capitalists' main struggle was to discipline 19th century peasants or craftsmen, Marxists are today almost always on the wrong foot. When there is no obvious class struggle to explain technology they either have to invent a devious one, so devious that it is hidden to everyone but themselves, or, worse, they have to admit that some aspects of technology may be 'neutral' or even 'good' after all.

It would be as absurd to say that the class-struggle no longer counts as to say that Machiavellian's Princes are always perverse. What we have to understand is how many struggles the Prince is engaged in, so that, according to need, he sometimes exploits, sometimes rewards, sometimes lies, sometimes tells the truth, sometimes skills, sometimes deskills. How many fronts are to be added to the class-front to have the beginning of an idea of how subtle the Prince's stratagems have to be? Let me list the most obvious.

The struggle inside the palace with his own collaborators, advisors, departments, is far from the least important as has been documented by Machiavelli in his study of the 'Nobles' and by modern sociologists of organizations. Many technics —especially softer ones— are devised, borrowed, transformed, to keep collaborators at bay or under control. The struggle is especially fierce when the Prince is not yet in command but has to fight against others who say they are the Prince. The dimension of the Prince should not be assumed beforehand but varies in time from being a whole country to being just one man in the crowd (Callon and Latour: 1981). It is never sure whether the Prince, like Proteus, is an individual, an assembly, a techno-structure, a nation or a collective.

A third front is constantly opened by other Princes. To resist their takeover, many new allies (human and non-human alike) should be fetched and kept in line —and this may necessitate a softening on the home front. The three fronts together (workers, collaborators, peers) already require quite a lot of ingenuity —that is, a lot of 'heterogeneous engineering'.

A fourth one is of paramount importance and is studied by Machiavelli under the name of 'people' or, by modern economists, under the name of 'consumers'. How to convince people to follow the Prince, or consumers to take up the goods? To what extremities is not a Prince led in order to interest, please, seduce, force, capture, or imprison consumers. How unreliable and feckless people are, always shifting from opinion to another, enslaved by fashion and passion. To keep them well aligned, one needs constantly renewed and fresher resources. The four fronts together (workers, collaborators, peers, consumers) already require the proliferation of socio-technical innovations and especially of this new Leviathan, the giant corporation, so masterly described by Chandler (1977).

A fifth one is as important and too much overlooked. Machiavelli touched on it briefly when he talks of fortifications and weaponry, but engineers and technologists have documented it at length. How to convince non-human allies to have a bearing on human affairs, to engage in social struggle, to have some relevance for establishing power. How to shape and fetch microbes, electrons, atoms, and to make them play a useful role in keeping men and women in place. How unreliable, feckless, undisciplined they are, always escaping our grasp, shifting from one opinion to another, betraying our expectations. How much confidence should be put in the people who claim to talk in the names of these non-human actors?

Fighting on the five fronts at once necessitates quite a bit of socio-technical ingenuity and creates what Machiavelli could not have anticipated, that is, these 'Networks of Power' beautifully described by Hughes (1983) in which many strongholds to keep people in place are actually made of electricity, copper, meters or even out of thin air. "The bond of love is one which men, wretched creatures that they are, break when it is to their advantage to do so; but fear is strengthened by a dread of punishment which is always effective" (p.96), answers Machiavelli to the question whether it is better to be loved than feared. Clever indeed, but how cleverer it is to bind together men, these wretched creatures that are always ready to break their contracts and go to gas companies or to competitors, by wires, meters, copper, and filament lamps. Instead of a tiny list that includes love and fear, the modern Prince has a long mixed list that includes many other elements in addition to love and fear.

William McNeil (1982) has summarised all the many battlefields together under his key notion of mobilisation of men and resources. Each

innovation, whether in organisation, in ship design, in metallurgy, or in communications, is assessed for its contribution to civil or to foreign wars. Commerce is a subset of politics and there is not much difference between commercial wars and other wars except a slight preference, in his terms, for 'market behaviour' over 'command behaviour'. The European Princes he describes, like the Italian ones Machiavelli had portrayed, are all of a similar force. This means that the slight supplement of strength offered by engineers and later by scientists may indeed tip the balance. Each of them, caught between a Beirut of civil wars (cold and hot, commercial and military) and a total (simulated) atomic foreign war, has to innovate to survive for a bit longer. That is, each of them is ready to betray his 'society' and fetch more and more foreign allies to help him out, thus increasing the socio-technical mixture (3).

