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Editorial introduction

The History of Technology as Experiment and Tragedy

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Abstract
This editorial proposes a conceptual clarification of what it may mean to speak of tragedy in relation to the history of technology. Rather than treating the tragic as a loosely evaluative label for catastrophic events, it reconstructs tragedy as a structured constellation centered on rational action under conditions of epistemic limitation. Against this background, the editorial contrasts two influential interpretive frames for understanding technological change: the experimental and the tragic. The experimental frame, prominent in twentieth-century risk analysis and technology assessment, interprets the history of technology as a learning process that generates knowledge through feedback from real-world experience and promises prospective intervention and control. The tragic frame, by contrast, foregrounds irreversibility, responsibility, and the loss of prospective agency, thereby questioning the assumption that historical experience functions as a reliable epistemic resource. The editorial argues that neither frame is sufficient on its own. While the experimental perspective risks cynicism toward victims and blindness to irreversible loss, the tragic perspective, taken in isolation, tends toward fatalism and political paralysis. The central claim is therefore not one of replacement but of complementarity.

Keywords: Technology; History of Technology; Tragedy; Social Experiments; Collingridge-Dilemma

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[1] If one of the editors of this special issue needs to remain anonymous, this is due to sanction frameworks in this time of fractured geopolitics. Academics and academic institutions are faced with the challenge to position themselves in regard to present conflicts and the prospects for peaceful cooperation in the future. In this case, it was the policy of an institution that prompted the under-cover involvement of Anonymous

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Редакторская заметка

История технологии как эксперимент и трагедия

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Аннотация
Данная редакторская статья предлагает концептуальное прояснение того, что может означать понятие трагедии применительно к истории технологий. Вместо того чтобы рассматривать трагическое как расплывчатый оценочный ярлык для катастрофических событий, в статье трагедия реконструируется как структурированная констелляция, сосредоточенная вокруг рационального действия в условиях когнитивной ограниченности. На этом фоне противопоставляются две влиятельные интерпретационные оптики для понимания технологических изменений: экспериментальная и трагическая. Экспериментальная оптика, заметная в риск-анализе и оценке технологий XX века, интерпретирует историю технологий как процесс обучения, который генерирует знание через обратную связь от практического опыта и сулит возможность перспективного вмешательства и контроля. Трагическая оптика, напротив, выдвигает на первый план необратимость, ответственность и утрату перспективной агентности, тем самым ставя под сомнение предположение, что исторический опыт функционирует как надёжный эпистемический ресурс. В статье утверждается, что ни одна из этих оптик не является самодостаточной. В то время как экспериментальная перспектива рискует скатиться к цинизму в отношении жертв и слепоте к необратимым потерям, трагическая перспектива, взятая изолированно, тяготеет к фатализму и политическому параличу. Таким образом, центральный тезис состоит не в замещении одной оптики другой, а в их взаимодополняемости.

Ключевые слова: Технология; История технологии; Трагедия; Социальные эксперименты; дилемма Коллинриджа

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[2] Если один из редакторов данного специального выпуска вынужден сохранять анонимность, причина этого кроется в действующих санкционных режимах в эпоху геополитической раздробленности. Перед академическим сообществом и научными учреждениями стоит сложная задача определить свою позицию в отношении текущих конфликтов и перспектив будущего мирного сотрудничества. В данном конкретном случае именно политика одного из учреждений обусловила скрытое участие Анонимного автора.

Linking the concepts of *technology* and *tragedy* is, at first sight, far from obvious. Tragedy is an aesthetic category rooted in antiquity; technology is commonly taken to be a signature of modernity. Where the two are nevertheless brought together, this often happens in the mode of polemics: technology is portrayed as a hubristic enterprise that must, by its very nature, end in catastrophe. But does the tragic really lend itself to a serious analysis of technology? What does it mean, in the first place, to call something "tragic"?

At a closer look, the tragic is not a simple, intrinsic, or irreducible quality, as it may seem when we describe an event as "tragic." Rather, it refers to a complex constellation defined by at least two constitutive elements. First, the object of the tragic is not an event but an action – specifically, an action that is rational, coherent, and responsible. Second, speaking of the tragic presupposes a spectator. The tragic is, indeed, always also an aesthetic category. This introduces a distance between the acting subject and the observer, a distance that crucially involves an epistemic asymmetry. From within the actor's horizon, the decisions made are rational and well-grounded; from the observer's broader perspective, however, it can already be seen that these very decisions will, by inner necessity, lead to ruin. In the extreme case of Oedipus, the agent seeks the guilty party without grasping that he himself is guilty – precisely because he acts responsibly and rationally (Ghirardello & Isetti 2023).

Historically speaking, the tragic is an ancient category and, as Kierkegaard suggested, an intrinsically premodern one. The epistemic limitation that is constitutive of the tragic is, according to him, closely tied to a premodern conception of agency. Actors are not understood as fully free individuals who hold their fate in their own hands, but as embedded in what Kierkegaard (1843/1944) called the "substantial categories" of state, family, and destiny. As he famously wrote: "Our age has lost all the substantial categories of family, state, and race. It must leave the individual entirely to himself, so that in a stricter sense he becomes his own creator; his guilt is consequently sin, his pain remorse; but this nullifies the tragic" (p. 35). Once this happens, aesthetic guilt loses its "gentleness" and collapses into ethical guilt.

