MEDIA TECHNOLOGY AND SOCIETY

A HISTORY: FROM THE TELEGRAPH TO THE INTERNET

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INTRODUCTION: A STORM FROM PARADISE

Technological Innovation, Diffusion and Suppression

THE INFORMATION REVOLUTION AS HYPERBOLE

> A Klee painting named 'Angelus Novus' shows an angel looking as though he is about to move away from something he is fixedly contemplating. His eyes are staring, his mouth is open, his wings are spread. This is how one pictures the angel of history. His face is turned towards the past. Where we perceive a chain of events, he sees one single catastrophe which keeps piling wreckage upon wreckage and hurls it in front of his feet. The angel would like to stay, awaken the dead, and make whole what has been smashed. But a storm is blowing from Paradise; it has got caught in his wings with such violence that the angel can no longer close them. This storm irresistibly propels him into the future to which his back is turned, while the pile of debris before him grows skyward. This storm is what we call progress.
>
> (Benjamin 1969: 257–8)

An image of history as something other than a progressive chain of events informs this book. It is my contention that the received understanding of our current technological situation, the view that we are living in the midst of an 'Information Revolution' or at the start of an 'Information Age', can be seen rather differently if the histories of the technologies involved are considered. I am not necessarily suggesting, with Walter Benjamin and Paul Klee, that if we take their view we will agree that we are drowning in an ever-growing pile of debris; but I am agreeing with them that, certainly, the storm of progress blows so hard as to obscure our vision of what is actually happening. What is hyperbolised as a revolutionary train of events can be seen as a far more evolutionary and less transforming process.

The suggestion that we are not in the midst of monumental and increasingly frequent change in information (or better, communications) technology runs so counter to our whole underlying philosophy of progress, as well as the particular rhetoric of the 'Information Revolution' itself, that it must surely be doubted by right-thinking people. But the position taken here, rather, is that Western civilisation over the past three centuries has displayed, despite enormous changes in detail, fundamental continuity – and that it continues to do so.

The concept of the 'Information Revolution' is implicitly historical, for how can one know that a situation has changed – has revolved – without knowing its previous state or position? Even the notion of a 'Digital Age' (to take another hyperbolic slogan) implicitly posits other preceding non-digital ages. It is therefore apposite to offer a critique of these ideas which is itself grounded in the past; in the historical circumstances surrounding the application of what may be broadly termed 'science', especially the science of electricity, to the human communication process.

Such an historical consciousness reveals the 'Information Revolution' to be largely an illusion, a rhetorical gambit and an expression of technological ignorance. The popular literature on these matters and the media resound with visions of techno-glory or apocalypse, the same set of phenomena being the source for both styles of pontificating. Curiously, more than a few supposedly scholarly works, again both the technophiliac as well as the jeremiads, exhibit the same traits – fervid but purblind imagination, unbalanced judgements and unidimensional insights.

This is the background against which I shall argue more specifically that there is nothing in the histories of electrical and electronic communication systems to indicate that significant major changes have not been accommodated by pre-existing social formations. The term 'revolution' is therefore quite the wrong word to apply to the current situation. Indeed, it is possible to see in the historical record not just a slower pace of change than is usually suggested but also such regularities in the pattern of innovation and diffusion as to suggest a model for all such changes. Repetitions can be seen across this diverse range of technologies and across the two centuries of their development and diffusion. Consider, for example, the ways in which ideas for devices occur, the importance of science and general knowhow, the relationship of prototypes to 'inventions' and the balance of forces pushing and inhibiting the technologies. A model to reflect these patterns implicitly suggests the primacy of the social sphere as the site of these activities, conditioning and determining technological developments. It allows us to go beyond a straightforward account of technological history to pose more general questions about how the pattern of innovation and diffusion of electrical and electronic communications illuminates the broader role played by such technologies in our civilisation.

MODELLING CHANGE

To do this, the model treats the historical pattern of change and development in communications as a field (the social sphere) in which two elements (science and technology) intersect.[1] The detailed relationship between the field and these elements can be elucidated by reference to a conceptual figure, drawn from Saussurian linguistics.

Utterance is, for Saussure, the surface expression of a deep-seated mental competence. In Chomskyan terms, each utterance is a performance dependent on this competence. By analogy, then, these communication technologies are also performances but of a sort of *scientific competence*. Technology can be seen as standing in a structural relationship to science. Technologies are, as it were, utterances of a scientific language, performances of a scientific competence (Figure 1). The model thus suggests that we view discrete communications technologies within the social sphere as a series of performances ('utterances') by technologists in response to the ground of scientific competence.

