‘The Sprawl of Entropy’: Cinema, waste, and obsolescence in the 1960s and 1970s

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Cinema, waste, and obsolescence in the 1960s and 1970s

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Abstract

The following discussion broaches the relation between cinema and waste not so much by addressing examples of cinema about waste, but by presenting cinema itself as a kind of waste. Such an approach is in part prompted by current debates about the obsolescence of cinema, be this obsolescence considered in strictly material terms – i.e. the imminent end of the film-based technology from which the medium derived its traditional definition – or from the (differently material) perspective of cinema as a socio-cultural practice, a mode of producing, circulating, and consuming moving images largely for and in the cinema theatre.

Keywords: cinema, entropy, waste

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There is a widespread sense that the contemporary meteoric diffusion of digital technologies, which endows the making and watching of movies with unprecedented suppleness, is set to make waste matter of film and its cumbersome historical structures, from celluloid to the regimented viewing of a cinematic setting. But while certainly fuelled by these current

developments, I hope to show that the alignment – if not the equation – of cinema and waste is not specific or exclusive to the present moment. In fact, my focus in outlining such an alignment will intentionally be on the 1960s and early 1970s, which I want to suggest are crucial in re-considering not only preoccupations about matters of waste and of cinema as waste more generally, but also more specifically in relation to cinema's obsolescence.

Making cinema, making waste: Antonioni's *Zabriskie Point*

One of the most effective and layered allegories of the relation between cinema and waste can be found in the grand finale of Michelangelo Antonioni's *Zabriskie Point* (1970). Waste is not only present as content (what the scene is 'about'), but cinema as such comes to be presented as a wasteful form. In this respect, the explosive end of this notorious film offers an incisive instance of what Karl Schoonover recently described as Antonioni's approach to cinema 'as a medium that not only works with waste but also needs waste to work'.[2]

It may be worth recalling this striking scene. The film ends with a lush modernist mansion in the Arizona desert blown to bits by a large explosion. To start, the image is given over to smoke, debris, and blazing fire, as the blast is repeatedly shown from progressively closer angles. Subsequently, the view turns cooler and more surreal. A series of smaller detonations – of a clothes' rack, a bookcase, a television set, a refrigerator – sends the multifarious contents of these objects floating into an icy-blue background to a hallucinatory soundtrack by Pink Floyd. The camera follows Kellogg's corn flakes, packs of sliced bread, books, and T-shirts in a centrifugal, slow-motion flight across the sky. Here waste is literally made in front of our eyes, produced by the explosion which turns what looks like a perfectly inhabitable house and its contents into unusable debris and detritus.

Most commentators tend to read this scene allegorically, as a not-so-subtle image of the extreme consumerism Antonioni found in America, where even the most durable goods might quickly turn into trash, rendered obsolete by patterns of production in permanent overdrive. Indeed, 'waste' was one of four words Antonioni listed to sum up his 'impressions of America' for an Italian magazine during the shooting of *Zabriskie Point*: '[w]aste in this country, as a mental attitude, habit, and article of faith, is on a fantastically inconceivable scale that is impossible to get used to, whether it involves making a movie or the way of life among the rich.'[3]

Waste is not only what the scene represents, it is also what the scene literally entailed and produced. Antonioni insisted on blowing-up an actual-size model of a villa (fashioned on the organic style of architects such as Frank Lloyd Wright, John Lautner, and Paolo Soleri).[4] He recorded the event with 17 cameras placed at varying angles and distances from the blast, and used a special high-speed camera to obtain the slow-motion effect of the secondary explosions. Trenches were dug to protect the camera operators closest to the detonations. Though some trees were painted white for *Il deserto rosso* (Red Desert, 1964) and some grass sprayed green for *Blow-Up* (1966) to endow the chosen settings with the precise shades of colour Antonioni desired, nothing of this explosive scale had ever taken place on the set of his films.[5] Clearly, Antonioni gave in to the culture of waste he experienced in America – and dug into his MGM production budget.