Keeping in mind all the fronts at once and never lumping together the non-human allies is all the more necessary since this is the key to understanding why the technics are sophisticated and the black boxes are black. The more that compromises on wider fronts have to be made, the more human and non-human elements have to be stitched together and the more obscure the mechanisms become. It is not because it escapes 'society' that 'technology' has become complex. The complexity of the socio-technical mixture is proportionate to the number of new ties, bonds and knots, it is designed to hold together. If 'technology' appears to have an inside it is because it has an outside. More exactly, society and technics are two sides of the same Machiavellian ingenuity. This is why, instead of the empty distinction between social ties and technical bonds we prefer to talk of association. To the twin question "is it social?/ is it technical?" we prefer to ask "is this association stronger or weaker than that one?" (Callon and Latour: 1981; Latour:1986; 1987,a).

There are of course many other fronts, but I have said enough to show how narrow the definition of a 'social shaping of technology' would be if it took into account only the one showdown that confronts a capitalist and his workers. Marx was right, a machine is the occupation of a position –very much like a word in the ***Scrabble*** game. But he was wrong about the number of elements simultaneously held by this position. In addition, let us also include in the picture all the trade offs, truces, shifts of alliances, that the activity of one front renders necessary on the others fronts so that, when the tension eases a bit, we are not immediately led to the conclusion that the war

is ended and that no further strategy is implemented. By saying this, I am not trying to innocent the Prince, but simply to give the analyst at least as much intelligence and deviousness as the Prince has.

Conversely, I have said enough to make it clear that simply adding some matter-of-fact technical elements to a sociological or economic discussion does not render full justice to the Machiavellian ploys I wish to describe. Like several others economists, Rosenberg (1982) claims to "open the black box". This is all very well, but what he does is to offer a clear, uncontroversial and homogeneous description of the technical parts of the innovation he studies. This has no more sense than if Tolstoy had described the battle of Borodino according to the chief-of-staff's plan (1869/1986). The technical part is not made of linear, homogeneous elements that could be used as a quiet backdrop for staging the disorderly pattern of political and management life. It is a controversial mixture that cannot, that should not be described in a matter-of-fact tone. It is precisely when turning towards the non-human elements that the polemical, controversial, stragegic discourse should increase, not decrease. Why? Simply because this is where fresh resources to win over polemics, controversies and battles may be found. If a new Tolstoyan style should be invented, it is for the technical battles (Latour:1984/1987, b). Opening the black box is a good idea, as long as people know that it is Pandora's black box that is at stake... (4)

We have reached a point at which the choice between human and non-human allies in any combination is made by the Prince or by the analyst without any privilege or simplification. Florentine Princes had an easy task compared to those of the new Princes, and in consequence Machiavelli's job was straightforward compared to ours. To grasp this point we have to sum up the Prince's goal in such a way that what appear as exceptions, or contradictions, are now seen as a possible range of alternatives among which the Prince freely chooses. "Keep your word" is obviously not a good rule since a Prince who would follow it would soon disappear, although "lie" is not the rule either. "Deskill your workers" is not the rule since it is sometimes necessary to give them skills. "Be the first to innovate" is not a general principle, since it is often necessary not to innovate first (Rosenberg:1982 pp.104-120). "Be offensive" is not a good advice either in war or in management since, as Freeman rightly points out (1982, p.170), "be defensive" or "be dependent" or "copy" are good alternatives. "Please the consumers" is often less efficient in some (French?)

industries than the opposite advice "do away with consumers". "Rely on machines" is balanced by the counter-advice "never trust them".

If I draw a common lesson from ***The Prince*** and from field studies of innovators at work, it is that each Prince needs to recruit others to fulfil his goals but that these others, being by definition feckless and unreliable, have to be kept in line. Either no one helps you out and so no power is granted to you; or they do help you out but then they pursue their own goals, not yours. The more grandiose the Prince's projects are, the more paradoxical his task becomes. The name of the game is thus always to solve this quandary: how to control those that are enrolled? (Latour:1987a, chapter III) Machiavelli was looking for a point of view from which all the contradictory advices given to the Prince will make sense: stay in power a bit longer in spite of the vagaries of fortune. The point I would chose is rather this one: make your environment such that whatever other human or non-human actors think or do, they are either kept at bay or else they help strengthen your position, making the world safer, more predictable and more enjoyable for you. With this very general goal in mind (5), chose whatever tactics and strategies that fulfill it.