'Science' here is being used very broadly, more in line with its original meaning of 'acquaintance with or mastery of any department of learning' rather than its

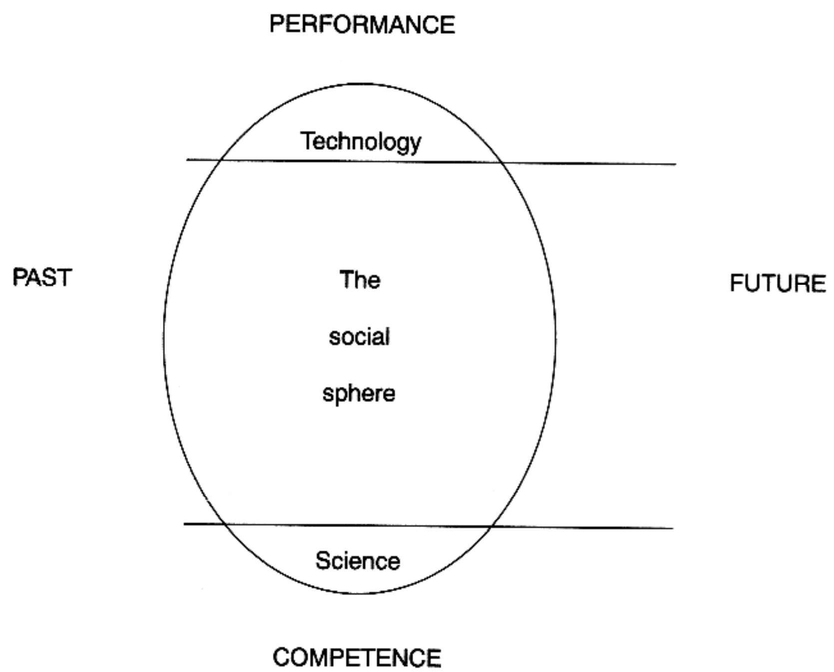

Figure 1 Building the model: the social sphere

modern sense of 'a connected body of demonstrated truths' or 'observed facts systematically classified'. The ground of scientific competence for these communications technologies includes, for example, the centuries-old investigations of electromagnetic phenomena and photokinesics.

The possibilities of using electricity for signalling, including photoelectric phenomena, march, from the mid-eighteenth century on, virtually hand-in-hand with the growth of the scientific understanding of electricity itself. Similarly, the development of photography involved knowledge of the different effects light has on various substances, a scientific agenda item from at least the Middle Ages on. The propensity of certain solids to conduct sounds seems to have been known in ancient times and was certainly a well-observed phenomenon by the late eighteenth century. It is such knowledge and understandings that form the ground of scientific competence which can then be transformed into technology. (All examples are described more fully below.)

The first transformation – *ideation* – moves the technology from the ground of scientific competence up to the level of *technological performance* (Figure 2). Its effect is to activate the technologist. To continue with the linguistic metaphor, the ideation transformation is akin to the processes whereby a transformation at the

