BOOK OF ABSTRACTS

THE VALUE OF SCIENTIFIC REPRESENTATION CLASSIC ISSUES AND CONTEMPORARY CHALLENGES

MARY B. HESSE'S "NEW EPISTEMOLOGY" PRINCIPLES AND LEGACY

KEYNOTE SPEAKERS

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SESSION 1

Quentin Ruyant (Universidad Complutense de Madrid)

Values and Levels of Abstraction in Scientific Representation

According to the value free ideal, scientists should ideally refrain from making value judgements when it comes to accepting or rejecting hypotheses. This idea is often motivated by the view that absolute truth is the ultimate aim of science. Critics can contend that modelling activities are directed towards various aims, implying taking into account local values when evaluating the adequacy of scientific models.

I will sketch a compromise between these views on the basis of a hierarchical account of scientific representation. I will argue that modelling activities take place within epistemic contexts directed towards particular aims, and that these contexts are organised in a hierarchy, from concrete experimental applications to abstract theoretical contexts associated with a large range of potential applications.

An implication of this idealised model is that values are involved in all representational activities, but the higher we climb the hierarchy of abstraction, the less the values involved are tied to particular social contexts, and the more they deserve to be called epistemic. This agrees with pragmatist truth being the ultimate aim of science, and this provides a way of reconciling defenders of the value free ideal and their opponents.

SESSION 1

Filip Buekens (KU Leuven; Tilburg University)

The truth of a proposition vs. the accuracy of a representation

Philosophers tend to identify truth and accuracy: a belief or assertion is accurate if and only if what is believed or asserted – its content, with a propositional format -- is true (Buekens 2017). After discussing some obvious examples where both notions come apart and do not even entail each other (accurate representations can be false, true statements can be inaccurate) I'll make a case for separating them on more principled grounds. I propose a suitable precisification of the concept of an accurate representation of a subject matter, how accuracy conditions differ from truth conditions, and why the distinction is important for understanding the nature of acts of representing a subject matter or target system. The background theory of truth I employ is a minimalist conception of truth (which may itself be considered a precisified concept, derived from our ordinary concept of truth). While truth is a thin inferential property ascribed to propositions, accuracy is a property of acts of representing a subject matter or target system. A minimalist conception of truth allows us to separate the non-normative (i.e. descriptive), non-evaluative and non-relative concept of truth from the normative, evaluative and assessment-relative notion of accuracy. Accuracy pertains to ways things are represented. Truth is what you have when a possibility obtains. Some surprising consequences of this view will be elaborated in the talk.

The main upshot of the proposed distinction is that propositions (the bearers of truth and falsity) do not have a representational nature. Propositions differ from representational devices to the extent that propositions contain objects and properties, while representations have subject matters or targets that are not part of the representation. (There cannot be a representational relation between an object and an abstract set-theoretical entity that contains that very object.) The objects of belief are ways things are or could have been, not representations of such ways. They are true when the possibility obtains (a view that goes back to Wittgenstein, and recently revived by Stalnaker and Hunter). Representations, on the other hand, are artefacts. They are epistemic tools designed to engender beliefs about their target systems. The distinction between propositions (true or false) and representations (accurate or not) helps us separating epistemic issues involving beliefs extracted from representations from the pragmatic qualities of representational devices and scientific models in particular. And the distinction also helps us separating the deeply relative, purpose-dependent and perspective-sensitive character of the accuracy of a representation of a subject matter from the truths and falsehoods that can be gained by interpreting representations.

SESSION 1

Virginia Grigoriadou and Frank A. Coutelieris (National Technical University of Athens)

Similarity and representation: an ongoing dialogue

Although similarity and analogue models have been widely utilized in various scientific fields since the 18th century, the concept of similarity was somehow neglected in epistemological issues of the Philosophy of Science until the late 20th century, despite that it is a core mechanism that allows experimentation. Several approaches to analogue models have been provided by philosophers in recent decades. However, the wide use of the concept of similarity during the application of analogue models requires further discussion on the role of similarity in the representation of existing physical systems through analogue models, and on the criteria on which the verification of a specific similarity between an analogue model and a system in the study should be based. Thus, this study aims to examine the relationship between similarity and representation and the value of scientific representation throughout the application of analogue models. To address this point, we examine two significant approaches to the concepts of similarity, analogy, and scientific model and the relationship among similarity, representation, and analogue models. Firstly, we examine the theory of Mary B. Hesse concerning the role of analogy during the application of scientific models. Moreover, we study the view of Susan G. Sterrett, who identified similarity as the basic method of analogue models. Also, a new perception of the concept of similarity is proposed here, being considered as the core mechanism allowing the transfer of knowledge between different scales of the same phenomenon (internal similarity) or among different phenomena or systems (external similarity). Finally, we highlight that the validity of this technique can be ensured if the similarity between two systems is verified, based on strict, scientific, and objective criteria rather than empirical notions.