By contrast, technology is commonly taken to be a hallmark of modernity and therefore seems, as expected, ill suited to tragedy. When the terms "technology" and "tragedy" are brought together, this typically reflects residual premodern assumptions, most notably the accusation of hubris, according to which technology is portrayed as an enterprise that must, by necessity, end in catastrophe. Yet it is far from clear how such an accusation is to be understood within a secular worldview – one that no longer operates with the idea of a god whose omnipotence could be challenged. Why, then, should we not at least attempt to extend our technological capacity to shape the world? Planetary boundaries are real, but they are not transcendent.

And yet, the category of the tragic may help us think about the role of technology in the modern world beyond these tensions, which may turn out to be merely superficial. There is, after all, a basic categorical fit between them. Technology is embodied practical rationality – instrumental reason made operative. We are therefore dealing with human action, not with events. In the tragic, the rationality of action is not suspended but presupposed. Moreover, technology realizes in a distinctly modern way the very

epistemic limitation required by the tragic. Technological action takes place in a space between complete knowledge and its complete absence, between total control and its total lack (Coeckelbergh, 2010). In this sense, technology operates under conditions of guilt without blame, as demanded by tragedy. A difficulty arises, however, from the fact that this category implicitly presupposes a collective, all-embracing subject – society – hereby rendering problematic the distinction between observer and observed, audience and protagonist.

In order to locate a possible place for the tragic within the analysis and assessment of technology, we contrast this perspective with another one that gained prominence in the twentieth century. In his 1969 *Science* article "Social Benefit and Technological Risk: What Is Our Society Willing to Pay for Safety?" Chauncey Starr argued that the history of technology can be read as a historical experiment in which a society's implicit preferences become visible as the operative standards of a social cost–benefit analysis of technological innovation (Starr, 1969). Put simply, societies introduce technologies – such as motorized transport or nuclear energy – and over time it becomes apparent whether they are willing to bear the risks associated with them.

Starr's account presupposes a learning process that operates as an effective feedback loop within society. In the end, the distinction between actor and observer collapses into a process of collective self-knowledge. This is why his approach can appear somewhat naïve. Is actual history really a learning process or epistemic site? Does and can one genuinely intervene in technological development and innovation dynamics on the basis of the insights gained from history?

Starr's reading of the historical process is also one-sided. Once a technology is deployed, its factual risks become visible and are recorded in national accident statistics. But what about its benefits? Here, Starr falls back on a naïvely individualistic framework when he measures benefit in terms of individual acquisition costs or contributions to income. This already raises problems, as the widespread adoption of a technology and its infrastructural effects can place individuals under structural pressure to adopt it as well – as is evident in the case of automobiles or smartphones. From a more distanced perspective, one may therefore ask whether we truly benefit from technological progress at all.

Against this background, the tragic perspective may promise a way out of these "naïve" presuppositions. It opens up a space for more fundamental questions and objections, such as the one identified by Rolf Peter Sieferle (1984) as the central critique of all narratives of progress: since needs are continually reshaped and expanded by the evolving means of their satisfaction, technological progress fails, in principle, to translate into an increase in subjective well-being – and this even irrespective of rising ecological costs. From a tragic perspective, the history of technology unfolds before our eyes as a process of fateful necessity, even as we already sense that it is heading toward catastrophe.

The tragic operates without the burden of an effective epistemic feedback loop. But it pays a price for this. It must dismiss as illusory any claim to political steering or control. "Tragedy" and "experiment" thus name two contrasting interpretive frames. An experiment is not a tragedy and excludes this narrative frame, insofar as it understands

history as a productive learning process – one from which we can, first, derive epistemic gains and, second, intervene prospectively, deliberatively, and correctively on the basis of these insights. Tragedy reads history differently. From its perspective, the experimental interpretation is cynical toward victims, blind to irreversible damage, and naïve in its technocratic optimism.

The two frames also diverge in their understanding of time. The experimental perspective conceives of history as iterative, adaptive, and open-ended. The tragic perspective, by contrast, understands time as directed, irreversible, and fateful. Insight does not arise prospectively and correctively, but retrospectively – always too late. Indeed, insight emerges only after the reversal; it is itself part of the catastrophe and constitutes its tragic character. Applied to technology, this means that we do not recognize risks before catastrophe, but through it – and that such recognition can no longer correct what has already occurred. We may learn, but only *post festum*, under conditions that are not repeatable and at the cost of damage that cannot be compensated – thus pushing the Collingridge (1980) dilemma to its extreme, where learning and progress are only possible at the price of irreversible loss. The genie cannot be put back into the bottle once the bottle itself has been shattered.

