Speculation: Forms and Functions

Dirk S. Hovorka
University of Sydney
dirk.hovorka@sydney.edu.au

Benjamin Mueller
University of Bremen
muellerb@uni-bremen.de

Abstract

Speculation is fundamental to scientific research. Both as an activity and an object, speculations take many forms and function in multiple ways. While speculation that obtains evidentiary support is well established as a source of theoretical contribution, other forms of speculation open pathways for transformation and critique. Digital geographies are proposed as an alternative form of speculation that enables researchers to foray into inhabited futures enabling critique of present research activities that are implicated in possible futures. Quality criteria are offered to enable legitimization of speculative approaches in IS research.

Keywords: Speculation, Imagination, Evidence; Futures, Alternate worlds

1. Introduction

"Bold ideas, unjustified anticipations, and speculative thought, are our only means for interpreting nature: our only organ, our only instrument, for grasping her"
(Popper, 1959, p. 280)

"I think that only daring speculation can lead us further, and not accumulation of facts"
(Albert Einstein, in a letter to Michele Besso in 1952)

"At the root of the problem lies […] a peculiarly modern severing of imaginary worlds from the world in real life"
(Ingold, 2021, p. xii)

It is well understood that knowledge does not come pre-packaged as discrete, self-justifying objects but must be wrestled into existence. There is a large literature and robust debate regarding the role of empirical observation, hypothesis generation and testing, and theory building in both quantitative and qualitative realms. Less discussed is the critical role in scientific progress played by proposition, conjecture, supposition, imagination, hypothetical scenarios, and other forms of speculative thought. While fine distinctions among these terms can be made, in aggregate, these activities provide "the language and conceptualization by which we produce contingent knowledge, ideas, abstractions, risks […] all of which radically shape our individual and collective futures" (Rogers, 2021, p. 3). What these terms have in common is a willingness to seek knowledge in a contingent manner that is speculative and relies upon imagination. While many scientists might not see that epistemic progress must include speculation and imagination, in Popper's view, speculative thought and bold ideas are a necessary means of grasping nature. From this view, construction of a hypothesis is a speculative account because it does not (yet) entrain evidence. The goal of the researcher is to create strong tests that will refute (falsify) the speculative account and in the absence of such falsification the speculation is held to be true. The justification for speculation is grounded in the researcher's ability to discover evidence. The quote from Einstein reinforces the idea that speculation is critical to scientific progress. It is through speculation or guessing that new knowledge is formed prior to the facts that are then mustered to support the speculation. In contrast, Ingold's account presents *imaginary worlds* as a foundational aspect of living and one that modern science has sought to expunge. From this view imagination "opens up paths in and through the world, rather than fixing endpoints in advance" (Ingold, 2021, p. 36). These three positions reveal that *speculation* is firmly embedded in scientific thinking and may take many forms and may perform multiple functions.

To explore these forms and functions, we assess a broad range of philosophical and scientific literature for the multiple ways speculative accounts appear in science. The empirical emphasis in most sciences, including IS, conceals underlying forms of speculation. For example, every proposition is an educated guess, a speculation for which the researcher believes acceptable evidence can be found. In another form, metaphors (e.g., conceiving of atoms as "miniature solar systems;" Haack, 2019), the generative capacity in problem solving (Schön, 1993), and the use of symbolic metaphor in information system development (Hirschheim & Newman, 1991) are examples of speculations that are not thought to be true but provide a basis for cognition and shared vocabularies (Lakoff & Johnson, 1980). Similarly, myths as "a dramatic narrative of imagined events" (Trice & Beyer, 1984, p. 655) are suggested to be a source of creative theorizing (Hassan et al., 2022). These contrasting examples illustrate speculative epistemologies that can be distinguished based on the need (or not) for confirmatory evidence and differentiated by function to reveal the world or to provoke discussion of contingent possibilities and choice.

To clarify the meanings and functions of speculation, we first identify a variety of accepted forms of contingent knowledge that are speculative in the sense that they are not (yet) considered to be true. They may be based on the expectation that supporting evidence can be obtained (e.g., hypotheses,

URI: https://hdl.handle.net/10125/107159
978-0-9981331-7-1

propositions) or they may be accepted, as in in the case of metaphors, but they are not literally considered as truth. We then examine the different functions of speculation that support fruitful research activity and navigating epistemic distance beyond the immediate and observable. Finally, we expand on the potential roles of speculative approaches for identifying *alternative futures* (Dunne & Raby, 2013; Frank, 2017; Hovorka & Peter, 2021b) as a site for inquiry and present action. Before concluding our discussion, we provide the first steps of a foundational debate toward establishing quality criteria for a scholarly use of speculation.

2. Conceptualizing Speculation

There is an increasing interest in the role of speculation in the sciences that extends the robust discussion in the philosophy of science regarding the functions of speculation in establishing and maintaining values, epistemic rules, and ontology (Friedman & Hendry, 2019; Ingold, 2021; Lennon, 2015; Weick, 2006). A sufficient set of examples of the importance of imagination in the progress of science (see for example: Currie, 2021; Ingold, 2021; Kuhn, 1962) shows that the debate is not whether speculation exists in the scholarly discourse, but where it can be productive and how it can be evaluated.

Unsurprisingly the roles of imagination in science are addressed from different perspectives with limited consensus regarding what imagination *is* (Holton, 1998; Murphy, 2022). For example, in comparing imagination of experimental procedures, "there are indeed many different uses to which imagination can be put, but when we constrain our imaginings to fit the facts of the world as we know them, we are using an epistemic procedure that is much more akin to scientific experimentation than it is to mere flights of fancy. Although our imaginative experimentation will not be fool proof, neither is scientific experimentation. But in both cases, when we proceed cautiously, the beliefs that we arrive at will usually be justified" (Kind, 2018, p. 244). From another perspective, imagination is considered to be the cognitive activity of forming 'images in the mind' (for a review see: Murphy, 2022). Within this perspective of 'mental images' or 'seeing in the mind's eye' there is debate on whether imagination is 'perception-like' (Kind, 2018) or a function of the 'unreal,' as a process of "deforming images provided by perception; it is above all the faculty of liberating us from first […] representations in perception" (Kaplan, 1972 p 3). Even more radically, Ingold (2021) argues that imagination is the process of "flying ahead of things as to disclose the present, in every moment of its emergence, as the future's past" (p. 36).