The elementary stitch in the 'seamless web'

We are now clear on three points: the Prince is engaged on many fronts at once; it is to hold some of these fronts that non-human elements are brought in, recruited, disciplined and made tractable; simply adding technical details to social elements will tell us nothing about the crucial novelty in the practical ways of achieving power (6): how are human and non-human alliances stitched together? The problem really is to define the elementary stitch of the 'seamless web', the movement of the needle, so to speak. Although it is often confused by artificial distinctions, this movement is quite simple: when your advance on one front is stalled, explore new possible allies which would be unexpected enough to tip the balance of forces; bring them together so that they act as one single force; make them have a bearing on the struggle at hand (Latour 1987, a). For reasons that are not clear to me, some analysts tend to call 'science' the first movement, 'technology' the second, 'economics' the third, and make every effort to clearly sever them from one another or to attribute the medal of honor to

one of them. In practice, however, the Prince —individual, collective, bureaucratic, or collegial— has simultaenously to define all the allies and all the enemies at once. As Mowery and Rosenberg (1979, reprinted in Rosenberg: 1982) have shown, it is as hard to decide what the consumers want, what the state of the art is, what nature may provide.

Hoddeson's beautiful study (1981) of the recruitment of Millikan's electrons by the Bell company should be enough to show that the needle can sew only if it does the three movements at one go: inventing consumers and markets, reshaping physics, creating technics. Yes, the electrons are an unexpected ally that could allow the Bell C° to get rid of the old mechanical repeaters and thus stretch its telephone line through the American continent. No, the electrons are not enough because, in Millikan's laboratory, they are undisciplined, untractable, useless as such, 'abstract' or 'analytical' as Simondon would have said (1969). Brought together in the new electronic repeater inside one of the first basic science industrial laboratories, they start to be tractable and disciplined, 'concrete' or 'organic' in Simondon's terms; they start to be a black box, a piece of equipment. But still, this is not yet enough. As in every battle, you need not only to know the balance of forces but also how to position them; many other elements are needed to position the electronic repeater in such a way that Alexander Bell can call Mr Watson in San Francisco and say "Hello, Mr Watson, would you come upstairs… ".

This movement that creates the first continental line and stitches together the East and West Coast of the United States, tying the Bell C° to millions of Americans who have to pass through its lines if they want to reach each other and strengthen their familial or business bonds, is it science-based? Technics-based? Economic-based? Is this an instance of market-pull? Or of technical-push? ***The Prince*** will never be expanded nor will we ever understand the fabulous expansion of the new Princes if we keep maintaining these dichotomies. 'Science', 'technology', 'economics' are three different faulty labels applied to only one serious strategical problem: stepping aside, recruiting new allies, drilling them so that they act on command, bringing them into the battle, winning the day -or losing it. As for every strategy, money spent, time passed and labor-force employed are useful indicators of the moves, but they do not provide an explanation of them.

The expression 'anthropology of science and technique' has been coined to account for this richly embroidered cloth that weaves together so many foreign elements: stones with laws, Kings with electrons, telephones with love, fear with atoms, stars with laborers. Ethnographers, who are so clever at describing this rich tapestry when studying exotic cultures, are struck by a strange blindness when they happen to turn their eyes towards the modern world and see nothing but two heaps, one made of drab machines and the other of sleek machinations (Latour: 1984/1987,b). As to the moralists, we may let them rest in peace; they believe that man is being dominated by technology !

Two symmetric misinterpretations stifle the development of this new anthropology of science: first a privilege granted to 'social' strategies, second a privilege granted to the hardware. Let us first do away with 'social explanations'. For instance, every time I want to reinforce the bonds with my old mother I also reinforce the Bell C°. Is this because I submit to a show of force from Ma Bell? Not at all. The Bell C° has insinuated themselves in such a way that whatever I do and think, they spread in a painless, quiet and necessary way. They have made themselves an obligatory passage point for everything else. Is it possible to explain Bell's influence by using terms such as 'power', 'force', 'domination' that have been devised by social scientists to describe Machiavellian politicians? No, because the mixture of non-human allies (wires, satellites, electricity, copper, optic fibres) has been woven to get away from the stalled fronts defined by classic political struggles. You can never reduce socio-technical stratagems to social explanations not because they are not stratagems, but because they have been devised to beat down social explanations in the first place ! Social scientists are always a war late, seeing devious political plots behind techniques, when the socio-techniques allow the Prince to add new fresh unexpected ways of redefining power. You expected to watch a show of force; you feel nothing but a violent desire to get in touch with your old mother through the telephone. Love, electronics and management are bound together. It is because the list of power ploys defined by Machiavellian social scientists is shorter than the one of the new Princes that they either have to consider most of science and technology as partially neutral, or else reduce telephones, atom bombs and contraceptive pills to hidden plots they are free to invent. Against every new invention they repeat the same interpretation: it is due to the power of the multinationals, of capitalism, of so and so... They have on the one hand a long

