Early Cinema and the Technological Imaginary
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CHAPTER 4: The Problem of Technological History and Invention

Overview
In film history, the hard technological determinist’s model of progress insists on the convergence of discrete inventions onto a single apparatus. This process is attributed to personal interaction between individuals meeting technical deficits in order to represent movement photographically as though it were a pre-existing goal. For example, Edison’s single-viewer, peep-hole machine is shown to be a primitive model of the projection device that the Lumière perfected. These two, quite different, modes of exhibition became synthesised as a consequence of the efforts of a number of other inventors and scientists, including Marey’s assistant, Demenj, in France, R W Paul, and Birt Acres in Britain, and the Latham and Raff and Gammon who redirected Edison’s project. For example, Anthony Michaelis, contributing to the standard reference work on the history of technology in 1978, begins with the observed condition of the human eye to retain an image and catalogues, chronologically, devices which use this aspect of vision, until he can close with the story of Méliès as a trick film-maker in order to arrive at narrative film. In his account, each device is attributed to a named inventor and leads inexorably to the Cinématographe. This model of technological history, which mixes morphological resemblance and character-centred causality, allows the differing objectives and practical solutions to recording the moving image reached by Edison, the Lumière and Paul, to be regarded as basically similar. Much of the evidence from Section 1, however, seems to suggest that they were fundamentally divergent and, once in the innovation phase, there appears to be even greater diversity in the technology and its uses.

Nonetheless, for all its shortcomings, technological determinism and the “great man” theory of invention have an undeniable logic, the primary appeal of which has been summed up by Douglas Gomery:

As with the “great man” theory of invention, technological determinism contains within it a kernel of unarguable fact: the state of technology at any given moment in film history imposes certain limits on film production. It marks out what is possible and feasible and thus makes more probable certain types of films and, less probable or even impossible, other types.

Gomery’s argument suggests that a product may only be open to free interpretation and re-interpretation by users and inventors within the possibilities dictated by physical laws and perceived cultural and environmental constraints. The mono-causal determination that this introduces to the history of the cinematograph stands in contrast to the ensuing discussions of film form, production, distribution and exhibition practices which characterise “new film history”. The problem has long been recognised and this chapter will discuss a number of attempts to reconcile this “kernel of unarguable facts” – some of which are detailed in the previous chapters – with a social and cultural perspective on technological change. Drawing on these, together with some work on the cognitive aspects of invention based on a close
study of the Edison archive, it will lead us to reconsider the role of the audience in
determining the course of early cinema technology and film form.

The problem of technological determinism for film history

Technological determinism is a concept which has become the subject of debate in
technology studies.¹⁴⁰ In its most rigid interpretation, technology is regarded as an inevitable
abstract force, offering little flexibility in its meaning. Since it shapes rather than responds
to history, the progress of inventions can be plotted retrospectively and a trajectory projected
to predict future development.¹⁴¹ Philosophical objections to hard technological determinism
are based on the assertion that “technology” can have no agency because it is an “...abstract,
disembodied, quasi-metaphysical entity”.¹⁴² In response to this, “soft” technological
determinists locate the agency of technology in the strong cultural belief that technology
shapes history. As Merrit Roe Smith and Leo Marx suggest: “Instead of treating
‘technology’ per se as the locus of historical agency, the soft determinists locate it in a far
more complex social, economic, political, and cultural matrix.”¹⁴³ While there is clearly a
kernel of unarguable fact in what might be called “hardware” events that do affect what is
possible at any given moment, accounting for technological change must also be addressed and

... may require consideration of certain material, geographic, demographic, and
socio-economic preconditions; access to raw materials or markets: the existence
of a mercantile capitalist economy; the operation of the profit motive; the
accumulation of capital; the availability of a needy, teachable, exploitable labour
force. Others attribute causal primacy to intellectual, cultural, or ideological
factors [...]Indeed, almost every identifiable attribute of early modern Western
societies has been proposed as the putatively critical factor.¹⁴⁴

In effect, soft technological determinism reflects on the current age and re-defines its term
to “now refer to the human agency to create the kind of society that invests technologies with
enough power to drive history.”¹⁴⁵ As the more historically conscious of the two positions,
soft determinism recognises variability in the amount of power invested in technology by a
community at a given historical moment.

