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THE KEY TO SUCCESS IN INNOVATION* PART II: THE ART OF CHOOSING GOOD SPOKESPERSONS

MADELEINE AKRICH, MICHEL CALLON and BRUNO LATOUR
Centre de Sociologie de l'Innovation
60 Boulevard Saint-Michel
Ecole des Mines de Paris
75272 Paris cedex 06, France
callon@ensmp.fr

Translated by ADRIAN MONAGHAN
School of Business and Management
Brunel University
Uxbridge, Middlesex,UB8 3PH,UK
adrianmonaghan@hotmail.com

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"Solve the technical problems first", we often hear, "then we'll deal with the market". The real history of innovations does not generally follow this simple schema; it is made of adaptations, series of trial and error and countless negotiations between numerous social actors. A genuine combat from which conquerors who know how to choose good representatives emerge.

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Introduction

We saw in the first part that the success of an innovation may be explained in two different ways, one emphasising the innovation's intrinsic qualities, the other on its capacity to create adhesion between numerous allies (users, intermediaries, etc.). In the first case, we use the term "diffusion model" (the innovation becomes widespread due to its intrinsic properties); in the second case, we use the term "model of interessement" (the fate of the innovation depends on the active participation of all those who have decided to develop it).

To Adopt is to Adapt

The gap between the two models clearly appears in the example of the continuous flow method. Let us follow the model of diffusion. It leads us to make an inventory of the advantages of the new production technology and an unambiguous prediction: the diffusion of the continuous flow method can only be rapid. Such a prediction assumes that the realised advantages present the same meaning and the same force for all and in all places. However, this similarity of situations and judgements is rarely the case a priori. At best, it is the result of a series of investments, adaptations and transformations. If, as Bela Gold has demonstrated (Gold *et al.*, 1981), the diffusion of the continuous flow method turns out to be particularly slow, at least in the USA, it is because its supposed advantages are not of equal worth and in certain cases turn against it. Each industrial site constitutes a particular case and *the interest* of the continuous flow method varies according to the site under consideration. The cases of successful implementation are very revealing: they demonstrate the formidable mobilisation necessary to diffuse an innovation. First of all, it is necessary to have a consenting management which is not discouraged by the desperately negative results of the first experiments, and which must be permanently convinced of the long-term interest of the process.

Workers, foremen and engineers must come together at the practical perfecting of the continuous flow method, especially during its problematic integration into traditional technical systems. These are the ones who identify problems, flush out the defects, tirelessly adapt the heat cycles. They are equally those who write the manuals for future users, in close association with the engineering societies. An immense collective undertaking which assumes the active support of all participating actors. It will take at least fifteen years before the first sheet steel produced by the continuous flow method will be commercialised. It will take numerous about-turns by general management who, at the point of launching new investments, will be seized by the fear of risk and will prefer to arbitrate in

favour of traditional technologies (Keynes, 1957: 162). Above all, the innovation must be taken in hand by an anonymous crowd of active and interested individuals. We are a thousand leagues from the diffusion model, from the all-or-nothing strategy and of the mysterious contamination which it assumes.

The model of interessement allows us to understand how an innovation is adopted, how it moves, how it progressively spreads to be transformed into a success. The socio-technical analysis underlines that the movement of adoption is a movement of adaptation. The continuous flow method does not exist in general. It must be transformed, modified according to the site where it is implemented. *To adopt an innovation is to adapt it*: such is the formula which provides the best account of diffusion. And this adaptation generally results in a collective elaboration, the fruit of a growing interessement (Rosenberg, 1976). The continuous flow method is the consequence of the work of researchers in their labs, but also of the myriad of engineers, foremen and workers who, factory after factory, have redefined its characteristics, adapting it to the specific conditions of the sites concerned. In the case of goods destined for users outside of the company, the collective work of adaptation encompasses the lead customers, who play an essential role, as often emphasised. At the end of the '70s, MacDonnell was in the lead in the software domain of CAD, but its policy was to retain ownership of it. Lockheed entered the market and sold its software to more than 200 users who rapidly improved it. In two years, Lockheed caught up with MacDonnell. In the same way, competition between IBM and GE to control user sites such as Bell and Carnegie-Mellon was intense (Peters & Austin, 1985). The stake in all cases is to identify the users who are in the best position to transform the innovation and to bring it to meet the demand of other users. To interest and to transform are two faces of the same reality.