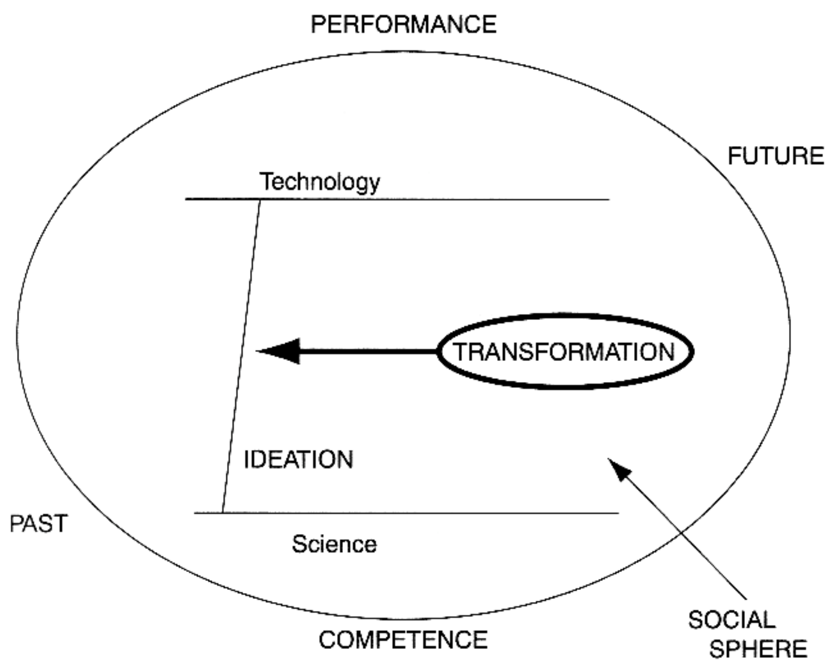

Figure 2 Building the model: ideation

level of competence takes place in the human brain, so that utterance, performance, can be generated. Ideation occurs when the technologist envisages the device – gets the idea, formulates the problems involved and hypothesises a solution. Those mysterious mental forces – creativity, intuition, imagination, 'the will to think' – are subsumed by ideation as are the general constraints of culture and the limits imposed by social forces of all kinds on the technologist's mind.

Although the technological idea will be grounded in scientific competence, it will not necessarily relate directly to science any more than a conscious understanding of linguistic competence is needed to generate utterance. Rather, just as in language a formal understanding of the deep structure of linguistic competence is not a prerequisite of utterance, so too a lack of formal scientific competence is no bar to technological performance. But the technologist will, at some level, have absorbed the science; just as a speaker, at some level, has absorbed grammar.

A German thought of the telegraph in the last years of the eighteenth century, three decades before the first working device. A Frenchman hypothesised the telephone in 1854, more than 20 years before Bell. The idea of television, which depended on the identification of the phenomenon of photoemission (i.e. that certain metals produce electrons when stimulated by light) was suggested in 1877. Bell Laboratory workers began worrying about the transistor in the 1930s when solid state amplifiers had already been envisaged for a decade. Some of these thinkers went on to test their ideas 'in the metal'; many did not. But more often than not their work was known to those who set about building devices.

Ideation transforms the processes of science into the testing of solutions – that is, the building of devices which is the business of technological performance. This will go on until the device is widely diffused and even beyond, as spin-offs and refinements are developed. In the first stage the technologists begin to build devices working towards fulfilling the plans which emerged from the ideation transformation. The devices they now construct can be thought of as *prototypes* (Figure 3).

However, we need to remember at this point once again that the technologist is a social being and that all this is taking place within the social sphere. The social has obviously informed the model thus far. The scientists conceptualising necessary fundamental understandings are as much social beings, exponents of and prisoners of the culture that produced them, as are the technologists who have ideas for devices and build prototypes. Yet now it is important to consider the social in a less general but more direct and concentrated way to answer some recurrent and basic questions.

Why, for example, are some prototypes abandoned while others are not? Why are some devices classed as 'inventions' when they did not work in significantly better ways than did other devices classed as prototypes? Why are many 'inventions'