Although distinct, the variety of views regarding imagination—from images on the mind, to distorted perceptual images, to making sense of the world by opening "paths in and through the world" (Ingold, 2021 p 3)—the literature notes there are numerous real situations where justification for progress in science is grounded in imagination, "that is, in which an imagining can justify our belief in a contingent claim about the world" (Kind, 2018).

We now turn attention on a specific type of imagination, speculation, that is well established in scientific studies. The dictionary definition of *speculation* provides a starting point:

a) the forming of a theory or conjecture without firm evidence.[1]
b) the act of guessing possible answers to a question without having enough information to be certain.[2]

It is observed that each of these definitions tie the quality of speculation to the sufficiency of evidence or information certainty. Our goal is to further expand our understanding of speculation and illustrate other functions for scientific speculation.

The rationale for this argument lies in the constraints imposed by the IS field's current research apparatus that limit the phenomena available for disciplinary scrutiny. There are phenomena, for which empirical observation is either difficult or impossible to obtain (Sullivan et al., 2023). These include but are not limited to emerging phenomena, criminal digital activity, highly sensitive or fragile human conditions, and notably, our relationships with the futures implicated in our research.

Moreover, our apparatus "[…] tend[s] to organize phenomena bewildering in their layered complexity into clean overviews. They make smooth schemes that are more or less linear, with a demonstrative or an argumentative logic in which each event follows the one that came before. What may originally have been surprising is explained and is therefore no longer surprising or disturbing…" (Mol & Law, 2002). While such attempts at cleaner representations might make originally complex phenomena easier to grasp, simplification sometimes comes at the cost of misrepresentation. For example, Poole et al. (2000) argue that more complex process-based phenomena often get misrepresented as simple, linear processes even though the underlying phenomenon does not progress in such a way.

The result of this narrowing is that the messiness of the world is obscured. For example, power relations, images of humanity, spatial distribution, and the epistemic rules of research itself are assumed to be self-evident and stable. In IS, it is frequently the technology or socio-technical system that is changed under "all else being equal" conditions. Although a small number of factors or conditions may be altered as a counter-

[1] Oxford Dictionary, 2017
[2] https://dictionary.cambridge.org/

factual (Rubinstein & Good, 2013), these studies are few in number and limited in scope in that they only change a limited set of factors. One alternative to this reductionism is to acknowledge the forms of imagination and speculation in research and to pursue the functions these approaches provide for research progress.

3. Forms of Speculation

Scientific research has an uneasy relationship with speculation in part because it is haunted by early views of science as rational, value free, and objective. When faced with unknown or emerging phenomena with limited or no data, imagination and speculation of possible explanations or understanding is a necessary process in advancing new concepts or theories. While the literature on speculation is limited, forms of speculation are deeply embedded in scientific practice. When unknown phenomenon are addressed, Popper (1959) states: "The actual procedure of science is to operate with conjectures: to jump to conclusions—often after one single observation" (p. 181). During periods of scientific instability (e.g., scientific crises), "the scientist in crisis will constantly try to generate speculative theories that, if successful, may disclose the road to a new paradigm, and if unsuccessful, can be surrendered with relative ease" (Kuhn, 1962, p. 87). Despite these philosophical admonitions, many areas of science employ a deductive approach that seeks *epistemic security* and demands that propositions, conjectures, hypothesis, and design principles be grounded in conservative, well-supported arguments from past scientific—often empirical—findings (Currie, 2021). This *truth-relevant speculation* appears in many forms in Information Systems research (Achinstein, 2018; Currie, 2021; Swedberg, 2021). Most common are hypotheses, propositions, and theories. For example Poon and Wagner (2001) make "educated guesses" and speculate regarding meta-success factors in development of executive IS. Whether derived deductively (from prior literature) or inductively (from data), the acceptance of these forms of speculation are justified by the assumption that the truth or falsity of the hypothesis, prediction, or future design outcomes can be validated through the collection of suitable evidence. These *truth-relevant* forms of speculation are a common and well-understood feature in social science. Here the question of what constitutes *evidence* that the speculation is true becomes crucial (Achinstein, 2001, 2018). In-depth discussions of the multiple conceptualizations of evidence are however outside the scope of this work (see for example: Achinstein, 2001, 2018; Chandler et al., 1994).

But the demand for epistemic security may well prove to be problematic when facing new phenomena in IS (e.g., generative AI, surveillance capitalism at scale, digital ethics, technology in environmental health) when both problems and solutions have not yet been tamed. In these instances imagination of possibilities and speculation "are important in conceiving new theoretical ideas, in exploring the explanatory resources of those ideas, and in working out how to bring theoretical ideas into contact with empirical constraints" (Levy & Godfrey-Smith, 2019, p. 2). Many layers of scientific arguments are needed to cross *epistemic distance* (Carolan, 2004) from what is immediately observable to claims regarding unobservable phenomena such as human sentiment, digital objects, or predications of the futures in which our designs, implementations, and processes are implicated but have not yet eventuated.