Term by term, the two models conflict again. The model of diffusion restricts the work of elaboration to the limited circle of the designers responsible for the project; the model of interessement underlines the collective dimension of innovation. In the former, the majority of actors are passive; in the latter, it is active. In the former, the innovation is either taken up or left; in the latter, adoption is synonymous with adaptation.

Negotiations in All Forms

Photovoltaic-light kits, perfected by French industrialists for developing countries, received a more or less reserved welcome from the potential users at the various experimental sites in which they were installed. The Centre for the Sociology of Innovation, in charge of studying the reactions which the kits provoked, discovered that one of the prototypes, after a series of unanticipated moves, ended up in a

mosque which it was not even destined for and where, to much surprise, it immediately aroused a fascinating infatuation (Akrich, 1992). The demand was unexpected, but powerful interests became clear which were ready to seize the device. Their demand expressed itself despite what plainly appeared as weaknesses of the system, weaknesses which revealed themselves on site, in the mosques. Why refuse this fantastic network that Islam and its places of worship represent? In order to take advantage of these allies who were as powerful as they were unforeseen, it was clear that a redefinition of the kits had to be accepted: to make provision for many small lighting tubes, to increase the power, to no longer make the length of the filaments impossible to modify. The concept of the object had to be changed in order to establish a satisfying compromise between its characteristics and the demands of the users. The social "material" and the technical "material" are both relatively malleable and the successful innovation is the one which stabilises an acceptable arrangement between the human actors (users, negotiators, repairers) and the non-human actors (electrons, tubes, batteries) at the same time. The particular strength of the innovator is to permanently play with both registers, to treat nature and society symmetrically. Why speak of technical feasibility and social acceptance? Why change the vocabulary? Acceptance, like feasibility, is just as social as it is technical.

The unrecognised geniuses or the unrealistic inventors are those who do not accept to enter into this process of omnipresent negotiations at the end of which, if skilfully managed, the innovation has created for itself a favourable context for its diffusion and acceptance. And, as in all negotiations, the possible strategies are infinitely varied. The means to be mobilised in order to arrive at a compromise are a matter of circumstance. If one feels sufficiently strong or cunning, for example, why not hold onto the technical device at all costs while attempting to remodel the environment which was recalcitrant to begin with? This is what the story in the form of the fable of the Post-It demonstrates (Peters & Austin, 1985; Nayek & Ketteringham, 1992). Art Fry, who works at 3M, has a passion: choir singing. But while he participates in the Sunday service, he confuses the hymns, because the little pieces of paper which he uses to mark the pages invariably get reshuffled. He then thinks of using an adhesive which is sticky enough to fix the pieces of paper to the pages, but not too sticky that it marks or tears the page when removing it. This is how the Post-It is born, these little yellow sheets that one now finds in all secretaries' offices. The reasons for success appear evident to us. However, we should not believe that the success was obtained without effort. Satisfied with his product, Art Fry soon turned towards his marketing colleagues who replied to him without beating about the bush: there is no market for this innovation, nobody will want it. Art Fry could have remained at this stage and the innovation would never have seen the light of day. But he did not

acknowledge defeat. He came up with the idea of distributing his yellow papers to all of the personal secretaries in his group and even to secretaries in competing firms. They become hooked so quickly that they asked for more! The only thing left was to strike. After a while, Art Fry decided to no longer answer his phone. The orders from secretaries in withdrawal were systematically redirected to the marketing department which found itself bombarded with demands for a product which supposedly had no market. The lesson is worth being understood. The innovator is perfectly free to believe in his product to the point of not wishing to transform it. But he must then show that he is capable of turning the resistances which block him upside down while finding new allies, reversing the force relations which are unfavourable to him. Technical intransigence only pays when one has the means to master the socio-economic context.

Such a strategic sequence is the exception. The technical combination and the social machination are rarely entwined in such a distinct way and with such neatness. The idea to freeze food dates from 1912. At the time, the idea appeared to have no future. In order to succeed, it had to build a favourable socio-technical environment for itself: identifying vegetable species which support freezing, a new method of assembling unfinished products, processing factories nearer to sources of supply, equipment and regulations specially designed for transport, storage and preservation of frozen foods, persistent action directed at retailers and households to convince them to buy this storage equipment, pressurising the public authorities to call an end to the price freeze of deep-frozen food (in the USA). It took forty years of bitter negotiations, of compromises allowing a play on the interests and projects of one another, and technical adaptations destined to circumvent resistances (Peters & Austin, 1985). It is the case of a genuine socio-technical machination where the (collective) innovator permanently plays on these two registers, that of society and that of the technical. Any analysis, any judgement which does not reconstruct this co-production of the object and *its* society, which erases this slow, patient and uncertain construction, through which, for example, a frozen-food economy is built, linking users, distributors, farmers, farm-produce companies, livestock and crops, regulations and research laboratories, would be of little use. Since we are far from the simplistic biological metaphors which talk about innovations being selected by their environment without recognising that the environment is produced at the same time as the innovation that it is going to judge (Kransberg, 1982; Nelson & Winter, 1990). It is indeed a strange trial in which the accused may choose his judges! Socio-technical compromises and negotiations are the two key notions which allow this work of mutual adaptation which commands adoption to be understood.