KEYNOTE 1

Michela Massimi (The University of Edinburgh)

Inferential blueprints and windows on reality

In this talk I present a view of models as inferential blueprints as I articulated it in Massimi (2022, OUP). I focus on the role of multiple models in some well-defined areas of inquiry, offering a case study from the history of nuclear models around 1930-1950. I argue that a plurality of seemingly incompatible models for the same target system should not be regarded as representing-qua-mapping onto incompatible states of affairs. Instead they perform an important exploratory function: they allow scientists to physically conceive the target system in particular ways so as to enable modal knowledge about specific phenomena of interest.

SESSION 2

Laura Bujalance (Universidad del Atlántico Medio)

Mary Hesse to the rescue in contemporary realism debates

Contemporary debates on scientific realism take the standard version by Stathis Psillos (1999) as a starting point. His proposal delves with the long-discussed topic of realism from three stances: ontological, semantic and epistemic. In this paper I suggest to use Mary Hesse's insights on scientific change, especially in her Forces and Fields (Hesse 1961), to counteract some of the criticisms that standard realism has received in the last two decades. Indeed, on the epistemic stance, Psillos uses the "non-miracle" argument to support realism, at least moderate realism. The success of a theory would, from this point of view, legitimize some sort of realism. Yet, as critics claim using pessimistic induction arguments, the non-miracle argument may be a fallacy, since history shows that scientific theories, at one time accepted as valid, true or proven, are often rejected, falsified or abandoned, thus dismissing any claim to success of the previous theory and, possibly, of any currently accepted theory (Levitt, 2005; Wray, 2018). But in her analysis of scientific change, Mary Hesse challenged the idea that a new theory stood on its own feet with no relation to past epistemic choices. From her point of view, any contemporary theory may be shown to preserve traces of its past, including traces from previous theories, thus invalidating the extreme rejectionist view from pessimistic induction and helping defend standard realism, at least on its epistemic stance.

SESSION 2

John Preston (University of Reading)

Mary Hesse's Scientific Realism(s)

To what extent, how, and why did Mary Hesse move from a kind of scientific realism to a kind of instrumentalism? In her early works she developed the idea of models and analogies as a way of opposing 'formalist' and hypothetico-deductivist views of scientific theory. Her initial arguments were intended to make space for a kind of scientific realism, a form based on a much fuller recognition of the role of models and analogies in science. Her commitment to scientific realism is explicit in her publications from the mid-1960s until the mid-1970s.

In the later 1970s, though, Hesse endorsed a form of instrumentalism or pragmatism. Had she had turned entirely against her earlier form of scientific realism, or perhaps all forms of scientific realism, and if so, why? Or did she think the form of instrumentalism she had come to endorse was compatible with her initial, model-based realism? I draw attention to a residually realist aspect of her views, which makes her an early and neglected proponent of structural realism.

Finally, by looking at one of her final articles I assess the extent to which Hesse can still be thought of as having been, all things considered, a scientific realist.

SESSION 2

David Hommen (Heinrich Heine University Düsseldorf)

Wittgenstein and Hesse on Metaphors and Family Resemblance

As part of her seminal work on models and analogies in science, Mary Hesse develops a general 'network theory of meaning' in which she posits that all language (both natural and scientific) is fundamentally metaphorical. Drawing on Wittgenstein's theory of family resemblance, she claims that the application of any concept to a novel case is based on the tacit perception of complex similarities between the new case and cases already subsumed under the concept in question, and thus amounts to a metaphorical transfer of that concept to the novel case. In this talk, it will be argued that Hesse's resulting theory of scientific language relapses into constructivist antirealism, as Hesse regards the similarities based on which all descriptive concepts are applied not as objective features of the world, but as a matter of psychological or social agreement. In contrast, it will be shown that Wittgenstein's original theory of meaning already contains a theory of perception that guarantees genuine epistemic access to objective resemblances in the world, which is established through a direct acquaintance of the cognitive agent with such resemblances. Wittgenstein's overall theory thus proves to be more realist than Hesse appreciates in her own interpretation and development of it.