In these instances, *truth-irrelevant* speculation (Achinstein, 2018) can provides a means of reaching into uncertain and contingent socio-technical worlds both present and future. For example, metaphor—long argued as a foundational aspect of cognition (Lakoff & Johnson, 1980)—is also a substantive part of science (Brown, 2003; Hassan et al., 2022; Hirschheim & Newman, 1991; Leclercq-Vandelannoitte et al., 2014; Schultze & Orlikowski, 2001) and problem solving (Schön, 1993). From this view, metaphors are not mere linguistic embellishments but "are foundations for thought processes and conceptual understandings that function to map meaning from one knowledge and/or perceptual domain to another" (Taylor & Dewsbury, 2018, p. 1). With the understanding that "metaphors ask us to imagine the world in a new way" (Cohen, 1998, p. 1) we begin to observe that science does not progress through the mere pursuit of facts. The comparison here is not to claim that metaphor is speculative but rather to establish that imagination plays a foundational role in science. No one thinks that an atom is literally a set of ball-like spheres with other spheres in rapid orbit. Visual and linguistic metaphors serve as "fictions useful for explaining, predicting, and unifying certain observable phenomena" (Achinstein, 2018 p 8). The metaphor allows people to grasp a shared understanding to work with the *concept* of an atom, rather than the literally accurate form of an atom. The IS field is rife with metaphors including: the information superhighway, cyberspace, artificial intelligence, and organizations as machines or organisms. These metaphors become reified in use and although common, often pass unnoticed as the imaginative fictions they are.

As another example, Maxwell's imaginary fluid hypothesis was a fiction that represented electricity as a fluid moving through tubes. It was not considered to be true but instead, "its purpose is to provide a fluid analogue of the electromagnetic field that will help others to understand known electrical and magnetic laws by employing an analogy between these laws and ones governing an imaginary fluid" (Achinstein, 2018 p 7). Here we can observe that speculating some similarity between electricity and fluids enabled researchers to articulate the problem in a manner that enabled progress.

In a similar vein, *social imaginaries* (Jasanoff & Kim, 2015; Taylor, 2004) provide speculative accounts in intersubjective social realms. Fictional imaginaries have long been a prominent feature in the literature (Asimov, 2004; Huxley, 2004; Shelley, 2018, 1818) and as a means to grasp and critique social organization. In the sciences, Marcus (1995) focuses on the roles of scientists in developing "futures and future possibilities but the context is on the imagination in the scientific workplace, and the imagination's aim and achievements are tied to forms of scientific production" (Jasanoff & Kim, 2015, p. 10). A broader approach, that places a stronger emphasis on a positive, normative stance toward what is desirable, addresses the persistence of multiple aspects of the world that can and should fit and maintain stability over long periods (Jasanoff & Kim, 2015; Taylor, 2004). The underlying ethos is that imaginaries encourage us to refuse to take "any aspect of the world for granted as natural or given, and hence foreclosed to investigation, even those that seem to hold still and do nothing; but instead to look around at all the compass points from which forces originate to make up reality as we see it." (Jasanoff & Kim, 2015, p. 16). These socio-technical imaginaries are of a different form in that they open-up worlds for consideration rather than propositional statements about specific causal relationships or processes of the world. Moreover, the worldmaking aspects of imaginaries expand the epistemic reach of science beyond the disciplinary conditioning of established methods, theories, and paradigmatic boundaries of science (Kuhn, 1962). While such stabilization of accepted methods and disciplinary bounding is necessary for progress in science (Kuhn, 1963), paradigms also maintain certain choices and exclusions and determine what can be seen and what passes unremarked (Jasanoff & Kim, 2015). Thus, the form is a theoretical framework that brings together both technologically and culturally produced perceptions of the world (e.g., socio-technical; Sarker et al., 2019), and "offers an entry point into the means by which is and ought remain fitted together while our awareness of the world and what to make of it both move" (Jasanoff & Kim, 2015, p. 14). Speculative imaginaries highlight the coproduction of worlds by taking the admonition "nothing comes without its world" seriously. The recognition is that we do not "encounter single individuals, the meeting produces a world, changes the color of things, it diffracts more than it reflects […]. Knowing is not about prediction and control but about remaining 'attentive to the unknown knocking at our door' (Deleuze 1989, 193)" (de La Bellacasa, 2011, p. 91).

Design is an inherently speculative activity that may be either truth-relevant or truth-irrelevant. In the former, paradigms such as Design Science Research (DSR) seek to create knowledge through the design, construction, and testing of artifacts. Claims about the artifacts are validated through the collection of evidence from a variety of tests (Larsen et al., 2020; Thakurta et al., 2017). Other forms, including speculative design (Drazin, 2012; Dunne & Raby, 2013), critical design (Dunne, 2008; Malpass, 2017), and speculative geographies (Hovorka & Peter, 2021a; Peter et al., 2020; Ward, 2011), use design activities and artifacts as a means of entering into future design spaces, rather than creating future designs. These activities are not intended to predict or project what the technology design will become, but rather to gather impressions that may enable better design or to bring a critical view to current design assumptions. In addition, the DSR approach in IS credits Simon (1969) as providing the rationale for learning by creating an artifactual solution to a class of problems by focusing on one class of solutions from within the broader solution space. This has the effect of providing a solution to one specific problem while narrowing the possibilities for future action. Less often articulated are his views on social planning as "designing without final goals". While paradoxical in comparison to the common perception in DSR as narrowing the design space to an artifactual problem solution, from this perspective on design, the "function is to motivate activity which in turn create new goals […]" (*ibid*, p. 196) and a proliferation of niches and variety. Simon places his argument in the context of concerns with matters remote in time and space in which goals and opportunities evolve. Thus, sociotechnical planning (e.g., computational inter-connections of the world; city planning) require thinking of design and progress with a significant lengthening of our time perspective. In addressing social planning where society is the client being designed with, evolving, not fixed, systems are desirable and the essential task "is simply to keep open the options for the future or perhaps even broaden them a bit by creating new variety and new niches" (*ibid*, p. 191). For example "toward the end of the twentieth century, the pioneers in ubicomp research tried to anticipate the impacts and applications of their technologies decades into the future" (Dourish & Bell, 2011, p. 3). While the anticipations of these researchers were accurate in some respects, there were many aspects of the world that were not considered, in part, because they had not yet happened. In this way Dourish and Bell liken aspects of research to "the complex and somewhat mystical process of inquiring into future events […] looking to uncover what lies hidden from immediate sight (*ibid*, p. 2).