There are more grounded objections to all shades of technological determinism. For
example, the idealisation of data around an assumed imperative (even if that imperative is
an imagined determining agency) requires that it is necessarily selective of its empirical
evidence in order to match it with a predetermined conclusion, such as the realistic
photographic representation of movement. A case in point is the story of the coming of
sound or colour which is often retold from this perspective as though, but for the necessary
technology, movies would have “talked” and been coloured earlier. Apart from the
historiographic problems with technological determinist/realist teleology, its ideological
assumptions have also been questioned. Realism, it has been argued, is a response by the
bourgeoisie to the social problems that technology presents.¹⁴⁶ Explanations for the invention
of cinema which rely on the causality of a social imperative for the real, suggest that
technology is yet another manifestation of the bourgeois ideology (in which case, the
predominantly bourgeois resistance to the cinema requires some forceful explanation). Allen and Gomery, however, have identified the economics of the major studios in a phase of aggressive competition as one of those factors. Economic determinism, however, like technological determinism, proceeds from an assumption of levels of consumer passivity which are neither safe, nor politically acceptable, since it reifies inertia. The sum of such objections is that hard technological determinism, idealises not just the data, but has a coercive effect by reducing the complexity of the social process of decision-making that shapes technology.

The objections to technological determinism have produced a number of more socially-determined accounts of film form (the software aspects of cinema) in the last three decades. As early cinema has begun to be analysed as a specific cultural practice rather than as an enabling technological event that facilitated the production of new kinds of artefacts, the social and economic determinants of cinema have become more important to historical explanations of film form than the stylistic innovations of individuals. These acknowledge that the cinematograph has become many things apart from an entertainment — for example, as data storage, a news medium, an instructional apparatus. These broader understandings imply that its use as “the movies” was not the inevitable consequence of the technology, nor was it the product of its initial exploitation by Lumière, Edison, Paul et al. Neither was it inevitable that, once established as an entertainment attraction, within a decade, the cinematograph would become principally a story-telling machine with its own mode of narration. By looking outside the realm of film studies at business records, public documents, patent licences, population census and legal records, new light has been shed on these issues. Some accounts have been able to show that the particular formation of the film industry was the product of a number of contingencies, ranging from demographic changes to industrial strikes by live performers. A close study of the impact of these apparently peripheral events can be used to account for the cinema’s subsequent use as a story-telling machine. Others have tracked the history of screen practices, entertainment preferences, population distribution, economic prosperity, industrial strategies, monopoly capitalism etc. to show how these determinants have borne, to a greater or lesser extent, on a specific machine and produced the institutional form called cinema. By plotting the social, economic and political determinants of the cinema it has been shown in “new film history” that this network of influences was reflected in the appearance and uses of film. The look of the films and the “dominant narrative codes”, it is argued, were a consequence of a multiplicity of factors rather than a mere imitation of existing entertainment forms by producers looking for a language.

Evidence for this is found in the way that film form changed quite abruptly after 1906/1907, to the extent that the conventions are now forgotten and contemporary viewers find them difficult to understand. Tom Gunning, for example, argues that the content and appearance of films prior to this date were organised around a specific form of pleasure shaped by the economics of the industry. Films and exhibition practices changed quite suddenly as exhibitor control gave way to the more long-term business ambitions of the producers. This favoured films with high production values that discouraged competition, and a cinema of narrative integration in which the performative aspects of the apparatus function took over
from the exhibitor as the narrator. At the root of this was the struggle between two interpretative agents in the shaping of cinema who had quite different, and fundamentally opposed, financial objectives for the emerging industry. A cinema of narrative integration that eliminated new competition gave greater control to producers who saw the industry as a source of long-term profits. Raising the demographic and social profile of its users could justify greater capital investment and so on. The embourgeoisment of cinema, with the rise of long theatrical narratives, therefore, was not so much the outcome of the genius of emergent directors developing a film language, but of the predisposition of capitalism to favour oligopolies. As a consequence of challenging the hard determinist explanations, the institutional shape of cinema as the handmaiden of the long fiction film is now understood as the outcome of a process of choices and decisions between groups with different financial understandings of the invention, rather than as the inevitable consequence of a technological invention to replicate movement more realistically.

Attempts to explain how the fiction film and the realist novel function in support of a passive bourgeois world-view encouraged some film scholars in the 1980s to look beyond the surface of the screen to the mode of narration, that is to the signifying system and the experience of viewing a film. What they have argued is that there is an inevitable subject construction in the cinema as a consequence of the technological arrangement. The ahistoricism of “apparatus theory” which emerged from these enquiries appeared to be supported by the “kernel of unarguable fact: the state of technology at any given moment in film history imposes certain limits on film production”. However, reconciling the state of technology at any given moment with its determining power involves no more than any other historical practice which needs to evaluate the influence of various agents in respect of the historically specific context. Marxist historians searching for recirculations, discontinuities and ruptures in the apparent seamlessness of causality revisited the questions of early cinema in an attempt to show how as an instrument of social control technology, film was invested with an exaggerated determining power. In this logic, the implicit sonambulance of technology can be shown to be an effective tool in the armoury of a bourgeoisie whose exercise of power masks its own repression. The danger here as Elsaesser sees it, is that, as a discipline, film history “... becomes a kind of intellectual challenge, whose pleasure lies in the ever greater complexity of the method, compared with the relative simplicity of the data”. The challenge then is to embrace the complexity implicit in re-evaluating technology as a less powerful order of determination, without intellectual inflation, to provide a more sustainable account of why technology changes.