SESSION 3

Kristina Engelhard (Tried University)

Theories, Models and Modeling in Metaphysics: The Value of Scientific Representation and the Problem of Progress in Metaphysics

A relatively novel account of metaphysics of science is the modeling account. The main idea is that since modeling is an important part of science, it might also be part of metaphysics. There are currently basically three different approaches to it. Common of them all is the idea that metaphysics is probably best understood as at least in part a discipline that develops models of parts of reality rather than theories and that this changes the view on how the truth claims of metaphysics should be understood (Godfrey Smith 2006; Paul 2012; Jaag & Loew 2020). The thesis I defend is that these accounts face serious problems concerning realism in metaphysics in contrast to science. I suggest an alternative approach to the modeling account of metaphysics: doing metaphysics is even to a large degree modeling, but truth approximation plays a major role in developing new metaphysical theories and that there is in a sense progress in metaphysics.

SESSION 3

Lorenzo Sartori (London School of Economics)

What Scientific Pictures Tell us

The use of images in science is pervasive and has become an essential part of scientific argumentation and reasoning. Building on the work of Nelson Goodman, Laura Perini developed a conventionalist account of scientific pictures, by analysing their own syntactic and semantic features. However, Letitia Meynell has provided compelling criticisms of Perini's attempt to apply conventionalist accounts to strictly non-linguistic representations such as micrographs, MRI scans, and astronomic pictures. Meynell argues that conventionalist accounts cannot be applied to these types of pictures, because intrinsically non-compositional. Instead, Meynell proposes an alternative account based on perception and geometrical projections.

This paper proposes a new conventionalist approach to images that appeals to the resources offered by the DEKI account of scientific representation, proposed by Roman Frigg and James Nguyen. In order to explain how scientific representations work, the account uses the concept of key, i.e., a function mapping the properties of the representation onto the properties that are eventually imputed to the target. By recognizing the role of the key as an integral part of representational systems, this paper suggests that the gap left open by Perini concerning pictorial images can be remedied, and a compelling alternative to Meynell's proposal can be provided.

SESSION 3

Robert Hudson (University of Saskatchewan)

The Return of the Pragmatic Theory of Observation

In the early 1930s, Rudolf Carnap formulated a theory of observation, called the 'pragmatic theory of observation', that had a profound influence on theories of observation subsequently formulated by Paul Feyerabend and Willard Quine during the 1950s and 1960s. Largely due to the well-known of arguments of Grover Maxwell, Hilary Putnam, Mary Hesse and others, the pragmatic, and other theories of observation have fallen into disrepute. In their stead, a new way of understanding the epistemic nature of our interactions with the world has emerged, formulated and defended by James Bogen and James Woodward, according to which the immediate products of our interactions with the world, called 'data', are of secondary importance to the ultimate theoretical interpretations of the data, called 'phenomena'. In this paper, I acknowledge the legitimacy of Bogen and Woodward's data/phenomena distinction, but argue that a sustainable observation/theory distinction is needed to provide an analysis of what constitutes 'data'. For this purpose, I resuscitate and defend the Carnapian pragmatic theory of observation as an account of 'data', as distinct from 'phenomena', and explain why scientists rely on data in the process of theory testing.

SESSION 4

Benjamin Genta (University of California, Irvine)

Inferring Relations by Analogy

Analogies and analogical inferences are used in various stages of the scientific process. Progress in our understanding of how we reason with analogies is therefore essential to the philosophy of science. The main contribution of this paper will be in carefully distinguishing two types of analogical inference: outcome- and relational- analogical inferences. These types, I show, differ in what is being inferred. Philosophers—championed primarily by the works of Mary Hesse (1966) and Paul Bartha (2010)—and cognitive scientists have focused their analysis on only outcome analogical inferences. In fact, prominent accounts seem to explicitly prohibit relational analogical inferences. As I will show, however, these are an important tool of scientific practice—especially in model-based disciplines.