This discussion reveals multiple forms of speculation as providing opportunities to expand the epistemic apparatus in different domains in IS research. The two broad forms, distinguished by their relationship to truth claims, each have a productive impact in progressing our knowledge of current and of future phenomenon. We observe that the initial and common definition of speculation are overly reliant on the possibility of evidentiary grounding. This limitation provides the basis of additional distinctions within speculation that emphasizes more imaginative forms which serve different functions.

4. Functions of Speculation

A function-first account of speculation is a starting point for developing quality criteria for activities and outputs of this form of inquiry (Currie, 2021). Rather than characterising speculation in terms of its relationship to evidentiary support, a focus on functions makes visible how imagination is critical in scientific research and opens pathways toward broadening the apparatus through which knowledge is created.

Truth-relevant speculation: Hypotheses, propositions, conjecture, and theories serve primarily epistemic functions (Currie, 2021). These can be briefly listed as:

1. **Explicating**: a speculation makes a theory concrete and amenable to empirical tests. By operationalizing the speculation in the form of a hypothesis, the theory is made intelligible in the context of the assumed background knowledge.
2. **Scaffolding**: through the articulation of hypotheses or propositions, speculation provides a platform—a place to stand—in the structuring of empirical work (e.g., experimental design; field data collection; validation of claims regarding a designed artifact).
3. **Theory Building**: speculation that is expressed as propositions and hypotheses provides formalization of theory which can, in turn, lead to deduction of additional hypotheses and testing.
4. **Linking**: speculations can be used in connecting disparate bodies of knowledge. For example inter- or transdisciplinary developments such as linkages between chemistry and biology (e.g., Darden & Maull, 1977) have been used to address phenomenon that neither discipline could address on its own.

Taken together, we can observe that it is not the evidentiary support that is important to the epistemic functions but rather how these forms improve downstream science by generating (and testing) new ideas, opening new research areas, and bringing disparate bodies of knowledge together.

Truth-irrelevant speculation: Speculations that are not intended to approximate truth can also be functionally beneficial. They provide additional benefits in:

5. **Staging**: Forms such as metaphor "function as invitations from speaker to audience, writer to reader, to explore similarities between two things, phenomena, etc." (Haack, 2019, p. 2064) and as such provide common language upon which research can be performed, communicated, and evaluated. For instance, user and system metaphors have been found to influence success in information system development (Hirschheim & Newman, 1991; Kendall & Kendall, 1993). Maxwell's imaginary fluid provided a starting point for research to develop the mathematics of electrical and magnetic laws. Evidence for such an imaginary fluid was irrelevant because the truth of the speculation is irrelevant (Achinstein, 2018).
6. **Critiquing present action**: Social imaginaries and digital geographies envision alternative technocultural futures (e.g., Hovorka & Peter, 2021a; Jasanoff & Kim, 2015; Mager & Katzenbach, 2021). In the design space, alternative designs (Dunne & Raby, 2013; Malpass, 2017; Rosner, 2018) can open lines of inquiry, scope the design space, and provoke debate on current practice. By making alternative futures legible, they serve to ground new concepts and vocabularies, posit new types of relationships (Frank, 2017, 2021; Hovorka & Peter, 2021b), and provide a framework for understanding and analysing the underlying present-day assumptions, beliefs, and values that shape our sociotechnical society. By uncovering and questioning our assumptions we can better understand the roles of current practices and theorizations in the making of worlds (Schultze, 2017).

As a final note, all forms of speculation rely on extra-epistemic factors. In addition to the 'on-stage' support provided through explicit evidence, there are numerous 'off-stage' practices and background knowledge that must be taken for granted (Achinstein, 2018; Currie, 2021). These include experimental designs, instruments, methodologies, data-collection and analyses, as well as the institutional features of publication outlets and review practices (Currie, 2021). Thus, the emphasis on truth-relevant evidentiary support—that is, what counts as evidence and its production—reveals that "most scientific results are speculative to some extent" (Currie, 2021, p. 603). This suggests that emphasis on the productive functional accounts of speculation, rather than the reliance on evidentiary support is warranted.

To take the socio-technical nexus of IS seriously (Sarker et al., 2019), we need to recognise that our research apparatus and claims about "proper" method have a historical context. That context sets the assumption that "social science tends to work on the assumption that the world is properly to be understood as a set of fairly specific, determinate, and more or less identifiable processes" (Law, 2004, p. 5). The desire to simplify the world, to reduce it to fundamental and graspable simplicity is a characteristic of much of social science that carries numerous implications. For example, taming the complexities that exist in the world-at-large may work well in a laboratory or small case study. But when problems at large scale are considered, the larger set of ongoing influences and relationships do not fit the schemes produced at smaller research scales. (Mol & Law, 2002). Rather than holding the technical as something unique and separate, we need a research apparatus that is capable of recognizing the technical as produced in relation to,

and along with social, political, environmental, economic, and cultural arrangements. This suggests a need for loosening our grasp on epistemic certainty and for creating a research apparatus that makes worlds visible as "a generative producer of realities" (Law, 2004, p. 7).

5. Futures: a Site of Speculative Inquiry

Reviewing the scientific functions of speculation above leads us to observe that our sixth function—critiquing present action—differs from the others in that it seeks to bridge a far greater *epistemic distance* than the others. In this, it serves a very particular function that we suggest is worthy of expanded development here: that of bringing into view alternative futures *on their own terms*, not merely as projections of the present/past into the future. This is an endeavour that intends to critically foreground present day commitments, assumptions, and activities by looking *backwards in time* from a speculative future. It is a form of speculation that provides the function of navigating the epistemic distance between the immediately observable present and as-of-yet unrealized enactments of future worlds and of providing critique of present-day research activity. This approach overcomes the limitations imposed by current language in conceptualizing new phenomenon and recognizes the contingencies of future technocultural enactments—the future could be otherwise (Frank, 2017).