> I think they must teach it at school – how to consume. And when you grow up, it gets worse, you consume much more. And since the cinema is run by grown-ups, the result is that there is a squandering of material and money such as I've never seen in Europe. *Zabriskie Point* is certainly the most costly film I've made.[6]

However, a measure of excitement must have accompanied Antonioni's declared frustration with the wastefulness of Hollywood. Referring to the explosion scene specifically, he later described it as one of his happiest filming moments, since 'the audacity of the scene was so appealing'.[7] The explosive finale of *Zabriskie Point* simultaneously embraces and critiques waste, making it a matter of cinematic representation while also alluding to the ways in which cinema may itself be a matter of waste – something that, as Schoonover says, 'needs waste to work'.

Yet what is most interesting about this scene's simultaneous staging and making of waste is not in its allegorical dimension, its function as Antonioni's commentary on America's extreme consumerism. More interesting is the extent to which Antonioni's allegory speaks historically, the way in which it frames and reveals a historical moment. The film's engagement of waste as both subject matter and means of the cinematic image makes it a kind of document of growing preoccupations about waste in the postwar decades. Not unlike other films by Antonioni, from the early short *Nettezza Urbana* (N.U., 1948) to *Il deserto rosso*, *Zabriskie Point* makes manifest the growing awareness of the environmental impact of human development in the second half of the 20th century.[8] While flying clothes and processed foods suggest waste matters in relation to a consumer society, the film's

grand mushroom-shaped blast (intentionally obtained by adding petrol to the explosive mix) also obviously connects waste to the nuclear test explosions routinely carried out in the American desert at the height of the Cold War, connoting waste in terms of toxicity and contamination as well as spectacular excess.[9] The film's finale crystallises in one image the interconnected military, technological, and consumerist developments of the postwar decades, but also the apocalyptic anxieties to which such developments contributed when considered more critically or through a less optimistic lens.

As key texts of postwar environmentalism such as Rachel Carson's *Silent Spring* (1962), Paul Ehrlich's *The Population Bomb* (1968), and Barry Commoner's *The Closing Circle* (1971) begin to indicate, the demographic and consumerist booms of the 1950s and 1960s fed concerns about the depletion, contamination, destruction, and end of the world at least as much as nuclear weapons did. It is precisely by bringing into relief the centrality of waste to these economic and military developments that the film's grand ending of devastation taps into and displays the period's apocalyptic mood. Waste – if not a wasted or spent landscape – is what both consumerism and nuclear programmes may leave behind.

Entropy

Using a term which – though originating in the 19th century – had returned very much in fashion by the 1970s, we could say that entropy is the apocalypse of *Zabriskie Point*.[10] In its original thermodynamic definition in the mid-19th century (the word and concept had been coined in 1865 by Rudolf Clausius), entropy signalled waste. In apparent contradiction to the first law's principle of the conservation of energy, the second law of thermodynamics postulated its dissipation: in a closed system, when energy (in the form of heat) is turned into work, there is always some that escapes conversion and degrades into unusable waste, something that cannot be converted back into energy. Entropy, then, is the measure of such degradation and waste, which in a closed system (and the universe as a whole, too, is considered to be such a system) tends naturally to increase. It is indeed because this wasted energy – or energy turned into waste – cannot be recuperated that entropy is also described as an 'arrow of time', an indicator of temporal irreversibility.[11] In this sense, the kind of end suggested by the explosion – an end which is rhetorically placed at the end of the film itself – is entropic: at a literal if not also a metaphorical level, it figures the

irrecoverable breaking down of a system, be this the exploded house or consumer capitalism itself.