This is why an object never deduces itself from previous objects by way of a simple mutation of a technical parameter (Simondon, 1958; Leroi-Gourhan,

1964–5; Deforge, 1985). If certain technical centres are graveyards for innovations without any prospects, it is not because of their incompetence: it is because they lack the resources, maybe even the will, to take part in this tireless activity of shady deals, very often in the name of a highly idealised conception of technological virtuosity. The future belongs to hybridisation rather than to clearly defined lines of development.

The Socio-Technical Transformation

The research of compromise, which is nothing more than another name for the will to succeed, occurs through experiments which take place everywhere and through successive iterations. Innovation comes from anywhere. Scientists and engineers do not have a monopoly of the imagination. It can come from a research centre or from a commercial department, from a customer or from within a factory. Then, from a badly conceived and unrefined project, from a programme still vague, it progressively transforms itself through a series of trials and experiments which confront it with theoretical knowledge, know-how or users, into a device which is capable of gaining interest. The famous linear model, where successive stages are distinguished whose chronological order cannot be disrupted, is the least well adapted model to account for this erratic movement. We propose to substitute it with the whirlwind model which allows the multiple socio-technical negotiations which give shape to the innovation to be followed.

The example of the Macintosh

One of the most representative examples of this whirlwind process which increases the trials is the design of the famous Macintosh (Guteri, 1984). Where did the idea come from? From inside the mind of an old Apple engineer who believed in a cheap, easy-to-use computer. These objectives are sufficiently clear and simple in order to indicate where the effort should be directed. Production automation seems an absolute necessity as soon as one wants to slash the price. A team is quickly set up which consists of software and hardware engineers, marketing people, designers and production engineers. All of these under the leadership of the famous Steve Jobs. It is here, in the heart of this united and versatile team that the Mac will take shape. Under Jobs' guidance, the team quickly becomes as compact and integrated as the Mac will become. It is because the form of a technical object is directly dependant upon on the identity of the actors who participate in its development and the nature of the relations which they maintain. Before the Mac, the micro-computers consisted of numerous stamped circuits, separately installed by specialists. Through the presence of the

manufacturing engineers, introduced into the team to prepare the production automation, came about a new generation of micro-computers which consisted of no more than two integrated circuits: by reducing the number of the items to be installed, the assembly is simplified *and* moreover, the speed of the computer markedly increased. Similarly, the daily discussions with marketing led to a four-voice sound generator which efficiently uses certain properties of the machine. The assembly factory is developed at the same time as the computer that it will build. Innovation takes shape through this rapid movement of incessant backwards and forwards, furthered as in the classical tragedies by the unity of place, which go from the designer to marketing, from the designer to the software developer. The phases are not carefully separated, they are conscientiously mixed up. It is an imbroglio from which successive shapes emerge which materialise, through interposed technical choices, the result of all previous compromises i.e. of all of the successful "interessements".

The whirlwind model

In this schema, innovation continuously transforms itself according to the trials to which it is submitted i.e. of the "interessements" tried out. Each new equilibrium finds itself materialised in the form of a prototype which concretely tests the feasibility of the imagined compromise. Smith claims that it is unnecessary to provide a separate controller for the Mac's mouse. Nobody believes him. And to convince them, he decides to get back to his office, returning a few days later with a working prototype. The marketing people assert that nobody wants the Post-It. Art Fry sets up an experiment, which will prove the opposite. The first prototype created is occasionally, but rarely, sufficiently convincing. In general, several passes are necessary. The innovation transforms itself at every loop, redefining its properties and its public. Thus, Eastman, all set to devise a camera and products destined for professional photographers, soon finds himself confronted by reactions of refusal (Jenkins, 1987). Rather than persist in following a strategy which promises to be difficult, he redirects his investigations and through successive drifts defines a new product, the easy-to-use camera body, and a new social category, the amateur photographer. As you can see, this creative whirlwind can extend itself very far, giving birth in one case to a social group which did not exist and leading in the other case to the first completely automated micro-computer factory.

