DESIGN PERFORMANCES: HOW ORGANIZATIONS INSCRIBE ARTIFACTS TO CHANGE ROUTINES

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Organizations often create and employ artifacts in order to change their routines, but little is known about how artifacts can be designed to intentionally influence routine dynamics. In this paper, I present findings from an inductive, ethnographic study of how a law enforcement agency fabricated a game-theoretic artifact to modify its patrolling routine. Based on my in-depth analysis of the actions associated with creating this game-theoretic artifact, I develop a theoretical model that shows how organizational actors iteratively engage in a series of design performances to envision new sociomaterial assemblages of actors, artifacts, theories, and practices. These design performances influence routine dynamics by both eliciting mechanisms of abstracting grammars of action, exposing assumptions, distributing agency, and appraising outcomes, and by creating new assemblages that can be deployed in future routine performances. By revealing the generativity of design performances and sociomaterial assemblages, this empirical study contributes to our understanding of routine dynamics, performativity, and strategy tools.

Organizations intentionally modify routines—i.e., "repetitive, recognizable patterns of interdependent actions, involving multiple actors" (Feldman & Pentland, 2003: 96)—to pursue organizational objectives. For example, organizations pursue performance improvements by implementing new technologies, such as innovative medical equipment (Barley, 1986; Edmondson, Bohmer, & Pisano, 2001) or virtual collaboration tools (D'Adderio, 2001, 2003). Organizations also attempt to replicate best practices throughout dispersed geographies (Gupta, Hoopes, & Knott, 2015; Knott, 2003; Winter & Szulanski, 2001) and adopt administrative innovations designed to facilitate new product development (Hales & Tidd, 2009; Howard-Grenville, 2005) or improve product

quality (Lazaric & Denis, 2005; Zbaracki, 1998). Yet, scholars who have adopted a variety of perspectives have acknowledged that organizations struggle—and often fail—to implement such changes successfully (Gupta et al., 2015; Knott, 2003; Pentland & Feldman, 2008; Reynaud, 2005; Szulanski & Winter, 2002).

In recent research on routines, scholars who have taken a practice perspective (Howard-Grenville & Rerup, 2016; Parmigiani & Howard-Grenville, 2011) have shown how routines are altered through dynamic interactions between specific performances of action (i.e., the "performative" aspect), abstract patterns of action (i.e., the "ostensive" aspect), and human-made objects (i.e., "artifacts") (D'Adderio, 2008; Feldman & Pentland, 2003; Pentland & Feldman, 2005). Organizational actors create artifacts such as standard operating procedures (Hales & Tidd, 2009; Lazaric & Denis, 2005), software (Cacciatori, 2012; D'Adderio, 2011), or signs (Bapuji, Hora, & Saeed, 2012) to articulate their intentions and control future performances of routine actions (Simon, 1970). However, empirical studies have highlighted that these materialized intentions of organizational actors are subverted and transformed through ongoing routine performance (Hales & Tidd, 2009; Lazaric & Denis, 2005; Reynaud, 2005). Specifically, the plans of intentional change cannot fully specify future circumstances, so the actors who perform routines must skillfully adapt to the contextual idiosyncrasies of particular situations (D'Adderio,

2008; Dittrich & Seidl, 2017; Pentland & Feldman, 2008; Suchman, 2007). Consequently, researchers have emphasized how mechanisms generated by the ongoing performance of a routine—such as trial and error learning (Rerup & Feldman, 2011), cultural shielding, shoring and molding (Bertels, Howard-Grenville, & Pek, 2016), or political jockeying (Hales & Tidd, 2009; Zbaracki & Bergen, 2010)—overwhelm the original intentions of organizational actors.

Although organizational actors dynamically use artifacts in ways that deviate from the designed intent as they perform routines, studying the actions associated with the design process is important for two reasons. First, the material properties of artifacts established during design create constraints and affordances that substantively influence how users perform routines (D'Adderio, 2008, 2011; Simon, 1970). For example, Spee, Jarzabkowski, and Smets (2016: 764) have shown how the material properties of Excel spreadsheets influence deal-appraisal routines by requiring underwriters to input particular parameters and providing underwriters with outputs from macro-embedded automatic calculations. Second, scholars who have taken a performativity perspective have shown how communities of organizational actors use designing activities to inscribe artifacts with worldviews or theories that promote their interests (Akrich, 2009; Cacciatori, 2012; D'Adderio, 2008). For example, Callon (2007) recounted how organizational actors leverage different variants of economic theory to reconfigure routines for pricing products or forecasting demand for products. Novel amalgamations of theories, artifacts, actors, and practices—*sociomaterial assemblages* (Callon, 2007; D'Adderio & Pollock, 2014)—have the potential to substantively reshape organizational routines (e.g., Aroles & McLean, 2016). Because the actions associated with the designing of artifacts materially influence the ongoing use of the artifacts in ongoing routine performance, understanding routine dynamics requires scholars to theorize the "development and use of these artifacts together" (Pollock & Williams, 2016: 23). Consequently, I ask the question: *How do organizational actors design artifacts to change routines?*

Following other studies in the routines literature (D'Adderio, 2001, 2004; Dittrich, Guérard, & Seidl, 2016; Feldman, 2000; Howard-Grenville, 2005; Pentland & Rueter, 1994; Rerup & Feldman, 2011), I present a single, in-depth case study of the organizational dynamics involved in designing an artifact to change routines. I collected data as a participant observer of a pilot project in which a law enforcement organization (Metropol, a pseudonym) designed an artifact—software that uses a game-theoretic algorithm to generate patrol schedules—to change patrolling routines intended to prevent or limit criminal activity. This setting provided an excellent context for investigating my research question since the express purpose of the organizational actors was to design a game-theoretic artifact and test its ability to improve the effectiveness of their patrolling routines. Based on these data, I inductively develop a theoretical framework that explains how organizations engage in a series of *design performances* to create artifacts in order to intentionally change routines. I find that design performances elicit four different mechanisms—*abstracting grammars of action, exposing assumptions, distributing agency,* and *appraising outcomes*— and create sociomaterial assemblages of actors, artifacts, theories, and practices. These mechanisms and sociomaterial assemblages lead to changes in routine dynamics.

My findings underscore the central importance of design performances for understanding how organizations intentionally change routines. Design performances produce more than material objects, such as software algorithms or standard operating procedures: they both inspire actions and produce assemblages of actors, artifacts, theories, and practices that fundamentally influence future organizational actions. This research makes three contributions to management research. First, I contribute to literature on routine dynamics by showing how design performances and sociomaterial assemblages influence the efforts of organizational actors to intentionally change routines. Second, I contribute to research on performativity by theorizing how organizational actors create new assemblages by using theories to inscribe artifacts. Finally, I provide scholars with a framework that enables a better understanding of how organizational actors create strategy tools that can adapt to dynamic, rapidly changing environments. In summary, this research shows how design performances generate actions that have the potential to create more mindful, "live" routines (Cohen, 2007; Levinthal & Rerup, 2006).

THEORETICAL BACKGROUND

At the most fundamental level, organizational routines enable groups of people to work together to achieve common goals and objectives (Howard-Grenville & Rerup, 2016; March & Simon, 1958;

Nelson & Winter, 1982; Parmigiani & Howard-Grenville, 2011). Routines coordinate organizational activity by providing actors with a cognitive understanding of appropriate behavior (Cohen & Bacdayan, 1994), motivational goals that adjudicate between different functional interests within an organization (Nelson & Winter, 1982; Zbaracki & Bergen, 2010), and performance targets that guide actors during ongoing routine performances (Nelson & Winter, 1982). Although routines provide a stable, habitual means for organizations to perform interdependent actions consistently, organizations often intentionally change their routines in order to implement strategic initiatives (Bertels et al., 2016; Cohendet & Simon, 2016; Rerup & Feldman, 2011), integrate new technologies (Barley, 1986; Edmondson et al., 2001), adapt to changes in the environment (Kaplan, 2015; Zbaracki & Bergen, 2010), or simply pursue goals such as improved performance (Becker, Lazaric, Nelson, & Winter, 2005; Bresman, 2013; Knott, 2003).

Artifacts—objects made by humans to accomplish practical purposes—lie at the center of such efforts to intentionally change routines (Simon, 1970). Artifacts play three central roles in routine dynamics: they create affordances and constraints for organizational actors, they "encode the intentions of managers or designers," and they "participate as actors that take actions" (Pentland & Hærem, 2015: 470). For example, organizations often create artifacts such as formal representations of routines (i.e., standard operating procedures or computer software applications) to articulate intended or espoused patterns of action in order to guide future routine performances (D'Adderio, 2008; Feldman & Pentland, 2003; Hales & Tidd, 2009; Pentland & Feldman, 2005). Similarly, organizational actors create artifacts such as signs to communicate intentions and guide the behaviors of others (Bapuji et al., 2012). Efforts to intentionally change routines thus often involve organizational actors in the present attempting to influence organizational action in the future by creating artifacts to shape ongoing routine performances.

Research findings have suggested that when organizations use artifacts to intentionally change routines, the actual results of their change efforts often substantively differ from their intended outcomes (Knott, 2003; Lazaric & Denis, 2005; Pentland & Feldman, 2008; Rerup & Feldman, 2011; Reynaud, 2005). Although organizational actors may craft a vision to describe future performances of routine actions, their projected intentions cannot fully specify the characteristics of a situation in advance—the contingencies and exigencies of situated action require actors to adapt their actions in ways that may diverge substantially from the original envisioned intentional change (Suchman, 2007). For example, Hales and Tidd (2009) showed how mechanisms such as political priorities, and nonformal activities such as storytelling, played a more important role than artifacts such as standard operating procedures in an organization's efforts to change a routine associated with new product design and development. Similarly, Bertels, Howard-Grenville, and Pek (2016) revealed how mechanisms of cultural shielding, shoring, and molding fundamentally transformed one organization's intentional efforts to adopt another organization's template of an operational compliance routine. Pentland and Feldman (2005: 797) succinctly synthesized this theoretical perspective: "Managers create artifacts [such as rules or standard operating procedures] in an effort to shape actual work practices, but the practical effect of any particular rule or procedure is often quite remote from its original design or intention." Findings in existing research have thus demonstrated that intentional efforts to change a routine often lead to unintentional consequences (Rerup & Feldman, 2011).