Nöel Burch, for example, gathers up a spectrum of impulses into a single imperative that shapes the use of moving-picture technology as entertainment. For him, the forces of bourgeois ideology controlled the interpretation and legitimate use of the machine as cinema as a further step in the project of social control. He attempts to reconcile aspects of science, technology, entertainment, economics and sociology into a single explanatory model to account for the emergence of cinema from a technological collage. Burch draws evidence from both the centres and the peripheries of cinema and entertainment to show how certain interpretations and responses to devices that science and technology had rejected or outgrown, became re-circulated for profit in a wider culture as empty amusements. His
explanations draw on an array of tangential and minor social, scientific and intellectual determinants that in certain combinations are capable of profound effect. In doing so, he adopts revisionist approaches in other fields, most notably in contemporary histories of science and technology, and is able to show how the dominant social, economic and scientific understanding of the individual had an effect on how machines were used and institutions organised. Burch holds that cinema was incorporated into the bourgeois project of the control of representation through privileging specific modes of analysis and description. To achieve this, science and technology were enlisted as reifying authorities whose ideological objectives were also concealed. Cinema became an extension of the numerous inventions and optical devices developed in the 19th century which gave the illusion of movement, and was intended, in part, to show a discontinuity between human visual perception and reality. Burch’s historical argument, inflected by Marxist theory, is that this use of scientific devices was a gesture towards an ideology that had a heavy investment in re-defining the real in a way that privileged bourgeois cultural values.

Moving image technology epitomised this, as for example, when Jules-Etienne Marey’s analytical studies into human movement using chronophotography to show “real” movement were subverted by his assistant, Georges Demeny, who projected them as illusions. Whereas Marey was interested primarily in understanding the discrepancy between experience and language, Demeny’s projection of moving images denied the effect of that discontinuity by producing an hallucination of reality. By the late 1890s, the hallucinatory aspects of the technology were uppermost. For some, however, this was still insufficiently real. In 1896, Maxim Gorky visited a presentation of the Lumière machine and wrote the following day:

Last night I was in the Kingdom of Shadows. ... It is a world without colour. Everything there — the earth, the trees, the people, the water and the air — is dipped in monotonous grey. Grey rays of sun across the grey sky, grey eyes in grey faces, and the leaves on the trees are ashen grey. It is not life but its shadow, it is not motion but a soundless spectre ... And all this in a strange silence where no rumble of wheels is heard, no sound of footsteps or of speech. Nothing. Not a single note of intricate symphony that always accompanies the movements of people.156

According to Burch, what so depressed Gorky was not the absence of poetry but the lack of realism in cinema that a naturalist ideology of representation demanded. 157

The radicalism of the 19th century bourgeois required nothing less than the de-materialisation of reality by relocating vision in the body of the observer. This required what Jonathan Crary has called “... techniques for imposing visual attentiveness, rationalising sensation, and managing perception”.158 Apart from projects such as Marey’s, which examined the link between surface activity and interior structure, there were other scientific claims that the psychological motivations of the criminal and insane could be decoded from visible evidence on the surface of the body. This shaped the initial reception of moving pictures and Burch notes that the day following the very first screenings in Paris in 1895, the
only two newspapers to report the event both saw the cinema as a technology for the reproduction of life. Both remark that this new machine could overcome the finality of death by reproducing the walking, talking image of a loved one. “When these cameras are made available to the public, when everyone can photograph their dear ones, no longer in a motionless form, but in their movements, their activity, their familiar gestures, with words on their lips, death will have ceased to be absolute.”

On the other hand, Gorky’s declaration on seeing the Lumière programme in Moscow is more reflective about lived experience of time and space. “The thirst for such strange sensations as it gives will grow and we will be increasingly less able and less willing to grasp the everyday impressions of ordinary life. This thirst for the strange and new can lead us far, very far, and The Salon of Death may be brought from Paris at the end of the 19th century to Moscow at the beginning of the 20th.”