Be prepared to launch into several successive passes, without turning this principle into an intangible rule: it is in this formula, which does not exclude the linear model (in certain circumstances it is strategically adapted), that the art of the innovator is held. On the other hand, the linear model established in dogma

or in action rule ("Solve the technical problems first and then we'll deal with the market") renders difficult the possible adaptations which should be realised during the course of the project in taking into consideration, for example, unexpected technical evolutions, changes in user expectations or in competitors' strategies. Like the game of Scrabble, one must be prepared to take into account the state of the board that the turns played by adversaries permanently modify. Sometimes it is better to change combinations i.e. redefine the product so as to take advantage of an opportunity rather than to stubbornly persist in passing one's go while waiting for the hypothetical opportunity to put down the complete word which has been prepared on the letter-rack.

In the linear model, the only possibility of adaptation, if it turns out to be necessary, is the progressive complexification of the project and of the devices which it runs into: hence we know of robots which have become more and more monstrous with the passing months, because a return to the initial conception to take into account the difficulties thus encountered is refused. The linear model leads straight to the well known strategy of relentless pursuit in spite of all the evidence. For a long time (perhaps too long), innovation lives in a fluffy world and, at the moment where contact with the harsh economic and social rigours provokes a sudden traumatism, it is too late: the more time has passed, the more material and emotional investments have solidified and the more difficult, indeed impossible, to turn back the clock: it's what we call "having let your chance pass you by". Conversely, the whirlwind model, and the socio-technical transformations which it favours, establishes the art of compromise and the capacity of adaptation in the cardinal virtues. Devil take the perfection obtained at the end of time. The time which has passed, which produces irreversibilities, saturates the Scrabble board, redistributes the pawns and the resources, and everything changes and you arrive too old in a world too young. In the whirlwind model the collective innovator, instead of delaying sanctions and judgements, provokes all the critics and objections, even if, sure of himself and of his strategy and with full knowledge of the facts, he decides not to take them into account. The commonplace distinction between technical and user tests are abolished, since the innovator is ready to play on the two registers, to overcome the reluctance of certain users by modifying the technical conception of his innovation, to avoid uncertain scientific investigations by identifying a "new" public which will be satisfied with the innovation in working order. We must be ready at all times to burn that which we used to worship. If the word "research" is applied to innovation, it is in this specific sense, of the research of evaluations and of all sorts of trials to which one wishes to submit oneself to. And this research, the only one which deserves the name, is the most difficult and painful that there is.

The Difficult Choice of Spokesperson

Certain myths have a hard life. We know the one which surrounds the work of Mendel, which we continue to believe was unrecognised in his time despite all the historical proof to the contrary. Edison does not escape this disastrous fate which seizes great inventors: he becomes the handyman of genius who, from inside his laboratory, concocts the innovations which are going to bowl over the entire world.

A laboratory such that no-one has ever seen

Edison is not the self-taught Nimbus professor he is supposed to be. As described by T. Hughes in his fascinating book dedicated to the story of the electrification of the United States (Hughes, 1983), he reminds us of Rastignac, a Rastignac who, on one of those nights when the most secret ambitions are expressed, would have exclaimed "I'll take you on America!". Consulting Edison's reports primarily, Hughes meticulously reconstructed the lesser events which marked out this genuine epic of the modern times. The portrait obtained is impressive. A certitude and tenacious will at the outset: to replace gas with electricity as the source for domestic lighting. What Edison does next resembles what we would imagine only from a long distance. Edison is everything but a handyman of genius. He is an organiser, an entrepreneur, a strategist, a researcher, a public relations man and if there is any genius, it is in this ability to pass from one role to another and to play each of them with equal delight, that it must be situated.

What do you think Edison starts with? With the end, obviously. He puts the cart before the horse. So why jump into a difficult venture which nobody believes in? Rather than study the technical feasibility of his project, which would be considered as rational behaviour in the land of Descartes, he reels off sensational statements in press conferences. His message, which he hammers out day after day, is simple: electricity is the energy of the future, gas is trying to survive, networks are for tomorrow. Thanks to this fantastic publicity stunt, he prepares opinion while testing it at the same time. Nobody shouts out that it is a hoax. Half of the ground has been covered: if Edison ever embarks on electrification, nobody will ever think of him as a dangerous madman! Only when he has passed this first test can he start on the second stage: that of setting up a laboratory. He established it at Menlo Park, far away from the furies of the city. The most difficult remains to be done: not to solve the technical problems, but to recruit those who will decide on the success or failure of the venture. Another stroke of genius. Edison the genius handyman? You may laugh, but Edison would make the best-known recruitment agencies turn pale! He gathers together an impressive

