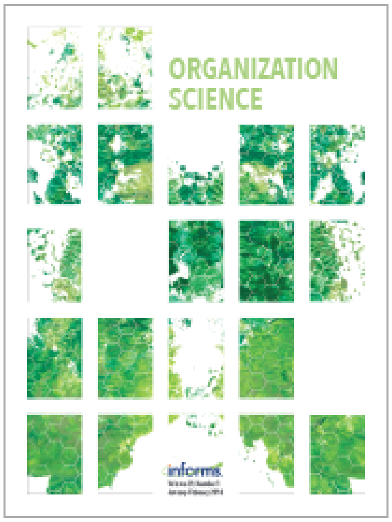

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We Are All Theorists of Technology Now: A Relational Perspective on Emerging Technology and Organizing

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Abstract. Technologies are changing at a rapid pace and in unpredictable ways. The scale of their impact is also far-reaching. Technologies such as artificial intelligence, data analytics, robotics, digital platforms, social media, blockchain, and 3-D printing affect many parts of the organization simultaneously, enabling new interdependencies within and between units and with actors that many organizations have typically considered to be outside their boundaries. Consequently, today's emerging technologies have the potential to fundamentally shape all aspects of organizing. This article introduces the special issue "Emerging Technologies and Organizing." We treat these new technologies as "emerging" because their uses and effects are still varied and have yet to stabilize around a recognizable set of patterns and because the technologies themselves are, by design, always changing and adapting. To theorize the relationship between emerging technologies and organizing, we draw on relational thinking in philosophy and sociology to develop a relational perspective on emerging technologies. Our goal in doing so is to create a new way for organizational scholars to incorporate the ever-increasing role of technology in their theorizing of key organizational processes and phenomena. By developing a relational perspective that treats emerging technologies not as stable entities, but as a set of evolving relations, we provide a novel way for organizational scholars to account for the role of technology in their topics of interest. We sketch the outlines of this relational perspective on emerging technologies and discuss the implications it has for what organizational scholars study and how we study it.

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We offer this special issue on emerging technologies and organizing—and this conceptual article that sets the stage for it—as scaffolding for organization scholars to grapple with the coconstitution of emerging technologies and organizing and in so doing to extend their own theorizing about organizations and the activities of the people working within them. In particular, we invite scholars who typically keep technology in the background or consider it peripheral to their studies to find approaches for theorizing how emerging technologies are intertwined with their phenomena of interest. We also invite scholars who foreground technology to consider how the approaches offered in this special issue can help them to engage more deeply in conversations across a range of organizational processes. We make these specific invitations because emerging technologies are increasingly infusing everything that happens within and around organizations.

Technologies such as artificial intelligence, data analytics, robotics, digital platforms, social media, blockchain, and 3-D printing are reshaping human action and interaction. Many of these technological advances carry with them new opportunities and constraints for organizing. Increasingly, these technologies incorporate the ability to learn and act autonomously in ways that mirror human intelligence and, thus, make them different from most technologies historically used in organizations. From organizational boundaries to employment relationships to individuals' identification with organizations, these technologies are increasingly deployed in almost every process, form, and condition for organizing; their adoption and use are thereby calling into question our fundamental theories and ideas about organizations and organizing. At the dawn of this age of the proliferation of data-intensive, modular, and intelligent technologies, we are increasingly in need of new theories of organizing that do not simply account for or acknowledge that technologies are affecting organizational action, but that recognize that technology occupies a central and constitutive role in the organizing process.

Technologies have always carried with them the seeds of change. For example, the technologies of writing, the assembly line, and the personal computer have long been recognized as having a large societal impact and at the same time always emerging in the sense that they have never been "complete" or stabilized for long. Through product cycle enhancements and user modifications, these technologies' underlying components, configurations, and arrangements are always in a state of flux (Henderson and Clark 1990, Baldwin and Clark 2000, von Krogh et al. 2003). Whereas organizations have always had to manage the emergence of new technologies during the last century, the associated changes have often taken the form of *internal* change (e.g., the disk drive, CPU, and keyboard in the laptop changed). By contrast, the data-intensive and intelligent technologies that are proliferating across organizations today are entwining human participants in more intimate and complex relations. These new technologies combine data and other inputs with the digital exhaust, or trace data, from organizational processes and human actions at an unprecedented scale and detail. Changes in these data sources affect the way the technology works and what it is able to do. Thus, today's technologies emerge through a set of expanded relations and continue to emerge in new ways as those relations evolve. We offer three arguments as to why these differences matter for organizing.

First, current emerging technologies—although still in their infancy—are becoming increasingly autonomous and intelligent and, thus, carry the possibility of supplementing or replacing human cognition and action. Such technologies continuously acquire knowledge and skills, possibly operating autonomously or in concert with humans. Current developments in such areas as robotics, machine learning, deep learning, autonomous vehicles, smart sensors, intelligent diagnostics, augmented reality, data analytics, additive manufacturing, and immersive environments are leading to the emergence of intelligent technologies that could someday mimic or possibly outperform humans in a wide variety of skilled and cognitive acts. For example, emerging technologies are increasingly performing work such as collecting and processing information; dividing, assigning, and integrating tasks; allocating resources; and making decisions (Faraj et al. 2018, von Krogh 2018, Leonardi and Treem 2020). This ability to learn and act autonomously makes emerging technologies very different from most technologies historically used in organizations.

Second, by using digital exhaust generated by the digital applications that increasingly control and at times govern our social, consumer, and work lives, emerging technologies permit new forms of backend analytics that greatly enlarge the reach of organizations in tracking, monitoring, deciphering, and directing the behaviors of individuals and groups. Social media sites collect comprehensive trace data about people's activities, preferences, and interactions. Platform work sites capture an array of worker performance information, such as number of accepted jobs and client ratings of work (Lazer and Radford 2017, Rahman 2021); employers of truck drivers, warehouse workers, and retail clerks, among others, minutely track workers' activities and transactions (Levy 2015); wellness programs encourage the use of fitness wearables that extend data collection to workers' exercise and health habits (Ajunwa et al. 2017); and all manner of organizations gather detailed performance data in the background through employees' and customers' use of computer and software systems (Leonardi 2021). The result is an increasing transparency of work processes and quantification of work outcomes, prompting a rise in audit cultures and the use of metrics within organizations and culminating in what Zuboff (2019) insightfully labeled surveillance capitalism.

Third, emerging technologies enable new possibilities for innovation and collaboration within and across organizations (Malone 2004, von Krogh and von Hippel 2006, Faraj et al. 2016, Kane et al. 2019, Davis and Sinha 2021, Faraj and Pachidi 2021). How, when, and where work gets done as well as by whom and for whom are rapidly evolving, leading to the creation of new business models (e.g., new employment arrangements via platforms whose algorithms enable the short-term contractual engagement of independent contractors). As people and organizations are afforded new forms of collaboration and coordination, such as nonhierarchical, boss-less, or agile organizations as well as open innovation, open science, network organizations, and meta-organizations, they accelerate the recombination of ideas and development of novel products and processes (e.g., Lanzolla et al. 2020, Majchrzak et al. 2021). They also rapidly disrupt existing market and industry structures (e.g., Menz et al. 2021). Moreover, organizational boundaries become increasingly porous: in many cases, the ideas and knowledge that prove most relevant for innovation reside without, not within, a focal organization. Overall, these new forms of collaboration erode traditional epistemic, organizational, intellectual property, and national boundaries. At the same time, geography can take on greater importance as local, civic, and financial actors attempt to develop clusters of innovation, some based on regional strengths, some based on novel technology, and some marrying both (Cohendet and Simon 2016).