Each of these responses to the first screenings show the cinema not so much as something new but, in Burch’s view, an ideological extension of trompe l’oeil scene painting which takes vision into the realms of immateriality.

These responses confirm for Burch that the cinema as a public spectacle, to say nothing of the host of “pre-cinematic” optical toys, was, at the outset, linked with questions concerning the re-constitution of life. The names given to the various devices by inventors and entrepreneurs — Vitascope, Animatograph, Biograph etc. — reflect the close association with moving images and artificial life. In this choice of names, and in the critics’ reflections of the defeat or immanence of death, a new definition of life was acceded to which the cinema could make visible and enshrine in a popular cultural form. This defined life as either a series of discrete moments that might, with the right apparatus, be seen as a flux, or as a flux which might be scientifically analysed as a series of discrete moments. Life, understood as change, could either be simulacra or be scientifically replicated. This description of life as a synthesis of fixed points was consistent with a number of influential ideas, not least Bergson’s hugely popular writing, as well as the dominant methodology in science and medicine. Viewed from the standpoint of ideology, as expressed in Burch’s seminal reading of the responses to the first screening, the Cinématographe and the images that it showed were technological representations of a variety of individual and collective mental models. These reached a consensus through cognitive processes that were often only loosely connected with the state of technology.

Using different data, Jean Louis Comolli and Michael Chanan have argued that the cinematic apparatus was the product of a political and economic milieu in which an imaginary relationship with the social machine replaced the real relationship as a way to maximise the exploitative potential of capitalism. They subscribe to the idea that the basic premise that underlies hard technological histories is realism, which they view as an ideological instrument in the control of a political group for whom the idea of continuous progress masks the re-circulation of the conditions of control, ensuring they remain an elite. Consequently, to reiterate these assumptions in histories is to reinforce the power relations that are concomitant with that ideology. The apparent seductiveness of such historical explanations of the cinematic apparatus — histories that might be called “” of the technology — amply supports the Marxist claim that the cinematic apparatus, which also makes representations, is an ideological machine. As Comolli put it in Machines of the Visible:
There are not only the representations produced by the representative apparatuses as such (painting, theatre, cinema, etc.); there are also, participating in the movement of the whole, the systems of the delegation of power (political representation), the ceaseless working up of social imaginaries (historical, ideological representations) and a large part, even, of the modes of relational behaviour (balances of power, confrontations, manoeuvres of seduction, strategies of defence, marking of differences or affiliations). On the other hand, but at the same time, the hypothesis would be that a society is only such that it is driven by representation. If the social machine manufactures representations, it also manufactures itself from representations — the latter operative at once as means, matter and condition of sociality.\textsuperscript{161}

Comolli claims that the relationship between how the cinema represents the world and its technological ability is more complex than a simple chronology of invention. He points out that the massive increase in technologies of the visible in the 19th century caused a general instability in the representational contract between the viewer and the viewed. In the vortex of this panic an ideological apparatus — the photograph and later the cinematograph — was invented, and delusion was normalised and the spectator reassured that "...delusion is in conformity with the norm of visual perception."\textsuperscript{162} Comolli's project was not primarily historical since he was much more concerned to show the ideological power of a representation machine. Citing historical evidence, he shows how a conscious manipulation of technologies is used to maintain in the spectator's mind an imaginary relationship with the image. For Comolli, this means that attention to socio-economic relationships explains the appearance of cinema technology at a specific historical moment as an outcome of a historically-attenuated and generalised discourse of class struggle.

Michael Chanan takes up the general claims of Comolli and applies them to a specific period in the formation of British cinema.\textsuperscript{163} In doing so, he strengthens the claims by citing specific social and historical evidence. He shifts the formative emphasis on the use of technology away from economics to a more sociological reading in which class struggle, and especially the subjugation of the working class, is the influential factor. As a machine that makes generally acceptable representations of the world, the cinema normalises this subjugation in the double action of its own historical account. As Chanan puts it "... the largely unconscious product of the ways we have of representing the world — cinema being one of these ways — which in turn is the result of the organisation of the social world."\textsuperscript{164}