bevy of high-flying scientists. First, a certain Upton who carried out extensive studies in mathematics and physics in the USA and Germany. Then Jehl who is a holder of several remunerative positions: numerous prestigious degrees in physics, maths and chemistry, the next more impressive than the previous. Edison takes these two on to work on perfecting dynamos. He also recruits an expert in mechanics, an expert in transmissions and generators, and finally, a confirmed bench scientist. The men are important, but other resources are necessary. He buys machine tools, chemical materials, top-of-the-range scientific instruments… He sets up a library with all of the journals and books which his team will need. Jehl is appointed to systematically read about the subjects which interest them in the scientific and technological publications which are published all over the world. Finally, he recruits a lawyer to deal with financial issues.

> 'Lowrey promised in 1878 that the income from electric-lighting patents would be enough to fulfil one of Edison's dreams: it would "set [him] up forever…[and] enable [him] to build and formally endow a working laboratory such as the world needs and has ever seen" ' (Hughes, 1983, 30).

We are far from the solitary handyman. Edison has built a team and given it the means to work. But we would be wrong to limit his role to that of simply an organiser, an able manager. It is not enough to recruit the best, to buy the best materials. A good non-specialised engineer (in the French sense of engineer) would be able to do this. If Edison was one of these, he would manage existing ventures, he would not commit himself to a terrible "corps-à-corps" with American society. By recruiting such an engineer, such a scientist, by choosing books and journals for the library, by deciding to buy such a machine, Edison is not content to manage, he makes strategic scientific and technological choices; in actual fact, he is doing research. If he is mistaken about the specialism, if he forgets the good journals, if he bypasses a promising technology, then his project is questioned. But if, to the contrary, he makes good choices, then it is on the right trajectory. Everything works at this precise moment, after which he will only have to manage, to experiment.

Edison's ambition is to transform American society, to make it pass from gas to electric lighting. Facing him are companies, town councils, consumers…who are ready to make his life hard, to scupper his project. A sensible man should abandon ship. Edison builds Menlo Park; and he claims that, with this pathetic tool of ten versus several millions, he is going to gain the upper hand. Menlo Park — pathetic? Come off it! A genuine war machine. This is what Edison has created. It is not a quality infrastructure to guide good research, but a microcosm

which represents through a simplified but faithful form all the forces, all the allies which will be necessary to transform an entire society.

Edison took care to meet journalists, those who form public opinion. Not a month goes by without him inviting them, alongside council representatives, to Menlo Park to let them chart his progress. The media and the decision-makers are at his side. Behold the first reinforcement. Next come physics, chemistry, electro-technology, mathematics, transmissions technology. Edison obtains this support thanks to his judicious recruitments. And by keeping abreast of the ongoing research results worldwide, Edison sets up his library, a key element of the device he has imagined. And the bankers' money which Lowrey is in charge of. Microcosm, Menlo Park? Yes, but not just any microcosm. With it, Edison has America under his control, or rather, all that is crucial in America and the entire world for his project to succeed. He has at his side science already made, science in the making, equipment, finance, law, opinion and town councils. Menlo Park is lost in the countryside and yet Menlo Park is linked up with all of the networks which matter. Menlo Park is not at the periphery but at the centre of the world and of American society. Thanks to his genius, which led him to imagine and build up his laboratory as he actually did, Edison holds the future in the palm of his hand.

Edison's lesson

Let's look at Edison's lesson. The fate of innovation, its content but also its chances of success, rest entirely on the choice of the representatives or spokespersons who will interact, negotiate to give shape to the project and to transform it until a market is built. Change the recruitment, forget the library, install other equipment, and it is at best a different innovation which sees the light of day, and at worst no innovation at all. It is the consequence of the model of interessement and of the socio-technical compromises from which it emerges. Since innovation moves, via the reactions which it provokes, from negotiation to negotiation and from redefinition to redefinition, everything depends on the identity of the protagonists who are mobilised: tell me with who and what you are innovating, and I will tell you what your innovations are made of and how far they will spread. From which stems the importance of the notion of representativeness. Will Lowrey be able to transmit the bankers' expectations and worries to Edison, and convince him to make his project evolve in such a way as to keep them durably interested? Will Upton and Jehl be in time to mobilise, among the most recent scientific knowledge, that which is unquestionable? Will Claudius, at the time of his travels in Europe, be in a