However, before they are used in ongoing routine performance, designers create artifacts with material properties and functions intended to meet prespecified goals or objectives (Simon, 1970). The material properties of artifacts shape ongoing organizational activities (Kaplan, 2010). For instance, Pollock and D'Adderio (2012: 578) showed how the graphical layout of a 2×2 matrix used to rank software vendors influences rankers who want to create a "beautiful picture." Similarly, Spee et al. (2016) showed how an Excel workbook used in a deal-appraising routine defines relevant data, performs repetitive calculations and provides users with a default series of actions. Once in place, artifacts subtly and significantly influence future routine activity as they "tend to sink in and become part of the users' habitual background" (D'Adderio, 2008: 774).

Additionally, communities of organizational actors attempt to shape routine performance by inscribing theories into artifacts (Akrich, 1992; Cacciatori, 2012; D'Adderio, 2008). Designers of artifacts envision future scenarios and establish proposed scripts that "define a framework of action together with the actors and the space in which they are supposed to act" (Akrich, 1992: 208). For instance, Callon (2007) and Mirokowski and Nik-Khah (2007) described how economists proposed new ways of

organizing Federal Communications Commission (FCC) spectrum auctions. These proposals involved envisioning alternative assemblages[1] based on complex interactions between theories (i.e., different types of auction models derived from game theory and experimental economics), diverse actors (i.e., economists or federal agencies), and artifacts (i.e., the material apparatus required to facilitate the auctions). Mirokowski and Nik-Khah (2007) empirically showed how the ultimate structuring of the FCC auction proposals could only be understood by recognizing the deep interconnections between cohesive sets of actors, artifacts, theories, and practices struggling to influence the auction process. Although scholars who have taken a performativity perspective have highlighted the importance of understanding assemblages, there has been limited research examining how actors concurrently design and use assemblages (Pollock & Williams, 2016).

In summary, scholars have explained how organizations intentionally change routines by stressing the ways in which intentional change efforts are subverted and modified by ongoing routine performances; their findings have suggested that mechanisms associated with the ongoing performance of the routine overwhelm the intentions of organizational actors that attempt to design routine change. However, when organizational actors design artifacts to change routines, they prospectively incorporate material properties that can substantively impact sociomaterial practices (Orlikowski, 2007). Further exploring the relationship between the actions associated with artifact design and ongoing routine performance thus provides an opportunity for scholars to better understand the relationship between organizational efforts to intentionally change routines and routine dynamics. In this study, I ask the question: *How do organizations design artifacts to change routines?*

METHODS

My inductive study features a law enforcement organization piloting the use of an artifact—a game-theoretic algorithm embedded in software—to modify patrolling routines. This pilot project, which

is part of a broader data collection effort related to my dissertation research (Glaser, 2014), served, for three reasons, as an ideal context to develop a theory about how organizations design artifacts to change routines. First, patrolling in law enforcement is a prototypical routine that features multiple actors engaging in repetitive, interconnected actions that form patterns of action (Feldman, 2014). Second, the aim of the pilot project was to intentionally design an artifact (D'Adderio, 2008, 2011) to randomize patrolling routines. As such, the project did not revolve around the typical challenges associated with implementing a routine across an organization; instead, the project provided a compressed opportunity to observe the actions related to artifact design. Finally, the project also featured an external organization that had to learn about a unique client context. This involvement of outsiders who were relatively unfamiliar with patrolling routines engendered interactions that made the design process more transparent and facilitated the identification of new theoretical concepts.

Research Setting

Metropol (a pseudonym) is a law enforcement organization located in a large metropolitan area in the western United States. Metropol used patrolling routines to schedule and deploy law enforcement personnel to protect the city's transit operations (i.e., bus and rail lines). Metropol enacted different patrolling patterns to suppress different types of criminal activity. For example, in counterterrorism patrolling routines, the law enforcement agency attempted to establish a police presence that would make it more difficult for terrorists to realize a successful attack. In this patrolling pattern, Metropol leadership responded to a suspicious incident by compiling an inventory of available resources—patrol units such as Visible Intermodal Prevention and Response (VIPR) teams, K-9 units, and plainclothes officers—and deploying them to different locations using an Excel spreadsheet depicting projected times and locations to patrol. When the patrol officers reached a location, they observed activities, queried individuals, or looked for suspicious materials such as abandoned backpacks. Another example is fare evasion patrolling routines, which propagated different patterns of action: Metropol periodically audited bus and rail transit systems to ensure that passengers had purchased valid tickets and not abused the "honor system." In this pattern of action, a Metropol watch commander deployed

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[1] Callon (2007) used the label sociotechnical *agencement.* In this paper, I use the term sociomaterial assemblage or just assemblage to refer to the same concept (cf. D'Adderio & Pollock 2014).

TABLE 1
Metropol Patrolling Routine Patterns

	Counterterrorism Pattern	Fare Evasion Pattern
Objective	Establish a police presence to make it more difficult for a terrorist to realize a successful attack	Use a police presence to ensure transit system passengers have bought tickets
Actors	Lieutenant, sergeant, plainclothes officers, VIPR teams, K-9 units, etc.	Watch commander, deputy patrol officers, security assistants
Artifacts	Schedule (Excel Spreadsheet)	Schedule (Excel Spreadsheet) Cell phone to check rare validity Citation booklet
Action Pattern	1. Suspicious incident reported 2. Leaders compile an inventory of available security resources 3. Schedule generated 4. Pre-patrol briefing 5. Patrol officers travel to locations 6. Patrol officers conduct patrols 7. Patrol officers debrief and report on unusual incidents	1. Schedule generated for next day 2. Morning briefing 3. Patrol officers travel to Metro Station 4. Patrol officers check fares 5. Patrol officers ride trains and check fares 6. Patrol officers report on daily activities

deputy officers and security assistants to transit stations, trains, and buses to audit passengers for fare payment. While patrolling for fare evasion, the officers used a cell phone application to check fare validity, and issued citations to passengers without valid fare documentation. I summarize these distinct routine patterns in Table 1.

Metropol became interested in the idea of using game theory as a tool that could facilitate the random deployment of security resources in its patrolling routines. Metropol valued randomly deploying security resources because randomness makes it harder for criminals to exploit predictable patrolling patterns. However, producing random schedules challenged Metropol; human schedulers struggled with a tendency to fall into predictable scheduling habits. Game theory employs formal mathematical models that address this challenge by analyzing a fundamental step in a patrolling routine: the decision about which targets law enforcement should protect from the attacks of adversaries (i.e., terrorists or criminals). To explore the viability of integrating a game-theoretic tool into their daily operations, Metropol contacted Algo-Security, a research organization that specializes in conducting academic research that could apply to real-world problems in the security industry. Prior to the study period, Algo-Security had deployed game-theoretic algorithms to create randomized patrol schedules for several other law enforcement agencies.

To calculate game-theoretic strategies, Algo-Security had to design a customized game matrix for every new client. Larry, an Algo-Security post-doctoral researcher, described this process:

> If you are a new customer, I ask you the following questions: Can you identify a set of targets you need to protect? What resources are available to you? What are the capabilities of those resources? Can you provide some metric of how important each target is? ...We construct a payoff matrix. Basically, we create scenarios where the adversary wins dollars, and we lose dollars. As we create the game matrix, we work with users to think about what their attackers will observe. We spend time understanding what is going on in the real world so we can take real world constraints and build them into the model; we take the information about the real world and optimize the decision-making process. (Interview, Algo-Security post-doctoral researcher, March 7, 2013)

This initial setup process was used to architect a mathematical algorithm that enabled Algo-Security to map characteristics of a client's security environment into a game-theoretic artifact that could generate scheduling recommendations for patrol routines.[2] Algo-Security also had to design a means by which a client organization could interpret the output of the game-theoretic model and integrate that output into their patrolling routine activities.

In July 2012, Metropol and Algo-Security initiated a project to design a game-theoretic artifact to randomize patrolling routines. At the start of the project,

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[2] I provide an overview of the game-theoretic models used by Algo-Security in Appendix 1.

the two organizations worked together to create a mathematical formulation of a game-theoretic model applicable to Metropol's patrolling routine. Upon completion of this formulation in February 2013, Algo-Security and Metropol focused on designing a software artifact that could apply this model to Metropol's patrolling routines for counterterrorism and fare evasion. In March 2013, they began to design a game-theoretic artifact to modify their counterterrorism patrolling routine. Their design activities revolved around the efforts of a federal security agency to determine the readiness of their patrol officers to respond to a terrorist threat and to evaluate the potential benefits of a random, game-theoretic scheduling approach. In June 2013, Metropol and Algo-Security designed the game-theoretic artifact to modify their patrolling routine for fare evasion. These design activities focused on comparing the impact of the game-theoretic algorithm's scheduling decisions with alternative approaches to scheduling. The project concluded in 2013, at which time Metropol's executive leader described the program as an "unqualified success."

> Although we are in the initial stages of evaluating automated crime patrols to reduce serious crimes, preliminary indications are that, (a) the patrol deployment schedules are being generated more efficiently, (b) the mobile app makes the schedules easier to follow, as they adjust to account for real-time events during the patrols, and (c) the randomizations assign patrols to locations of anticipated higher incidence of crime, thereby facilitating more effective police deployments. (Archival Data, September 2013)

Metropol did not immediately deploy the game-theoretic approach to scheduling but began the process of considering an organization-wide initiative to utilize the approach for their patrol routines. Algo-Security leveraged their lessons from this project to pursue other potential clients.

Data Collection

I spent seven months (from February 2013 to September 2013) as a participant observer of the collaboration between Algo-Security experts and Metropol staff to design a software artifact based on a game-theoretic algorithm to randomize patrol officer deployments. During data collection, I followed methodological recommendations about how to study routines (Pentland & Feldman, 2005) but customized my data collection strategy to fit my research context (Feldman, 2014). I participated in the pilot project as unpaid support staff for Algo-Security. My research design incorporated data from participant observation, interviews, and archival materials.

Between February 2013 and September 2013, I spent an average of approximately 10 hours per week as a participant observer working on the project with Algo-Security and Metropol personnel. Initially, I attended Algo-Security meetings and accompanied staff during preliminary site visits to Metropol. As the project unfolded, I observed different exercises conducted to test the algorithm and participated in various design-related activities, such as shadowing Metropol schedulers, riding along with Metropol patrol officers, and accompanying Algo-Security personnel to meetings, conference calls, and field trials of the game-theoretic algorithm. As part of this field work, natural opportunities emerged to interview employees of both Metropol and Algo-Security about the existing patrolling routines and the design of the game-theoretic algorithm. For example, during an all-day training exercise in May, I opportunistically conducted intensive informal interviews with Metropol and Algo-Security staff. While I conducted this fieldwork, I took extensive notes to capture as much detail as possible. After each day in the field, I rewrote these detailed field notes to record my experiences and general reflections and observations.