Comolli, Chanan and other like-minded scholars — notably, Stephen Heath — are conscious of the ideological consequences of teleological histories. Their alternative method is to show significant ruptures in the apparent continuum of progress that these posit. Heath's essay, "The Cinematic Apparatus: Technology as Historical and Cultural form" which opens the collection \textit{The Cinematic Apparatus}, co-edited with Teresa de Lauretis, is a stout rebuttal of technological determinism and its more dilute form, symptomatic technology. For Heath the "...whole notion of an instance of technology cannot be assumed"\textsuperscript{165} nor can understanding be reached by "...the mechanical assertion of chains of cause and effect".\textsuperscript{166} However, Chanan grounds this essentially theoretical point in empirical
history by re-examining the early years of British Cinema. Refraining from universal claims about the significance of cinema and its emergence, he uses an anthropological methodology; looking at a community as a whole entity and relating a particular cultural practice to the political and social formations in order to understand its meaning to that particular society. He argues that the technologies of cinema were the result of subtle interactions between a specific historical and social formation and its various institutions — late 19th century Britain — on the one hand, and existing and imagined technologies and political contingency on the other. The creative manipulation of the discrete parts that come together to make the cinematograph into a coherent whole — the institution of cinema — was not so much the consequence of a number of inventions, but the meaning given to a particular machine-ensemble constituted by the social/economic body that exploited it.

Chanan borrows Lévi-Strauss’ term *bricollage* to describe the cinematic apparatus, and this allows him to move from the material to the conceptual using the same theoretical model. He is able to take an undifferentiated and non-hierarchical view of the many components of the cinematic apparatus and combine the various novel optical devices with changes in both chemical technology and engineering practices, and to relay this to a coherent, multivalent causality that is socially inflected. This opens the way for him to develop a resistance to realism in an extended criticism of Bazin while acknowledging the determining power of the realist impulse as an essentially repressive ideology overseen by an equally repressed bourgeoisie. The cinema’s passage towards greater “realism” as culturally determined can be acknowledged while, at the same time, affirming that it does not constitute an essential factor in the art of cinema. Since the bourgeoisie, with their investment in realism, exerted a significant influence on the shaping of the social machine called “cinema”, the belief in realism can be linked directly to a softer technological determinism based on a generally-held, if misplaced, belief that culture is shaped by technology. In this way Chanan provides an explanatory bridge between the various forms of technology — the cheap optical toys and novelties etc. — which do not essentially lead us to cinema, and the consolidated machine ensemble, including the studio system, that becomes the high capital industrial form we now know. His approach finally also offers some explanation for why cinema became a public entertainment rather than a domestic one by pointing to the tendency of late capitalism to form oligopolies, and closes the circle with “new history” accounts of film form.

Burch, Comolli and Chanan provide a convincing challenge to hard technological determinism by recognising the state of technology without investing it with overwhelming powers to shape history. Mapping a network of social, economic and technological determinants they are able to offer a softer, multivalent explanation of the ways in which technology and culture interact. Their thesis argues that physical laws are constituent parts of the network of forces that periodically coalesce into a particular invention. Where J L Comolli, Michael Chanan and Noël Burch have reverse-engineered the invention of cinema from a macroscopic viewpoint and explained it as symptomatic of the organising principles of society, W Bernard Carlson and Michael E Gorman have approached the processes of invention from the point of view of a microanalysis of the individual to make general claims about the origination and organisation of invention. In doing so, they have stripped away the concept of an overarching social determinant and insisted on historical specificity. They
have re-examined Thomas Edison's work on early motion picture technology to suggest that
the invention of the Kinetoscope may be understood through a systematic study of the
cognitive processes. Although they acknowledge the impact of culture and history on the
individual, they argue that:

Before one can fully comprehend how social, cultural and economic forces
inform the design of technology, one needs to conceptualise clearly the process
of technological invention. In particular, one must understand what occurs in the
mind of the inventor — how an individual perceives the world, takes ideas from
his social and cultural milieu, and utilises those ideas to create new devices.167

They proceed from the view that what are generally called inventions begin as individual
mental models which are then represented using some personal heuristic strategies. In their
study of the Kinetoscope they show how documentary evidence from the Edison archive
supports this model. Thomas Edison, they claim, used the current engineering, problem-
solving vernacular, freely available in engineers' stock books, together with original
components of his own notes, to represent his mental models. He achieved this through a
heuristic of a systematically-organised research laboratory at West Orange, comprising a
team of engineers and scientists. In this environment he was able to build more sophisticated
representations of mental models as prototypes which allowed him to dynamically organise
his thoughts about an invention. This method sometimes yielded apparently illogical
solutions but these were antecedent stages that have been retained, even though they
apparently serve little purpose. For example, Carlson and Gorman note that even when
Edison was aware that electrical filaments oxidised rather than melted, he still included a
voltage regulator in the vacuum electric lighting system. Similarly, the retained mental
picture of the apparatus that successfully recorded sound determined his early attempts to
record movement, and he had difficulty casting this aside. They argue that he chose to design
the Kinetoscope with a cylinder and a spiral of photographs because these were similar to
elements of his phonograph. However, Edison understood that, unlike sound recording, the
progress of the inscription past the "read head" needed to be intermittent, and to represent
this mental model he returned to the stock-ticker and various ideas he had developed in
relation to the telegraph and the electric light. Having achieved a sketch representation,
Carlson and Gorman identify the next phase as the development of a problem-solving
strategy or heuristic. Edison broke down the task into two separate areas, the electrical and
the photographic. He then commissioned teams to work on the problems, and it was at this
stage, they suggest, that the difficulties that have preoccupied some histories of this period
arose.