With the potential for such changes in relations and scope, new questions arise about how organizing can and should happen in the future, including questions related to ecosystems, networks, business models, coordination, control, communication, hierarchy, professional roles and boundaries, socialization, practices, and much more. The articles in this special issue expertly develop new theory and most empirically demonstrate just how integral emerging technologies are becoming to the phenomena that organizational scholars care about. Studies, for example, demonstrate how employees are controlled, how they find meaning through work, and how they collaborate to create value, all of which is changing with digital platforms (Cameron 2022, Cameron and Rahman 2022, Lin and Maruping 2022). The special issue studies also show how decision making and prediction are transforming in the face of AI and machine learning algorithms (Waardenburg et al. 2022) as well as what it means to be an expert or to have expert judgment (Choudhury and Allen 2022, Lebovitz et al. 2022). The papers also tell us the ways in which organizations are held accountable for their actions and by whom and how this is recast with social media (Karunakaran et al. 2022). We learn about how military drones change what it means to work remotely (not just from home, but from half a world away and while embedded in a completely different context) and with what consequences (Rauch and Ansari 2022).

More broadly, emerging technologies are pushing us to reimagine central phenomena in organization studies. For example, data that once served in the background to support management, when clustered into data objects, such as user profiles or machine representations, now take center stage in processes of knowing in organizations (Alaimo and Kallinikos 2022). Similarly, given the far-reaching role that digital technologies play in affecting the trajectory of our economy and society, the linkages between technology, organization, and public policy are increasingly implicated when deciding about the deployment of emerging technologies (Bodrožić and Adler 2022). A promising way to approach how organizations can take new paths with the new actions afforded by emerging technologies is to build on new analytical methods (Pentland et al. 2022). The spread of emerging technologies across most if not all realms of organizational phenomena, as highlighted by these studies, suggests the need to engage more deeply with technologies both theoretically and empirically, and in doing so, all organizational scholars must become, to a certain extent, theorists of technology.

In showing the ways that emerging technologies are becoming core components of diverse organizational processes and practices (and by developing novel theory about how, why, and under what conditions these technologies play such a constitutive role), the articles in this special issue do not simply treat emerging technologies as objects around which organizational action occurs. Instead, they show that emerging technologies are relational in the sense that the organizational actions they enable or constrain are dependent upon the components of the technology, the external data sets from which they draw and to which they contribute, the rules that govern their usage, the people who deploy them in their work, and a host of other entities that are themselves defined by multiple relations. Moreover, the articles make clear that the relations into which emerging technologies enter are altered and often expanded from what they were previously.

In addition to the theoretical advances of each of these articles and taking as our focus these changing and expanding relations, we develop a relational perspective that complements the articles in the special issue and provides a conceptualization of and vocabulary for studying organizing and emerging technologies. This perspective allows organizational scholars of all stripes to identify and theorize the role emerging technologies play in their own program of research. Although not new to organizational scholarship, such relational thinking has become more important given the types of transformations we describe. We build upon the broader relational turn in the social sciences and the move toward a process metaphysics approach in philosophy. From this foundation, we develop, abductively, a set of concepts for organization scholars to begin theorizing and empirically studying emerging technologies. We apply our abductive reasoning by illustrating these concepts and building our relational perspective in a context unfamiliar to most organizational scholars: apple production. We chose apple production (which includes growing, harvesting, processing, and distributing apples) specifically because it seldom appears in organization studies and is, thus, free from the baggage of prior interpretation. Yet it is a context characterized by multiple forms of organizing and rapid technological change. The case of apple production helps us to demonstrate how a move to seeing from a relational perspective can enable scholars to study emerging technology in a broad array of empirical domains.

Theorizing Emerging Technology and Organizing: Relational Foundations

In recognition of these fundamental shifts and to move theory and research in the direction of conceptualizing organizational processes and phenomena as fundamentally entwined with technology, we offer a relational perspective for studying technology and organizing. At the highest level, the argument is simple: rather than viewing technologies as fixed entities in fixed relations, we offer that it is more fruitful to approach them as made up of relations and entwined in relations that are constantly evolving. By evolving we mean, first, that all the "things" we might call technologies, such as robotics and 3-D printers, are themselves constituted by multiple underlying technologies that exist in relation to each other. Over time, the set of constituent technologies may change; for example, some technologies may undergo improvements, and others may drop out of the relations, possibly to be replaced by novel ones. Second, technologies exist in relation to many other entities that we would not typically think of as technological, such as people, data sets, routines, policies, and norms. An important aspect of currently emerging technologies, compared with those in past technological waves, is that the set of relations in which they are entwined tends to be large and expanding. We argue that the magnitude of the relational possibilities, in combination with their dynamism, means that emerging technologies are increasingly brought into constitutive relations with key organizational processes.

One way to move toward a processual view of technology and organizing is to stop focusing on technologies as stand-alone objects and instead focus on the relations through which technologies are constituted and through which they interact with other processes and entities around them. We approach technology from the perspective that all of the things we recognize in our everyday lives as entities are constituted by relations. Because relations are always in flux, entities are never stable. In some ways, it is a misnomer to call them "entities" (because the term connotes stability), yet doing so is useful for conversational brevity so long as we remember that an entity is shorthand for a set of evolving relations. Thus, in the case of technology, all technologies are constituted by evolving relations such that technologies are always emerging.

This move to conceptualize technology as a set of relations among entities follows the process metaphysics movement in philosophy and the relational turn in sociology. Rescher (1996, p. 2), a process philosopher (along with Whitehead and others) argues that "process has primacy over things. Substance is subordinate to process: Things are simply constellations of processes." Rescher (1996, p. 38) defines a process as "a coordinated group of changes in the complexion of reality, an organized family of occurrences that are systematically linked to one another either causally or functionally." Rescher (1996, p. 47) notes that the relations among entities (things) are what give those things their meanings: "The fact is that all we can ever detect about 'things' relates to how they act upon and interact with one another—a substance has no discernible, and thus no justifiably attributable, properties save those that represent responses elicited from interaction with others."

Such a processual view implies that to understand the things we think of as technologies and the role they play in the organizations that design, produce, and use them, we need to focus on the relations that constitute them. Adopting such a processual view, Emirbayer (1997) argues persuasively for a relational perspective on social action, suggesting that the very terms or units involved in a relation derive their meaning, significance, and identity from the changing functional roles they play within that relation. The relation, which is a dynamic, unfolding process, becomes the primary unit of analysis rather than the constituent entities themselves.

Relations in Technology Studies

A long history of technology studies within organizations shows that one important set of relations occurs between the technology and the social context in which it is used. Historians and sociologists of technology have long noted that technology is not an independent force impacting society, but rather, it is a product of human action and societal pressures (e.g., Winner 1986, Smith and Marx 1994). Technologies mirror society, and their trajectory is beholden to a complex interplay of political, economic, institutional, and occupational pressures (e.g., Bijker and Law 1994, Jasanoff 2016). Organizational scholars working in this area urge us to consider technologies as "social objects" (Barley 1990) or as "technologies-in-practice" (Orlikowski 2000) in that the same technology can be used differently and to different effects. Technology-focused organizational scholars have come to accept that technology's material and social aspects are entwined or entangled in a complex set of coconstitutive relations and that together they can perform the modern organization (Boudreau and Robey 2005; Zammuto et al. 2007; Orlikowski and Scott 2008, 2014; Leonardi 2011; Barrett et al. 2012; Mutch 2013; Cecez-Kecmanovic et al. 2014; von Krogh 2018; Leonardi et al. 2019). Whereas these researchers have debated the extent to which the relation between the social and the material is ontologically separable or performative, they generally view technology as an emergent and entangled force in understanding both the constitution of organizations and how organizing transforms.

Technologies exist within and are inseparable from the relations with the people and organizational and institutional contexts in which they are developed, implemented, and used (Rodriguez-Lluesma et al. 2021).