I also gathered supplemental archival data. I obtained and cataloged publicly available information about Metropol through its website and published annual reports. I gathered information about Algo-Security from its website and by observing several lectures in which team members introduced and explained their game-theoretic approach to law enforcement to academic audiences. This general archival information enabled me to familiarize myself with industry terminology and to understand the cultural background of each organization. As a participant observer, I collected documents related to the design process, such as visual representations of mobile software and dashboards. I also compiled information about the performative aspects of the patrolling routines by obtaining copies of daily and monthly performance reports. Additionally, I gathered all relevant e-mail exchanges related to the project.

Data Analysis

To analyze my data, I adopted a practice perspective (Feldman & Orlikowski, 2011; Nicolini, 2013).

I developed a customized analytical approach (Gehman et al., 2017; Langley & Abdallah, 2011) by reflecting on methodologies used in studies of technology (i.e., Orlikowski, 2002; Orlikowski & Scott, 2008) and routines (i.e., Feldman, 2014; Pentland & Feldman, 2005), and process studies more broadly (i.e., Gehman, Treviño, & Garud, 2013; Langley, 1999; Pentland, 1999). My customized analytic approach consisted of four steps.

In the first step, I developed a temporal narrative and constructed a timeline of events that transpired during my field work. As I conducted this analysis, I sought to identify the major events (see Table 2) and critical actors (see Table 3) associated with the temporal unfolding of the project (Langley, 1999). During this analysis, I realized that although I had initially conceptualized my case as a study of traditional routine dynamics, the actions I observed differed from the ongoing performance actions and patterns associated with a patrolling routine. Rather, I observed actions that revolved around the iterative design of a software artifact that used a game-theoretic algorithm to change patrolling routines.

In the second step, I analyzed the temporal dynamics associated with the case in greater detail by constructing a visual map that showed the relationships among the events I observed (Gehman et al., 2013; Langley, 1999). To construct the elements of the visual map, I developed a summary table for 31 events that occurred during my field work. Following recent studies that have highlighted the importance of paying attention to all persons and objects playing a role in these events (i.e., "actants" associated with an assemblage), I developed a synopsis of each event's purpose, the actants involved, and major tasks. I connected these events using arrows depicting temporal and conceptual links, creating two distinct paths: one for events associated with designing the game-theoretic artifact for counterterrorism and the other for events associated with designing the game-theoretic artifact for fare evasion.

In the third step, I zoomed in (Nicolini, 2009) on each critical event and engaged in two rounds of coding using the constant comparative method (Strauss & Corbin, 1998). In the first round of coding, I developed categories for the empirical actions associated with the practices related to designing the software algorithm (Van Maanen, 1979), specifically leveraging comparisons between design activities associated with the different patrolling patterns for counterterrorism and

TABLE 2
Timeline of Major Events During Project Implementation

Month	Major Event
July 2012	• Metropol contracts with Algo-Security to consider using a game-theoretic algorithm to randomize patrol scheduling
February 2013	• Algo-Security completes formulation of game-theoretic problem and develops an algorithm to solve that problem
March 2013	• Metropol and Algo-Security conduct a counter-swarming exercise
April 2013	• Tabletop exercise simulating patrolling routine for counterterrorism
May 2013	• Full-scale exercise simulating patrolling routine for counterterrorism
June 2013	• Metropol initiates field trials to design the patrolling routine for fare evasion
July 2013	• Metropol and Algo-Security employees participate in ride-alongs to become familiar with the patrolling routine for fare evasion • Algo-Security conducts field trials to test the effectiveness of the game-theoretic approach to the patrolling routine
August 2013	• Final report published for the counterterrorism full-scale exercise • Final results captured for fare evasion field tests

TABLE 3
Metropol and Algo-Security Project Team

Organization	Team Members (Pseudonyms, except for the author)
Metropol	Lieutenant Emrich—Senior Management (Project Sponsor) Sergeant Dale—Line Supervision (Metropol Project Coordinator) Sergeant Aponte—Line Supervision (Project Support, Counter Terrorism) Deputy Rivera—Line Supervision (Project Support, Fare Evasion) Metropol Patrol Officers and Security Assistants—Various (Project Support) Other Agency Patrol Officers—Various (Project Support)
Algo-Security	Dr. Olson—Full Professor (Academic Expert) Dr. Conklin—Director, Business Development (Sold Project; Support) Daniel Ramsey—Post-Doctoral Researcher (Project Leader) Larry Pangle—Post-Doctoral Researcher (Project Support) Robert Clark—Computer Science PhD Student (Project Support) Author—Business School PhD Student (Project Support)

fare evasion (Strauss & Corbin, 1998). In the second round of coding, I iterated between my data and the existing literature on routines to develop theoretical concepts, creating a data structure grounded in an iterative corroboration between my empirical categories and the theoretical literature (Gioia, Corley, & Hamilton, 2012; Kelle, 2005; Stigliani & Ravasi, 2012). I present the resultant data structure in Figure 1.

In a fourth and final step, I sought to understand how to connect the concepts in my data structure, paying particular attention to the temporal dynamics in the data (Langley, 1999). During this step, I observed the iterative unfolding of design activities, paying attention to the ways that the design process caused the nature of the artifact and the understandings of the routines to change over time. I also sought to identify the surprises in my data that existing theories could not explain (Eliasoph & Lichterman, 1999; Kelle, 2005). My goal was to develop a theoretical explanation of the organizational processes—grounded in the empirical data from my field site—by which organizations design artifacts to change routines. Figure 2 depicts the resulting process model.

Key Analytic Concept: The Design Performance

A puzzle that challenged me during data analysis revolved around a fundamental question: How did the design activities associated with the creation and customization of the game-theoretic artifact relate to existing theoretical constructs (i.e., ostensive or performative aspects of routines) in routine dynamics research? Inspired by recent research focused on how different performances and patterns influence routine dynamics (i.e., D'Adderio, 2014; Dittrich et al., 2016; Spee et al., 2016; Turner & Rindova, 2012), I conceptualized the events associated with the design of the game-theoretic artifact as a series of _design performances_, defined as organizational actions to create an artifact in order to intentionally change (or influence) a routine. Design performances are distinct from the repetitive daily activities involved in the ongoing enactment of a routine. By examining design-related actions through the lens of design performances, I established an analytic focus that enabled me to analyze actions associated with the initial design and redesign of an artifact.

Design performances differ from the creative project concept (Obstfeld, 2012) in that the focus is on examining the specific, iterative performances through which organizational actors engage in intentional design activities related to artifacts, rather than conceptualizing a creative project's broader trajectory. A design performance is closely related to an experimental or reflective space (Bucher & Langley, 2016), but focuses on the actions that unfold in a space associated with artifact design as opposed to a more general bounded
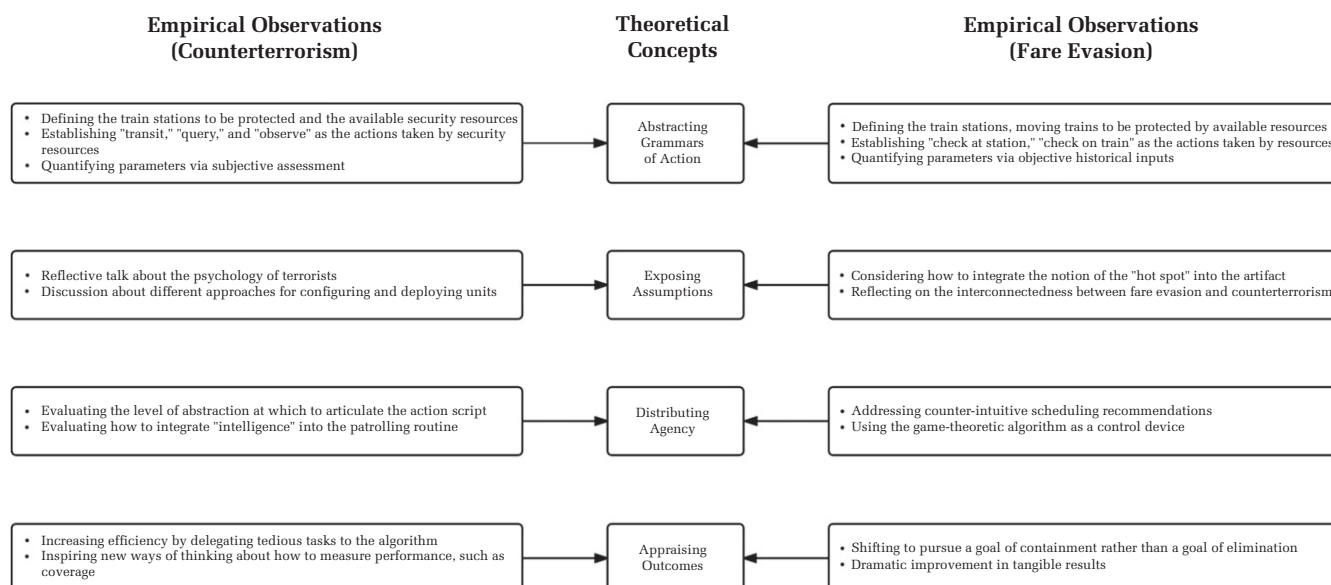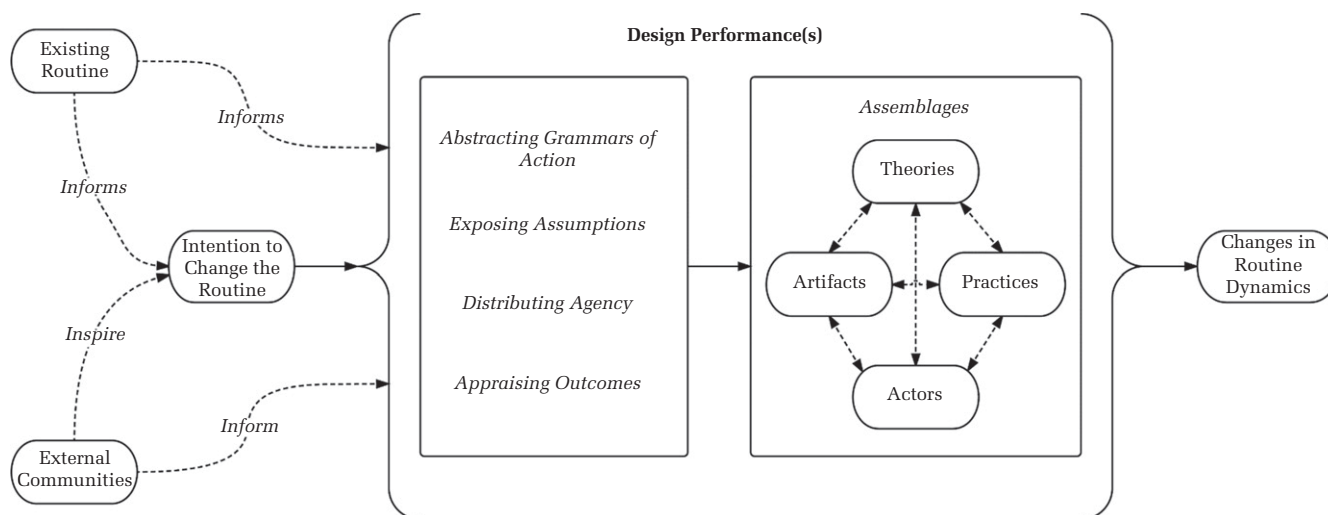
FIGURE 1
Data Structure

FIGURE 2
A Theoretical Framework Explaining How Organizations Use Design Performances to Change Routines

social setting. Design performances thus reflect the concentrated activities organizational actors undertake in the pursuit of intentional—and often strategic—initiatives. In my empirical context, I specifically observed design performances associated with the creation and modification of the game-theoretic artifact intended to change Metropol's patrolling routines.