heterogeneous list of contrivances to be explained and, on the other, a short homogeneous and repetitive list from which to offer the explanation (7).

But the discussion of the Prince's moves is as much stifled when a privilege is granted to non-human allies as if they were the only and best way to win the day. This is never the case. In a study that is not outmoded because it has the sharpness of an origin myth, Marc Bloch has illustrated this point beautifully (1935, reprinted in MacKenzie and Wajtman, 1985). In the late Middle Ages, the grinding stones, the gears, the wheels and the rivers are good unexpected allies that, once tied together in one mill, makes a formidable stronghold. But their efficiency stops there. A stronghold can be in the middle of a battlefield, thus bearing on the issue of the battle, or away from the battlefield. If each household goes on grinding corn by hand, the Prince, who holds the communal mill, will hold nothing but wood, water and stones. The mill will become a stronghold only if the Prince fetches the militia, enforces the King's ruling, the Church's teachings and compell every household to break their hand-grinders and to pass through the miller's stone. Many industries and even countries have floundered because the solidity of the strongholds they had build reassured them that no strategical analysis was necessary any more. It is not the solidity of the gathered allies that count but the solidarity it offers with other human struggles. It is not the two parallel lines of the first diagram above that tell us anything, but the meandering negotiation of the middle line. The huge iron and steel plants of Lorraine are rusting away, no matter how many elements they tied together, because the world they were supposing to hold has changed. (8) They are much like these beautiful words ***Scrabble*** players love to compose but which they do not know how to place on the board because the shape of the board has been modified by other players.

The same limit could be found in the notion of trajectory through which machines are transformed into biological species endowed with a sort of autonomous life. For instance, is Wernecke's photo camera on the same species line as Eastman's one (Jenkins: 1975)? In a sense yes, since Wernecke's ideas have been seized and copied by Eastman. But why did Eastman seize them? Because he started with a completely different strategy, that of a mass market for amateur photography, and then went back to earlier systems that were yet unpatented. The deep transformation Wernecke's black box underwent in Eastman's hands has nothing to do with biological mutation and selection. It has to do with a new strategy of how to

design a camera that becomes indispensable to millions of people. It is only retrospectively, once Eastman has succeeded in capturing and holding a mass market with his deeply different camera, that museum-keepers can align the two artefacts in the same show-case and point out the differences with nice labels and arrows. The hardware is only the shadow projected by the socio-technical plot. Reduced to itself, it is as much a ghost as society.(9)

Because of these two symmetric misinterpretations the information we get on the Prince's moves is rendered incomprehensible. We either get the social relations —meaningless without the non-human allies that keep them in place— or the hardware —meaningless without the strategical positions it occupies. When we read through the literature of social sciences or of the natural ones, our situation is often as absurd as that of a geographer who would get, from navigators sent around the world, either the longitudes or the latitudes of the points he wishes to map but never the two together! In order to map out what ties all of us together we have to invent a projection system that provides both for the information about human and about non-human actors.