As the measure of the degradation of the energy of a system in thermodynamics – and an indicator of dis-organisation, dissipation, and ruination in lay applications of the term as the concept percolated into culture more widely – entropy was certainly congenial to the apocalyptic feelings fostered in the second half of the 20th century by the development of nuclear weapons and ecological concerns.[12] Initially revamped in the nascent fields of information theory and cybernetics in the 1940s and 1950s, entropy had again become a cultural buzzword by the time Antonioni set out to make his film. Obvious manifestations of what, in 1968, the art critics Lucy Lippard and John Chandler described as the 'current international obsession with entropy' are offered by the fiction of authors such as J.G. Ballard, Italo Calvino, Thomas Pynchon (one of whose early short stories is simply titled 'Entropy' [1960]), film and art theorist Rudolf Arnheim's book-length essay *Entropy and Art* (1971), a number of 'structural' experimental films including George Landow's *Film in Which There Appear Edge Lettering, Sprocket Holes, Dirt Particles, Etc.* (1965/66), and the art and writings of the American conceptual and land artist Robert Smithson.[13] In fact, though the novel disciplines dedicated to the study of information were largely based on the notion that the amount of entropy of a communication system could somehow be kept in check, even an enthusiast of entropy management such as Robert Wiener, the father of cybernetics, seemed to accept the irreversible increase of physics' entropy at a planetary and universal level – which, as he himself put it, acted as a 'compelling' and 'persuasive' 'memento mori' communicating to us 'the very true sense in which we are shipwrecked passengers on a doomed planet'.[14]

While bearing in mind the broader apocalyptic significance of the term (the sense of it being, as Smithson put it, an 'evolution in reverse'[15]), I want to focus on the ways in which entropy crucially inflected a more local reflection on cinema as waste – a sense that, besides being a wasteful form and a form relying on waste, cinema may itself be or become waste. To do so, we indeed turn to Smithson, for not only is the articulation of entropy found in his essays from the 1960s exemplary for extensiveness and eloquence but, also, cinema specifically is used to explain or even to prove entropy in more than one way.

Cinema as waste: Robert Smithson and entropy

The American artist Robert Smithson, most famous for his seminal earthwork *Spiral Jetty* (1970), a monumental coil of earth and boulders jutting into the Great Salt Lake in Utah, was very fascinated by entropy in the 1960s. As a work exposed to, rather than protected from, the erosive action of its environment, *Spiral Jetty* itself was intended as a manifestation of entropy in its own way, and the concept recurs in his writings. In 1967, in what was to become one of his better-known essays ('A Tour of the Monuments of Passaic, New Jersey'), Smithson set out to provide an elaborate double 'proof' of the concept. This appears in the essay's concluding paragraphs, where he writes:

> I should now like to prove the irreversibility of eternity by using a jejune experiment for proving entropy. Picture in your mind's eye [a] sand box divided in half with black sand on one side and white sand on the other. We take a child and have him run hundreds of times clockwise in the box until the sand gets mixed and begins to turn grey; after that we have him run anti-clockwise, but the result will not be a restoration of the original division but a greater degree of greyness and an increase of entropy.[16]

This initial proof of entropy draws on the statistical re-conceptualisation of the idea (developed as early as the 1870s by James Clerk Maxwell and Ludwig Boltzmann, among others, in the context of thermodynamics), which became increasingly current as entropy was revamped for the information age. In its statistical interpretation, the waste and degradation marked by entropy are described in terms of the 'disorder' of a system – where disorder, in turn, is understood as the more likely development of a system over time than order. In thermodynamic terms, as visualised by Maxwell via a prosopopeia of a naughty demon, this would mean that in a condition of maximum entropy high-energy molecules (molecules possessing heat) and low-energy molecules (colder molecules) have thoroughly mixed within a system, thus reducing the system's overall usable energy and ability to perform work – or, more simply, to work tout court.[17] Counter-intuitively then, in this context the disorder of a system is greater when its degree of (thermal) uniformity is higher. Smithson's mixed-up sandbox endeavours to visualise entropy as the degree of disorder of a system (where disorder may further signal degradation, un-usability, reduction to waste) and increased disorder as the more likely development of a system over time. Just as in the statistical definition in a thermodynamic context the higher disorder – the greater entropy – of a system is, somewhat paradoxically, manifested by

increasing thermal uniformity, so in Smithson's proof it is the increasing evenness of the colour of the sand, its turning into overall greyness, that indicates a state of increased chaos, of augmented entropy. Furthermore, this is a situation which – as he suggests by evoking the option of asking the child to run anti-clockwise to restore the initial separation between the two differently-coloured sands – is irreversible.