Scholars studying innovation provide another lens through which relations matter: how the relations between components enhance innovation processes or produce technological change. As Arthur (2009) asserts, complex technologies are based on a combination of subassemblies that are themselves technological components. Technology evolves as these technological components are fine-tuned or replaced by higher performance ones. Mastering technological complexity requires that components be designed independently and integrated into a working whole (Henderson and Clark 1990). This focus on modularity as a design principle emphasizes that "structural elements are powerfully connected among themselves and relatively weakly connected to elements in other units" (Baldwin and Clark 2000, p. 63). It also links back to organizational design theories in which a goal is to encapsulate relations of dependency within organizational units that are then linked with other units via specific coordination mechanisms (see Thompson 1967). Today's emergent technologies take modularity a step further in allowing users and external stakeholders to customize or initiate a change in the technology's features or functions. For example, by allowing plug-and-play access, APIs facilitate the formation of new relations and collaborative possibilities with the result being more open access and architecture for both technology products and processes (Parker et al. 2016, Baldwin 2019).

Taken together, this prior research on technology and organizing has made two key contributions. First, technology studies within organizations point to the increasingly complex entwining between people and the technologies on which they rely. These studios tell us that viewing technologies as entities that are autonomous objects that are only tied to the social environment via use relations is no longer productive. Today emerging technologies accentuate this point as they generate myriad new types of possible relations between people, technology, and organizing. Now, technologies are increasingly enacted—they come into being and have meaning in the world—through these relations. Second, these studies demonstrate that technologies are not monolithic or black-boxed: any nontrivial technology is best represented via its constitutive relation to its subsystems and increasingly through its relations to external technologies. When you peel back the physical casing of a laptop, you see that the technology we treat as an entity is really no more than a collection of other entities (components) placed in relation to one another in particular ways. Of course, those entities are not monolithic either; they comprise more entities in relations—all the way down to the smallest, indivisible components. As actor–network theorists recognize, entities affect the world via their relations and how these relations are mobilized (Callon 1986, Latour 2005).

We argue that existing theories are insufficient to explain the magnitude and dynamism of relational possibilities involving emerging technologies. Thus, frameworks that were once useful for explaining technology and organizing may be too limited to explain the rich and expansive set of relations that occur with emerging technologies, thus limiting a comprehensive understanding of key organizational processes. By foregrounding relations, we advocate for decentering of technology as a stand-alone object and instead emphasize the coconstitution of technology and the various organizing processes with which they are engaged. We do so by offering a framework that allows for a more comprehensive understanding of key organizational processes by accounting for the constitutive role of technology in them.

Entities, Relational Functionality, Constellations of Relations, and Relational Dynamics

To provide a starting point for organization scholars to begin theorizing and empirically studying emerging technologies using a relational perspective, we offer four concepts: entities enacted in relations, relational functionality, constellations of relations, and relational dynamics. These concepts are not by any means comprehensive, but are sufficiently varied and expansive to capture the units, levels of analysis, and dynamics that are essential components of a relational perspective. First, we discuss the concept of an entity, arguing that entities, such as technology or human beings, can be viewed as made up of relations or in relation to each other.[1] The second concept, *relational functionality*, specifies the functions that exist or are potential within the relation rather than the presence of a relation between entities; an example of such a function is providing remote maintenance. Thus, rather than emphasizing the presence of relations, relational functionality emphasizes how entities act or react to serve their own or other entities' needs. Once we shed light on how entities relate by the functions they perform, we scale up and specify the third concept, *constellations of relations*. We talk about constellations of relations rather than "systems," "networks," or "webs" because these terms carry with them narrower ontological assumptions and theoretical associations. This concept depicts complex compounding of relations, such as those found among humans, machines, and organizations in production and the boundaries those compounding relations create toward other constellations of relations. For example, the constellation of relations that defines an autonomous vehicle is broader and more diverse than that of traditional vehicles as modern-day vehicles continuously interact with each other, applications such as navigational software, transportation databases, and more. The fourth concept, *relational dynamics*, captures the continuous transformations within constellations of relations as entities get introduced or discarded in those constellations, as novel relations between entities are discovered, as new functions are performed in existing or new relations, and so forth. To illustrate these concepts, we work through an example from agriculture, a rich and underresearched domain within organization science; specifically, we draw upon apple production.

Apple Production

The size and standing of the apple industry make apple production a robust example for our purposes. Because its organization varies greatly by country, we focus on the United States, but we suspect that many of the dynamics that we describe will resonate with other apple-producing countries as well as other tree and field crops. In the United States, the organization of apple production has been relatively stable for more than a century. Farmers grow apples in orchards, harvesting the crop with the help of seasonal labor. At processing facilities, harvested apples are sorted into grades and packed for transport to large customers and fruit brokers (who distribute to small customers). Cold storage facilities hold much of the crop for later release. State apple associations market the state's crop, and licensing groups govern sales of restricted-use cultivars. Academics, many in land-grant institutions, develop new cultivars (i.e., new apple varieties) as well as new production methods and technologies. Private companies sell equipment, pesticides, and other treatments. The U.S. government oversees food and worker safety, environmental protections, and the H-2A visa program for temporary workers.

Although the organization of apple production has been stable, technology has seen ongoing change. Whereas. in the past. bags, bins, ladders, and tractors comprised the technological suite, today's arsenal includes drones and spectral imaging technologies that monitor plant health, deliver treatment such as fertilizer to selected plants, and keep bad products from entering the supply chain. Robotic pickers under trial employ mechanical arms, computer vision, and learning algorithms to pick only ripe apples. Sensors collect data for soil analyses, pest and water management, crop damage, and environmental monitoring. At processing facilities, computer vision technologies aid in sorting and grading apples; similarly, sensors provide data for management of cold storage facilities. Software platforms at the tail end of apple production serve as seamless intermediaries between growers and large buyers.

Entities Enacted in Relations

A traditional approach to studying emerging technologies and organizing focuses on entities, often with the aim of understanding how work is accomplished, by whom, and with what broader effects following a new technology's introduction. For example, an inquiry might investigate changes in individual roles, occupational status, or interactions across organizational units that arise in the wake of the use of the new technology. This entity focus foregrounds the particular features of the new technology that distinguish it from the technologies it replaces to better understand how differences in form and function (e.g., interface and interaction) shape outcomes. Such studies also, most likely, consider how workers and managers, through their work practices and decisions, shape how, when, and if these new features are utilized (and possibly altered). In short, the traditional approach most commonly asks what the effects of new technology introduction are and places the technology in the center of the inquiry's focus.

Adopting a relational perspective aims to alter and expand this technology-centered, entity-focused approach by considering a broad range of entities beyond technology as a thing and bringing into focus the other relations and actors that are now involved. Specifically, a relational perspective implies that any phenomenon (object, idea, event, activity) depends on the connections in which it is embedded (Bradbury and Lichtenstein 2000, Feldman et al. 2016). A relation, broadly understood, specifies how two or more entities are connected and, through this connection, how they constitute a phenomenon. In this sense, entities are defined not so much by their features as by their behavior and the services they render in relation to other entities. This capacity to behave and serve may depend on an entity's knowledge of other entities, interfaces, or scripts that enable it to connect (Tilly 1998; see precursory ideas in Simmel 1906) and is enacted as relations to other entities commence, evolve, and solidify, at least temporarily, into mutual exchanges. For example, the activity of "apple production" arises in part from relations between the apple, the weather, and the farmer: the farmer plants and tends the trees on which the apples grow, the weather in a given year interacts with crops and crop yields, and the farmer or laborer harvests the apples at the end of the season. This way of "seeing" relations invites an examination of the various functions that entities perform within their relations. We turn to this issue next.