The longitude and the latitude of our projection system

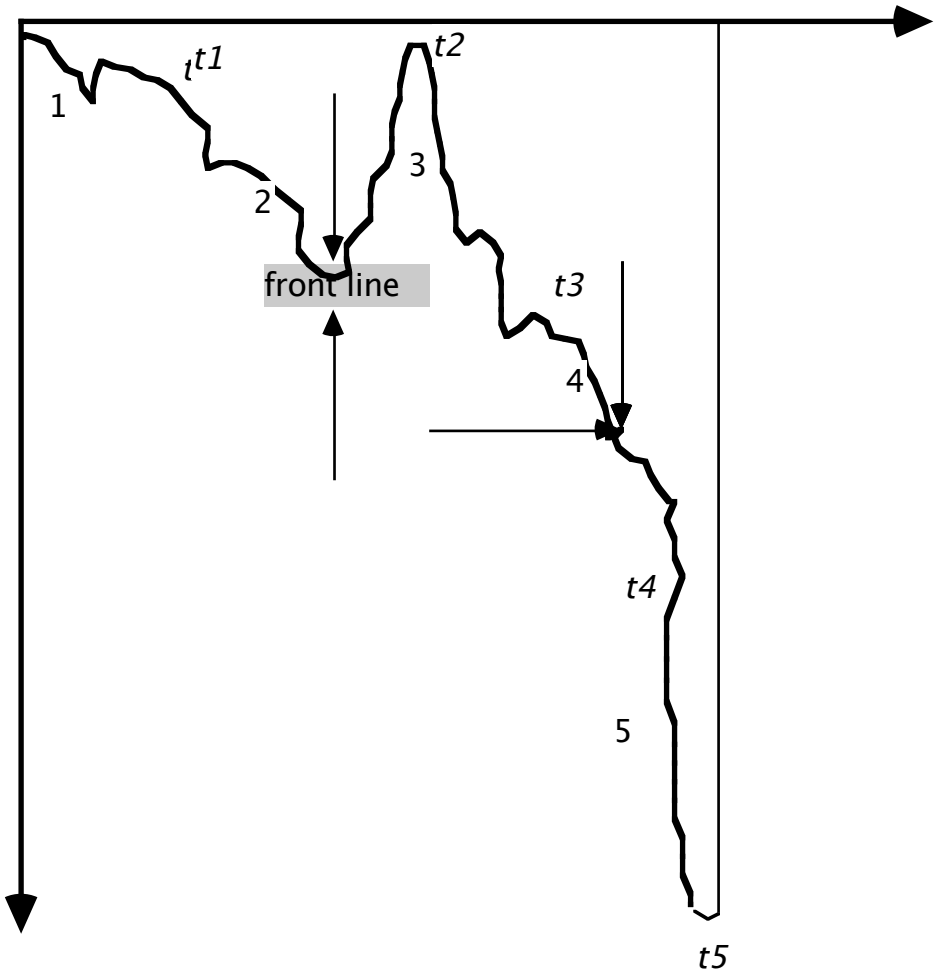
The new Princes are free to chose human or non-human resources to weave their ways around the many confrontations they are engaged in. The Prince is like Plato's royal Weaver that he portrays as the ideal statesman. He never stops weaving, but what he weaves together is sometimes soft, sometimes hard, sometimes human, sometimes non-human. His only concern is to decide which tie is weaker and which one stronger in a given encounter. Pusillanimous observers will see either new social ties being redefined, or new technical associations being introduced, and will then marvel at how the two might be related, interconnected, reflected, influenced... If we wish to be a bit more audacious and follow the new Princes as closely as Machiavelli did with the older ones, we should be able to define the woof and the warp of the seamless web.

Following the cartographic metaphor, we will define the longitude and the latitude of the projection system, in such a way that every socio-technical imbroglio may be defined by two dimensions:

how many (10)people are convinced and take it as an uncontrovertible black box;

if it is interrupted by people who doubt it and wish to open the box, what sort of transformations has the project to undergo in order to convince more people, that is what sort of fresh non-human allies have to be fetched ?

In the next diagram, I have sketched these two dimensions: the transformation (or translation, or negotiation) on the horizontal line; the success of the enterprise on the vertical one . The life history of a given project is represented by the meandering line. The more it moves toward the right the more it has to depart from the original idea, that is the harder the struggle and the more heated the controversy. The more it moves toward the top, the less people are interested and convinced in the future of the project. The surface behind the meandering line is an approximation of the number of elements tied to the fate of the project. This means that toward the end (5), when many people use the black box as a routine fixture that is no longer transformed, it is also the time when the largest amount of resources and people have been aligned to keep the users in line.