What is particularly interesting in the context of our discussion is precisely Smithson's association between entropy as an index of waste and cinema as a form subject to degradation. Cinema becomes waste in Smithson's explanation. This is developed in the very last paragraph of the essay. Having proved entropy with this simple yet effective example, Smithson then concludes his essay with the following passage:

> [o]f course, if we filmed such an experiment we could prove the reversibility of eternity by showing the film backwards, but then sooner or later the film itself would crumble or get lost and enter the state of irreversibility. Somehow this suggests that the cinema offers an illusive or temporary escape from physical dissolution. The false immortality of the film gives the viewer an illusion of control over eternity – but the 'superstars' are fading.[18]

Starting off with a volte-face seemingly aimed at negating his very proof, Smithson, in fact, quickly doubles it – rhetorically using his counter-example to prove entropy once more. Smithson's recourse to cinema is part of a tradition of explaining the concept via this medium, as the film historian Mary Ann Doane has noted.[19] Yet, Smithson uses cinema quite differently here. While most proofs of entropy which rely on the moving image draw on the medium's representational properties – its specific ability to depict a process as it unfolds in time – Smithson is instead focusing on the materials of the medium as such. His proof is not based on cinema's representational attributes (its capacity to show us a glass of water being spilled, for instance) but on its physical apparatus. In Smithson's explanation, cinema is not a neutral illustrative tool whose moving images can show us entropy as if from the outside, but is itself a system subject to entropy. In marked contrast with an established tradition of seeing cinema as a medium of preservation, permanence, and repetition, Smithson lays emphasis on opposed traits. Cinema is presented as an impermanent medium, subject to 'crumbl[ing]' and 'physical dissolution', whose ability to preserve images – or 'superstars' – is but 'illusive' or 'temporary'. Cinema may enable preservation and repetition, yet each repetition wears it down, eventually reducing it to waste. Where the French film critic André Bazin had described cinema in

the 1940s as 'change mummified' and that which allowed 'the exorbitant privilege of repeating' – and therefore somewhat countering – what is 'essentially irreversible' (i.e. 'lived time'), Smithson stresses cinema's own material enchainment to irreversibility.[20]

So this, then, is the first way in which Smithson's entropic thinking links – indeed, equates – cinema to waste. In his explanation, cinema functions as a demonstration of entropy precisely because, as a material and at the physical level, the medium is exposed to degradation: it is set to become unusable, irredeemable waste. What makes cinema particularly interesting for Smithson's purpose of buttressing his initial proof of entropy is precisely the fact that technologies such as photography and cinema would primarily be associated with ideas of durability and the possibility of infinite repetition and endless reproduction. For Bazin, photography 'preserve[d] the object' as if 'in amber', and cinema added the bonus of 'duration' to such preservation, so that the change and movement of a real-life event could also be captured and re-visited again and again. While for Walter Benjamin, in a different modulation of this conviction, these media enabled the repetition of their representations across time and space and did away with the qualitative – and even with the ontological – differences between 'original' and 'copy' that had existed with manual processes of reproduction.[21]

Today, the fragility and limitations of photography and cinema vis à vis reproduction are very much on our mind, as they are often pitted against the putative indestructibility and incorruptibility of the digital image. This was not so in the 1960s – though Smithson's entropic reflections may be symptomatic of a developing awareness of these media instabilities. The famous texts by Bazin and Benjamin from which I quoted above, 'The Ontology of the Photographic Image' (1945) and 'The Work of Art in the Age of Mechanical Reproduction' (1936), were only just appearing in English translation in the 1960s (Bazin in 1960, Benjamin in 1968) – and, to a significant extent, their ideas articulated and resonated with more widely-circulated views about these media. The capture and preservation of significant moments in a life-like fashion and unfading colours would be recurrent tropes in adverts for family still and movie cameras. One 1950 Kodak advert, for instance, read '[y]ears from now, they'll still look the same, in their vacation pictures' over an image of young children around a campfire. Ten years later, in a campaign from 1961, the tone was pretty much unchanged:

> [r]emember how cute the children were … what you all wore … the places you went … people you saw? … You'd need a photographic memory to recall all the happiness in a family holiday.