position to unequivocally discover among all the generators being developed those which will actually emerge? We find the uncertain situations which we started with. But they now concern the choice of speakers or collaborators who will participate in the innovation's development. And the question in abeyance is of a radically new nature. When listening to such a scientist that I have chosen as collaborator, having confidence in such a marketing specialist, in believing such an opinion poll, in taking up the results presented in such journals, am I becoming involved in a redefinition of my project which multiplies the number of allies that I am interesting, rather than isolating myself more and more? Will users, electrons, the competition, bankers all act in the way that these spokespersons surrounding me maintain? These spokespersons whose status as representatives I am unsure of, that is to say, whether they will be refuted in the following instant by all those, electrons, consumers, bankers, in whose name they claim to speak (Callon, 1986; Latour, 1987; Akrich, 1992)? Do all these pieces of information and assurances deserve to be believed?

Therein resides uncertainty. The innovation which succeeds is the one which comes to master it by choosing good speakers. A strategic choice which depends on the project being undertaken and which also assumes this irreplaceable intuition which gives one the impression that this remarkable discourse, held by a single being, is credible. It is not until after the blow, but only after the blow, that one will unequivocally know if the retained spokespersons were legitimate:

> 'The tautomeric forms I had copied out of Davidson's book were, in Jerry's opinion, incorrectly assigned. My immediate retort that several other texts also pictured guanine and thymine in the enol form cut no ice with Jerry. Happily he let out that for years organic chemists had been arbitrarily favouring particular tautomeric forms over their alternatives on only the flimsiest of grounds. In fact, organic-chemistry textbooks were littered with pictures of highly improbable tautomeric forms. The guanine picture I was thrusting towards his face was almost certainly bogus' (Watson, 1978, 149).

Described in the "The Double Helix", this is the difficult situation in which Watson finds himself at the moment when he believed that he had reached his goal. He has all of the chemistry manuals under the sun with him, he has a model of the double helix which is still consistent. The objections thrown at him by his smiling laboratory colleague are the only obstacle. Who should he believe? Who should he satisfy? It is not a matter of emotion, but of a strategic question. Who speaks legitimately in the name of amino acid chemistry? Are all of the manuals which provide certain tautomeric formulae in unison? Is Jerry who, alone and

proud of himself, inclined towards another configuration? At the least, one would hesitate. An error could be fatal. If you make the wrong decision, it is chemistry in its entirety which will turn against you and take back the Nobel Prize which you avidly sought after. Watson finishes by opting for his colleague who becomes, in his eyes, the legitimate spokesperson. He decides to go back to square one, to destroy his beautiful construction, to consider the most prestigious manuals as a web of errors.

> 'Since for many years he had worked at Cal Tech on the crystal structures of small organic molecules, I couldn't kid myself that he did not grasp our problem. During the six months that he occupied a desk in our office, I had never heard him shooting off his mouth on subjects about which he knew nothing' (Watson, 1978, 149).

A fantastic turnaround. Some presumptions and some indices are enough to reduce months of work to nothing! Genius, my dear Watson. But not the kind of genius we ascribe to the great thinkers in Descartes' land. Rather, the genius of the negotiator or of the dealer, who risks everything because he believes to be onto a good thing without having any certainty about it. A good researcher would ignore Jerry. A good inventor would believe him: this is all the difference. Human, science and technology? Yes, too human, in the most profound sense possible. No innovation, no invention develops without this initial bet, without this act of elementary trust, which defines our relation with others, and which leads to regarding the spokespersons with whom you prepare to negotiate your innovation project as legitimate.

Microcosm-Macrocosm

In comparison with choosing the intermediaries who will give shape to the innovation, the rest seems like a picnic.

Negotiating

First, management. Edison deserves the top prize. Thanks to its distance from places of distraction, Menlo Park has become a real community. They live there as a family, they work collectively without worrying about regulated working hours, they taste all the pleasures of life there. The rule is simple: once the spokespersons, whose weight in supposed alliances is considerable, have been recruited, make them permanently interact. The fate of the innovation depends on the spokespersons' constant negotiations, on trials of all sorts which they will

inflict upon each other, on contradictory existences which they mutually assert. In negotiating the project, in transforming it so that it is convincing *to the inside of Menlo Park*, they collectively prepare their success *on the outside of Menlo Park*. Because if the spokespersons, the multitude of intermediaries are well chosen, the microcosm which constitutes the laboratory represents in all its richness and complexity the macrocosm which gives shape to American society, such that the acceptable solutions for the former are the same as for the latter. As in the ancient cosmologies, secret and hypothetical relations have been weaved between the two. The venture's success depends upon them, upon their validity and solidity. Community life is not enough, nor is the circulation of good information, because success or failure is *in fine* hanging from the mobilised spokespersons and the unfolding of the negotiations which they introduce among each other.