We begin our development with the assertion that the future is a contested space. It is viewed through multiple lenses for multiple purposes. Organizations want to manage their place in a largely unknown economic landscape of competition and customers. Technologists want to project technological influence and change what is possible into what is preferable. Policy makers and nation states have wide ranging interests from global-scale climate change and local impacts to economies of conflict to social conditions of a populace. There is a long history of futures studies that reveal current interest in accessing the future is grounded in a wide variety of approaches (Markus & Mentzer, 2014; Slaughter, 2021).

A challenge from within the IS domain that provides illustration of this point is the conceptual frontier of "intelligent", semi-autonomous systems working with humans. As the system itself "learns" from its interactions and has its own agency, it would not appear to be a case of a human worker merely using a system. But we currently lack the empirical basis for conceptualizing the human-machine relation (e.g., as a partnership, delegation, friend, colleague, co-author) (Baird & Maruping, 2021; Demetis & Lee, 2018; Grudin, 2017). Here, alternative worlds in which these possible relationships are explicated would enable discussion of when and where useful conceptual distinctions are made as this phenomena becomes prevalent (Frank, 2017; Hovorka & Peter, 2021b). In a similar fashion, alternative worlds would allow for critique of fashionable trends such as the addition of the label *digital* to traditional aspects of IS research—such as, for example, "digital transformation" rather than just "IS-enabled organizational transformation." Increasingly, arguments arise that question whether marking phenomena as *digital* is a distinction that will cease to make sense as more of the world is underlain with digital foundations. For example, Mueller et al. (2021) argue that many phenomena heralded as digital today will soon become mundane and everyday, such that any study of, for example, corporate *digital* responsibility as distinct from any other form of responsibility might no longer make sense (Mueller, 2022).

The plurality and uncertainty of post-digital futures is highlighted by Parmiggiani et al. (2020) who suggest that many such futures are likely not mere extrapolations or projection based on today. We cannot take the trajectories of the past decades for granted, especially when post-digital futures will not be merely technological landscapes, but will be lived worlds with social, political, cultural, and environmental facets too.

In light of challenges like this, the function of speculation is to enable critique because "we are concerned with the future because securing a satisfactory future *may require actions in the present*" (Simon, 1969, p. 184). For instance, and in contrast to projections or predictions of futures that are focused on specific technological enactments, an alternative epistemic approach such as *speculative geographies* enable *forays into futures* as a site of critical inquiry (Hovorka & Peter, 2021a). A key characteristic of speculative geographies is that they speculate *inhabited worlds* (Hovorka & Peter, 2021a). In many existing types of futures-studies (e.g., Markus & Mentzer, 2014), the technological landscape is projected to change but social aspects are *ceteris paribus.* The futures implied in these academic narratives tend to focus on technological or industry aspects and do not disclose the lived-experience of human or more-than-human inhabitants of those futures. The result is often a paradoxical illusion of infinite technological expansion while simultaneously narrowing cultural visions of futures (Appadurai, 2019). For example, power relations and structures of employment, what it is to be human working with artificial intelligence machines, environmental conditions or what counts as knowledge are assumed as self-evident and are thus not problematic. Yet our interest in technological change is not for its own sake but the betterment of human and environmental conditions. What is needed here are new approaches that make visible the technocultural elements—how our present research will bequeath politics, economies, cultures, social relations, and environmental concerns onto our descendants.

There are two specific characteristics of such forays that have not been previously articulated but which are important if they seek to meaningfully critique present action; that is, serve their epistemic function. First,

forays into richly inhabited future(s) position *imagination as organized work within research practices* (Jasanoff & Kim, 2015) rather than as an opposition to 'scientific approaches', unserious or unproductive (Currie, 2021). In this way imagination, expectations, and imaginaries are revealed as legitimate approaches to connecting technology with the production of social order, distributions of power, environmental concerns, and a shared sense of ethics (Jasanoff & Kim, 2015). Second, by refuting the narrative that phenomena are simple and that epistemic simplicity and certainty is a virtue (Achinstein, 2018; Mol & Law, 2002), speculating alternative futures *expands phenomena to scale, includes spatial differentiation* (Haj-bolouri et al., forthcoming), *and provides an approach to overcoming epistemic distance* (Carolan, 2004). By foregrounding the messy complexity of inhabited worlds, we make visible the contingent commitments of present action. The dichotomous prioritization of the technological over the social, and the digital as a substitute for the real obscures the tightly integrated coproduction of present/future worlds. These forays focus on developing the categories with which to *think worlds*.

6. Quality Criteria for Speculation

Although the term speculation infrequently appears in the scientific literature, we have demonstrated that imaginative speculations are common in the sciences. Moving forward, we propose that establishing an approach to assessing the quality of speculations is critical if we are to add it to the epistemic apparatus in IS research.

A first step to quality assessment is attending to its epistemic function. As noted, speculation may be mobilized to develop new research studies, expand conceptual machinery (e.g., theories, new conceptual language, alternative worlds) or hypotheses, or to provide linages among existing bodies of knowledge. Speculation can explicate theories and provide possibility proofs. These are very different *epistemic situations* that require crafting the speculation to meet the intended situation. A speculation regarding a new theory would take a form different from the explication of an existing theory. A speculative digital geography of futures addresses a very different epistemic distance from a speculative explication of specific hypotheses of an existing phenomenon. Each of these examples could be evaluated as fruitful or productive of new thinking that advances research but would do so on a very different basis.