Relational Functionality

Relational functionality signifies that entities in a relation offer one or more functions (e.g., production, economic, physical, or support function) and, thus, can open up action possibilities. Entities derive "meaning, significance, and identity from the (changing) functional roles they play" within the relation (Emirbayer 1997, p. 287), and they may be in multiple relations at one time. The idea of marrying a relational perspective of entities with the functions they perform in those relations has roots in the relational sociology of Norbert Elias (1991). However, an important difference is that we consider a broad array of entities and relations rather than relations between humans only.

Relational functionality abounds in the context of apple production. For example, human pickers strap canvas bags to their bodies to hold the apples that they remove from the tree. The relation among the bags, pickers, and apples offers a physical function in which the bags' design (i.e., their shape, size, and material) protects the picked apples from bruising and allows movement on the part of the pickers. The bag–picker combination is simultaneously in a relation with apple trees and wooden or plastic bins; this relation provides a production function in transmitting apples from the trees to the bins. Bags are in an economic relation as well: farmers purchase the bags from vendors and equip their pickers with them. None of the bags' relations, however, breach the orchard; specifically, they do not extend to the processing facility, thus serving as a reflection or reinforcement of the organizational boundary separating orchards from processing facilities. We deepen this point on boundaries as we discuss constellations of relations.

Clearly, today, neither bags nor bins are emerging technologies.[2] However, both technologies remain in widespread use in apple production today (whereas many others have come and gone) and what we see in the examples to come is a technological scaffolding that builds upon bags and bins, a scaffolding that spikes sharply in size and scope as emerging technologies, many of them data-driven, breach the orchard's boundaries and bring apple farmers and apples into an array of new relations. Distinguishing functions and relations in the way we exemplify facilitates theorizing and empirically examining such increasingly complex relations. In the case of apple production, the introduction of the trellis system,[3] which U.S. apple growers began implementing in earnest in the 1990s and which came to serve as the foundation for much of the technological scaffolding we see today, provides a good example of at least two traits of relations—interchangeability and dynamics—that speak to flexibility in relations and that allow us to deepen our theorizing on the fundamental interplay among entities, relations, and functions.

Interchangeability. Interchangeability arises when a single relation between entities serves multiple functions. For example, the relation between apple trees and trellis systems serves at least three functions. First, for the tree's fruit, the trellis system provides greater access to sunlight, which prompts better and healthier growth, thus serving a quality function. Second, because trellises keep tree branches closer to the ground, ground-based pesticide blowers no longer need to aim for high canopies; thus, trellis systems serve an environmental sustainability function by reducing the amount of pesticide required. Third, rows of equally spaced trellises featuring linearly growing apples serve a productivity function by literally setting the stage for mechanized platforms that can move easily among the trellised rows, raising and lowering as many as six human pickers who need not reach deep into a tree canopy to retrieve higher fruit.

Interchangeability is also evident when one function is fulfilled by different relations. For example, in apple production, mechanized platforms eliminate human pickers' need for ladders, but individual human pickers working independent of a platform may still employ ladders. Thus, we see that a single function (apple picking) can be performed through at least two relations: apples, human pickers, and mechanized platform or apples, human picker, and ladder.

Dynamics. In addition to featuring interchangeability, relations are dynamic, which similarly arises in at least two manners. First, entities in a relation may see their function change over time as the relation evolves (Orlikowski 1996, Leonardi 2007). This dynamic may be best understood as a process in which prior relations give rise to new relations and functions as exemplified by the growing scaffolding in apple production. Specifically, the entity of the mechanized platform, whose presence is made possible by the trellis system, is slowly seeing its function change in its relation to apples and human pickers. Originally, this relation enabled a single function (picking apples). But new efforts in research and development are adding emerging technologies in the form of GPS and computerized vision systems to create self-driving, mechanized platforms. Self-driving platforms free up the first human picker on the team to simply pick, not pick and drive. With the addition of these emerging technologies, the mechanized (and now digitized) platform begins gathering data that may prompt new functions and relations. For example, to automate driving, the platform uses computerized vision to see how densely apples appear in the upcoming branches so as to speed up or slow down its pace (it presumes the pickers pick at a steady pace). These branch-density maps may prove useful for university researchers seeking to improve crop quality, land yields, or harvesting time. They may also aid technology developers seeking to improve picking technology, pesticide application, and the like. Hence, the same relation between apples, six human pickers, and a platform may soon have multiple functions—not a single one.

Second, and perhaps more simply, entities in a relation may be replaced in ways that preserve functions as when a new technology replaces an older one. The trellis system offers at least two examples of replacing entities in relations: dwarfed trees replaced "lollipop" canopy trees and mechanized platforms replaced ladders.

In addition to illustrating flexibility in relations and functions, the trellis system, with its many current and forthcoming changes in functions and relations, serves to expand what we next wish to examine, namely, constellations of relations.

Constellations of Relations

Our aim is to best conceptualize the unfolding and dynamic interactions that we foresee arising between emerging technologies and organizing, which requires that we account for a mix of various entities as well as how these entities may dynamically interact. First, we talk about a constellation of relations rather than systems, networks, or webs that carry with them prior ontological assumptions and theoretical associations that would prevent us from laying clear new ground for the concepts to follow. A constellation of relations emerges among a mix of entities with varied rather than unified qualities. These entities may include, but are not limited to, mechanical tools, digital devices, algorithms, raw and manufactured products, locations, buildings, individuals, organizations, and communities. Our examples thus far demonstrate this range of entities through the presence of apples, farmers, trees, human pickers, bags, bins, bag vendors, orchards, processing facilities, ladders, trellis systems, pesticide, ground-based blowers, mechanized platforms, and platform vendors. Apple production features many more entities, including robotic pickers, computer vision, machine learning algorithms, drones, spectral imaging technologies, sensor software platforms, seasonal workers, hiring agents, fruit brokers, grocery stores, cold storage facilities, apple associations, university researchers, cultivars, chemical companies, equipment vendors, and the U.S. government. The apple industry, thus, reflects a wide range of entities within a single constellation of relations offering a primary function that differentiates it from that of other industries or systems: to grow apples and bring them to consumers.

At first glance, this conjecture of constellations of relations becoming increasingly differentiated over time through the distinctive relations they compound resembles the social systems theory of Niklas Luhmann (1995) and earlier structural functionalist work in sociology (e.g., Durkheim 1947, Parsons 2013; see Schnore 1958). However, structural functionalism tends to assume that entities and relations represent stable traits of social systems, whereas a relational perspective assumes that constellations pivot on change and emergence in entities and relations. In addition, whereas structural functionalists tend to draw conclusions about social structure from the high-level function or purpose of a social system, a relational perspective acknowledges that the high-level function of a constellation of relations is always in flux and may emerge and collide at many levels of observation. This point becomes clearer in the next section on relational dynamics.

Second, a mix of entities is nested in a coherent and self-sustaining constellation of relations with each other (Tilly 1998), offering a variety of emerging functions within those relations. In contrast to a dyadic view of relations, multiple entities can share, compete in, draw on, alter, or discard the *same* relation to perform a given function(s). For example, we see that, when the desired function is to pick apples, both ladders and mechanized platforms can enter into a relation with apples and human pickers, thus competing in that relation. But, in addition to providing an opportunity for mechanized platforms to maneuver the wide spaces between tidy rows of dwarfed trees, trellis systems also enable robotic harvesters to cruise through those same spaces. These new robotic harvesters with mechanical arms that can reach high or low require no human pickers. Thus, the robotic harvester aids in the function of picking but through a relation solely with apples, discarding the relation with apples and pickers in which ladders and platforms engage. An ambitious human picker on a ladder may try to outperform the robot by picking faster and handling the apples with more care, thereby competing across relations as well as within them to fulfill a function. In another twist, the high expense of robotic harvesters means that a primary vendor opts to lease, not sell, the harvesters to farmers. Thus, the relation between farmer, robotic harvester, and vendor supports both a production function (providing harvesting equipment) and a financial one (providing the financial arrangement).