A few features of this diagram interest me. First, although it overlaps with the usual categories (research, 1; development, 2 to 4; production and sales 5) the project never stops from being a front line, even when it seems that everything has been done and that 'mere consumers' are now to be convinced. From the beginning to the end it never stops from being the resultant of a fourfold strategy: whom should I convince? How strong is the resistance of those I choose to convince? What new resources should I enrol? What transformations should the project undergo? Second, time (t1 to t5) is not one of the dimensions of the diagram but one of the consequences of the process of conviction and enrolment. "It takes time" or "it goes fast" depending on the number of people to convince and on the ability of the Prince to negotiate. But a more suggestive feature is that the reality of a project is a variable result of the Prince's strategy. At t2 for instance the degree of reality of the project decreases and approaches zero. The feasability, credibility, absurdity of a project entirely depends on the stitching

and knotting made by the strategist. Neither reality nor time (or the state of the art) explain the evolution of a project, they are both dependant variables.

Whatever the future connections between economics of R.&D, micro-sociology of innovations and history of technique, it is already clear that some effort will have to be put into adapting the diagrams, the type of data and probably the mathematics, to these notions of translation, fronts, association, persuasion. This integration probably passes through an understanding of the metrological character of the sciences like accounting, management and economics. Every new stratagem, in order to succeed, has also to define, develop, position and enforce its own ways of assessing itself. Every innovation is considered as risky, difficult to evaluate, expensive, unreliable, not because we do not have good economical or technical tools to assess it, but because it is part of the innovation to redefine the very tools that evaluate how risky, expensive, efficient, reliable it is. In other words, there is an uncertainty principle in this topic that is inherent not to a weakness in our instruments but to the very phenomenon we wish to detect. Either you have an innovation and part of this innovation is in the struggle to set up measurement instruments or to settle responsibility —in this case, you lack precise definitions and the whole business is uncertain; or you do have good figures, reliable statistics, but then they are the final result of a stable, quiet and routinised network —and in this case you are no longer studying an innovation. It is thus a contradiction to approach innovations with stabilised devices in order to evaluate productivity or to attribute responsibility to labor, to capital or to management. The challenge is to adapt our economics and our sociology to the network quality of the Prince's moves (Callon, Law, Rip :1986).

Back to democracy

Now that we are expert at avoiding the twin impression that society or techniques exist, it is possible to understand what makes the new ***Prince*** so very difficult to write and his powers so hard to check. Machiavelli's Principates who had seized power had very few extra-human resources to render their position irreversible. Apart from God —appealed to equally by all—, apart from swords and a few stone walls, the Principates had to rely on ties such as passions, fears, loves and ambitions as soft as the bodies they had to attach. The mega-machine so dear to Mumford's heart was not a

machine and this is why his central metaphor is so misleading. No matter how heated the fights, the foreign armies that the Princes go and fetch from outside in order to win are never that foreign. At worst they are made up of mercenaries —that Machiavelli considered as the least reliable allies, that is of humans, who again have to be kept in line by the same soft human bonds. The situation starts to be deeply different when the Principates are ready to step aside, to make a detour, to betray and to bring into the fight allies that are real strangers and do not look at all like men and women. A generalised arms race is going to be triggered, which no Prince can avoid. To the piling of tender human bonds, will be added the piling of harder non-human bonds; to the software race of the past, will be added a hardware race, of which the weapons race is but a particular case, as McNeil has so masterly shown in a book which is obviously the best draft of ***The Prince*** one can find (1982).

One small example will show the consequences of this over-Machiavellism. The radical Paris municipality and the major private railroad companies had fought for two decades when, at the end of the last century, the subway was finally decided upon. But how was it to make sure that the railroad companies would not take over the subway if, by chance, a new right-wing municipality won the election? How can the momentary balance of forces be rendered irreversible? One solution was to use narrower tracks for the subway than for the railways. The military objected on national security grounds. Convinced by this threat in case of national war, but not wanting to abandon their (cold) civil war position, the municipality finally decided to make the subway tunnels smaller than the smaller coaches of the railroad companies (Daumas et al. 19) (10). They shifted their alliance from legal or contractual ones, to stones, earth and concrete. What was easily reversible in 1900 became less and less reversible as the subway network grew. The engineers of the railway company now took these thousands of tunnels built by the subway company as destiny and as an irreversible technical constraint.