The very insistence on pristine preservation and unfading colours which one finds in advertisements for these products seems to address a widespread awareness that such attributes may actually often be found wanting – an anxiety about the permanence of the photographic image. In this context, Smithson's paradigmatic entropic reading of cinema stands out, but also taps into an emerging sensibility which was beginning to notice – and to attract attention to – the medium's susceptibility to degradation and corruption: in short, its propensity to become waste.

When in 1967 Smithson used cinema as his counter-proof of entropy, there was no short supply of contemporary avant-garde works demonstrating and playing out the crumbling of film. In 1964, with perhaps the most minimal set-up possible, Nam June Paik had highlighted the inevitability and irreversibility of film's deterioration and decay with his *Zen for Film*. Consisting of a loop of plain, unexposed film leader destined to be projected again and again and allowed to collect dust and scratches until, eventually, it would become unusable, *Zen for Film* used repetition somewhat counter-intuitively as the very means for disclosing irreversibility, producing a film whose images are the very record of its gradual disintegration. As Paolo Cherchi Usai was to argue several decades later in his book *The Death of Cinema* (2001), the very projection of film (what literally made cinema in the pre-digital era) causes it to deteriorate and eventually turns it into waste. In a similar vein, Landow (a.k.a. Owen Land) made the crumbling of film one of the principal subject matters of works such as *Film in Which There Appear Edge Lettering, Sprocket Holes, Dirt Particles, Etc.* and *Bardo Follies* (1967). Initially shown on a continuous loop, *Film in Which…*, as the title itself announces, made the dirt particles accumulating on its surface in this process an integral feature of the work itself, while *Bardo Follies* took this further by depicting the projection of footage overheating and burning inside a projector, thus presenting the viewer with images of melting celluloid.

Experience or awareness of these films is likely to have inspired Smithson's ultimate proof of entropy via cinema in 'A Tour of the Monuments of Passaic'. Smithson himself adumbrated as much in a later essay, 'A Cinematic Atopia' (1971), where he wrote: '[a]fter the "structural film" there is the sprawl of entropy'.[22] Drawing on the term 'structural', which the influential avant-garde film critic P. Adams Sitney had coined in his eponymous article

of 1969, to classify what he saw as a newly-emerging range of experimental films (including, indeed, Landow's) reflexively concerned with returning the medium to its stripped-down essentials, Smithson nevertheless seems to understand them somewhat differently than Sitney.[23] These films may well aspire to make their simplified and clear shape their very content, as Sitney puts it, yet what they seem to yield, according to Smithson, is a certain shapelessness – 'the sprawl of entropy', which attacks, deforms, and dissolves their very shape and structure.[24]

In fact, in 'A Cinematic Atopia', Smithson's conviction about the inevitable 'sprawl of entropy' also introduces a second, different association between cinema and waste. The alignment of cinema and waste is also articulated as a mental rather than physical matter. Cinema is entropically summoned as so much mental detritus:

> [d]oes it matter what film one is watching? Perhaps. One thing all films have in common is the power to take perception elsewhere. As I write this, I'm trying to remember a film I liked, or even one I didn't like. My memory becomes a wilderness of elsewheres. How, in such a condition, can I write about film? I don't know. I could know. But I would rather not know. Instead, I will allow the elsewheres to reconstruct themselves as a tangled mass. Somewhere at the bottom of my memory are the sunken remains of all the films I have ever seen, good and bad they swarm together forming cinematic mirages, stagnant pools of images that cancel each other out. A notion of the abstractness of films crosses my mind, only to be swallowed up in a morass of Hollywood garbage.[25]

'A Cinematic Atopia' offers a concentrated sense of Smithson's avid and eclectic cinema-going, which, as can also be surmised from other essays and the numerous film volumes in his library, included sci-fi movies as well as European art cinema and experimental film.[26] However, rather than seeking to profile a cinephilic distinction between auteurs, genres, and individual films, Smithson is striving to present the memory of cinema as a 'tangled mass', as 'stagnant pools of images that cancel each other out'.