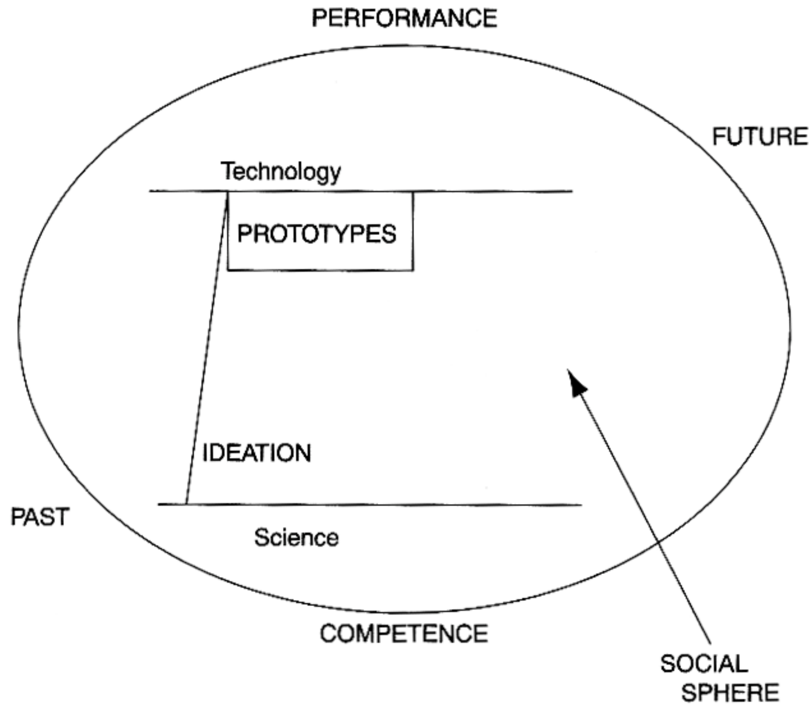

Figure 3 Building the model: prototypes

created more or less simultaneously by technologists who had no contact with each other? The answers to such conundra are to be found in the operation of a second transformation impacting on, and transforming, technological performance, this time coming not so much from the (socially conditioned) minds of technologists as from society itself. This transformation is, as it were, a concentration of the generalised social forces which have hitherto been determining the process of innovation. Now these generalised forces coalesce to function as a transforming agency which I will call *supervening social necessities* (Figure 4). Just as ideation worked upon the ground of scientific competence to create prototypes, so more general supervening social necessities now work on these prototypes to move them out of the laboratory into the world at large. In the nature of the case this second transformation is more amorphous than the first. There is no limitation on the forces that can act as supervening social necessities. They can range from the objective requirements of changed social circumstances (such as the consequences of the introduction of one technology forcing the development of another) through to the subjective whims of perceived needs (such as the introduction of new

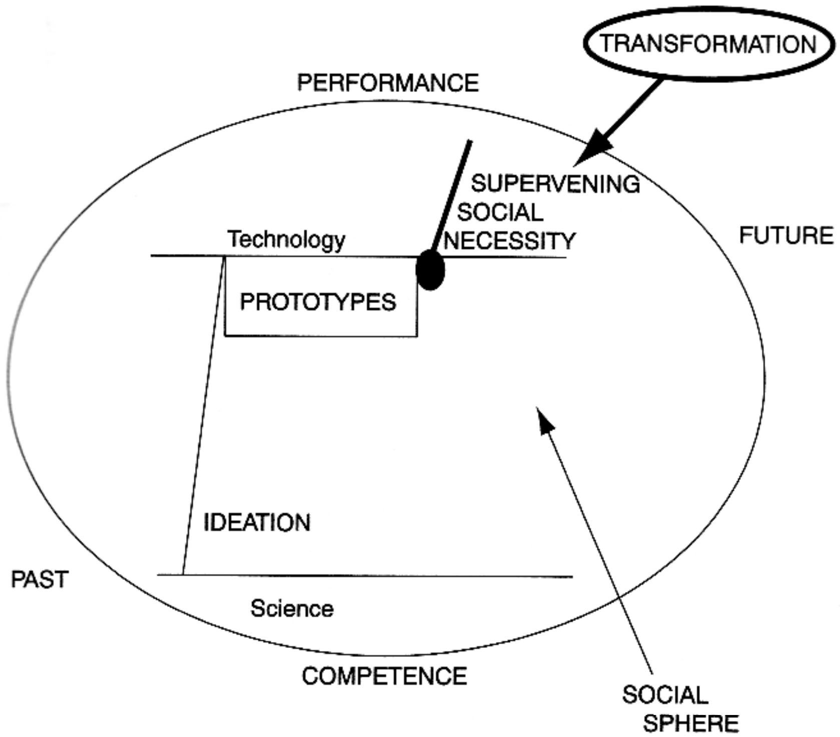

Figure 4 Building the model: supervening social necessity

consumer technologies to fulfil essentially the same function as those filled by previously diffused consumer technologies).

It is supervening social necessities of one kind or another which define the various different sorts of prototypes discernible in the historical record and which transform such prototypes into inventions. First, let us consider the four classes of possible prototypes:

The prototype can be *rejected* because a supervening necessity has not yet operated and no possible use for the device is seen. Ronalds' demonstration of a working telegraph in 1816 would be an example of this. The British naval authorities, understanding that the semaphore was the only machine to use in long-distance signalling, simply refused to acknowledge the superiority of his electromagnetic technology. Nearly every technology has its Ronalds.

The prototype can be *accepted* because the early and incomplete operation of a supervening necessity has created a partial need which the prototype partially fills. The daguerreotype photographic process which was widely used in the mid-nineteenth century is among the clearest examples of this accepted group. The efficiency of Hollerith punch-card calculators, introduced at the turn of the century but made increasingly sophisticated in the years after the First World War, can be said to have been so well accepted that the development of the electronic computer was delayed.

Parallel prototypes: these will occur when the device which will become the parallel prototype is already in existence solving another technological problem. Its potential use for a secondary purpose is realised only after the operation of a supervening necessity. Various laboratory contrivances existed in the last two decades of the nineteenth century to demonstrate the validity of electromagnetic wave theory by detecting the presence of radio waves. Distinguished physicists such as Hertz and Lodge are associated with these demonstration machines. They were in fact a species of radio but were not seen as such. Their existence is, however, of importance in tracing the work of Marconi, Popov and others which led to radio. The cathode ray tube, before Rozing, would be another example.