DESIGN PERFORMANCES: INSCRIBING A GAME-THEORETIC ARTIFACT TO CHANGE PATROLLING ROUTINES

I present my first-order empirical findings through two narratives. In the first narrative, I describe how Metropol and Algo-Security designed the game-theoretic artifact to change the counterterrorism routine. In the second narrative, I explain how they designed the game-theoretic artifact to change the fare evasion routine. I introduce each narrative with a brief overview of the temporal trajectory of the design performances involved and organize the detailed narratives in terms of my overarching theoretical concepts.

Narrative 1: Inscribing a Game-Theoretic Artifact to Randomize Counterterrorism Patrolling Routines

Metropol and Algo-Security needed to design an artifact to apply the mathematical game-theoretic model to counterterrorism patrolling routines. They engaged in design performances with a specific objective in mind: preparing for a full-scale exercise, a national security training event intended to evaluate the ability of local law enforcement agencies to respond to terrorist threats. The full-scale exercise provided Metropol and Algo-Security with an opportunity to compare performances of counterterrorism patrolling routines scheduled using the game-theoretic artifact versus existing practices. In preparation for and in response to the full-scale exercise, Metropol and Algo-Security engaged in 19 different design performances between March 15 and August 15, 2013 to create a game-theoretic artifact that could be used in counterterrorism patrolling routines. These design performances unfolded via four mechanisms: abstracting grammars of action, exposing assumptions, redistributing agency, and reappraising performance.

Abstracting grammars of action. To design an artifact that would randomize patrol scheduling for counterterrorism, the project team had to convert the actions and understandings of the typical pattern of routine performance into knowledge that could be embedded into an artifact (D'Adderio, 2003). To do so, Metropol and Algo-Security had first to abstract the grammars of action, "a set of possibilities from among which members accomplish specific sequences of action" (Pentland & Rueter, 1994: 486), associated with patrolling for counterterrorism. Specifically, creating the artifact required the project team to develop lists of the locations Metropol protected, the types and quantities of available security resources, and the actions

that those resources could perform. Algo-Security's project leader, Daniel Ramsey, presented initial suggestions for these grammars of action to the Metropol project team members during a design performance on March 27, 2013. In a document providing a preliminary description of the envisioned game-theoretic artifact, Daniel proposed that Metropol had 10 targets to protect. He defined available Metropol security resources as consisting of a highly visible uniformed patrol, a mobile search and screening team, a VIPR team, a high visibility weapons team, explosive K-9 teams and crisis motor response teams. Daniel then articulated the actions these resources could take:

> While patrolling a station, each team can do three different actions (with different duration): the team can **query** the people in the station (duration: 15 min), the team can **observe** the station without taking any action (duration: 10 min), the team can **transit** through the station to get to another one (duration: 10 min) or it can transit between different levels of a station (duration: 1 min). (Archival Material, March 27, 2013)

Algo-Security had to abstract from the existing routine pattern to articulate the basic structure or grammar of the routine (Pentland & Rueter, 1994); they could use this abstraction to produce an action script that could be inscribed into a software artifact.

As part of this process, the project team also had to incorporate Metropol officers' tacit knowledge. For example, to produce accurate patrol schedules, the project team needed to embed parameters such as travel time, "the average time it takes for a team to move from one location to another" (Field Notes, March 27, 2013), into the game-theoretic artifact. Similarly, Metropol had to define "the level of attractiveness of each station as a target" (Archival Materials, March 27, 2013). Algo-Security and Metropol thus had to articulate tacit knowledge undergirding the performance of the routine into an explicit numerical value to enable the model to generate recommended patrol schedules—an artifact-generated scheduling recommendation that fit into an abstracted grammar of action.

Exposing assumptions. The design performances stimulated reflective talk (e.g., Dittrich et al., 2016) about the deeper assumptions undergirding the game-theoretic artifact and the counterterrorism patrolling routine more broadly. I observed two recurring topics of conversation that illustrated this mechanism: the project team delved into the psychology of the terrorist, and questioned fundamental

assumptions about how to configure and deploy units most effectively.

The game-theoretic approach to security scheduling relied upon a fundamental assumption about human behavior: individuals are rational, utility-seeking maximizers. During the design process, Algo-Security project team members questioned this assumption as they attempted to define the parameters that quantified the value a terrorist places on potential targets. Specifically, Algo-Security wondered whether criminals actually behave as rational actors; they also questioned whether another assumption of the game-theoretic model—that terrorists originating from different cultural backgrounds behave in the same way—accurately reflected Metropol's security environment. Lt. Emrich defended the rational actor assumption and expounded a philosophy that terrorists, despite different motivations, will act in similar, predictable action sequences.

> Lt. Emrich notes that he's been working counterterrorism since 1989. He learned a lot from his experience...about how to deter terrorism. Basically he says that although there is a distinction between the IRA and an Islamic jihadist in terms of motivation, their behaviors are almost identical. The phases of terrorism will be more or less similar based on the phase of the operation, not the identity of the terrorist. Emrich scoffs at the idea that Al Qaeda is anything but a rational actor. He says that all experience and research shows that the terrorists are very logical and balance symbolic and instrumental goals. (Field Notes, March 27, 2013)

Reflecting on these fundamental assumptions of terrorist psychology led Algo-Security to reconsider how to represent the value terrorists place on targets in the payoff matrix. After the aforementioned conversation, Dr. Conklin observed that one of Algo-Security's fundamental game-theoretic assumptions—that the game matrix reflected a zero-sum game where the law enforcement agency and the terrorist placed identical values on potential targets—might need re-examination.

> The idea that the cost to the adversary and the cost to the protector are the same is a pretty fundamental assumption that is wrong. For example, on 9/11 the cost to the adversary was $500,000, but the cost to us was $10 billion. (Field Notes, March 28, 2013)

Importantly, such discussions about the psychology of the terrorist influenced how Metropol abstracted the action patterns inscribed into the game-theoretic artifact. For example, exposing

the assumptions associated with the psychology of the terrorist influenced how Metropol modeled the values terrorists assigned different targets. Similarly, exposing the assumptions also influenced the definition of the actions that law enforcement would take to deter a terrorist. As a result, exposing fundamental assumptions about the psychology of the terrorist contributed to a new materialization of the game-theoretic artifact. Eventually, these conversations impelled Algo-Security and Metropol to develop a new vision for a future version of the software that would enable Metropol to incorporate knowledge about different types of law enforcement adversaries into a single game-theoretic artifact.

The design performances also stimulated reflective talk about the assumptions related to the configuration and optimal deployment of different types of patrol units. As mentioned earlier, Metropol and Algo-Security had to define categories for distinct types of patrol units to abstract the structure of routine actions. However, Metropol could also configure and deploy these patrol units differently. For example, Metropol could either send a K-9 unit on an independent counterterrorism patrol or it could pair a K-9 unit with a plainclothes officer who could surreptitiously observe how individuals responded to a K-9 unit from a distance. Consequently, during the initial design performances in March, Metropol had to decide whether to schedule units independently or in groups. During an informal interview, Daniel reflected:

> In the parameters, we have to model how each team performs with other team members: Is there a co-ordination benefit, or is there a solo effectiveness benefit? In the first schedule, I had positive effectiveness for team coordination, and this meant that all of the teams bunched together and we didn't get a spreading out of the security resources. (Informal Interview, May 16, 2013)

The same day, Lt. Emrich commented that the design process led him to reconsider how to best configure and deploy patrols.

> Lt. Emrich says that they should think about what types of patrol configurations generate the best results. He also talks about the importance of co-ordination, making sure that for the most part people don't show up at the same place at the same time—he observes that this is an issue with the "let people wander around" philosophy. Lt. Emrich comments that this was an issue in today's patrolling, when a guy with two knives came out, and too many people converged on the event. (Field Notes, May 16, 2013)

The artifact thus provided organizational actors with the affordance of being able to change the synchronization of assets through the manipulation of parameters, but also inspired discussion about the existing routine's underlying assumptions related to the synchronization of assets.

Distributing agency. While designing the game-theoretic artifact and abstracting action patterns, Metropol and Algo-Security had to distribute agency to the actants. Put simply: designing an artifact with abstracted action patterns required the project team to think through which particular actant would perform which particular type of action—and how. I observed this practice of distributing agency in the counterterrorism patrolling routine design performances in two different sets of actions: evaluating the level of abstraction at which to articulate the action pattern and considering how to integrate "intelligence" into the patrolling routine.

The Metropol and Algo-Security project team could conceptualize the action pattern of the patrolling routine at different levels of abstraction. For example, the script of the artifact for an officer patrolling a train station might direct the officer to look for criminal activity by walking around the station (i.e., more abstract) or by visiting specific platforms in a particular order (i.e., more concrete). To develop the game-theoretic artifact, the project team had to specify the level of abstraction for such action patterns. During initial design performances in March, Metropol infused the game-theoretic artifact with a high level of abstraction—concepts of "travel," "observe," or "query" provided minimal direction to patrol officers. Metropol thought this high-level articulation of an action pattern effectively represented the existing counterterrorism patrolling routine: Sgt. Dale opined, "human judgment will always be necessary to deal with the specific situations that emerge" (Field Notes, March 27, 2013). As a result, the game-theoretic artifact initially distributed the scheduling randomization to the algorithm but left control of all other activities to the discretion of individual patrol officers.

However, subsequent design performances led the project team to reconsider this initial distribution of agency. For example, during the full-scale exercise, Lt. Emrich began to muse about whether the algorithm could provide more detailed

instructions to focus the attention of the patrol officers.