Edison's heuristic involved collaborative work within, and between, groups. However, in
Carlson and Groman's model, each contributing element in this problem-solving process is
subject to the same incremental triad as Edison's — mental model, heuristic, representation.
At times, it seems that Edison did not understand or appreciate other individuals' mental
models, nor they his. As director of the project, however, he had final control, and the
outcome of this process was the Kinetoscope — an optical version of the phonograph to
which Edison initially aspired. As Carlson and Gorman point out, W K L Dickson, who had
joined him especially to work on a magnetic ore-milling project, had a different mental model, or possibly could not fully grasp Edison's. As a consequence, in March 1890 Dickson developed a projecting version of the "phonograph for the eyes" that he had been working on in Edison's absence, that included synchronised sound. When it was presented to him, Edison was not enthusiastic and, to Dickson's irritation, he re-directed him to the magnetic ore-milling project, and work on the Kinetoscope continued intermittently until certain technical problems were resolved and manufacture of the device began in 1893.

The role of the imagined in engineering history
Carlson and Gorman's evidence, drawn from Edison's notebooks, reinstates the visual aspects of invention and technology which, from the perspective of the late 20th century, have been lost. In doing so, they return us to a consideration of what technology meant at the time of the invention of the cinematograph and point to the historical specificity of its modes of practice. It is from this perspective that Eugene Ferguson offers some insight into the late 19th century in his critical examination of what it means to be a technologist today. Ferguson criticises modern engineering practice as having lost sight of the imaginary dimension of engineering that was understood as vitally important in the last century. He notes that the currently preferred model of analytical engineering science favours only that knowledge which can be expressed in mathematics and this overlooks, and ultimately destroys, those aspects of engineering which reside in non-verbal knowledge. This tendency to prioritise the documented, colours our understanding of the history of invention by relaying current practices onto the past. Ferguson uses the examples of Leonardo da Vinci and Thomas Edison to show how much of what, in determinist historical accounts, are strokes of genius were recapitulations of images and ideas that were quite firmly in the public domain. Referring to Thomas Edison's laboratory note-books, he also shows that many of the "original" solutions to the mechanical problems his inventions necessarily encountered — the transport of film strips or the encoding of images — can be traced directly back to popular engineering manuals that even a semi-professional inventor would have been familiar with. This generalised practice is also confirmed by much of what has been established in the story of the invention of moving-picture devices, and many of the disputes that are encountered in relation to priority can be traced to this simple oversight. Where some historians, such as Hendricks, have seen fraud and plagiarism, for example, Ferguson's conclusions suggest that claims to priority of invention are post-hoc debates which have little relevance or bearing on the day-to-day practice of technologists in the 19th century.

Ferguson argues that, as a result of this common practice in the engineering profession to recapitulate ideas in the public domain, the resolution of engineering problems, was often similar and frequently simultaneous. Simultaneous invention may not necessarily mean intellectual theft but simply that, as a matter of routine, inventors had similar methodologies and referred to the same sources (manuals and stock books etc.) and, consequently, they often developed similar solutions to the same problem. The dominance of one particular device over others was not solely decided by technical efficiency but, more often than not, by negotiation between the parties involved over whose mechanical representation most closely matched a shared mental model. Successful technologies which were then innovated
were those which matched the imagination of both the engineer and the client. Sometimes, as Wieber Bijker argues, new kinds of clients subsequently appeared who reshaped the meaning of a technology in a way the inventor did not envisage. This process was dependent on all parties sharing a similar perception of the world as it currently is, and transferring some technologically-modified version of this perception into a shared image of the future. In short, new technologies acquired different, widespread meanings as they were being adopted through heuristic processes which (at least in the 19th century) were similar to those of invention.