Secondly, the specific domain of research will guide quality evaluations. For example in a design context where a new phenomenon is being created, a design speculation can be assessed in relation to what it reveals about the taken-for-granted assumptions of both the designer and of the person participating in the design process (Dunne & Raby, 2013; Rosner, 2018). Setting industrial design (e.g., commercially oriented and produced with a market orientation) as the contrast class, a knowledge-creation design orientation "acts as a form of critique and argument […] established through the design of objects and the communication of an objects narratives of use" (Malpass, 2017, p. 1).

There are many ways in which speculation can be legitimately criticized. For example, hypotheses may be presented in the wrong functional context (e.g., if it is incorrectly inferred that it is truth-relevant and thus subjected to evidentiary support when it should be understood on the basis of a productive linking of research domains). To strengthen the concept of productive speculation will require that the IS field relinquishes its grip on empiricism and is willing to acknowledge informed, critical engagement. A deeper understanding of the forms and functions of speculation will reduce the tendency to confuse scientific speculation with statements of fact (Currie, 2021).

We have established that speculation is a key aspect of knowledge creation, and we acknowledge that relinquishing the reassuring assumptions of empiricism will not be easy. A key ingredient in this process of establishing the legitimacy of speculation in our scholarly debate will be a discourse on establishing quality criteria. As a start to this discourse, we propose three quality criteria for scientific speculation:

1. ***Identify epistemic function***: for differing epistemic situations, speculations may be supported by evidence. In other situations, they expand research studies, enable new conceptual machinery, or link disparate bodies of knowledge. Accordingly, researchers employing speculation should seek to identify the specific epistemic function of their speculation. Our earlier discussion provides a first list of relevant functions and can thus help to explicate a speculation's specific purpose it must be evaluated against.
2. ***Establish fit in domain of research***: suitability of the speculation for the intended purpose in the research domain. These include but are not limited to, for example, assessing a truth-claim regarding a theory or hypothesis or foregrounding taken-for-granted assumptions in design. Similar to the first quality criterion we suggest above, this second criterion serves as a form of discursive signpost that helps readers and reviewers to appropriately interpret the speculation vis-à-vis the current discourse.
3. ***Provide critique***: the ability of speculations to foreground the genealogy of knowledge, power structures, images of humanity, spatial and temporal distribution, and the epistemic rules of research itself enable surfacing the assumptions underlying the way knowledge is produced, maintained and distributed. This third criterion help to highlight the value of a speculation a researcher engages in, specifically in contrast to other, more conventional methods of inquiry. This criterion should also be seen as an encouragement to

critically engage not only with the subject matter of the speculation, but of the research apparatus itself. That is, speculating researchers should reflect on why speculation as a tool is needed and why more conventional approaches cannot yield the insights their present study contributes.

Clearly, the three criteria we propose here are but an initial impulse for the discussion how speculation is evaluated as a step towards greater recognition and inclusion as an addition to the research apparatus in IS research. The development of a full set of such criteria and their gradual refinement, however, are beyond the scope of our work here for two reasons. First, especially the refinement of these criteria is an activity for which we, as a discipline, will need a richer set of contributions that rely on speculation to assess their quality. Second, quality of studies is not an absolute, objective fact easily measured with some instrument, but must be seen as a function of a discourse process in science (see Hovorka in Bichler et al., 2016).

In the long run, we envision that further engaging with the forms and function of speculation in our research will help the IS community to better grasp what Weick (1989) described as "disciplined imagination." Specifically, a debate on quality criteria for speculation as a form of such disciplined imagination will play a crucial role—similar to what Lee (1991) has done for qualitative research or what Hevner et al. (2004) have done for design science research—in our discipline's progress toward a richer research apparatus.

7. Conclusions

In this work, we have argued that speculation is a fundamental activity and productive object in scientific research. The IS field's focus on empirical research, on theory development, and on theory testing obscures and diminishes the forms and functions imagination and speculation have in research. By identifying these forms, we seek to legitimize and strengthen imagination and speculation as a fruitful activity and as an object of scrutiny in IS research.

This is not to suggest that speculation is always needed, or productive. But multiple forms of speculation provide valuable functions to a greater degree than derogatory accounts of speculation acknowledge. In offering a broader conception of speculation than is commonly recognized, we seek to expand the epistemic apparatus available in IS. In its common forms, researchers speculate prior to seeking evidentiary support. But the functions of speculation are not limited to the relation of speculation to evidence. In the case of design, speculation can enable transformation through the refinement of designed artifacts and systems. Through the use of alternative worlds, such as digital geographies, researchers can return inhabitants of futures to the concerns our present day activities should have for them. In doing so we can develop new relationships to futures and create new epistemic and axiological ways for futures to be accepted, produced, or performed. In the future, by legitimizing speculation and imagination in IS research, we seek to open a pathway to new forms of speculative research apparatuses. Specifically, we offer imaginative alternative futures not as a prediction or articulation of desirable futures but as acknowledgement of the messiness and multiplicity of lived worlds and as an approach for critically appraising current research activities. Just as future worlds are contingent, our current research activities, discursive spaces, conceptualizations, and theories are also contingent. Our current research apparatus and research foci *could be otherwise*. In this way, the future is disclosed as "a profoundly vital component of the present (however defined) or, more fundamentally, a principle of present action" (Slaughter, 1998, p. 372). As a foray into alternative futures, speculative approaches such as digital geographies begin a process of laying out spaces that function as critique as we walk through them. These possible critiques reveal a multiplicity in the way futures are ordered, the logics from which they emerge and the material and discursive practices through which the future is intimately connected to present action.

8. References

Achinstein, P. (2001). *The book of evidence*. Oxford University Press.

Achinstein, P. (2018). *Speculation: Within and about Science*. Oxford University Press.

Appadurai, A. (2019). The Scarcity of Social Futures in the Digital Era. In *Futures*.