A socio-technical analysis

To choose a spokesperson is to define, or implement, strategic orientations, but it is also to choose what is to be innovated and the problems which will need to be resolved. Once again, Edison's adventure is exemplary. Let us read his work reports. Edison starts with a detailed economic analysis: given the price of copper and realising the foreseeable costs of production and management (Edison includes in this price evaluation: buildings, boilers, annex installations, electrical currents and meters, he doesn't forget to include all of the employment costs, going so far as to include the chief stoker and assistant stoker…), the future of electric lighting versus gas necessitates small-section filament in order to minimise the amount of copper used. Edison, having given a brilliant lesson in economic analysis, then turns to the scientists and engineers. The problem he sets for them is perfectly clear: how do you reduce the filament's section without increasing the loss in transmission caused by the Joule effect? This is where Menlo Park demonstrates its effectiveness. All of the scientific knowledge of the era is mobilised to come up with a response. Combining Joule's Law and Ohm's Law, Edison anticipates the solution:

> 'It was a eureka moment, for they realised that by increasing the resistance of the incandescent-lamp filament, they would raise the voltage in relationship to the current. Thus began the time-consuming search for material suitable for a high-resistance filament. The notable invention was this logical deduction: the filament was a hunt-and-try affair' (Hughes, 1983, 36).

The socio-technical analysis leads to the major invention of the high-resistance filament. This is not the fruit of genius intuition. It is the product of a highly

strategic and well thought-out activity which would have been simply impossible if skills and worries of all sorts (from economics to fundamental physics via knowledge of management and technology) were not reunited in the same place within reach and intellectual capacity. A mix of genres, a variety of questions and know-how, but organised around a well-defined strategy: the replacement of gas lighting with electric lighting.

> 'Edison's method of invention and development in the case of the electric light system was a blend of economics, technology (especially experimentation) and science. In his notebooks pages of economic calculation are mixed with pages reporting experimental data, and among these one encounters reasoned explication and hypothesis formulation based on science — the web is seamless. His originality and impact lie as much in this synthesis as in his exploitation of the research facilities at Menlo Park' (Hughes, 1999, 58).

This example just goes to show the impressive effectiveness of scientific research. Edison's strength lies in this ability to introduce new resources and new realities into the economic game. It is banal but essential: the researcher, different from all other social actors, has the capacity to overturn the rules of the game. By inventing a high-resistance filament, by introducing a powerful light bulb which consumes little electricity, Edison and his collaborators weaken the position of the companies who provide gas lighting. Prior to the discovery, these companies had a complete monopoly; after the discovery, they find themselves subjected to an unexpected competition, as unexpected as the high-resistance filament. The laboratory is the workshop which dispatches new troops onto the market, troops who turn the positions of the most established upside-down. But this irruption is not without risk. It is the fruit of a strategic calculation. If a carbon filament is enough to drastically change the technology and economics of light, it is because everything is played out on this terrain which Edison carefully reconnoitred. He who holds the filament holds the market. Edison *translated* a commercial object into a research problem: all he needed to electrify America was a high-resistance filament. This translation is the result of a socio-technical analysis which would have been impossible without the presence of all the spokespersons brought together by Edison at Menlo Park. To set up a laboratory, to appoint all of these spokespersons and intermediaries of which we spoke previously, is not only to give oneself the means with which to resolve problems, it is, above all and before all, to put oneself in a position to formulate pertinent questions i.e. to translate an economic strategy into research activity.

Management of Innovation or Management of the Process of Accusation?

Lost in this world of "fog and illusion", the innovator can only find his bearings by endeavouring, through negotiations and socio-technical compromises, to interest more and more actors. It is a question of research, this collection of all sorts of allies, human or non-human, from the high-resistance filament to the journalists responsible for alerting public opinion. The laboratory is one of the privileged instruments of this eclectic collection.