Moving-picture machines and the popular heuristic
Carlson and Gorman offer an account of the processes of invention that accommodates some of the archival evidence that we have from Dickson. Not only does it throw light on the local intellectual negotiations at West Orange, but it can be applied to other inventors such as the Lumières and Paul. Moreover, like Burch, Comolli and Chanan, although their emphasis is on the history of the production of a viable prototype that satisfies the basic ideological and technical ends, they also acknowledge that the processes of invention do not cease once a viable technical arrangement has been built:

While we have demonstrated how Edison constructed a mental model of the kinetoscope, we are vitally aware that he subsequently had to negotiate the meanings embodied in his mental model with the social groups who purchased kinetoscopes and watched the early motion pictures.

As we have seen in the previous chapter, once in the public domain, where Thomas Edison’s influence was weaker than at West Orange, the representation of his mental model was overwritten by other individuals and groups who used the Kinetoscope and combined it with their own ideas. (A more widespread representation of the idea of a moving-picture machine happened to be closer to Dickson’s, but neither had the last word in what the technology meant). The same dynamic process applies to other inventors in the field, including both the Lumières and Paul. The development of a mutual intelligibility for the Kinetoscope and Cinématographe (and other similar inventions) repeated the interaction of ideas and representation that the principle inventors had rehearsed at a more generalised scale in the national, (and rapidly international), arena of popular participation. The difference between these two constituencies, however, was that whereas the “inventors” used the resources of their engineering stock books, earlier inventions, and previous experience as engineers, the public by and large were restricted to the artefacts on the market – (the state of technology, so to speak).

However, just as after 1895, the films and the entertainment contexts in which they where exhibited varied widely — actualities, “senics”, “topicals”, scientific records, story and gag films shown in halls, fairgrounds, cafés, open courtyards, amusement parks etc. – in the years preceding 1895, a host of cinematograph-like machines informed this process of popular participation. Deac Rossell’s Chronology of Cinema, covering the seven years prior to 1896, shows the range and variety of representations of the mental model to make pictures move. Romance histories have singled out a handful of these for attention finally restricting
the choice to the peep-hole machine or the projection system, whereas an anonymous history of the invention of the cinema suggests that its mutual intelligibility is the product of a multitude of inventors and belongs to a broad collective consensus of interpretation. Moreover, as historians as far apart as Terry Ramsaye and Charles Musser have shown, after 1894 Dickson, and many other inventors, made contributions to the realisation of a projecting machine, using the principles behind the Kinetoscope in a cascade of other representations of mental models. In addition, many entrepreneurs and entertainers (Doublier, Paul, Hepworth, Trewey, Raff and Gammon, Francis Jenkins etc.) also used the Kinetoscope and Cinématographe to represent their own mental models — models that were driven by different imperatives and informed by different experiences. The processes of invention from mental model through an heuristic to a representation did not cease with the completion of the Kinetoscope, nor did the bricolage of components stop being re-interpreted as its exhibition became a conventional part of the showman’s repertoire. After 1895, however, with the consolidation of the rich variety of possibilities into a dominant configuration, it was the films and how they were used that became the more responsive element of cinema technology and the objects of widespread cultural and economic negotiations.

In Britain, once the Kinetoscope left the parlours and temporary displays, exhibitors were inclined to integrate moving-picture shows across a social spectrum of entertainments from the science lecture and theatre to the fairground, as well as the long-established, socially-subversive, working class entertainment of the music hall. In France, however, where the cinema was initially integrated with an egalitarian culture of heterogeneous spectatorship, it became one more aspect to a flânerie that did not distinguish between the entertainment value of the morgue and the waxwork museum.173 Showmen quickly understood the Cinématographe as an attraction in itself, not only to slake the curiosity of the bourgeoisie, but also as an addition to the café concert and live conjuring show. Even within this relatively homogeneous culture, there were significantly different interpretations. Noël Burch has suggested that the moving-picture in France was viewed by some, rather bleakly, as a machine for the re-creation of life while, for others, it was a device of poetic and metaphysical potential. Yuri Tsivian has identified a similar cultural polemic in Russia.174 These various responses to the Cinématographe show that early cinema was, for a brief period, interpreted differently both in various countries and sometimes by members of the same audience within a given community, as an expression of particular world views and cultural priorities.