SESSION 4

Davide Vecchi and Giorgio Airoldi (Universidade de Lisboa)

Analogies as global narratives in sentience research

One of the focuses of behavioural analysis concerns the evaluation of the degree of organismal behavioural flexibility. Animal researchers associate significant degrees of flexibility (e.g., motivational trade-offs) to sentience capacities. The underlying intuition is that flexibility should be associated to organismal choice. This intuition stems from analogising animals to humans, postulating that valence (e.g., pain experience) co-determines the animal's behavioural choices. Flexibility is contrasted with deterministic and mechanical behaviour. Instead of associating behavioural flexibility to organismal choice, bacteriologists describe the biochemical and molecular basis of behaviour, adopting a molecular determination model: put crudely, it is proteins that determine bacterial "decisions". This way of thinking stems from analogising organisms with machines, discounting valence as a determinant of behaviour. Thus, two general models of behaviour founded on two different analogies can be applied across phylogeny, engendering disputes concerning their application to specific lineages. Nevertheless, it is unclear what kinds of evidential or theoretical considerations might solve such disputes. We shall argue that one reason is that analogies play a global narrative role in sentience research.

SESSION 4

Helene Scott-Fordsmand and Mauricio Suárez (HPS, Cambridge University/Clare Hall)

Negative Analogies and Representation in Medical Practice: A Case from Clinical Orthopaedics

We argue for a role for analogical reasoning in medical practice, in particular in clinical orthopaedics, and show that exploring this role can contribute to the philosophical understanding of scientific representation. Our argument proceeds by means of a case study in the use of classificatory representations in treatment of shoulder fractures. A key device in diagnostics in this area is the Neer classification schema, dating from 1970 (Neer 1970). This schema looks at face value like an isomorphic representation of natural classes of bone fracture, with each of sixteen distinct graphical depictions holding a relation of positive similarity in shape and displacement to their appropriate targets in the patient population. However, in practice, employing the Neer classification is far more complex than merely matching patient cases to the fracture classes. Instead, the system works heuristically, in terms of guiding attention and action – even in cases where there is no obvious conclusion as to which class the patient case belongs to. Drawing from observations of clinical practice and sources on the historical development of the Neer classification schema we show, first, that it functions not as a pictorial depiction, but as a scientific model. And that taking it as such makes sense of clinical examples as well as statements made by Neer on the nature of his classification system. Rather than a depiction of natural classes, the Neer system can thus be seen as a template for analogical reasoning. Second, we argue that the intuitive appeal to understand this classificatory system – and others like it – in terms of similarity between class and case is particularly misleading in that it overlooks the importance of relations across entire classificatory systems, as well as patterns of reasoning through negative analogies. Drawing on Mary Hesse's tripartite distinction between positive, neutral, and negative analogies, we show that, contrary to received wisdom, negative analogies play as important a role, if not the decisive role, in how the model supports reasoning and decision making. Our analysis is of a piece with other recent studies that emphasise the indispensable role of 'inverse negative analogies' (Pero and Suárez, 2016) and 'dissimilarities' (Boesch, 2021) in scientific modelling practice. These analyses display the subtle ways in which the different elements in a model interact holistically in inferential practice (Fang, 2019, Suárez, 2010), which is rendered opaque by analyses in terms of similarity, or isomorphism.

KEYNOTE 2

Alisa Bokulich (Boston University)

Reconstructing Extinct Life: Analogues, Homologues, & Biomechanical Models

In her celebrated book Models and Analogies in Science, Mary Hesse illustrates the concept of material analogy using the biological examples of homologies and analogies (sensu biology "analogy b "). As she explains, homology is a similarity of structure in two different species or taxa due to a shared evolutionary history (e.g., the human hand and a bat's wing are homologues inherited from a common ancestor).

Analogy b, by contrast, is a similarity of structure in two different taxa due to a similarity of function, but arrived at independently (e.g., a bat's wing and bird's wing). In the context of paleontology, where scientists are trying to reconstruct what an extinct species was like from a highly incomplete and distorted fossil record, these two forms of material analogy have traditionally defined two competing research programmes: the phylogenetic approach, which focuses on the use of extant taxa that are homologues in order to reconstruct some unpreserved aspect of an extinct organism, versus the functional morphology (and later including biomechanical) approach, which focuses on the use of various functional analogues (including analogous b extant taxa, biorobotic analogues, and biomechanical computer simulations).