> Lt. Emrich then talks about cops: Where are they? The cops are where the pretty girls are. If you don't give specific direction, then they end up doing things that are more pleasurable or easy to do. So there is a real benefit in a system like Algo-Security that tells them exactly what to do: you focus the team, give them purpose, give them direction. (Field Notes, May 16, 2013)

The game-theoretic artifact could operate at a lower level of abstraction to focus officer attention more directly. By doing so, the artifact would exercise additional agency (i.e., provide officers with specific instructions) and refocus the attention and agency of the human patrol officers (i.e., provide officers with clear missions). In summary, the design performances generated new ideas about how to distribute agency to different actants through the use of the game-theoretic artifact.

Metropol and Algo-Security team members also had to consider issues related to the distribution of agency as they discussed how they would integrate "intelligence"—real-time information about the dynamic security environment—into the patrolling routine. During a tabletop exercise in late April, Metropol, Algo-Security, and officers from other law enforcement agencies discussed a simulated scenario of an unspecified bomb threat and how they would perform a counterterrorism patrolling routine in response. This scenario stimulated a difference of opinion about the hypothetical role of a game-theoretic artifact.

> Dr. Conklin then asked Captain Mavin if he would deploy his resources to Metropol based on a random algorithm. Captain Mavin said, "We would deploy if it was reasonable." A Metropol officer challenged this. She said, "Do I have a problem listening to a computer? Sometimes. Computers get hacked. I wouldn't trust a system. I would trust the person behind the order. But there's no way in hell I'm sending people based on what it says on a computer." Captain Mavin weighed in and said that he would balance random recommendations with his subjective expertise. "This is where intelligence comes in. During a normal day, randomization happens all the time. But during an event, we may need to redirect the randomization." (Field Notes, April 25, 2013)

This disagreement during the design performance created a space in which team members could talk through the dynamics of distributing agency. Sgt. Dale's conclusion closely reflected the original thoughts about the distribution of agency:

> Sgt. Dale makes it clear that in his mind the officers on the ground can always override the randomized schedule. They have access to real-time information. The schedule's guidance isn't a steadfast rule that says, "you shall do this." It's guidance. The type of action that the schedule recommends—talk to people, search a bag—leads to some actions being taken. But if you have to arrest three people, you're busy and you're off the schedule. Then you have to reshuffle everyone's deck. That is why the program ultimately has to be dynamic. (Field Notes, April 25, 2013)

The conversation about the ability to override the schedule continued as the project unfolded. In the design performances leading up to the full-scale exercise, Dr. Conklin asked, "Is there a way to encourage or discourage the importance of following the schedule?" (Field Notes, May 13, 2013). The game-theoretic artifact thus functioned as an actant that could exercise more or less control over the ongoing performance of the routine; the design performance inspired iterative, active discussion that could change the nature of the game-theoretic artifact and the actors' understandings of the patrolling routine.

Appraising outcomes. The design performances also led to discussions about how to reappraise outcomes. The practice of appraising outcomes revolved around project team members addressing two questions of concern. First, did the game-theoretic artifact make the life of the routine's human actors easier? Second, how could they measure performance of the counterterrorism patrolling routine using the game-theoretic algorithm as compared to other ways of performing the routine?

Metropol officers found the existing scheduling process for the security resources involved in the counterterrorism patrolling routine cumbersome: manually creating randomized schedules took a significant amount of time. For example, during a March design performance, Sgt. Aponte reflected on the manual process involved in creating a patrol schedule: "[I] would identify the number of locations to be covered, at the desired coverage rate, and just divide it up by resource—[I'd] have my high school daughter use her algebra to do it" (Field Notes, March 27, 2013). Sgt. Aponte's opinion strengthened as the project unfolded. In providing feedback about the

game-theoretic artifact during the full-scale exercise, he commented:

> Sgt. Dale and I did the schedule. We had the luxury of having lots of time to make the schedule and we still made mistakes. We had unrealistic ETAs [estimated time of arrivals]. If we did the exercise again, we could do it more effectively. Still, Algo-Security's schedule blew us out of the water. And it would have been even more so if we had to make the schedule faster. Even with all of our experience, I felt like Algo-Security's schedule was way more efficient—so did all of the players. (Field Notes, May 16, 2013)

The game-theoretic artifact thus reduced the amount of time required to create a schedule for the patrolling routine.

The game-theoretic artifact also provided officers with a more effective way of generating a random schedule. Specifically, to create a random schedule the Metropol officers had to think about being random, which took time and energy. Sgt. Aponte said, "the randomized system will be more efficient. It takes time for the officers to figure out what they're doing, but the efficiency of not having to pull out the piece of paper is part of why there will be extra coverage" (Field Notes, May 16, 2013). Organizational actors thus appraised outcomes by considering how the game-theoretic artifact could automate tedious, repetitive human actions.

Design performances also inspired new ways of thinking about measuring performance. Algo-Security's game-theoretic artifact measured performance by optimizing a metric called "expected defender utility." However, Metropol and other law enforcement agencies struggled to understand this abstract concept and to connect such an abstract, mathematical measure of performance with real-world outcomes.

Subsequently, the project team needed to construct new, alternate ways of appraising outcomes. After several design performances in April and May 2013, Algo-Security proposed three ways to evaluate the effectiveness of the game-theoretic artifact: "a perceptual, behavioral survey; a comparison between the manual and the automated schedule; and some measure of defender expected utility" (Field Notes, April 30, 2013). This tripartite approach to appraising outcomes created a blended way of measuring performance that diverged somewhat from the game-theoretic artifact's underlying logic. For example, coverage referred to observers' perceptions of the law enforcement agency's presence. Although coverage might correlate with expected defender utility, the game matrix placed value on items other than coverage—such as the values

placed on targets by terrorists (which did not necessarily correlate with measures of presence).

The design performance also stimulated other thoughts from individuals about how to think about outcomes. During the full-scale exercise, Sgt. Aponte mused, "What has to be analyzed is this: What wasn't covered? It's not where the resources go that is most important, it is what wasn't covered" (Field Notes, May 16, 2013). He argued, "I should be able to ask somebody, 'How long was the platform level not covered?'" (Field Notes, May 16, 2013). In summary, design performances stimulated discussions about how to appraise outcomes. As a result of the appraisal and reappraisal of performance outcomes, the project team increasingly supplemented their focus on mathematically optimal outputs with a broader conception of performance that embraced multiple approaches for appraising outcomes.

Outcome: an inscribed artifact and new insights into counterterrorism patrolling routines. The design performances inscribing the game-theoretic artifact for counterterrorism patrolling routines came to an end in August 2013 with the publication and discussion of an after-action report evaluating the full-scale exercise. From a practical perspective, the game-theoretic artifact had been developed and deployed successfully during the exercise. However, evaluators offered somewhat mixed reviews regarding the effectiveness of the artifact. Although Metropol personnel and field officers from other law enforcement agencies almost universally praised the game-theoretic artifact's utility, some administrators and agency executives questioned the incremental value it produced. Despite this outcome of political uncertainty, the design performances provided participants with numerous insights into both the existing counterterrorism patrolling routines and the potential utility of an envisioned game-theoretic artifact by stimulating talk and actions related to the mechanisms elicited from the design performances: abstracting grammars of action, exposing assumptions, distributing agency, and appraising outcomes.

Narrative 2: Inscribing a Game-Theoretic Artifact to Randomize Fare Evasion Patrolling Routines

After the full-scale exercise, Algo-Security and Metropol turned their attention to designing a game-theoretic artifact for fare evasion patrolling routines. Metropol, responsible for auditing train and bus passengers for fare payment (the transit system operated on an "honor system"), worked with Algo-Security to conduct field trials of a game-theoretic

artifact specifically designed to randomize fare evasion patrolling routines. Although some of the Metropol participants in the counterterrorism project remained involved, the Metropol leaders shifted from Sgts. Dale and Aponte to Deputy Rivera. Having concluded that the full-scale exercise had proven that randomized scheduling using the game-theoretic artifact produced stronger results compared to traditional manual scheduling efforts, Algo-Security and Metropol created a series of comparison tests that evaluated the effectiveness of the game-theoretic algorithm relative to randomized scheduling directed by a human patrol officer. Algo-Security hired undergraduate student testers to accompany Metropol security assistants to record performance metrics such as the number of citations given. I observed Metropol and Algo-Security enact 12 different design performances between June 1 and August 5, 2013 that elicited the mechanisms of abstracting grammars of action, exposing assumptions, distributing agency, and appraising outcomes.

Abstracting grammars of action. To design the game-theoretic artifact for randomizing fare evasion patrolling routines, the project team had to abstract the grammars of action (Pentland & Rueter, 1994) associated with the fare evasion patrolling routine. These action patterns differed significantly from those in counterterrorism (see Table 1 for an overview of the difference between fare evasion and counterterrorism patrolling patterns). As with the game-theoretic artifact for counterterrorism, the project team had to articulate the grammatical structure of the routine by classifying locations protected, the types and quantities of security resources available, and the actions those resources could perform. However, the content of this grammatical structure differed significantly for fare evasion. For instance, the only resources involved were deputy officers and security assistants, who both used mobile devices to validate passengers' fare cards through a process they called "tapping."

The project team also had to embed parameters such as travel time into the game-theoretic artifact, as well as assumptions about resource capabilities such as the number of passengers that security assistants and deputy officers could check within each period, either at a train station or on a moving train. Additionally, the project team constructed target values for fixed train stations and moving trains, as well as for security assistants (150 taps/day) and deputies (75 taps/day). Unlike the counterterrorism patrolling routine, which relied on officers' subjective assessments of the relative importance of terrorist targets, the fare evasion patrolling routine relied on quantitative historical measures of average passenger counts.

Exposing assumptions. The design performances for fare evasion also stimulated conversations about the deeper assumptions undergirding the game-theoretic artifact and the patrolling routine more broadly. Since the fare evasion design performances occurred after most of the counterterrorism design performances, many discussions built upon the concepts described in the first narrative. I observed various members of the project team grappling with two different fundamental assumptions: they questioned the similarities and differences between the psychology of a fare evader and a terrorist, and they explored the interconnectedness of patrolling routine patterns for fare evasion and counterterrorism.

Although Metropol considered both fare evaders and terrorists to be adversaries, they recognized that these forms of criminal activity featured extreme differences in identities and in the natures of their adversarial behaviors. Considering these differences led to discussions about the relevance of the game-theoretic mathematical model for fare evasion patrolling routines. Before formally beginning field testing of the software artifact for fare evasion, Lt. Emrich made the following observation:

> A problem with the terrorist models that we've been using: with serious crime, you can't assign weights or model agent activity in the same way. The criminal is more opportunistic, you have to model the hot spot…in criminal activity, you have to model multiple sets of interactions. (Field Notes, April 16, 2013)

As the project progressed, discussions led Algo-Security and Metropol to reinforce an emphasis on coverage as a metric of primary importance for fare evasion (relative to "randomness").