Finally, in this stage of technological performance, there can be *partial* prototypes which are machines designed to perform effectively in a given area but which do not. The telephonic apparatus developed by Reiss in the 1860s and, arguably, Bell's earliest machines were of this type. Baird and Jenkins' mechanical televisions were also partial prototypes.

These then are the four prototypes – rejected, accepted, parallel and partial (and all the examples given are dealt with more fully below). This classification is without prejudice to the efficacy of the devices. Except for partial prototypes which simply did not work very well, the other three classes of prototype all work, more rather than less. The degree of their subsequent diffusion, though, depends more on the operation of the supervening necessity transformation than on their efficiency. An accepted prototype is a device which effectively fulfils the potential of the technology but, because the full power of the supervening necessity has not yet been called into play, there is still room for development. The rejected prototype might work just as well as the device eventually 'invented' but will achieve no measure of diffusion because there is no externally determined reason for its development. The parallel prototype is a similar case. The initial thrust of the technology is directed towards purposes other than those which eventually emerge. The effectiveness of this prototype in solving the problem for which it was originally designed has nothing to do with its effectiveness as a device in the second area. It is, in effect, a species of *spin-off*.

All these devices are then, as it were, impacted by those concentrations of social factors I have designated as supervening social necessities. These too can themselves be roughly classified into three sub-types:

The least difficult class of supervening social necessity to discern is that occasioned by the consequences of other technological innovation. For instance, it was the railway which transformed telegraphic prototypes into a widely diffused technology. Before railways, as Ronalds discovered, there was no demonstrable need for such devices. Single-track systems, however, required, as an urgent matter of safety, instantaneous signals. Similarly, the radio came into its own with the development of the ironclad battleship. With these, for the first time, naval battle plans called for ships to steam out of sight of one another, thus rendering the traditional signalling methods useless.

A concentration of social forces working directly on the processes of innovation, rather than being, as with the first sub-type, mediated through another technology, constitute a second, more difficult to discern, group of supervening necessities. The rise of the modern business corporation created today's office, the architecture of the building which houses it and the key machines – telephone, typewriter and calculator – which make it function. In the middle decades of the nineteenth century the possibility of the limited liability company was established for the first time in law. The legal development of the modern corporation thus, in this sense, engenders telephony. In the same way, the growing urban mass impacts on the technologies of print, photography, cinematography and then on the electronic mass media as I shall show below.

Strictly commercial, as opposed to these sorts of social, needs for new products and other limited marketing considerations would form a third type of necessity – less certain in guaranteeing diffusion and producing less significant innovation than either the consequences of social change or the effects of other technological advances. Super 8mm film, Polaroid movies, 16 rpm records and the CD can stand for the host of devices to which commerce makes us heir under this rubric.

'INVENTION'

The action of a supervening necessity does not account for the entire development and reception of a technology. Rather it transforms the circumstances in which the technologist labours creating fertile ground for innovation. It follows from this that there must be the possibility of a fifth class of 'prototype', as it were, one which is either synchronous with or subsequent to the operation of a supervening necessity. The production of such machines is the business of further technological performance and leads to what is commonly called the '*invention*'. So within the laboratory the work continues as it did in the prototype stage but the supervening necessity transformation means the devices now produced are *inventions* (Figure 5).

Since the difference between such devices and the previous group of prototypes is the operation of a widespread transformation (social necessity), it is likely, and history reveals common, that such creations will occur in a number of places synchronously. The telephone is but the most extreme example of this because Bell and his rival Gray filed patents for a speaking electric telephone on the very