This is why the question of the freedom of the engineers and of the people is only relative to the number of non-human ressources weaved in their struggle. Still, they remain free to decide, like Sartrian characters, what will play the role of fate and what willl play the role of freedom. The best proof is that, 70 years later, when the nationalised rail-roads and the nationalised subways decided to interconnect their networks, the engineers

were asked to reverse this irreversible situation, at least locally, and to enlarge a few of these tunnels. Here is where the hardware race best manifests itself. What could have been reversed by election 70 years ago, had to be reversed at a higher cost. Each association made by the socialist municipality with earth, concrete and stones had to be unmade, stone after stone, shovel of earth after shovel of earth. Worse, to shake each of these older associations, new, more powerful tools had to be recruited, drilled and positioned into the struggle (bulldozers, explosives, drill-tunnel machines). The megamachine became bigger. People now flow by the million inside the landscape of the new ***RER*** subway network.

But it is the second consequence of the hardware-race that is the more striking. Holding a point is necessary but not sufficient, since it also means remaining in one place. What would be better, would be to keep the strongholds and yet to move elsewhere. Alas, the Prince knows very well that leaving his Palace or his Fortress, entails treachery, betrayal, revolts. How can he move on and nevertheless remain in charge? Politics provides the answer: by delegating powers to others. But delegation to other men would be as unreliable and shaky as the human bonds themselves. Why not delegate some powers to a few non-human actors that would thus be in charge of their fellow non-human actors? Why not invent a sociology and a politics of the things themselves(11)? For instance, policemen at each cross-road are useful to regulate traffic, but then they cannot move elsewhere fulfilling other functions. Replacing their arms and white gloves by traffic lights is one of these ways of being absent and yet remaining present. Drivers and traffic lights will look after themselves. Yes, but drivers are feeble creatures tempted to cross even when the light is red if there is no other car at the intersection. Why not hook up the lights to the wheels of the oncoming cars through an electric impulsion, so that the lights automatically adapt their rythm to the traffic flows? The lights are now checked and triggered by an adaptable supervisor who no longer wears a helmet. An automatism is born that will soon become more complicated and 'concrete' or 'organic' —in Simondon's sense— because series of traffic lights will be regulated by one computer. Then all the series will be visualised at the Police headquarters on the screen, in front of which is seated a policeman with white gloves. When we go from Machiavellian politics to automatisms, we do not go from sociology to technology, we pursue the same associology with a longer list of bonds and bondages. The story is not that of men and women

being replaced by machines. The story is of a complete and continuous redistribution of roles and functions, some of them being held in place by human, other by non-human ties (12).

Inertia and automatism are thus the two main effects of the hardware race. This is where the question of democracy raised by Machiavelli comes in, a question that is the only justification of his amoral picture of the Prince and of our associological description of the new Princes. The two most common clichés about technology, its inertia that would be too strong for anyone to resist, and its inner complexity that would be too much for any one to fathom, are real enough, not as the cause of the Prince's moves, but as the effects that the Prince strives to achieve.

The first principle of technical democracy is thus never to offer this goal to the Prince on a golden plate. Alas, this capitulation is very frequent among well-minded analysts of technology who accept that there are trajectories, inertia, and inner complexities, in brief that technology exists. Another capitulation occurs when analysts of society, no less well-minded than the former, insist that there is something like an overarching society, knowable, at least in principle, that should control and check the development of technology. These two symmetric capitulations paralyse democracy because the only way to envision a modification of a technique is then by appealing to an alternative technology and society (13). If there is a Technology and if there is a Society and if the only way to think possible changes is by imagining an alternative Society, then the Prince is perfectly free in his palace, unhindered, weaving at leisure human and non-human actors, redefining locally, as much as pleases him, what ties all of us together. Observers outside will see nothing but techniques moving, thanks to their own autonomous thrust and a society moving in parallel according to its own autonomous laws. Instead of the harsh constraints of democracy, the Prince will only hear moralists' remonstrances and a few empty talks about the 'participation of the public in technical decisions' —once everything has been decided upon. If science and techniques are politics pursued by other means, then the only way to pursue democracy is to get inside science and techniques, that is, to penetrate where society and science are simultaneously defined through the same stratagems. This is where the new Princes stand. This is where we should stand if the Prince is to be more than a few individuals, if it is to be called 'the People'.

An earlier version of this paper was read at the meeting on Technology and Social Change, organized by the Center for Canadian Studies, Edinburgh, june 1986. I thank Michel Callon, Madeleine Akrich and also the Dutch colleagues met at the "De Borderij" , in Eschende, for many stimulating discussions.

(1) Convincing Anglo-Saxon writers that techno-logy should be used in the same sense as epistemo-logy, that is as the science of techniques, and not as a redundant word for the artefacts themselves is, I know, a lost cause. I will maintain this acceptatnce, however, and when I use technology it will be ironically.