More recently, paleontologists have begun to recognize the value of incorporating evidence from both of these types of material analogies (sensu Hesse, "analogy H "), and the number of different analogues H for a given extinct taxon has proliferated. While this new multi-analogue, "integrated" approach holds great promise, it raises substantive philosophical and methodological questions about precisely how these various diverse lines of (sometimes conflicting) evidence are to be properly integrated.

In my talk I review the strengths and weaknesses of each of these types of analogies H and explore proposals for how these diverse lines of evidence can best be integrated. I illustrate the promise and perils of these approaches using two primary case studies: The first case is an ostensibly successful reconstruction of the locomotion of the 290-million-year-old tetrapod species Orobates pabsti using a robotic biomechanical analog "OroBOT", integrated with evidence from fossil trackways, extant tetrapods, and computer model simulations. The second case study is a recent high-profile failure of the use of robotic and other analogues to reconstruct the behavior of the large, 95-million-year-old dinosaur Spinosaurus aegyptiacus as an aquatic predator—indeed the only hypothesized aquatic dinosaur. These paleontological case studies provide valuable methodological insights into how diverse lines of evidence using analogical H reasoning are to be combined, as well as broader philosophical lessons about the importance of model validation (evaluation), sensitivity analyses, adequacy for purpose, and uncertainty estimation in science..

SESSION 5

Francesco Striano and Alberto Romele (Uniersità degli Studi di Torino)

Hermeneutics of technoscience: expanding Hesse's approach to scientific modeling and the case study of the use of images

The purpose of our presentation is to further develop Hesse's ideas regarding scientific modeling. Like Hesse, we propose a middle ground between realism and constructivism, wherein scientific theories and models have an impact on scientific discoveries. However, we argue that scientific theories and models are also rooted in imaginaries or worldviews that extend beyond the realm of science and can be just as influential. To support this argument, we draw on Galison's book Image and Logic, and demonstrate how debates over the role of images in science are based on a particular extra-scientific understanding of images.

Our proposal is to outline a "hermeneutics of technoscience" as a middle ground between realism and constructivism. In our view, a hermeneutics of technoscience acknowledges that (a) the data produced by scientific research depend on the scientific models and technological tools available to researchers, and (b) scientific models themselves are shaped by cultural contexts and imaginaries.

In the first section, we will introduce Hesse's perspective on the role of models. The second section focuses on the recent interest of material hermeneutics in science and technology. In the third section, we will apply this model to the case study of technoscience's use of images.

SESSION 5

John Huss (The University of Akron)

Models, Paradigms, and Narratives: a Hesse legacy

As Mary Hesse pointed out in a 1975 paper, the equivocation between models in science and models of science is fruitful because it reminds us that there are what she called "vertigo-inducing" relationships between models in the Geisteswissenschaften and the Natürwissenschaften, not to mention paradigms. To wit, as she points out, Kuhn ushered in a new paradigm in the historiography of science. In the present extension of Hesse's legacy, I identify a comparable inter-level phenomenon I call "narrative feedback." Narrative feedback occurs when the personal narratives of scientists (narratives of their own research) feed back into their narratives of nature (their accounts of the behavior of their objects of study). At another level, philosophical and sociological meta-narratives (narrative schemata) available from the Geisteswissenschaften may seep into the personal narratives of scientists. This opens up the possibility that the most general narrative schemata of how science proceeds may—and I shall argue do—affect scientists' accounts of their own behavior, feeding back into the narratives they give of their objects of study. I illustrate this point drawing on research from the formative years of analytical paleobiology in the work of Gould, Eldredge, Raup, Schopf, Sepkoski and others.

SESSION 5

Amedeo Robiolio (King's College London)

Causal Explanations and Explanatory Causation

An account of causal explanation would have to have this form: a phenomenon is scientifically explained iff x. It turns out that the x in the definition must involve causation in some way (Skow 2014). But the notion of causation cannot be appealed to unless there is an adequate scientific account of causation. However, there can be no adequate account of causation which is scientific. Causality, like mathematical concepts, is a concept used by science, which cannot be proven by science: like numbers (Field 1980), it might be a useful fiction. This is because causation requires by its nature an intensional account: causation is a necessary connection, and necessity is an intensional property. But scientific accounts can only be extensional: only extensional truths can be falsifiable, i.e. make some measurable difference. Causation is not: if e.g. occasionalism were true, science would never notice. Science can only observe a high correlation. Therefore, there can be no adequate account of scientific explanation. It remains open, however, whether it is a problem for science that it is unexplanatory, or rather a problem for explanation that it is unscientific, e.g. because it is a heuristic which has only pedagogical, but not epistemic value.