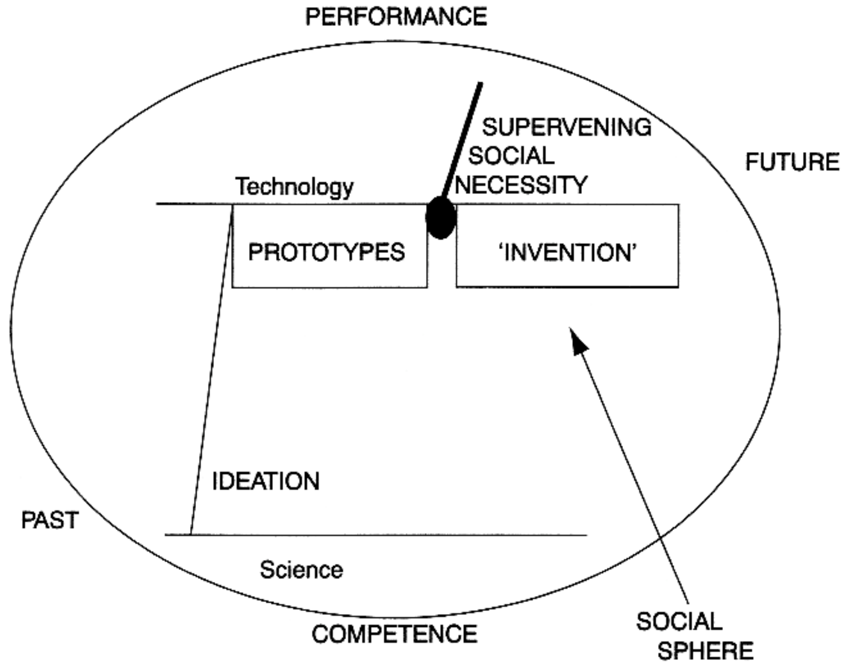

Figure 5 Building the model: 'invention'

same February day in 1876. Since they were both responding to the same social necessity (the rise of the modern corporation and its office) there is thus no mystery in the synchronicity of this communication invention – nor indeed of any other.

The suggestion here is that the distinction between prototype and 'invention' is far less clear-cut than is often supposed to be the case. Given that arguments about innovation are quite frequently resolved in court, there is a tendency for the victors in such cases to obscure the failings of their own technologies with as much public relations hyperbole as they can muster even as they denigrate the strengths of their rivals' ideas and machines. Again, the telephone is a good case in point. Its early history is of endless court battles in which the rival prototypes were subjected to very thorough drubbings at the hands of Bell's lawyers, exactly because Bell's patented apparatus did not really work. It is possible that at least some of these other devices were as close or as far from the speaking telephone as was Bell's.

This stage in the model will be designated *technological performance - invention*. Of all the stages, this is the best known. Herein are to be found all the heroes of communication technology's Hall of Fame – Reiss, Rosen and Hoff, Mauchly and Eckert, Baran, Gabor and the rest.

The *invention* now moves into the market place. Yet acceptance is never straightforward, however 'needed' the technology. As a society we are schizophrenic about machines. On the one hand, although perhaps with an increasingly jaundiced eye, we still believe in the inevitability of progress. On the other hand we control every advance by conforming it so that it 'fits' to pre-existing social patterns. The same authorities and institutions, the same capital, the same research effort which created today's world is also trying to create tomorrow's. A technologically induced hara-kiri on the part of these institutions, whereby a business 'invents' a device which puts it out of business, is obviously impossible. But what is equally true, although less obvious, is the difficulty of inventing something to put other businesses out of business; and the bigger the threatened business the more difficult it is. Progress is made while going down the up escalator (or, as optimists might argue, up the down). This jerky advance into the future can be seen constantly repeated in communications history. Its daily cavorting can be read in the trade press. It is theorised by historians such as Fernand Braudel as a conflict between historical 'brakes' and 'accelerators' being applied to technological progress: 'First the accelerator, then the brake: the history of technology seems to consist of both processes, sometimes in quick succession: it propels human life onward, gradually reaches new forms of equilibrium on higher levels than in the past' (Braudel 1981: 430).

In this model, the 'accelerator' is the supervening social necessity transforming the prototype into an 'invention' and pushing the invention out into the world – causing its diffusion. But there is also a 'brake': this operates as a third transformation, wherein general social constraints coalesce to limit the potential of the device radically to disrupt pre-existing social formations. I will refer to this particular 'concentration' of determining social factors as *the 'law' of the suppression of radical potential* (Figure 6).

Understanding the interaction of the positive effects of supervening necessity and the brake of the 'law' of the suppression of radical potential is crucial to a proper overview of how communications technologies develop. Constraints operate to slow the rate of diffusion so that the social fabric in general can absorb the new machine and essential formations such as business entities and other institutions can be protected and preserved. Such a pattern, far from atrophying in the face of supposedly revolutionary change, persists. If anything, there has been a significant diminution in the cut-throat nature of the market place because the desire for stable trading circumstances, coupled with external restrictions and monopolistic tendencies, works to contain the crudest manifestations of the profit motive.