(2) In this paper, I am pilfering the work of Thomas Hughes, Michel Callon, John Law, Mickès Coutouzis, Madeleine Akrich and many others. For three recents reference books, see W. Bijker, T. Hughes and T.Pinch (eds) (1986); J. de Noblet (editor) (1983); D. MacKenzie and Wajtman (1985) and the special issue of the ***Année Sociologique*** edited by B.P. Lécuyer. To this should be added the still useful masterpiece of Gilfillan (1935/1961). See also Elzen (forthcoming).

(3) MacNeil (1982) is probably the clearest writer to formulate -if not solve- the anthropological puzzle: "why Us and not They?". The Great Divide is not to be found in mental, technical or political abilities but along these lines: in which society is it possible for a Prince to appeal to foreign, non-human emigrants and mercenaries and not be considered as mean or outcast? Which society accepts harder facts and harder artefacts as so many ways of pursuing politics on a larger scale? Which society is so Balkanized that a few harder facts and artefacts are able to tip the balance?

(4) The literary constraints on what I could call a good field study of socio-technique is easy to pin down. Every time there are as many versions of the technical aspects as there are actors in the story, it is a good story. Every time there is only one, it is a useless account, even if other chapters add to it the 'social', 'economic' or 'managerial' aspects of the same story.

(5) Phrased as it is, this goal retains psychological traits as if I was defining what people, in their inner soul, really strives for. In spite of this limitation, I maintain it here because it is in keeping with Machiavelli's definition of power and motives. For a less psychological interpretation, see Latour (1987, b, second part).

(6) The expression 'power' is taken here uncritically although it is, of course, the first notion that should be deconstructed once technical elements come into play. For a critique of the notion see Latour (1986).

(7) The sorry limitation of the list is not a problem for social scientists because they believe that each word in the list constitutes the cause of

which the various technics are simply the effects. Thus they are not surprised if the same powerful cause is able to trigger many different effects. For the Prince there is no cause, only effects. The cause is never more than a retrospective attribution once everything has been put into place.

(8) This is why Bertrand Gille's notion of a 'système technique' (1978) is misleading, even though it is useful to group artefacts without being limited by the harware. For instance, in his technical system, the gear of the mill would go with the wheel and with the river and with the grinding stone and with the roads onto the same list. But what about the Church, the King and the armed men? They are part of the same Machiavellian list, not of Gille's one. These elements are to be found in another page, when Gille deal with the social or economic or cultural structure.

(9) More generally, the biological metaphors appear useless to me, first because evolutionary biology is itself a mess of conflicting versions of what is a surviving strategy for organisms, and, second, because, in biology, it is the organisms themselves which are the calculating Princes. This is not to say that biological study of early hominid tools are not perfectly sensible as Leroi-Gourhan (1967) showed so forcefully, but this is because they are part of the body itself as much as brain or hands. Once they are distinct from the body they can no longer be lumped together in trajectories except inside museums. This is not to say that an evolutionary study of artefacts is not possible, but to do so it is a generalized socio-biological point of view that would be required. From this point of view the body itself would be seen as the technical stabilisation of earlier strategies -hardwiring versus soft wiring, genes versus learning (Dawkins: 1982).

(10) "How many" is simply a rough indication of the relation of forces and not a quantitative measure, since part of the negociation is to define, calibrate, diffuse, impose et upkeep the metrological chains that allow to define the forces in a quantitative way.

(10) I purposely chose an example which is the perfect counterpart of the New-York architect Moses studied by Winner (1980) and also by MacKenzie (1984).

(11) The notions of delegation, distribution of roles and 'inner sociology' forms the basis of a comparative semiotic of technical artefacts that could be called techno-graphy.

(12) Ruth Cowan has demonstrated this unexpected redistribution in an excellent study of housewives at work (1983). They work a lot more with many new automatisms that render indispensable quite a few new companies, but they are also transformed, redefined, reagenced. Reducing such a story to woman-freed-by-machinism or to women-enslaved-by-capitalism would be a pity.

(13) This position is nowhere more striking than among Marxists who have developed an extreme sado-masochist relation to technology —sadic because in its Stalinian version it allows large scale killing in the name of an alternative society, masochist in the European left-wing way because it allows people to be deliciously inefficient, maimed and tortured in the name of an alternative society —but still be right.

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