> Dr. Conklin says the key to presence is to put people in places where you can't miss them. This isn't a randomization issue, but we can use our algorithm to help put assets in places that can't be missed. (Field Notes, June 24, 2013)

This line of reasoning led to a temporary questioning of the appropriateness and applicability of the game-theoretic artifact for fare evasion. However, further conversations during design performances led the project team to conclude that the game-theoretic model still provided an effective way to model criminal activity. For example, in response to probing questions, Metropol officers commented

that passengers observed them and tried to take advantage of their absence.

> For the last 2 weeks, two of the security assistants were stationed in a fixed post at three or four stations in response to a wave of crime, but the crime just moved to other stations they weren't at. Throughout the day, the two security assistants talk about how intelligent the criminals are, and that they watch and evade the security patrols. (Field Notes, July 10, 2013)

Ultimately, Algo-Security and Metropol maintained the game-theoretic infrastructure for their artifact but modeled different payoff matrices customized for fare evaders.

Metropol and Algo-Security team members also had many conversations about the interconnectedness of fare evasion and counterterrorism. On the surface, fare evasion and counterterrorism seemed like very different forms of criminal activity that could justify different artifacts with minimal overlap. However, designing the artifacts for fare evasion patrolling routines caused the members of the project team to reflect on an underlying interconnectedness with counterterrorism patrolling routines. For example, Dr. Conklin mentioned:

> We need to make sure that we don't separate fare evasion from terrorism. We can't think of these as different issues, as protecting against a shoplifter helps protect us against crime…our algorithm can help law enforcement with fare evasion or deterring terrorism. (Field Notes, June 24, 2013)

Lt. Emrich agreed. He commented at the beginning of a design performance in late June, "Fare evasion gives you an excuse (that doesn't lead to discrimination charges) to talk to potential terrorists" (Field Notes, June 27, 2013).

Exposing these assumptions thus reinforced the initial design of the game-theoretic artifact. However, these conversations led to the creation of distinct payoff matrices and further discussion about envisioning a single future artifact that might be able to generate schedules for different patterns of the patrolling routine.

Distributing agency. As the design performances for fare evasion began, Metropol and Algo-Security relied on their experiences with the counterterrorism patrolling routine to establish an initial distribution of agency between the artifact and the officers: the artifact would provide an initial schedule that officers would flexibly interpret. For instance, Daniel described his objectives for an introductory

meeting with the Metropol deputies and security assistants:

> What we want to say: I'm still interested in your experience. All we want to do is take over the scheduling. We can maintain flexibility in how you interpret the schedule. (Field Notes, June 24, 2013)

However, in a design performance in early July, events transpired that began to challenge Metropol and Algo-Security's belief in this distribution of agency. During a trial, I observed the following incident in which the human actors questioned the decision made by the game-theoretic artifact.

> At 9:53 the Algo-Security algorithm says that we are supposed to stay at the Grand Station—not on the train, but at the station for an hour. [Grand Station seems to be in an isolated place with minimal train traffic]. The deputies automatically say that this is wrong—they say that we should only stay between one or two trains [for 10–15 minutes]. (Field Notes, July 9, 2013)

This event provided a natural opportunity to stimulate discussion about the distribution of agency between the human and nonhuman actors: Was the algorithm wrong, or was there a problem with the humans not understanding the inner wisdom of the algorithm? Daniel's response was interesting:

> Daniel automatically tells [the Metropol officers] that the schedule isn't right, so he encourages them to get on the train…What's interesting, though: the security assistants seem to write many citations while we are at the station. So much so that a security assistant comments to me later that they normally didn't have this many citations. (Field Notes, July 9, 2013)

Although this event seemed to reinforce the distribution of agency favoring flexible interpretation of the schedule by the human security assistants, opinions changed over the course of subsequent design performances. By the end of July 2013, the results of the algorithm seemed to speak for themselves: evidence from the early tests suggested that across the board, the game-theoretic artifact increased the number of fare evaders cited. Daniel's frustration shifted: he complained that "apparently the officers have been choosing NOT to write the citations, because they've been uncomfortable with how many citations they are getting" (Field Notes, July 23, 2013).

As a result of the design performances, the project team began to form a belief that following the new fare evasion patrol schedule provided

more value to Metropol than following the new counterterrorism patrol schedule. Although the officers believed that "everything changes so much on a given day that the schedule is only a starting point and a guideline" (Field Notes, July 10, 2013), the ability of the algorithm to use tangible data from ridership and past citations provided a more effective method for defining the relative importance of locations in terms of finding passengers who violated the honor system. The algorithm became a means of control for Metropol leadership: by distributing control to the game-theoretic artifact, law enforcement supervisors and managers were able to generate better results (in terms of the number of citations written). In many ways, the design performances led to the creation of an artifact that helped executive leaders like Lt. Emrich realize a desire for more control. Lt. Emrich commented: "All data should be captured, and if anyone doesn't do this, they need to talk to me…we should have the number of cites, then train the officers on using the phone, then we can hold them accountable for performance" (Field Notes, June 27, 2013).

Appraising outcomes. Design performances for fare evasion also generated actions and discussions about appraising outcomes. I describe the practice of appraising outcomes for fare evasion patrolling routines through two illustrations: the construction of a 21-day experiment and a shift in the understanding of security goals.

The design performances for fare evasion provided Metropol and Algo-Security with an opportunity to respond to an important political critique that emerged from the full-scale exercise. As mentioned earlier, a few observing executives from federal law enforcement agencies questioned whether the game-theoretic artifact improved the effectiveness of a patrolling routine as compared to other potential artifacts, such as a simple Excel spreadsheet using an out-of-the-box randomizing function. To respond to these critiques, Algo-Security set up an experiment to compare how the results generated by the game-theoretic artifact compared with results generated by alternate methodologies (Archival Paper, January 2014). Algo-Security structured the experiment by having two teams of two officers patrol 14 stations on a train line for two hours per day over a period of 21 days. The experiment compared schedules generated by the game-theoretic artifact with schedules based on a uniform random distribution augmented with insights from a Metropol deputy officer.

The result: a dramatic improvement in the tangible results from using the game-theoretic artifact for fare evasion patrolling routines. In mid-July, Daniel reported:

> We have 8 days of tests: 4 days for the Game-Theoretic approach and 4 days for the random approach. Thus far, the results are very promising. By using game theory, the officers were able to perform twice as good as using the random approach. More specifically, our results show that by using game theory we were able to: check approximately twice the number of passengers than the random + human approach, issue twice the number of warnings, issue twice the number of violations. The results also confirm that train checks are more effective than station checks which confirms what the officer told us. (Archival email, July 17, 2013)

For the project team, these tangible results provided confirmation of the value of the game-theoretic artifact. These results also reinforced support for articulating more specific and concrete action scripts to control security assistants and deputy officers.

However, some Metropol security assistants had little enthusiasm for the game-theoretic artifact. Although Deputy Rivera and many security assistants liked the idea of using the game-theoretic artifact, others presumptively questioned the ability of the algorithm to generate positive results. For example, toward the end of the experiment, Robert Clark and I discussed the game-theoretic artifact with a fare inspector.

> The fare inspector, a security assistant in his mid-20s, is not a fan of the system. He makes comments like, "When we're at this particular station—this is where the tickets are. By the schedule telling me where to go, it prevents me from being as efficient as I can be." (Field Notes, July 26, 2013)

This security assistant believed that his personal judgment would generate superior results to both a uniform random distribution and a game-theoretic approach to scheduling.

During the process of designing the game-theoretic artifact for fare evasion, conversations unfolded about the general philosophy behind appraising outcomes for the system as a whole (i.e., protecting the transit system from fare evaders, criminals, and terrorists). These holistic conversations led to the introduction of a new concept: the idea of containment versus elimination. As Metropol and Algo-Security team members reflected on the performance of the

game-theoretic artifact, Dr. Conklin mused: "It's not how good Algo-Security's algorithm is, it's what happens in the absence of the Algo-Security algorithm. What happens in the absence of a program that is truly random?" (Field Notes, June 25, 2013).

This way of thinking about containment versus prevention emerged because the concept of containment shifted the focus away from measurable results toward a more general philosophical argument that game-theoretic scheduling offers the best protection against the various criminal adversaries that threaten society. Metropol and Algo-Security thus simultaneously sought to justify the value of the game-theoretic artifact by providing both quantifiable evidence (i.e., the 21-day experiment) and a rhetorical rationale (i.e., game-theoretic scheduling contains various forms of crime more effectively than other methodologies).

Outcome: an inscribed artifact and new insights into fare evasion patrolling routines. The design performances associated with fare evasion concluded following the 21-day experiment comparing game-theoretic scheduling with human-augmented, uniform randomized scheduling. The tangible results of this comparison provided clear evidence that game-theoretic scheduling generated superior results as measured by citations, relative to human augmented randomized scheduling. The design performance changed the game-theoretic artifact and understandings of the routine in two significant ways. First, as a result of discussions about the interconnectedness of fare evasion and counterterrorism, Metropol and Algo-Security sought to develop a single artifact that would be able to randomize both counterterrorism and fare evasion patrol patterns. Second, the design performances led to a new, more nuanced understanding of the patterns of routine action that altered the dynamics of how agency was distributed between human patrol officers and the nonhuman game-theoretic artifact.

A THEORETICAL FRAMEWORK EXPLAINING HOW ORGANIZATIONS USE DESIGN PERFORMANCES TO CHANGE ROUTINES

The empirical findings detailed in these two narratives provide grounded support for a theoretical framework that explains how organizations use design performances to change routines (see Figure 2). By studying the actions associated with the design of an artifact intended to change a routine (Feldman & Orlikowski, 2011; Suchman, 2007), this model yields insight into the relationship between design activities and routine dynamics.

As previous research has shown, an organization's intention to change a routine can either emerge from internal performances of the routine (i.e., Feldman, 2000) or external influences (i.e., Bresman, 2013). In the case of Metropol and Algo-Security, Metropol's intent to change the routine was informed by its historical experience with the routine and its interaction with an external community of practice—Algo-Security's game-theoretic experts. More broadly, organizational actors intending to change a routine might engage external communities from inside the organization (Bresman, 2013), outside the organization (Bertels et al., 2016), other functional, occupational or profession-based disciplines (Cacciatori, 2012; D'Adderio, 2008), or analogical domains more broadly (Etzion & Ferraro, 2010; Glaser, Fiss, & Kennedy, 2016). Inspired by such internally and externally generated ideas, organizations enact a series of design performances—organizational actions aimed at creating an artifact in order to change (or influence) a routine.