Two caveats must be entered as to the chosen designation of this third and crucial transformation. Beyond the proper and necessary caution required when

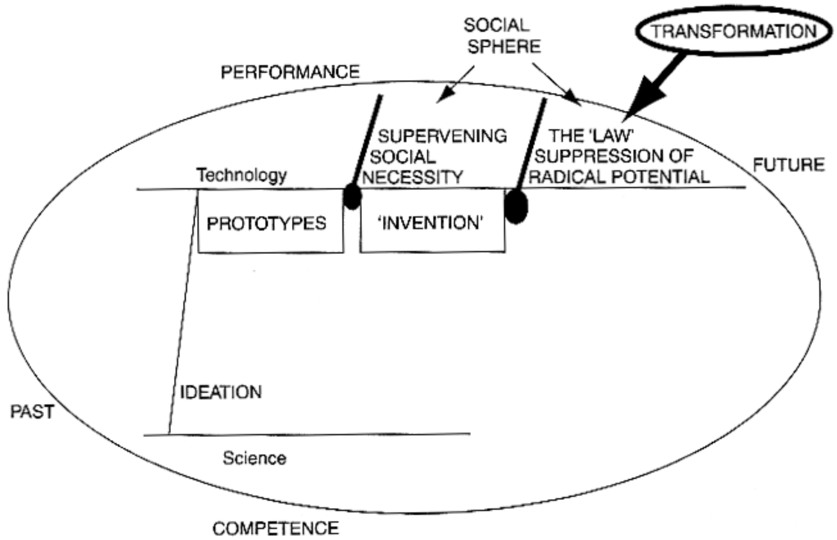

Figure 6 Building the model: suppression of radical potential

postulating historical laws, '*law*' here is apostrophised to indicate that although the phenomenon under discussion can be found in the histories of all telecommunications technologies it is not so regular as always to manifest itself in the same form with equal force at the same point of development. It is recurrent enough to be a 'law' but not certain enough in its operation to be a law. Thus it is not a law, a universal hypothesis, in the Hempelian sense in that it does not assert that:

> In every case where an event of a specified kind *C* occurs at a certain place and time, an event of a specified kind *E* will occur at a place and time which is related in a specified manner to the place and time of the occurrence of the first event.
>
> (Hempel 1942: 35)

Second, *suppression* must be read in a particular way. As Lewis Carroll said, suppression is 'rather a hard word'. Here it is not meant to convey the idea of overt authoritarian prohibition or to indicate the presence of any form of conspiracy, conscious or unconscious; rather *suppression* is used in the more scientific senses given by the OED, i.e.: 'to hinder from passage or discharge; to stop or arrest the flow of; (in Botany) absence or non-development of some part or organ normally or typically present'. It is possible that even with these caveats the word is still too 'hard' to cover the sense of a technology's potential simply being dissipated by the actions of individuals and institutions. However a mere 'tendency' towards dissipation or retardation would be too soft to convey the strength of the forces at work.

The most obvious proof of the existence of a 'law' of suppression of radical potential, then, is the continuation, despite the bombardments of technology, of all the institutions of our culture in forms subject to alteration but not revolutionary change. To many, such changes as have occurred loom very large; but any sort of informed historical vision creates a more balanced picture of their true size and scope. It is the 'law' of suppression that ensures any new communications technology takes decades to be diffused.

Let me just add that the 'law' of suppression is conceived of as being far more powerful than the concept of 'development cycles' determining, through an examination of business alone, the factors and time involved in diffusing an innovation. It seeks to capture a far wider set of phenomena, which work in the broadest possible way to ensure the survival, however battered, of family, home and workplace, church, president and queen, and above all, the great corporation as the primary institution of our society. To offer one specific example, it is the 'law' of suppression which led the British Government in 1997 to ignore digital television's potential as a means of providing a new high definition 1000+ line standard. Instead it licensed the technology to established industrial entities, including, in effect, the comparative newcomer satellite broadcaster as well as the old terrestrial players. The 'law' was at work to stabilise the sector by both constraining the radical potential of the latest development and, at the same, bringing the exploiters of the previous 'new thing' into the fold.

This does not in any way mean that the technologists cease to produce devices. On the contrary, supervening necessity has transformed prototype into invention and supervening necessity now, despite the operation of the 'law' of suppression, continues to encourage technological performance in the form of production, spin-offs and redundancies. There follows a struggle, as it were, between the accelerator or the push of supervening social necessity and the brake or the pull of the 'law' of suppression. This conflict governs the nature and pace of the diffusion of the technology (Figure 7). Supervening social necessity guarantees that the 'invention' will be produced. The 'law' operates as a constraint on that production. This final transformation thus occasions a tripartite phase of *technological performance – production, spin-offs and redundant devices or redundancies,* which reflects the effects of the contradictions which are at work.