SESSION 6

Luca Guzzardi (Università degli Studi di Milano)

How scientific models shape sociality. A case study from multi-messenger astrophysics

Since Mary Hesse's studies on the role of models and analogies in much attention has been paid to their function as representational means. Thereafter, particularly regarding to the ontological underpinnings, the notion of model has been developed by many philosophers of science in various and partly conflicting ways. By contrast, the guiding function of models has been an underrated area of philosophical debate until recent times.

In this paper, I argue that the emergent field of multi-messenger astrophysics — i.e., the combined study of radiation from the cosmos conveyed by mediators different in nature: neutrinos, photons in all frequencies, gravitational waves, and cosmic rays — allows to appreciate a feature of models that has been largely overlooked so far. Here not only models shape astronomers' expectations and guide much of their experimental effort. They also suggest that many experiments will need a plurality of cooperating actors to be performed, thus narrowing the scientists' choice about what kind of social behavior they should adopt. So, models in multi-messenger astrophysics exemplify an intriguing case in which the scientists' attitude toward cooperation is not due to social or economic constraints but mainly motivated, not to say determined, by epistemic requirements.

SESSION 6

Victoria Martín del Campo (Universidad Panamericana)

Heuristics on explanations from black box AI models

In science, the validity of a discovery is judged based on its explanatory power. However, Artificial Intelligence (AI) applications like AlphaFold lack explainability, raising questions about whether they should be considered valid scientific instruments. This has led to a discussion on explainable AI as a scientific instrument, exploring the notions of weak and strong opacity in AI models and their capacity for better explanations.

While scientific instruments are usually considered valid only if they support an explanation, a paradigm shift in the notion of science is needed. The validity of a discovery should also depend on its ability to make more accurate predictions, even without a robust explanation. AlphaFold is an example of an opaque model that provides better predictions without robust explanations.

In light of the above, we explore the definition of understanding under the competing notions of explainability and prediction. In particular, given the many levels of abstraction one can take to analyze a system, we explore whether understanding can be seen as prediction at every level of the system following Dicarlo's. This informs a new understanding of scientific models in which explanations are complemented by predictability and which include AI as scientific instruments.

SESSION 6

Zed Adams (New School for Social Research)

The Dialectic of Mind Design

In this paper, I explore the role that metaphor plays in the development of new scientific models. My goal is to illustrate metaphor's fecundity in this regard, the way in which it extends our understanding in surprisingly diverse ways. As Mary Hesse put this point, "it is precisely in its extension that the fruitfulness of the model may lie" (1980, 114).

The particular focus of my paper is on the history of what John Haugeland called 'mind design': the use of mechanical models to reverse-engineer how minds work (1997, 1). My history focuses on two such models: the clockwork model and the computer model. In each case, I show how a metaphorical understanding of the model led to conceptual innovation in two distinct ways. First, it provided an interpretive frame that guided new research by offering an abstract, hypothesized structure to be later filled in by empirical research (Camp 2020). Second, it provided a concrete exemplar to contrast with human minds (Daston 1994). For instance, while on the one hand Descartes invoked the clockwork model to explain how color vision works (Adams 2015), he also invoked it as a vivid illustration of how human reasoning does not work (Riskin 2016).

It is this second source of conceptual innovation that is the real core of the paper; it reveals what I call 'the dialectic of mind design'. This dialectic is especially evident in our tendency to redefine what it is to be human in response to new technological developments. For instance, it is evident when take something that was previously assumed to be paradigmatic of mental acuity, such as the ability to play chess, and redefine it as something merely mechanical (Ensmenger 2012). But it is equally well evident when we take something that was previously taken to be mechanical—such as color vision—and redefine it as paradigmatically mental (Chalmers 1997; cf. Adams and Browning 2020). The concept of mindedness is, in this sense, a constantly moving goalpost that is perennially being redefined in response to new technological developments.