If cinema is understood as a form set to become waste at the material level in 'A Tour of the Monuments of Passaic', in 'A Cinematic Atopia', it is outlined as a type of immaterial waste. Though freed from its perishable physical support, cinema still ends up as waste in the mind of the viewer (here, Smithson himself), where its rapidly-consumed images accumulate as 'sunken remains … somewhere at the bottom of … memory'. This description of cinema in terms of mental entropy, as something susceptible to becoming waste in the mind, points again (though from a different angle)

to the ephemerality and impermanence of the medium: as entertainment, cinema may indeed fall into obsolescence as soon as it is consumed.[27] The obsolescence called into play could perhaps be described as 'experiential'. Smithson is evoking cinema's disposability after consumption as a mass medium; the way in which – even with the most cinephilic or critically-oriented of viewers, and despite their best intentions to preserve them intact and pristine in the mind – many of its images are liable to become a kind of waste, a 'limbo' of 'rejected film clips', or, as he writes towards the end of the essay, a 'vast mud field'. [28]

To conclude, I briefly turn to the other sense of cinematic obsolescence that, as suggested, was beginning to find articulation in the 1960s: the sense of the medium's technological obsolescence. While Smithson points to this question in 'A Cinematic Atopia' – imagining the possibility of 'cinema expanding into a deafening pale abstraction controlled by computers' – we will do so here by considering the writing of another American artist, the photographer and filmmaker Hollis Frampton.[29]

Cinema and obsolescence: Hollis Frampton

If to a lesser degree than his contemporary Smithson, Frampton also thought entropically. Like Smithson, who described entropy as 'evolution in reverse', for Frampton entropy was a concept that maintained process while doing away with progress. As he told Simon Field during an interview in London in 1972:

> art doesn't progress, of course; we don't progress either, we are just subject to more and more entropy, right? That's the gist of the dust to dust business.[30]

In less overt ways, it is this understanding of entropy as 'the gist of the dust to dust business' that informs Frampton's reflections on the obsolescence of cinema in the course of the 1970s.

In one of his best-known essays, 'For a Metahistory of Film: Commonplace Notes and Hypothesis', Frampton identified cinema as an obsolescent medium:

> I was born during the Age of Machines. … We believed it would go on forever, but when I was a little boy, the Age of Machines ended. … Cinema is the Last Machine. … It is customary to mark the end of the Age of Machines at the advent of video. The point in time is imprecise: I prefer radar, which

> replaced the mechanical reconnaissance aircraft with a static, anonymous black box. Its introduction coincides quite closely with the making of Maya Deren's *Meshes of the Afternoon*, and Williard Maas's *Geography of the Body* [both 1943]. The notion that there was some exact instant at which the tables turned, and cinema passed into obsolescence and thereby into art, is an appealing fiction that implies a special task for the metahistorian of cinema.[31]

Though writing at a time of excitement about video and computer devices – which, if via institutional rather than personal ownership initially, had started to become more widely available after the mid-1960s – Frampton is dating cinema's passage into obsolescence back to the 1940s and the diffusion of radar. In important respects, the technological principles he calls upon are cognate and stem from the development of electronics and the conviction that electronic circuits (analogue, then digital) mark a shift away, as Frampton underlines, from machines 'made up of distinguishable "parts"', whose working and 'physical principles' are 'readily apparent' or 'intuitively verifiable' from 'inspection' of such parts.[32] Certainly, Frampton's appeal to the 'black box' of radar works to bring into relief a line of continuity between that device and the opacity (or closed-box effect) of the devices spawned by our current digital era, whose workings, because of their microscopic scale, are unavailable to human sight and not readily verifiable by intuition. Ours is no doubt an era in which film-based cinema's obsolete status is now widely accepted as a matter of fact; but what is worth outlining in Frampton's identification of the 1940s as the point of cinema's entry into obsolescence is the extent to which it shows that such entry is precisely not instantaneous but durational. Though the idea of an 'exact instant', as Frampton suggests, is 'an appealing fiction', cinema's obsolescence is more like a slow fall or a lengthy entropic process that started at the mid-point of the 20th century.