In this case, tragedy would be anti-experimental. It is not an experiment but opposed to it. It dispenses with the assumptions that underwrite the experimental frame and instead permits us to acknowledge and articulate responsibility, inevitability, and moral overload. At the same time, however, it cannot offer guidance for action. Where the experimental perspective appears cynical, blind, and naïve from a tragic point of view, the tragic perspective itself risks becoming fatalistic, politically disabling, and normatively blocking. It confines us to the position of spectators, from which we may at best hope for an individual and perhaps even elitist form of catharsis.

Both perspectives – the experimental and the tragic – come with their own difficulties and blind spots. We do not propose to replace the experimental frame with the tragic one. What seems crucial to us, rather, is the observation that the two are complementary: while each has characteristic limitations, each also illuminates and partly compensates for the blind spots of the other. Tragedy confronts us with irreversible developments that are real and cannot be undone. At the same time, the narrative framework of the experiment continues to sustain the hope that it may still be possible to overcome the fatal flaw implied by tragedy – and perhaps even our own hubris. Each new technology might offer an opportunity: to break with the capitalist logic that often drives innovation against social interests; to escape the dual-use dilemma by deciding against the weaponization of emerging technologies; or to invest in environmentally sustainable technologies on a scale comparable to current investments in artificial intelligence, in order to mitigate climate change and secure the conditions of human existence on this planet. The question of tragedy and technology thus ultimately becomes the question of whether humankind is capable of acting against its own fatal flaws and of transforming itself – or whether it is condemned to assume the role of the tragic hero or heroine, whose "deficiency in character or awareness prevents them from reaching the goal" (Booker, 2005, p. 330), leaving us only to witness the unfolding of an inevitable tragic destiny.

For these reasons, it appears worthwhile to supplement interpretations of technological history framed as experiment with a tragic perspective and to hold both in a provisional balance. The present special issue therefore invites contributors to reassess the suitability of the tragic as a category for the analysis and assessment of technology.

Setting the stage, Jan Grossarth and Armin Grunwald differentiate the ways people ordinarily associate technology and tragedy (Grossarth and Grunwald, 2025). Suggesting that the awareness of the tragic dimension may be on the increase over the course of technological development, they consider the many facets of the tragic in the history of human flight, starting with Daedalus and Icarus – again and again, hubristic visions and the phantasma of technical control are frustrated by reality.

Tiago Mesquita Carvalho (2025) considers the dialectic of technical controllability and tragic inevitability from quite another angle. To the extent that technology is committed to finding solutions and repairing problems, it lacks a sense of the tragic. According to philosophers of technology like Günther Anders our situation might be characterized as tragic since we find ourselves incapable to fathom even our own destructive powers – but with a technological mindset we lack the awareness even of this deeply disturbing discrepancy.

In their essay Anastasia Lisenkova, Victor Kukel, and Svetlana Ulianova mobilize "the tragic" to help us become aware of a new kind of disproportionality in the digital world, namely the gap between algorithmic procedures and lived experience (Lisenkova et al., 2025). Sercan Sever argues similarly but focuses instead on the gap between our hopes for resonance and their disappointment (Sever, 2025). Discussing three case-studies from Japan, he speaks of a tragic miscalculation when we confidently expect that technical flaws will produce greater resonance in human-world relations – instead, they lead to a deterioration which leads us to look for „non-technology" as an alternative.

Turning the question on its head, Alexander Markov and Anna Sosnovskaya do not buy into the separation between ancient conceptions of the tragic and the technologies of the modern world. Instead, they reconceptualize tragedy and consider it an existential mechanism. As the human will runs up against and becomes entangled with the recalcitrance of people and things, tragedy dramatically reenacts this conflict, representing it as the clash of human agency and some super-human system which may carry the name of destiny or fate (Markov and Sosnovskaya, 2025). But once representation comes into view, the question arises why we should privilege tragedy as the lens through which to view struggles of and against the will. Maria Jose Rios (2025) therefore seeks to show that there are numerous non-Western framings for stories about technological disruption.

This inter- or transcultural dialogue features centrally also in Irina Berezovskaya's contribution. Following her argument, one might say that the tragic spirit rebels against instrumental rationality or technocratic thinking. But the rebellion against alienated reason in a technologically fashioned world takes very different forms – it becomes communicative rationality and a defence of public reason in liberal democracies, whereas Martin Buber counters the tragedy of technorationality by an attempt to humanize technology even by way of a radical religiosity. The Russian cosmist Nikolai Fedorov,

finally, seeks to escape technical reason by transforming it into a universal project for the salvation, even resurrection of the soul (Berezovskaya, 2025).

In the midst of this multiplicity of narratives – all of which arising in response to a possibly tragic human condition – Yervand Margaryan (2025) turns to a very old and very powerful myth, namely an early medieval story about the Armenian people. He uncovers in this myth the dramatic technology that resides within narratives. This is not to claim that tragedy represents tragic social mechanisms, but rather, that narratives evoke the theater and its dramatic machinery: the birth of tragedy is in the technology of the theater. And this rounds off our discussion of technology and tragedy – even as it calls for another special issue on the relentless execution of theatrical machinery.

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