What follows from having a mix of entities nested in a coherent and self-sustaining constellation of relations is tremendous potential complexity that itself spawns new relations. For example, in the constellation of relations around apple production, a farmer must collect data to prove compliance with more than 5,000 U.S. government regulations in addition to the data gathering and analysis necessary in the fundamental tasks of growing, harvesting, processing, and selling apples (e.g., recording pesticide application, requesting seasonal laborers, arranging market contracts). Faced with these existing data demands, farmers may be stretched too thin to think about how sensor data on emerging technologies are being collected, let alone how to analyze those data to improve soil and water management, sustainability efforts, and the like. Thus, any increase in complexity arising from a wealth of new data gathered by emerging technologies may prompt farmers to enter relations of data analysis—not just growing, harvesting, processing, and selling—with technology vendors. In doing so, farmers may also alter the existing relational boundaries in apple production and prompt issues of data governance and governance of the commons across the industry.

Relational Dynamics

The final concept included in our current treatment of the relational perspective is relational dynamics, which refers to patterns of changes that occur not within single relations, but at the constellation of relations (Kallinikos 2012; see also Anteby et al. 2016 for a treatment on relational dynamics in professions). Given the changing capacity of entities to mix in relations and the functions emerging in relations as we have discussed, a variety of relational dynamics may be conceptualized. Our focus in this section is on two salient dynamics in the apple production example: systemic emerging functionalities and relational cascades.

Systemic Emergent Functionality. By "systemic emergent functionality," we refer to modified or new functions that bring about a new ordering in a given constellation of relations. Collective concerns for novelty, quality, efficiency, or effectiveness may shape systemic emergent functionalities, offering a range of economic, social, ecological, legal, or other benefits. Often, these benefits are achieved through changes in the capacities of entities that enable them to perform functions better. For example, a mechanized platform that is retrofitted with digital cameras that enable it to be self-driving retains its relation to apples and pickers: it remains as the conveyance that enables pickers to harvest apples from trees. Yet data from the digital camera about such visual attributes as the fruit's spatial density, distribution, and ripeness may open up possibilities beyond simply guiding the pace and direction of the platform in its apple-picking function. Such data may, for example, provide information for next year's planting or design and use of a host of orchard technologies (e.g., blowers, sensors, and drones). Moreover, these improvements to the relatively simple entity of the platform may improve the constellation of apple picking relations over time (e.g., higher yields, faster picking).

Such changes in entities' capacity can make them more likely candidates for remaining within the constellation of relations, at least until new entities with better capacities emerge or relations change in such a manner that established capacities are no longer necessary or effective. Thus, we can conceptualize systemic emergent functionality as occurring through established or novel relations that may improve existing functions or create new ones, resulting in a 2×2 matrix (established/novel, functions/relations) of possibilities. In Table 1, we provide examples in each cell of the matrix. In the first cell, we offer the example of automated irrigation systems whose sensors perform the function of continuous monitoring of soil humidity. The sensors channel data to the irrigation algorithm, which directs watering of the orchards in a targeted manner consistent with the principles of precision agriculture. Compared with human inspection of the soil and global manual irrigation, the novel relation among the soil, sensors, algorithms, and automatic targeted irrigation greatly reduces the consumption of water and energy. Not all systemic emergent functionality derives from improvements in the capacity of established entities in established relations, however, as the examples of remote-controlled wind turbines, field data about apples gathered by picking technologies, and drones in the other three cells in Table 1 make clear.

In fact, one advantage of a relational perspective is that it allows us to better see that relations are as generative of new functions as entities are, thus helping to shift our analyses from entities to relations. That is, a traditional perspective on the technological entity might focus on how a self-driving mechanized platform or a robotic harvester would be presented to and adopted by farmers and to what effect. By contrast, a relational perspective recognizes that the novel function of employing data about apple spatial density, distribution, ripeness, and the like for purposes other than the immediate picking of apples came about because a relation was already established among apples, the self-driving mechanized platforms or robotic harvesters, farmers, and the equipment vendor. In short, the most important aspect of the introduction of a new technology (self-driving mechanized platform or robotic harvester) may have nothing at all to do with its perceived primary function (picking apples) in a restricted domain (the orchard), but with its secondary function (data gathering and analysis) made possible by a relation that spreads far and wide.

Thus, as we propose, a "function" is not an innate quality of individual entities, but instead arises in the relations among entities. What matters, then, is not that an entity is established or novel but that a function or relation is (for this reason, entity is not on par with functions and relations in Table 1). In that spirit, systemic emergent functionality allows researchers to address how the amalgamation of entities in relations brings about new phenomena (cf. Faulkner and Runde 2009), a point we address further in our section on how to study the relational perspective empirically in which we consider how researchers might use the matrix of Table 1 to guide their research design.

Table 1. Systemic Emergent Functionality Through Established and Novel Functions and Relations[a]

		Relations	
		Established	*Novel*
Functions	*Established*	**Systemic deepening** *Established entities now perform the function better as when a worker gains skill or a technology is improved.* An example is when, through precision agriculture, a farmer adds sensors to an existing irrigation system to continuously monitor soil humidity with algorithmic analysis of the data permitting targeted watering of individual trees.	**Relational extending** *Novel entities may enter an existing relation or a wholly new relation may form to accomplish an existing function.* An example is when farmers enter into new relations with vendors who provide software applications that use cellular networks and internet connections to enable farmers to remotely control existing wind machines in the orchard; the wind machines protect apples against frost, and remote control uses less energy and improves crop yields (through targeted usage and quicker responses to changes in weather).
	Novel	**Functional extending** *Established entities now perform a novel function within their established relation.* An example is when the data about apple density, ripeness, and the like that are gathered by a self-driving mechanized platform or a robotic picker for the purposes of picking are later put to use by either the farmer or the equipment vendor of that technology for other purposes (e.g., to alter planting or improve the equipment design).	**Systemic extending** *Novel entities may enter an established relation or a wholly novel relation may form to accomplish a novel function.* An example is when a farmer uses drones equipped with cameras to gather data on crop health and canopy coverage and then later equips other drones to identify and kill pests (replacing pesticides) based on algorithmic analysis of those data.

[a]Like Henderson and Clark (1990), who suggest that component technologies and the architecture that bind those together are distinct but interrelated domains of knowledge, our matrix is based on the idea that knowledge about functions in a constellation and the relations that bind them are also specific and connected knowledge domains.

Relational Cascades. Given our call for fresh thinking about emerging technologies and following our arguments about systemic emergent functionality arising from relations, we need to consider how scholars may escape the narrow notion that emerging technology is simply a changing entity. We argue that what is most important is not that technology itself changes (e.g., through upgrades or new versions) or is replaced in relations. Rather, what is most important is that technologies as enacted in relations have effects across their many relations, and this cascade of effects is likely to be more prominent in the case of emerging technologies because so many of them feature the channeling of digital data among entities. Moreover, many emerging technologies involve sets of technologies that work together as when a robotic harvester employs mechanical arms, computer vision, and machine learning algorithms to pick only ripe produce. Therefore, in a relational perspective, an emerging technology is better conceptualized not as a single changing entity, but as a dynamic set of relations constituted by a constellation of functions toward a specific end.