Asimov, I. (2004). I, Robot [1950]. *Bantam Dell, New York*.

Baird, A., & Maruping, L. M. (2021). The next Generation of Research on IS Use: a Theoretical Framework of Delegation to and from Agentic IS Artifacts. *MIS Quarterly*, *45*(1), 315-341.

Bichler, M., Frank, U., Avison, D., Malaurent, J., Fettke, P., Hovorka, D., Krämer, J., Schnurr, D., Mueller, B., Suhl, L., & Thalheim, B. (2016). Theories in Business and Information Systems Engineering. *Business & Information Systems Engineering*, *58*(4), 291-319.

Brown, T. L. (2003). *Making Truth: Metaphor In Science*. University of Chicago Press.

Carolan, M. S. (2004). Ontological politics: mapping a complex environmental problem. *Environmental values*, 497-522.

Chandler, J. K., Davidson, A. I., & Harootunian, H. D. (1994). Questions of evidence: Proof, practice, and persuasion across the disciplines.

Cohen, D. H. (1998). If, what-if, and so-what: Mixing metaphors, conditionals, and philosophy. The Paideia Archive: Twentieth World Congress of Philosophy,

Currie, A. (2021). Science & speculation. *Erkenntnis*, 1-23.

Darden, L., & Maull, N. (1977). Interfield Theories. *Philosophy of science*, *44*, 43-64.

de La Bellacasa, M. P. (2011). Matters of care in technoscience: Assembling neglected things. *Social studies of science*, *41*(1), 85-106.

Demetis, D., & Lee, A. S. (2018). When humans using the IT artifact becomes IT using the human artifact. *Journal of the Association for Information Systems*, *19*(10), 5.

Dourish, P., & Bell, G. (2011). *Divining a digital future: Mess and mythology in ubiquitous computing*. Mit Press.

Drazin, A. (2012). Design anthropology: Working on, with and for digital technologies. *Digital Anthropology*, 245-265.

Dunne, A. (2008). *Hertzian tales: Electronic products, aesthetic experience, and critical design* Royal College of Art].

Dunne, A., & Raby, F. (2013). *Speculative everything: design, fiction, and social dreaming*. MIT Press.

Frank, U. (2017). Theories in the light of contingency and change: possible future worlds and well-grounded hope as a supplement to truth. Proceedings of the 50th Hawaii International Conference on System Sciences,

Frank, U. (2021). Language, Change, and Possible Worlds. Crisis and Critique: Philosophical Analysis and Current Events: Proceedings of the 42nd International Ludwig Wittgenstein Symposium,

Friedman, B., & Hendry, D. G. (2019). *Value sensitive design: Shaping technology with moral imagination*. Mit Press.

Grudin, J. (2017). From tool to partner: The evolution of human-computer interaction. *Synthesis Lectures on Human-Centered Interaction*, *10*(1), i-183.

Haack, S. (2019). The art of scientific metaphors. *Revista portuguesa de filosofia*, *75*(Fasc. 4), 2049-2066.

Haj-bolouri, A., Conboy, K., & Gregor, S. (forthcoming). An Encompassing Framework for Conceptualizing Space in Information Systems: Philosophical Perspectives, Themes, and Concepts. *Journal of the Association of Information Systems*.

Hassan, N. R., Lowry, P. B., & Mathiassen, L. (2022). Useful Products in Information Systems Theorizing: A Discursive Formation Perspective. *Journal of the Association for Information Systems*, *23*(2), 418-446.

Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). Design Science in Information Systems Research. *MIS Quarterly*, *28*(1), 75-105.

Hirschheim, R., & Newman, M. (1991). Symbolism and Information Systems Development: Myth, Metaphor and Magic. *Information Systems Research*, *2*(1), 29-62.

Holton, G. J. (1998). *The scientific imagination: with a new introduction*. Harvard University Press.

Hovorka, D. S., & Peter, S. (2021a). Research Perspectives: From Other Worlds: Speculative Engagement Through Digital Geographies. *Journal of the Association for Information Systems*, *22*(6), 1736-1752.

Hovorka, D. S., & Peter, S. (2021b). Speculatively Engaging Future(s): Four Theses. *Management Information Systems Quarterly*, *45*(1), 461-466.

Huxley, A. (2004). *A Brave New World: Revisted*. Vintage Books.

Ingold, T. (2021). *Imagining for Real: Essays on Creation, Attention and Correspondence*. Routledge.

Jasanoff, S., & Kim, S. H. (2015). *Dreamscapes of modernity: Sociotechnical imaginaries and the fabrication of power*. University of Chicago Press.

Kaplan, E. K. (1972). Gaston Bachelard's philosophy of imagination: An introduction. *Philosophy and phenomenological research*, *33*(1), 1-24.

Kendall, J. E., & Kendall, K. E. (1993). Metaphors and methodologies: Living beyond the systems machine. *MIS quarterly*, 149-171.

Kind, A. (Ed.). (2018). *How imagination gives rise to knowledge*. Oxford University Press.

Kuhn, T. S. (1962). *The Structure of Scientific Revolutions* (3rd ed.). University of Chicago Press.

Kuhn, T. S. (1963). The function of dogma in scientific research. In A. C. Crombie (Ed.), *Scientific Change Historical Studies in the Intellectual, Social and Technical Conditions for Scientific Discovery and Technical Invention, From Antiquity to the Present: Symposium on the History of Science, University of Oxford, 9-15 July 1961."*. Heineman Educational Books.

Lakoff, G., & Johnson, M. (1980). *Metaphors We Live By*. University of Chicago Press.

Larsen, K. R., Lukyanenko, R., Mueller, R. M., Storey, V. C., VanderMeer, D., Parsons, J., & Hovorka, D. S. (2020). Validity in design science research. International Conference on Design Science Research in Information Systems and Technology,

Law, J. (2004). *After method: Mess in social science research*. Routledge.