American entrepreneurs and their public saw the cinema in another way — as an extension to a variety of entertainment screen practices, including vaudeville. Charles Musser’s extensive work on the history of early cinema, Before the Nickelodeon and The Emergence of Cinema: A History of Screen Practices, develops the view that the Kinetoscope, in all its various forms, was technologically continuous with the entertainment screen practices of the 19th century. These included the magic lantern, X-rays, shadow plays, Alex Black picture plays etc. that were integrated with theatrical presentation and public amusements like fairs and expositions. According to Musser, the entertainment attractions of the scientific experiments of Marey, Muybridge, Jansen et al derived economic advantage by product
differentiation, since new screen entertainment needed to be different to attract audiences. Consequently, in the United States, Musser’s focus on audiences explains, for example, why early cinema did not overwhelm its rivals but became a major feature of popular entertainment, competing with other, less realistic, screen entertainments, such as the enormously popular magic lantern song slides which endured well into the 20th century. The cinema, in this historical scenario, did not oust earlier, “cruder” entertainment forms; on the contrary it was obliged to imitate them. As Musser puts it:

Given the cultural framework in which they [early films] were shown it would be too easy for the cultural historian simply to dismiss these imitations as derivative. Vaudeville and the vitascope valorised tradition and continuity as well as change and innovation.175

America, perhaps more than Europe, was an aggressively market driven culture of popular pleasure and excitement at the close of the 19th century. The response to moving pictures there was considerably different to Europe, and only after two decades did it reach a compatible consensus with other nations to the extent that it could become a significant exporter of films.

As we have seen in the last chapter, some aspects of the cognitive processes of invention were reiterated in the preliminary diffusion of the cinema, and audiences also used the screenings and presentations to realise, albeit more passively, their own representations of mental models. In the early days of cinema, when exhibitors were often producers, audiences were able to influence the determination of the technology and its software and the many uses that were made of the technology. The cinema provided many pleasures and opportunities, not least the sense of self-empowerment that was apparently part of the attraction. These ranged from a temporary diversion and extension of the social life of the city street to an informal language laboratory, or a space for social subversion by legitimating new forms of spectatorship, including the deregulation of the female gaze.176

Moreover, exhibitions of new technologies provided an opportunity for lay people to temporarily place themselves at the centre of the technological changes that were shaping social and economic life. New inventions, undoubtedly performed certain obvious technical functions in public, such as projecting moving images, but some inventions such as the Cinématographe and the phonograph, also acted as a representation of ideas that the public had about technology — just as they did for the inventors. Consequently, although there were strong morphological similarities in the apparatus of the cinema and the camera-projector-screen ensemble, initially there were significant differences in the way it was understood by different communities.

Conclusion
The story of the invention of the cinema, as developed in previous chapters using just three principal figures and three exhibitors, provides a snapshot of what was, in reality, an enormously complex interaction of events and personnel. Navigating the wealth of data has often necessitated a reduced view of the ways in which technology and culture interact. If for nothing else, the need to reconcile historical approaches to the hardware with the
increasing sophistication of our understanding of film form and the institutions of the cinema has rendered the idealism of hard technological determinism untenable. Taking the lead from the field of cultural studies, significant revisions have been made in our understanding of why one machine ensemble rather than another finally dominated. The dangers of such approaches, however, have been recognised as replacing one top-down agency with another, with the result that empirical evidence is subject to the same selectivity and ahistoricism for which other idealisations are criticised. Moreover, reconciling these meta-discursive approaches with detailed evidence runs the risk of an intellectual inflation in which the relatively simple data is subject to more and more elaborate narrative. The alternative, which Carlson and Gorman's work proposes in respect of an individual inventor, invites us to consider the cognitive processes that shaped the final ensemble of cinema technology. Ferguson's analysis of practical engineering reiterates Carlson and Gorman's account of the process of invention, but places it at a collective level, among the professional inventors. Like them, he takes the view that invention can be understood as a cognitive process and is the product of mental models and their representation, but he further suggests that when the methodologies and orthodox practices of professional technologists are the heuristic, these influence the kinds of solutions that are developed. These social constructivist approaches to invention are not without their critics, including Bijker, but, putting these to one side, they restore to technology some of its epistemic status as a source of knowledge about the world that has been progressively appropriated by the practice of science.  

Whereas professionals had the resources of the workshop and laboratory, the non-professionals had a huge variety of devices, a range of exhibition and screen practices, and a multitude of social uses with which to represent their ideas about technology and what it might achieve. In short the equivalent resource to West Orange, or Jules Carpentier's workshop, for non-professional technologists was society itself. During the 19th century, and even before, the popular "workshop" was the community of specialists and generalists who structured the spectacle and engagement of ordinary people in the project of science and technology. The next section, therefore, will look at the determining factors — the historical context and the specific technological environment — that shaped the basis of the mental models represented by the cinematograph. In particular, it will identify the historical specificity of the determining power of the technological imaginary in shaping invention (in the public domain). To achieve this, it will examine how science and technology, as abstract concepts and cultural practices, were represented in both active participation and public spectacle in ways in which both the professional technologist and the lay public alike could share, enabling both constituencies to finally reach a stable, if temporary, consensus about the meaning of machines such as the cinematograph.