We use the term "relational cascades" to refer to the unfolding dynamics that a change in one set of relations may cause throughout the constellation of relations. As new complex relations and functions unfold, these dynamics may often appear as unintended effects of changing capacities, relations, and functions at a localized level. For example, upon its introduction, the bin—a large wooden or plastic box that holds 1,000 pounds (about 23 bushels) of apples—quickly replaced the much smaller and lighter wooden orchard boxes that had been in use. This drastic change in size and weight of the repository used to hold apples as they traverse the distance from orchard to processing facility had cascading effects on other relations in that the wagons and "whoopees"[4] that hauled orchard boxes were subsequently replaced by more substantial equipment in the form of forklifts and bin haulers. In this case, the functions within the relations (e.g., the bin's function vis-à-vis apples, pickers, bags, and vehicles) remained the same. However, the swap of one entity for another (bins for orchard boxes) prompted further swaps in other relations in the constellation (wagons and whoopees, no longer able to perform their function in the constellation of relations, were replaced by forklifts and bin haulers). It is striking that only by examining the functions performed in relations can we understand this shift in technologies.

Today, as relations increasingly channel data, a host of new functions can be performed that may rapidly and drastically alter constellations of relations. We have discussed how the introduction of the trellis system, with its wide spaces between tidy, linear rows of dwarfed apple trees, had the unintended consequence of making possible the introduction of mechanized platforms and robotic harvesters. In Table 1, we further note how the data about apple density, distribution, ripeness, and the like that these platforms and harvesters may collect as they navigate along the trellis rows might be put to use by entities within that relation (namely, farmers and equipment vendors) to alter planting or improve equipment design, respectively. Such uses of data, we say, reveal new functions within existing relations. But, because digital data are highly portable and because information about apples growing in the orchard may serve many potential functions, including ones not yet imagined, the relational cascade in this case, as with many emerging technologies, may be widespread. For example, one can easily imagine these data being used by university researchers to improve apple qualities (e.g., bigger size, earlier ripening, improved flavor) or by equipment vendors to develop new equipment (e.g., mechanical thinners that, by removing certain apples, allow the remaining ones to receive more sunlight and grow bigger, improving crop quality). In such cases, new relations as well as new functions are formed. One can imagine further that the data might be used by data analytic firms and government agencies for climate analyses, state agricultural inquiries, water management studies, and so on as the consequences emanating from an initial change in the constellation—the introduction of the trellis system—cascade far and wide across entities, relations, functions, and time.

Finally, severing existing relations within a constellation may also give rise to cascades of change. Pierre Bourdieu proposed to "break the relationships that are most apparent and most familiar, in order to bring out the new system of relations among the elements" (quoted in Oezbilgin and Tatli 2005, p. 859). In the many examples discussed so far, we see relations severed when a new technology replaces an existing one (severing the relation involving one entity to create a new relation involving its replacement) and when a new technology reduces the number of entities in a relation (as when the robotic harvester eliminated the need for human pickers, altering the relation from apples, human pickers, and a platform to apples and robotic harvester.) Such changes may cascade across the constellation; for example, in the latter case, it may have an effect on seasonal laborers, hiring agents, and the U.S. government's management of the H2-A visa program. But perhaps the most striking relational cascade resulting from a severed relation may be on the horizon should data captured by emerging technologies become the intellectual property of equipment vendors, thereby cutting farmers out of the relation. Should such an event come to pass, farmers' prominent role in the constellation of relations—not just in the apple industry, but throughout agriculture—might be greatly reduced as increasing value is derived from data that, ultimately, may come to nearly rival the value derived from the crops themselves. In short, in a data-transformed constellation of relations, farmers may effectively serve more as land managers than as farm and crop owners with status and power increasingly accruing to the technology companies that gather, analyze, own, license, and sell the data collected by farm machinery across a host of new relations and functions. Thus, the impact of digital technology on apple production should not be understood simply as "labor substitution" (e.g., replacing the farmer or picker by AI and robotics; see contemporary discussions in Brynjolfsson and McAfee 2014, Agrawal et al. 2019), but instead as a set of fundamental transformations in ecology, production, transactions, and consumption, intertwined with such technologies as they instigate cascades of change in relations among entities within the constellation.

Implications for What We Study and How We Study It

Inspired by the relational turn in sociology and process metaphysics, we abductively develop a set of concepts and a vocabulary for understanding emerging technologies as sets of relations. This relational perspective can help organization scholars to theorize, more precisely, about the interdependencies between technologies and organizing as society transitions into an age ushered in by emerging technologies. By applying these concepts and this new vocabulary to the case of apple production, we exemplify how a relational perspective helps to uncover the fundamental transformation this industry has undergone and continues to undergo. For example, although the robotic apple harvester could be seen as an entity, we show that it may be defined by its relations with the farmer, the equipment manufacturer, other equipment vendors, data analytic firms, government agencies, seasonal laborers, hiring agents, high technology companies, and others as it serves both apple production and data provision functions.

Examples of new ways to study emerging technology and organizing might leverage the quadrants in Table 1 in which we show how established entities perform functions better (systemic deepening), novel entities enter an existing relation or a wholly new relation may form to accomplish an existing function (relational extending), established entities now perform a novel function within their established relation (functional extending), or novel entities enter an established relation or a wholly novel relation may form to accomplish a novel function (systemic extending).

So what does this new perspective mean for future research on organizing? We advocate taking into account the fact that emerging technologies are embedded in complex constellations of relations and entities are defined by these dynamic relations rather than the reverse. Organizational life is constituted by sets of relations among entities, which are themselves no more than sets of relations. As organizational scholars, we tend to draw circles around certain sets of relations and denote them as our objects of interest. In doing so, we begin to treat certain sets of relations as entities with an essence of their own. But, as our elaboration of a relational perspective makes clear, there are no entities without relations. To improve theorizing about all organizational action in the age of emerging technologies, we need to expand the circles we draw. Take, for example, the set of relations that we typically think of as an entity called a car. The relations between powertrain and drivetrain, suspension and frame, and increasingly screens and software are where we often draw the circle. But today's cars equipped with AI and machine learning algorithms, lidar, and other sensors have relations with mapping software, transportation databases, weather forecasts, other cars, and the manufacturer itself through cellular connections. To incorporate all these relations, we need to expand what is included in our studies. Today, the entity that we call a car looks different than it has in the past because the relations that constitute it are more diverse than ever. Extending this analogy to organizational theory, we tend to draw circles around relations between action, culture, self-image, and people as relations that constitute a phenomenon such as identity. But the increasing proliferation of technologies in the production of action, culture, self-image, etc., mean that it makes little sense to draw a circle that does not include relations of those concepts to social media, smartphones, and digital ads. All of those relations are important in explaining the enactment and change of identity as with many other organizational phenomena of interest. When we say that everyone is now a theorist of technology, we mean that all organizational scholars must begin to expand their studies to include technological relations that they once believed were irrelevant to the phenomenon of interest. Without such broadening, our theoretical purchase on all organizational action is limited.

One implication of this perspective is that we must study technologies in relations, not technologies themselves, because it is in use that relations emerge and evolve. Studies benefit from examining suites of technology performing a variety of functions in relation to one another as well as in relation to other entities and from examining these relations over time (see Gibson et al. 2021 for a recent example). Another important implication is that, as functions and relations evolve over time, combinations between them are likely to confront many types of physical, economical, deontological, technical, legal, and other constraints. Future studies need to unveil such constraints and their role in organizing. We propose that pursuing these research avenues will bring to light existing research, yield new questions, and help the field to better theorize about modern organizations and organizing. An expedient way to start such a research pursuit may be to leverage the quadrants in Table 1 in which we show how established entities perform functions better (systemic deepening), novel entities enter an existing relation or a wholly new relation may form to accomplish an existing function (relational extending), established entities perform a novel function within their established relation (functional extending), or novel entities enter an established relation or a wholly novel relation may form to accomplish a novel function (systemic extending). By populating the matrix with examples, we may also begin to recognize a set of novel research questions.