In fact, Frampton articulated a prediction of the length of such a fall in a lecture titled 'The Invention Without a Future' that he delivered at the Whitney Museum of American Art in 1979 – the same year he made *Gloria!*, a film in which early cinema footage is paired with a pioneering use of computer-generated text.[33] In this lecture, Frampton estimates that 'our film process … will be all washed up in thirty years':

> what has happened is that what was once seen as a copious popular art is very rapidly becoming paradoxically fragile, rare, bounded in time … like the exercises of speech and sexuality, film and its allied arts of illusion are … painfully fugitive.[34]

It is interesting that such a prediction, made at a time when Frampton himself was actively experimenting with the emerging digital technologies that would hasten the demise of film, brings the end of cinema's fall into obsolescence right up to our fully established digital present. Even more interesting, perhaps, is Frampton's paradoxical intimation in the very title of his lecture, which borrows Louis Lumière's famous dictum that the cinematograph is 'an invention without a future', that cinema's slow fall into obsolescence and waste might have started at the medium's very birth.

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Notes

1. See among others: Rodowick 2007; Mulvey 2006; Cherchi Usai 2001; Balsom 2009; Nardelli 2009; Casetti 2009, 2011.
2. Schoonover 2011, p. 240.
3. Antonioni 2007 (orig. in 1969), p. 92. The other words were 'innocence', 'vastness', and 'poverty'.
4. See Schoonover & Rhodes 2011.
5. For detailed information about the blast see Lai 2001 and *Bianco e Nero* 1970.
6. Antonioni 2007 (orig. in 1970), p. 102.
7. Ibid., p. 216.
8. For a recent overview see Buell 2010, for historical testimonies of this raising awareness see Pursell 1973.
9. See Karl Schoonover's essay in this special section for a discussion of waste in terms of toxicity.
10. For a full historical overview of the concept of entropy, see Clarke & Dalrymple 2002, esp. Clarke 2002, pp. 17-33. Dimendberg 1998 characterises the finale of *Zabriskie Point* in terms of entropy, though entropy itself is only impressionistically evoked.
11. For definitions of entropy and its valence as 'time's arrow' see Morris 1985.
12. For a discussion of apocalyptic concerns in the nuclear era see Wójcik 1997, pp. 97-132.
13. Lippard & Chandler 1999 (orig. in 1968), p. 48.
14. See Wiener 1954, p. 26, 134.
15. Smithson 1997 (orig. in 1966), p. 15.
16. Smithson 1997 (orig. in 1967), p. 74.
17. Clarke 2002, pp. 23-24. For a fascinating discussion of the parallel emergence of thermodynamic entropy, statistics, and cinema in the late 19th century – and the place of contingency within each – see Doane 2002, pp. 108-139.
18. Smithson 1997 (orig. in 1967), p. 74.
19. See Doane 2002, pp. 117-119.
20. Bazin 1967 (orig. in 1945), p. 15; Bazin 2003 (orig. in 1949), p. 30.
21. Bazin 1967 (orig. in 1945), p. 14; Benjamin 1999 (orig. in 1936), pp. 214-217.

22. Smithson 1996 (orig. in 1971), p. 139.
23. Sitney 2000 (orig. in 1969).
24. Ibid., p. 327.
25. Smithson 1996 (orig. in 1971), p. 138.
26. For the complete list of Smithson's library see Reynolds, pp. 297-345.
27. Hastie 2007 touches on cinema's ephemerality and its material residue or detritus (e.g. cinema tickets, etc.).
28. Smithson 1996 (orig. in 1971), p. 139, 142.
29. Ibid., p. 139.
30. Field 1972, p. 71.
31. Frampton 2009 (orig. in 1971), pp. 135-136. Frampton's essay was originally published, along with Smithson's, in *Artforum* vol. 10, no. 1 (September 1971).
32. Ibid., p. 135.
33. For an illuminating discussion of the formal and technological strategies in *Gloria!* see Lunenfeld 2000, pp. 116-134.
34. Frampton 2009 (orig. in 1979), p. 178.

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