Leclercq-Vandelannoitte, A., Isaac, H., & Kalika, M. (2014). Mobile information systems and organisational control: beyond the panopticon metaphor? *European Journal of Information Systems*, *23*(5), 543-557.

Lee, A. S. (1991). INTEGRATING POSITIVIST AND INTERPRETIVE APPROACHES TO ORGANIZATIONAL RESEARCH. *Organization Science*, *2*(4), 342-365.

Lennon, K. (2015). *Imagination and the Imaginary*. Routledge.

Levy, A., & Godfrey-Smith, P. (2019). *The scientific imagination*. Oxford University Press.

Mager, A., & Katzenbach, C. (2021). Future imaginaries in the making and governing of digital technology: Multiple, contested, commodified. *New Media & Society*, *23*(2), 223-236.

Malpass, M. (2017). *Critical design in context: History, theory, and practices*. Bloomsbury Publishing.

Marcus, G. E. (1995). *Technoscientific imaginaries: Conversations, profiles, and memoirs* (Vol. 2). University of Chicago Press.

Markus, M. L., & Mentzer, K. (2014). Foresight for a responsible future with ICT. *Information Systems Frontiers*, *16*(3), 353-368.

Mol, A., & Law, J. (2002). Complexities: an introduction. In *Complexities* (pp. 1-23). Duke University Press.

Mueller, B. (2022). Corporate Digital Responsibility. *Business and Information Systems Engineering*, *64*(5), 689-700.

Mueller, B., Diefenbach, S., Dobusch, L., & Baer, K. (2021). From Becoming to Being Digital: The Emergence and Nature of the Post-Digital. *i-com*, *20*(3), 319-328.

Murphy, A. (2022). Imagination in science. *Philosophy Compass*, *17*(6), e12836.

Parmiggiani, E., Teracino, E. A., Huysman, M., Jones, M., Mueller, B., & Mikalsen, M. (2020). OASIS 2019 Panel Report: A Glimpse at the 'Post-Digital'. *Communications of the Association for Information Systems*, *47*, 583-596.

Peter, S., Riemer, K., & Hovorka, D. S. (2020). *Artefacts from the Future - Engaging Audiences in Possible Futures with Emerging Technologies for Better Outcomes* Twenty-Eighth European Conference on Information Systems, Marrakesh, Morocco.

Poole, M. S., Van de Ven, A. H., Dooley, K. J., & Holmes, M. (2000). A Typology of Process Theories. In M. S. Poole, A. H. Van de Ven, K. J. Dooley, & M. Holmes (Eds.), *Organizational Change and Innovation Processes: Theory and Methods for Research* (pp. 56-88). Oxford, UK.

Poon, P., & Wagner, C. (2001). Critical success factors revisited: success and failure cases of information systems for senior executives. *Decision Support Systems*, *30*(4), 393-418.

Popper, K. (1959). *The Logic of Scientific Discovery*. Routledge.

Rogers, G. (2021). *Speculation: A Cultural History from Aristotle to AI*. Columbia University Press.

Rosner, D. K. (2018). *Critical fabulations: Reworking the methods and margins of design*. MIT Press.

Rubinstein, I. S., & Good, N. (2013). Privacy by design: A counterfactual analysis of Google and Facebook privacy incidents. *Berkeley Tech. LJ*, *28*, 1333.

Sarker, S., Chatterjee, S., Xiao, X., & Elbanna, A. (2019). The Sociotechnical Axis of Cohesion for the IS Discipline: Its Historical Legacy and its Continued Relevance. *MIS quarterly*, *43*(3), 695-719.

Schön, D. A. (1993). Generative metaphor: A perspective on problem-setting in social policy.

Schultze, U. (2017). What kind of world do we want to help make with our theories? *Information and Organization*, *27*(1), 60-66.

Schultze, U., & Orlikowski, W. J. (2001). Metaphors of virtuality: shaping an emergent reality. *Information and Organization*, *11*(1), 45-77.

Shelley, M. (2018, 1818). *Frankenstein: The 1818 Text*. Penguin Classics.

Simon, H. A. (1969). Social planning: Designing the evolving artifact. In *The Sciences of the Artifical* (pp. 139-167). MIT Press.

Slaughter, R. A. (1998). Futures studies as an intellectual and applied discipline. *American Behavioral Scientist*, *42*(3), 372-385.

Slaughter, R. A. (2021). Stumbling towards the light: Four decades of a life in futures. *Futures*, *132*, 102794.

Sullivan, R., Hannon, O., & Hovorka, D. S. (2023). *Embracing Absence: Researching What is Not There* International Conference on Information Systems, Hyderabad, India.

Swedberg, R. (2021). Does speculation belong in social science research? *Sociological Methods & Research*, *50*(1), 45-74.

Taylor, C. (2004). *Modern social imaginaries*. Duke University Press.

Taylor, C., & Dewsbury, B. M. (2018). On the problem and promise of metaphor use in science and science communication. *Journal of microbiology & biology education*, *19*(1), 19.11. 40.

Thakurta, R., Mueller, B., Ahlemann, F., & Hoffman, D. (2017, January 4-7). *The State of Design – A Comprehensive Literature Review to Chart the Design Science Research Discourse* 50. Hawaii International Conference on System Science (HICSS 2017), Waikoloa, HI, USA.

Trice, H. M., & Beyer, J. M. (1984). Studying Organizational Cultures Through Rites and Ceremonials. *Academy of Management Review*, *9*(4), 653-669.

Ward, M. (2011). Souvenirs from the Future: The Role of Image Making in Speculative and Critical Design.

Weick, K. E. (1989). Theory construction as disciplined imagination. *Academy of Management Review*, *14*(4), 516-531.

Weick, K. E. (2006). The role of imagination in the organizing of knowledge. *European Journal of Information Systems*, *15*, 446-452.