Asking New Questions

The power of a relational perspective on emerging technologies and organizing is that it directs our attention to new research questions and, we believe, provides an opportunity to advance theory in important ways. Our perspective decenters the importance of the technology artifact and entangles technology with the process of organizing. What, for example, are the relations, entities, and functions that are constituting power, creating transaction costs, and fueling innovation? With this lens, technology is not an instigator, but a player in the set of relations. Instead of asking questions focused on the effect of an emerging technology, this perspective lifts up questions about how this constellation might operate differently if a particular function or relation changes. As we indicate when introducing Table 1, a good starting point for understanding how such constellations evolve is to first focus on a set of entities and their relations within the constellation. A researcher may seek to capture existing relations and the emergence of novel relations across those entities at the level of the constellation. The researcher may then scale down to focus on the relations that constitute the specific entities in question and then scale up to analyze the increasingly fine-grained dynamic interplay between relations and functions within clusters of entities and relations. In other words, we recommend that researchers begin by developing a grasp on the full constellation of relations and functions in question, and then begin tacking back and forth across levels of analysis to understand how relations and functions form into phenomena that we call entities and how those entities cluster with other entities enacted through dynamic relations.

This insight pushes organizational scholars away from treating emerging technologies from *either* micro or macro perspectives. Instead, the focus on relations showcases that, to understand the role of emerging technologies in the organizing process, researchers must begin to incorporate *both* micro and macro analyses in their work. We recognize that this is a radical statement. But, as the relational perspective suggests, without the ability to understand how relations congeal in ways that shape entities and without the ability to understand how those entities enter into relations with other entities, we cannot fully document or explain how emerging technologies are shaped by and become engines for organizing. Practically, this perspective recognizes that relations are truly multiscalable.

Returning to our apple production example, traditional technology-focused questions might ask what the effect is of the self-driving mechanized platform or the robotic harvester on the work and workers in the orchard or how data analytics affect the power held by growers. A relational perspective decenters the platform and the harvester and suggests instead a question such as how do the relations between the grower, the company providing the platform or the harvester, and the operators in the field affect the way that fruit is harvested and sold? This question recognizes the multiscalability of relations. In the case of the robotic harvester, for example, operators in the orchards may come to supervise multiple harvesters similar to the way supervisors currently manage teams of human pickers. Operators in such a case inspect fruit quality and, if needed, adjust machine specifications that govern which fruit should be picked. They may also address equipment problems and manage the staging and transport of picked bins of fruit. A relational perspective invites questions that explore and build theory about these relations, their functions, how they are (co)evolving, and the effect of these on organizing. We argue that such a perspective can offer fundamentally new research questions.

We can, for example, examine how professional identities evolve as the technology systems in which workers are embedded transform (Vaast and Pinsonneault 2021). If health workers are increasingly reliant on remote sensors for capturing patient diagnostics that are then subjected to data analytics with AI, how do health workers think about their relations to patients and their own evolving professional skills? Rather than asking how AI might affect workers' professional identities (an entity perspective), we might ask instead how the relation between a device, an algorithm, organizational roles, current personnel policies, and data analytics affect one's professional identity. Take, for example, Disney's "MagicBand," which uses sensors and data to track customers across Disney's amusement parks. If we look narrowly at the MagicBand and perhaps some AI that aids in merchandise planning, our view might be limited to the effect on buyers who are making decisions about how many stuffed Olafs to order. If we expand the aperture, we can begin to see the relations among the MagicBand, park-goers, employees who stock the stores, buyers, and even those who design Downtown Disney. We might see that, as a result of the relation between customer analytics and ordering platforms, store staff perceive that they are able to plan ahead to better meet the needs of customers. Further, how they stock shelves and interact with customers may be intertwined with the features of the constellation and the way they receive information, which are, in turn, constituted by the speed with which they work and customer purchase patterns, thus inviting a study of how such a constellation and the way workers engage with it transforms workers' relations to the organization and to customers along with their sense of meaning and self-worth.

Practically, one way to focus research taking a relational perspective in the context of many emerging technologies is to examine data flows. That is, what data are flowing between various entities, including devices, tools, individuals, organizations, physical settings, and the like? We can then ask how those data and the form of those data are reconfiguring the relations and defining the entities and the functions they perform in relations. Questions about the effect of a new entity, such as AI, a sensor, or a drone, become less useful because they presume an entity with a somewhat fixed relation. Instead, a relational perspective suggests asking about more gradual and cascading changes that occur as something new enters the constellation, potentially affecting the constellation and the relations and functions within it. Thus, one key to building robust theory about the role emerging technologies play in a variety of organizational phenomena is to follow the flows of data across the relations that define them.

A relational perspective similarly exposes new research questions related to innovation. Rather than focusing narrowly on the creativity of entrepreneurs inventing new agricultural technologies, for example, perhaps we expand to examine the relations between the research commission that funds technology start-ups, growers, a smart orchard, and the firm that is processing data collected in the smart orchard. Doing so could enable theory development that spans firm boundaries and focuses on the dynamics among key players in an ecosystem, which are now more than ever before instrumental in innovation (Ansari and Garud 2016).

Another approach is to consider relations among organizations and how relational cascades affect the demands for collaboration among, for example, an organization that produces hardware and captures data (e.g., 3-D printer producer, drone producer, etc.), the provider of data analytic tools (e.g., Microsoft), the person or entity from which the data are collected (e.g., patient, grower, park-goer, etc.), and the "user" of the data (e.g., the healthcare organization or park operator). Scholars of digital transformation note the increasing demand for cross-organizational collaboration, largely because of the speed of change and complexity of technology (Kane et al. 2019). A relational perspective provides an opportunity to go beyond an examination of technologies and organizations as entities and build theory relevant to these relations and what it means for organizing within an ecosystem.

Finally, we note that the relational perspective is focused on describing and explaining the interdependencies between emerging technologies and organizing. In this initial formulation of the perspective, we have not raised questions of value judgment. However, we recognize that it is inevitable that entities seek to pursue certain goals and interests when behaving and serving in relations. Their actions may very well shape the trajectory of organizing and of the continued emergence of technologies. Consequently, these actions may hold ethical implications for other entities within the constellation, raising questions about fairness, virtues, power, voice, justification of functions, and relations across levels. We encourage scholars to ask research questions that focus on the ethical implications of such actions so that we can, collectively, expand this relational perspective in ways that help to create a better future.

Exploring Alternative Methods

A relational perspective also portends changes to our methodological approaches. Earlier, we specified that we chose the term "constellation of relations" over system, network, or web. We did so because we think that the existing analytic methods associated with these other terms tend to emphasize individual relations, positions of entities, strength of relations, and the like. Instead, we are inviting researchers to embrace methods that take as their primary focus the multiple complex relations in and the dynamic nature of these emerging constellations. That is, we mean to borrow from biology the attention to form (morphology) and to creation and change within that form (morphogenesis). Like biologists, organizational theorists need to understand why certain constellations of relations develop as they do and how they are associated with the rise of certain forms of organizing.

In pursuing this morphological attention to form and dynamics, scholars will likely need to pay attention to the four concepts that we introduce in this paper: entities enacted in relations, relational functionality, constellations of relations, and relational dynamics. In turn, such an approach brings forth the importance of other concepts we introduce, namely, relations' interchangeability and dynamics, systemic emergent functionality, and relational cascades. Attention to morphology may show across sites or contexts (e.g., in different farms) that the constellations of relations may look relatively similar, whereas the entities themselves may be quite different. Once researchers understand one constellation well, it is possible that they will be able to translate their analysis more easily to other empirical contexts and build theory.

Researchers may not need to map the entire constellation of relations to benefit from a relational perspective. A simple first step could be figuring out the most important entities and relations that are relevant to the research question being explored. Researchers who are interested in governance issues, for example, might include equipment vendors and regulatory bodies in their analysis, whereas researchers concerned about changes in work might include HR systems and occupational groups.