Of the three distinct activities covered in this stage, the least problematic is that of *production*. The acceptance of the device is to a certain extent guaranteed by the operation of the supervening necessity. Much attention has been paid by economists to the symptomatic study of diffusion at both a macro and micro level with the result that the most scholarly literature available on innovation is skewed away

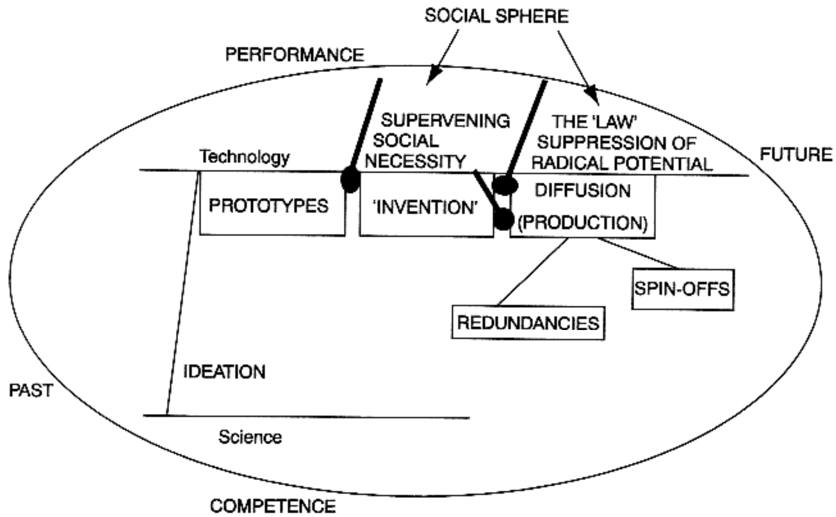

Figure 7 Building the model: diffusion

from the processes previously described in our model in favour of a concentration on these production and marketing phases. The problems of moving prototypes into production and marketing will therefore be peripheral to this study.

However, in the course of this movement the device can be modified, extended or refined; alternative solutions can appear as rival technologies. Such developments can themselves, as in the prototype phase, either be accepted or rejected. If such a development is accepted, diffused, it is a *spin-off*. Videogames, for instance, are an accepted extension of microchip technology which was certainly not developed with that specific purpose in mind. Similarly the CD, initially a computer memory technology, largely failed as a video format, succeeded in audio form (not least because the record industry simply stopped pressing vinyl) only to also re-emerge in CD-ROM form as a memory store for computing. As an audio medium, then, the CD can be classified as an accepted spin-off. Spin-offs are products of technological performance synchronous or subsequent to the original device's diffusion.

If, on the other hand, the technological performances of this post-production stage are rejected, as the video CD (the laser disk) was by the domestic market, then the technology can be described as a *redundancy* which suffers the same fate as a partial prototype. Before the all-conquering videotape, laser videodisks made little headway; and non-laser videodisks as well as Polaroid instant movie film suffered the same fate for the same reason, redundancies all. Again, these cases are discussed below.

These, then, are the various elements proposed for modelling the processes of change in the technologies of communication. This is not the place to inscribe an account of the debate as to the efficacy of what Popper has called 'historicism' or the propounding of 'historical prophecies'. Many, in seeking to understand the pattern of Clio's garments, have been tempted into predicting, on the basis of that understanding, what she will wear tomorrow. When it comes to communication technology though, such efforts tend to be unfettered by much understanding of the past beyond the anecdotal. Indeed, there is a profound tendency to historical amnesia behind, for example, the oft repeated assertion that the pace of change is now so fast as to be uncontrollable or that 'nobody could predict' this or that development. The historical implications of the word 'revolution' are not denied by this amnesia; instead a supposed transformational movement from 'then' to 'now' is celebrated.[2]

The purpose of this book is not only to explicate the 'then' by inscribing a fuller account of what actually occurred in the telecommunications past but also to offer an interpretation, necessarily revisionist, of those occurrences. In attempting to do this, the model offers an understanding of the history and current position of communications in our culture which depends on an examination of the operation of the accelerators and brakes, or social necessities and constraints, rather than on the performance of technology considered *in vacuo*. In what follows I shall apply the model first to the electrical systems of communication, the telegraph and the telephone. Then, in Part II, radio and television are dealt with. Part III is concerned with computing while Part IV looks at the whole development of electrical and electronic networks from the telegraph to the Internet. The conclusion suggests, via a consideration of the current state of research into holography, that the model is still valid.