Design performances can lead to the creation of different types of artifacts for different purposes. While Algo-Security intended to change the patrolling routine by creating software that used a game-theoretic algorithm to generate scheduling decisions, design performances could create or modify other types of artifacts as well: standard operating procedures to normalize performance (Hales & Tidd, 2009), signs to communicate intentions to outsiders (Bapuji et al., 2012), or generic protocols to coordinate store layouts for organizational employees spread across diverse locations (Sonenshein, 2016). Although distinctions between the type and purpose of an artifact may substantively influence routine dynamics, I theorize that design performances have the generalized capacity to elicit four mechanisms associated with the development of artifacts intended to change routines.

First, design performances require organizational actors to abstract grammars of action (Pentland & Rueter, 1994) by articulating the main components of the routine. For example, as Metropol and Algo-Security designed a game-theoretic artifact, they had to define generic types of actions taken by security officers (i.e., "transit," "query," or "observe") at typical locations (i.e., "station 1" or "station 2"). The Metropol and Algo-Security project team had to define the fundamental components of interest and agree on the level of abstraction with which to define each component. Location could refer to either

a station generally or a more specific part of the station (such as a "lobby" or "platform 1"). Abstracting grammars of action also occurs in other contexts in which organizations use artifacts to change routines. To illustrate, in an academic hiring routine (Feldman & Pentland, 2003), an organization could use a series of design performances to create a standard operating procedure (SOP). In design performances intended to create an SOP for the hiring routine, organizational actors would need to abstract a grammar of action by defining the components of the routine (i.e., establishing whether the SOP should address a particular type of position such as a tenure-track professor, or also include other positions such as adjunct professors or administrative staff) and articulating the detail with which to specify the actions of the routine (i.e., establishing whether to provide general guidance about conducting an interview or to delineate a specific interview protocol). Design performances thus generate reflexive discussion about grammars of action by requiring organizational actors to articulate fundamental components of the routine. This discussion can either reify existing understandings of the routine or engender fundamental changes to the grammar of action (e.g., Dittrich et al., 2016).

Second, design performances impel organizational actors to expose assumptions associated with the current routine and new knowledge associated with ideas imported from an external community. In my findings, the actions of the design performances caused the Metropol and Algo-Security project team to challenge deeper assumptions undergirding routine performance, such as the psychology of a criminal or the benefits of coordination between different types of security resources. Scholars have identified that deep assumptions associated with worldviews undergird many artifacts central to routine performance (Akrich, 1992; D'Adderio, 2008). For example, Cacciatori (2012) showed how artifacts associated with distinct occupations—cost consulting and engineering—take different forms as a result of distinct occupational assumptions. Design performances, due to the codification activities required to create an artifact (D'Adderio, 2003), induce organizational actors to expose these assumptions. Although existing literature has emphasized the potential conflicts between occupational groups (Cacciatori, 2012; Zbaracki & Bergen, 2010), design performances provide organizational actors with different occupational training experiences or ostensive understandings of a routine with an opportunity to learn about other perspectives.

Put another way, design performances provide a space for social interaction (Bucher & Langley, 2016) in which organizational actors can consider the appropriateness and practical implications of the assumptions undergirding the design of artifacts and routines.

Third, design performances provide organizational actors with the opportunity to take a future perspective (Gavetti & Levinthal, 2000) and distribute agency to actants (i.e., organizational actors or artifacts) (Emirbayer & Mische, 1998). In this study, organizational actors used the series of design performances to create a game-theoretic artifact that leveraged a software-embedded mathematical algorithm to replace a human decision-making component of a patrolling routine. The design performances stimulated reflective talk (Dittrich et al., 2016) that prospectively specified the actions taken by the game-theoretic artifact, as contrasted with the actions taken by other organizational actors or artifacts involved in the routine. As the project progressed, design performances stimulated a redistribution of agency between humans and the artifact. The notion that design performances induce organizational actors to distribute agency between humans and artifacts also applies to artifacts other than software algorithms. For instance, Danner-Schröder and Geiger (2016) showed how an artifact used in emergency response routines—guidelines describing workflow—support patterns of standardization and flexibility through the degree of specificity of instruction about how to accomplish tasks. Importantly, the design performance does not irrevocably specify a distribution of agency: the future performance of the routine matters. To illustrate, Sele and Grand (2016) described a situation in which an artifact—documentation of reviewer feedback—produced different effects depending on how organizational actors interacted with the artifact in conjunction with the broader assemblage. To sum up, organizational actors use design performances to analyze who should do what—when, where, and why (Burke, 1969). This projected distribution of agency may significantly influence and shape an organization's attempt to intentionally change the routine.

Fourth, and finally, design performances provoke conversations in which organizational actors explore and evaluate alternative means of appraising routine outcomes. The design performances spurred Metropol and Algo-Security to consider multiple measures of success for the patrolling routines, ranging from mathematical

notions of expected defender utility to more pedestrian notions such as coverage. Routines researchers have highlighted the importance of outcomes on routine dynamics. For example, Feldman (2000) showed how outcomes associated with routine performance that fall short of ideals or present new opportunities generate change; Dittrich et al. (2016) further demonstrated that talk supports collective reflection about evaluating outcomes. However, by focusing on outcome appraisal in conjunction with ongoing routine performance, researchers have failed to account for the possibility of more transformational shifts in routines that occur through actions that take place in reflective and experimental spaces (Bucher & Langley, 2016). The act of appraising outcomes in design performances influences the intentional change of routines in two significant ways. First, design performances are a fundamental means by which organizational actors facilitate the entry of novel ideas about how to incorporate performance appraisal into routines. Second, in design performances, organizational actors— particularly external communities—can construct new methods for appraising performance into the material properties of an artifact, shaping subsequent enactments of the routine in ways that reshape the landscape of possible routine actions. Design performances thus have the potential to trigger disruptive shifts in routine performance that extend well beyond traditional accounts emphasizing the predominance of trial and error learning.

In this study, Metropol and Algo-Security used design performances to develop an artifact that leveraged a game-theoretic algorithm to generate optimal, randomized scheduling decisions. Their design performances produced more than an artifact: iterative design performances led to the development of a new assemblage of artifacts, actors, theories, and practices (Callon, 1998; D'Adderio & Pollock, 2014; Orlikowski, 2007). Because of the design performances, Metropol and Algo-Security had to create a broader network of artifacts to support the game-theoretic artifact. For example, spreadsheets and eventually mobile devices displayed the results of the algorithm to field patrol officers, and reports documented the use and effectiveness of the revised patrolling routine. Design performances also shaped the ostensive understandings of individuals (Howard-Grenville, 2005) by helping them understand others inside and outside the organization through the mechanisms of abstracting grammars of action and exposing

assumptions; similarly, design performances shaped individual understandings of an idealized patrolling routine through the mechanism of appraising outcomes. The design performances likewise reshaped understandings of organizational practices through the mechanism of distributing agency, such as when the organizational actors developed new ideas and practices related to the coordination of units. To conclude, this theoretical model shows how organizations use design performances to envision new sociomaterial assemblages of actors, artifacts, theories, and practices. These design performances influence routine dynamics through mechanisms of abstracting grammars of action, exposing assumptions, distributing agency, and appraising outcomes and creating new assemblages of actors, artifacts, theories, and practices that can be used in future routine performances.

DISCUSSION

This study empirically examines how organizations attempt to intentionally change routines to pursue strategic goals and adapt to their environment by developing artifacts such as software or standard operating procedures (D'Adderio, 2008; Pentland & Feldman, 2008; Simon, 1970). Existing research has shown how such plans or intentions for change often fail to produce their intended consequences through mechanisms elicited by the ongoing performance of the routine (e.g., Hales & Tidd, 2009; Rerup & Feldman, 2011). However, explaining change by exclusively focusing on the actions associated with ongoing routine performance misses an opportunity to understand the multifaceted ways through which designing actions influence routine dynamics. By theorizing how organizations design artifacts to change routines, my findings have implications for research on routine dynamics, performativity, and strategy tools.

Design Performances, Assemblages, and Routine Dynamics

This study introduces a unique and novel perspective that extends how existing research has explained the relationship between organizational efforts to intentionally change routines and routine dynamics. I illustrate the utility of the design performance construct by exploring Pentland and Feldman's (2008) classic story of artifacts and organizational change. Pentland and Feldman (2008) presented an empirical example

in which organizational actors sought to change routines for scheduling and delivering executive education. To do so, management attempted to intentionally change these routines by purchasing a software package to standardize routine performance across different departments in the organization. A project implementation team successfully deployed the software package; however, during subsequent routine performances, organizational actors subverted the project implementation teams' intentions by using spreadsheets to maintain preexisting procedures. This study thus illustrates that ongoing routine performance can overwhelm the intentions of the change agents instantiated in artifacts. Pentland and Feldman (2007) therefore suggest that designers of artifacts should consider how artifacts fit into a broader narrative network.

Design performances and assemblages enhance our ability to understand such efforts to intentionally change routines. I suggest that the software implementation in Pentland and Feldman's account of designing a software artifact required organizational actors to engage in a series of design performances in order to envision a new assemblage. Although the assemblage that directly emerged from these design performances did not directly change routine performance in the way the project team responsible for designing the software artifact intended, I suggest that Pentland and Feldman's (2008: 239) account explicitly suggests that these design performances stimulated significant consequences: they observed that organizational actors created another artifact—a spreadsheet—that enabled organizational actors to ignore the designed intentions of the software implementation team. Although organizational actors rejected the original assemblage envisioned by designers, they enacted subsequent design performances to envision and create another assemblage that relied on new artifacts (i.e., customized spreadsheets). This new assemblage did materially influence ongoing routine dynamics. For instance, even if organizational actors maintained previous patterns of action, the actions associated with design performance created possibilities for future change by both impacting the ostensive understandings of organizational actors through the mechanisms of abstracting grammars of action, exposing assumptions, distributing agency, and appraising outcomes, and by creating a new assemblage that features potential for future changes (e.g., Sele & Grand, 2016).