The relational perspective we describe is in line with recent calls by network scholars for more research on network emergence and shape (e.g., Grandori and Soda 1995) and on the interaction between entities of different types (e.g., humans, machines, databases, etc.) (Contractor et al. 2011). Compared with a classic approach to network analysis (Granovetter 1973), a relational perspective demands such a type of analysis that captures entities of different kinds (e.g., humans, organizations, machines, etc.) and as well allows for the same relations to be dynamically composed of multiple existing and novel functions. For example, relational event modeling offers a fruitful way to examine multiple streams of action that precipitate events and reshape or usher in new relations (Butts 2008, Schecter et al. 2018). Studying relational events rather than nodes and dyadic relations may help capture some of the inherent complexity of constellations and the emergence of new patterns of relations.

We also advocate for field-based work. The way that entities become intertwined makes it challenging to anticipate, a priori, the relations that are central to an investigation. Observing entities in relation and the dynamics of the constellation should help identify important relations. We note that people and other entities have partial and subjective views of the constellation, so triangulation is required, rather than relying on one view of the constellation.

Scholars may also need to think more creatively about how to collect digital data. A defining feature of digital technologies is that every action conducted on or through them creates time-stamped metadata describing the action, its temporal occurrence, and those involved in it. Researchers characterize this metadata as digital exhaust—the by-product of other digital activities (Leonardi 2021). Such digital exhaust can be usefully analyzed to showcase patterns of entity and relation and functional formation, evolution, and dissolution. Digital ethnographies, for example, strive to collect traces of human and system behaviors that are left behind (e.g., Slack posts, email messages, purchasing behavior, etc.). Researchers could potentially collect data flows and communications among entities, thus characterizing the relations and, if collected over time, the dynamics of relations. One caveat is that it can be hard to conduct studies when so many of these systems are proprietary and opaque, multiple gatekeepers work to restrict access, and data protection is increasingly of concern.

Another approach is to apply machine learning algorithms to digital exhaust to identify patterns of relations. Such methods are particularly effective when researchers want to understand and abductively theorize relations among entities exchanging massive amounts of data (Shrestha et al. 2021). For example, entities that leverage digital technology to form online communities and self-organize the production of contents naturally produce large amounts of digital exhaust that can be analyzed effectively by such novel methods (He et al. 2020).

How This Special Issue Moves Us Forward

Taken together, the papers in this special issue offer generative ways forward to scholars interested in emerging technologies and organizing. Two of the articles deal with the big picture of how our world is transforming. Although public policy and organizing have always been intertwined with technology, Bodrožić and Adler (2022) remind us that the large-scale trajectories of transformation are driven by the intensification of overlapping technology developments as well as their amplified interaction with the organizational and societal spheres, urging us convincingly to bear in mind our public policy choices. Focusing on the changing role and origin of data in the constitution of organizing, Alaimo and Kallinikos (2022) offer the alluring and useful idea that today's data form new complex "data objects" that disrupt the traditional processes of knowing in organizations.

Three papers deal with how work and organizing are transformed in the context of digital platforms. Cameron's (2022) captivating study of ride hailing directs our attention to how drivers devise games that reflect new types of meaning making at work in interaction with the algorithmic software management as they engage their cars, their customers, the rides, and the company. Karunakaran et al. (2022) expertly help us to see how accountability is transformed beyond traditional stakeholders in the context of social media and service organizations through the "crowd's" online postings of service encounters. Cameron and Rahman (2022) provide an intriguing model of the interplay between algorithmic control and resistance on platforms, tracing how gig workers creatively alter resistance strategies as they experience reduced control through the phases of the service encounter.

The authors of two papers have engaged in deep fieldwork about work practices following the introduction of learning algorithms in work settings. In a discerning study of the inclusion of AI into radiological work, Lebovitz et al. (2022) find that professionals who interrogate AI recommendations are able to deal with the opacity of machine learning algorithms and, in turn, augment their diagnostic knowledge. Waardenburg et al. (2022) offer a compelling and dynamic view of brokerage as intelligence officers responsible for evaluating and passing on to the field the predictions from AI policing software initially acted as messengers, then as interpreters, and finally as curators while gradually claiming greater authority as algorithmic brokers. In a field experiment, Choudhury and Allen (2022) similarly look at the introduction of algorithmic work, capturing superbly how the introduction of an algorithmic tool is intertwined with the task itself, the problem being solved, and workers' sense of accountability to the organization—all moderated by workers' level of expertise.

Moving beyond algorithmic aspects of emerging technologies, Rauch and Ansari (2022) provide an illuminating example of modern-day remote work by detailing how pilots' interactions with and feelings toward their targets, their teams, their families, their jobs, and the work of the military is perturbed as pilots surveil and drop missiles across the globe from remote bunkers near their suburban homes, shifting the entire endeavor of modern warfare. Lin and Maruping's (2022) inspiring study demonstrates how new ventures with businesses based on digital technologies innovate in the early stages of their development through intensive knowledge sharing with established open-source software communities. Such communities provide emerging technologies that the ventures then exploit to further their commercial activities. And, finally, Pentland et al. (2022) show intriguingly through their simulation modeling that an emerging technology has a small likelihood of creating new possibilities for action if it lacks influence on the sequential steps through which work is accomplished. Together, these papers transcend what we have known for some time—that technologies shape work and organizing when they change how and on what basis people interact with one another—to show how emerging technologies create entirely new contexts for action, which can create opportunities for reimagining what work is, what it means to be a worker, and how organizing happens.

Each of these papers is superb in its own right, solidly advancing our understanding of emerging technologies and organizing. And, whereas we have avoided the obvious temptation to force these papers into the framework or language of our relational perspective, we cannot help but notice the rich concepts of relationality throughout them. We hope, then, that our introduction joins these papers in providing organizational scholars with new knowledge, insights, and ideas.

Conclusion

The relational perspective outlined here has the potential to surface new and exciting research directions that push theory in directions that better capture the changing realities of modern organizing. It invites joint consideration of technology with questions of broad interest to organizational scholars, such as identity, power, coordination, innovation, governance, ethics, and so forth, and suggests a path forward for crafting questions and studies that recognize the role of emerging technologies in these investigations. An important implication is that the study of technology can no longer be delegated to a few "technology" scholars. Rather, every organizational scientist is increasingly a theorist of technology.

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Endnotes

[1] There is much debate about whether entities can be considered fixed or stable and exist apart from the relations that enact them. Our relational perspective suggests they do not and cannot exist as stable entities apart from the relations that define them. However, the relations that make up entities can appear stable and unchanging depending upon the distance from which they are viewed and the time scales in which they are considered. It is helpful to think about entities and their relations as the difference between a picture and a movie. When you take a snapshot at one point in time, the recognition of the various entities is foregrounded, but the changing relations of what constitutes an entity or between them is obscured. When you make a movie of that same entity, though, you may observe that the entity is always in flux and in dynamic interplay with its surroundings. There are certain times and reasons why it is helpful for actors in the world to orient to and treat a set of relations as though they are stabilized entities. But from a theoretical standpoint, recognizing that those entities are always in relations that are dynamic helps us to better consider the many ways in which they become central to the organizing process.

[2] Bags were in use from the U.S. industry's beginning in the 1600s, and bins were introduced in the 1950s; neither is "smart" or data-driven.

[3] Trellis systems consist of steel posts and wire strung together in ways that allow farmers to graft dwarfed apple trees subsequently trained to grow linearly or in a Y-shape along tidy, thin orchard rows (rather than growing in the standard lollipop canopies of untrained apple trees). A dwarfed apple tree is a tree whose size has been reduced but that still produces full-size fruit.

[4] A whoopee was a Ford or Chevrolet vehicle whose body was converted into a flat platform placed on the chassis (Cassidy 1943).

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