Trust and suspicion

All of these kinds of negotiations are led, not directly with all of the concerned speakers, but with some delegates, some judiciously chosen spokespersons. Whether it is a case of identifying the behaviour of electrons or enzymes, to define user expectations of competitors' strategies, the innovator can only *put himself in the hands of some (very) rare speakers, of whom he never completely knows who or what they are representing, and whether indeed they really are representing them*. Doubt, trust, then gratitude and admiration, or on the contrary, suspicion, defiance and even hate, are at the heart of innovation. These passions do not come to interfere with the work of the engineer or researcher; they are the innermost and fundamental constitutive elements of their work. This is why it is pointless to try to separate the human factors and the technical factors, passions and reason. Just as it would be vain in the Shakespearean tragedies to dissociate the crime from the conquest of power, to deprive Lady Macbeth of the ambition which leads her to push her husband onto the throne. To innovate is to play some men off against others i.e. to challenge certain analyses or predictions in accepting others, whether the stake is to predict a chemical reaction or the reaction of a market. To mark his way, the innovator constantly assesses the people he meets or works with: there are those who will betray or have already betrayed, those who tell the truth and those who lie, those who are faithful or unconditional and whom he has decided to believe all the time, there are the half-hearted and the opportunists that he mistrusts but who he cannot risk ignoring. It doesn't matter if what is at stake is to establish either what carbon or electrons, or what researchers, marketing people, competitors or consumers, want or do. What is crucial is to know on who and on what you can rely to bring a project to a good end, but also to predict the way in which alliances will be redistributed if you decide to transform the project. This is why each decision is frequently accompanied by accusations uttered against those whose opinion you have just neglected: "I'm not getting involved in the development of combustible batteries

because the Beauregard lab is talking nonsense and I seriously doubt the competence of their researchers", "X is mistaken", which quickly becomes "X is misleading me", "while these marketing people were blatantly unable to listen to the customers, they made me believe that they knew users' needs very well; they have led me up the garden path". The processes of accusation, which we at the CSI have been able to observe as the fabric of innovation, are not some out-of-date forms of superstition or magical thoughts. They constitute one of the rare tools of analysis which the innovator can rely upon in order to establish his decisions or to explain his success or failure after the event.

Confronting the discourses of accusation

If the accusations do not represent a parasitic phenomena, it is because they form the actors' own analysis of the innovation process in which they are involved. And this analysis has nothing academic or abstract about it. It is entirely directed towards the research of effectiveness. According to the accuser, the identification of obstacles and the distribution of responsibilities will go in one direction or the other. For example, if an idea succeeds in asserting that the difficulties encountered by a new burner are due to the type of coal being used, *and if nobody stands up to defend the coal*, then the actions to be undertaken will naturally tend towards conceiving of as many burners as different qualities of coal or even to hold onto one particular quality. If, on the contrary, the failure of the burner is imputed to the researchers' inability to resolve a technical problem, and if these discourses dominate through a lack of detractors, then the decisions will naturally turn towards a reorganisation of teams, towards the recruitment of new scientists. The examples could be multiplied. They would show that all of the discourses of accusation are full of implicit or explicit choices, since they aim to distinguish between the representative spokespersons and those who are not. To call into question, as the phrase says, is to search for explanations and to draw up rules for action. Remember Edison: he surrounds himself by choosing intermediaries, and in deciding to believe them, he maps out his industrial and research strategy in the same movement. Whether we like it or not, the strategic dimension of innovation expresses itself wholly in these accusations which we believe to have come from another age.

The discourses of accusation are hypotheses, simple conjectures. To assert an accusation i.e. to impose a certain imputation of responsibilities, whether one is a potter in the Zande country, an engineer at Pechiney or a farmer in the Caux country, is never a picnic. It is a real trial of strength because it is not easy to admit to everyone that your neighbour or colleague is blocking your project or milking your cows dry. Accusations and counter-accusations intersect in a deadly

atmosphere. Each gauges his own strength, the strongest being the one who retains it the longest. And suddenly everything snaps. The weakest link in the chain bails out: researchers who have been unable to support the accusation are thanked, the licensee is dismissed because all the other suspects stood firm, the sources of coal supply are changed because it has been agreed to make it a scapegoat. The interminable controversies which pepper an innovation's life are nothing more than the impact of these discourses of accusation, which confront each other in order to determine among the spokespersons those who are legitimate and those who are not, those who are trustworthy and those who lie deliberately or lie without even realising that they are doing it. And as in the bocage, the words which circulate have a strength and effectiveness which are their own. Whoever wants to manage innovation must agree to immerse themselves in this world. *The management of innovation begins with the confrontation of various discourses of accusation which govern strategic decisions.*

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