I suggest that viewing efforts to intentionally change routines through the lens of design performances and assemblages extends our understanding of routine dynamics in three significant ways. First, design performances are powerful because they serve as a specific means by which organizational actors can introduce new ideas into a routine. Although existing research has highlighted how ongoing routine performances can endogenously change future routine performances and patterns, some recent studies have begun to theorize mechanisms associated with intentional, dramatic changes to routines, such as environmental jolts (e.g., Cohendet & Simon, 2016), creating space for experimentation (e.g., Bucher & Langley, 2016), or strategic attempts to overcome organizational inertia (e.g., Kaplan, 2015). As organizational actors draw on ideas or analogical examples from external communities to intentionally change their routines (e.g., Bertels et al., 2016; Bresman, 2013), they must translate such analogical exemplars into an assemblage that can function in their local environment. The actions that take place during the design performances elicit mechanisms that have substantive potential to introduce transformative ideas into a routine. For example, the grammars of action (Pentland & Rueter, 1994) that undergird a routine typically exist in the taken-for-granted background of routine performance (D'Adderio, 2008). My findings suggest that design performances impel actors to abstract these grammars, providing an opportunity for concepts associated with other domains to influence how organizational actors define the grammatical structure of a routine. Similarly, to create an artifact, design performances generate discussions about how to appraise the outcomes associated with the routine. Such actions can stimulate the introduction of new or adjusted goals, inherently initiating potential changes to routine dynamics through the mechanism of reflective talk (e.g., Dittrich et al., 2016).

Second, design performances influence routine dynamics because of the ways in which they shape the materiality of the artifacts integral to routine performances. Existing research has highlighted that the materiality of artifacts such as software can control the performances of organizational actors (D'Adderio, 2008). For example, in the aforementioned Pentland and Feldman (2008) case, the software implementation team designed software that required organizational actors to fill certain values in certain fields for different orders. Design performances consist of actions that impel organizational

actors to distribute agency to actors and artifacts. This mechanism of distributing agency is particularly important: it not only provides organizational actors with the means to control future routine performance by embedding decision rules into artifacts, it also functions as a means by which organizational actors can reflect on and change these controls. In other words, design performances function as a means by which organizational actors can expose and dynamically change the assumptions and decision rules embedded in artifacts and assemblages.

Third, design performances impact the nature of political dynamics in routines (i.e., Nelson & Winter, 1982; Zbaracki & Bergen, 2010). To create an artifact, organizational actors must negotiate among different understandings of the routine held by different communities of practice (Cacciatori, 2012; D'Adderio, 2014; Zbaracki & Bergen, 2010) and the multiple understandings of routine patterns held by individual members within an organization (Howard-Grenville, 2005). Existing research has highlighted how different occupational groups use political techniques to resolve competing objectives and incompatible worldviews (Gupta et al., 2015; Zbaracki & Bergen, 2010). For example, Zbaracki and Bergen (2010) showed how hierarchical leadership authority resolves conflict between different functional interests within an organization. Similarly, Gupta et al. (2015) developed a normative process model suggesting that successful change initiatives require organizational actors to identify stakeholders and systematically resolve issues of conflict. However, my study—by showing the actions associated with designing an artifact—shows how design performances create social interactions that may enable organizational actors to understand alternate perspectives. For example, the mechanism of exposing assumptions provides actors involved in the design performance with an opportunity to reflect on other perspectives (e.g., Bresman, 2013). Additionally, the mechanism of appraising outcomes may facilitate the construction of goals that could provide an opportunity for organizational actors to create superordinate objectives that unify disparate political groups (e.g., Sherif, 1961). Design performances thus lead to the development of new, localized assemblages that integrate actors, artifacts, theories, and practices from both existing routines and external influences. The mechanisms produced by design performances may reduce political conflict by helping organizational actors overcome divergent interests and worldviews to develop assemblages that address common, overarching problems.

Design Performances, Assemblages, and Performativity

Research in performativity has sought to explain the connections between academic theories and the social worlds they theorize, such as the relationship between economic theory and the economy (Callon, 1998; Gond, Cabantous, Harding, & Learmonth, 2016; Muniesa, 2014). Ferraro, Pfeffer and Sutton (2005: 8) suggested that social theories may "perpetuate themselves by promulgating language and assumptions that become widely used and accepted." For instance, scholars have suggested that economic theory does not provide a set of camera-like tools that take representative pictures of the economy; rather, economic theory functions as an engine that motors the economy (Callon, 2007; MacKenzie, 2007, 2008; MacKenzie & Millo, 2003). Specifically, performativity scholars have suggested that economics drives the economy through the introduction of new assemblages of theories, actors, artifacts, and practices that substantively shape market activities (Callon, 2007)—particularly by introducing novel means for calculating the values of products and services (e.g., Beunza & Garud, 2007; Beunza, Hardie, & MacKenzie, 2006; Callon & Muniesa, 2005; Glaser et al., 2016; MacKenzie & Millo, 2003). Scholars have also applied performativity to other business domains, such as organizational decision making (Cabantous & Gond, 2011; Cabantous, Gond, & Johnson-Cramer, 2010; Muniesa, 2017), organizational structure (D'Adderio & Pollock, 2014), business models (Doganova & Eyquem-Renault, 2009; Pollock & Williams, 2016), and strategy (Vásquez, Bencherki, Cooren, & Sergi, 2017). Although this research has highlighted the ways in which theories become real through interconnections with actors, artifacts, and practices (e.g., Çalışkan & Callon, 2010; Callon, 2007), scholars still have a limited understanding of the means by which organizational actors concurrently design, modify, and use assemblages at the "interstices" between the producers and consumers of theory (Pollock & Williams, 2016: 312). My study bears particular relevance to this discussion, as it features an empirical context in which the academically trained game theorists of Algo-Security worked with the law enforcement practitioners of Metropol to use game theory to change patrolling routines. I suggest that the theoretical model

explaining how organizational actors use design performances to intentionally change routines contributes to performativity research in two ways.

First, I theorize the process by which organizational actors associated with a theory (i.e., Algo-Security's game theorists) work with practitioners to influence specific organizational practices (i.e., Metropol's law enforcement patrolling routines). In design performances, organizational actors envision an assemblage that inscribes concepts from a theory into an artifact in order to shape and influence future organizational practices. Design performances elicit mechanisms that fundamentally transform the abstract theory into a theory instantiated in a local context. Specifically, the mechanism of exposing assumptions uncovers discrepancies between the theory and the local context envisaged by designers. For example, the assumptions of game theory as an academic discipline had varying degrees of applicability to Metropol's counterterrorism and fare evasion patrolling routines. However, design performances impelled Metropol and Algo-Security team members to fabricate a new assemblage that fused bits and pieces of both game theory and existing patrolling routine patterns. My model thus shows how the actions associated with designing substantively influence how academic theories influence organizations: design performances empower organizational actors "to multiply possible worlds through collective experimentations and performances" (Callon, 2007: 352).

Second, theorizing the dynamics associated with the processes of performativity responds to recent calls to understand performative "journeys" (e.g., Garud, Gehman, & Tharchen, 2017: 1). Some scholars have suggested that performativity's thesis that theories can be self-fulfilling provides the most interesting implication of performativity research (Felin & Foss, 2009; Ferraro et al., 2005; Marti & Gond, 2017). This emphasis privileges the role of so-called Barnesian performativity (e.g., D'Adderio, 2008; MacKenzie, 2007; MacKenzie, Muniesa, & Siu, 2007), but I suggest that an exclusive emphasis on this aspect of performativity may overlook the potential for a performative perspective to explain how theories shape social interaction through the processes of designing, modifying, and using assemblages. Since performative processes often unfold through a series of design performances, I suggest that theories may differ in terms of their generative potential to create new assemblages. For instance, Glaser, Fiss and Kennedy's (2016) study of the emergence of online advertising exchanges provides an empirical example of performativity in which market actors applied concepts associated with financial markets to reshape the practices used to buy and sell online display advertising impressions. Although finance theories undergirded much of this transformation, the study's processes of stretching, surface bending, structural bending, and generative bending highlighted how organizational actors incrementally and iteratively design artifacts and assemblages by tweaking and experimenting with relationships between actors, artifacts, theories, and practices to create increasingly sophisticated means of amplifying their abilities. In summary, design performances and assemblages help explain how theories engender substantive social effects, regardless of whether they generate self-fulfilling outcomes.

Design Performances, Assemblages, and Strategy Tools

Strategy-as-practice research has highlighted how strategy is a social practice, and consequently has emphasized the importance of studying the practices by which practitioners conduct strategy work (Jarzabkowski & Spee, 2009; Whittington, 2006, 2007). This research has investigated how strategy practitioners use strategy tools (i.e., a particular type of artifact) during the practice of strategy (Jarzabkowski & Kaplan, 2015; Seidl, 2007). For example, PowerPoint presentations mediate the strategic discussions of organizational actors (Kaplan, 2010); organizational actors use conceptual frameworks or tools such as Porter's five forces or a strengths, weaknesses, opportunities and threats (SWOT) analysis to make strategic decisions such as market entry (Jarzabkowski & Kaplan, 2015). Such strategy tools provide a means by which organizational actors construct a local rationality that establishes criteria used to evaluate decisions (Cabantous et al., 2010; Cabantous & Gond, 2011). Strategy tools create a "technology of rationality" that requires organizational actors to prospectively abstract typical situations, analyze historical data, and articulate decision rules that "consider alternatives in terms of their expected consequences and select the alternative that has the best expected consequences from the point of view of the organization's values, desires, and time perspectives" (March 2006: 203). Although the use of such strategy tools bears significant implications for managerial action, scholars still have a limited understanding of the processes by

which organizational actors design strategy tools (Jarzabkowski & Kaplan, 2015: 552).

My study is relevant to this discussion because it showcases a specific case of the development of a strategy tool: Metropol's use of a game-theoretic tool to instantiate a methodology for allocating patrol officers in software is a case in which an organization designs a technology of rationality to make (and control) decisions of strategic importance. My theoretical model introduces an important insight about how strategy tools are developed de novo. Organizational actors design or redesign strategy tools through a series of design performances. Even when organizational actors use strategy tools such as Porter's five forces or a SWOT analysis, they must modify generic tools to adapt to a particular context (Seidl, 2007). Specifically, in order to create a strategy tool that can be used, strategists need to envision and create an assemblage consisting of actors (i.e., which actors in the organization should be involved in using the tool?), artifacts (i.e., what should the material form of the tool be?), theories (i.e., which strategy frameworks should be used?) and practices (i.e., how should activities such as meetings be structured?). In doing so, their design performances elicit mechanisms of abstracting grammars of action, exposing assumptions, distributing agency, and appraising outcomes. These mechanisms suggest that when actors engage in design performances, they may craft more adaptive strategy tools that are less likely to lead to negative outcomes from the use of automated decision-making processes (Jarzabkowski & Kaplan, 2015; cf., March 2006). This observation is important because it suggests that the outcomes emerging from the use of strategy tools may be closely related to the processes by which organizational actors design them. In summary, existing research has highlighted the importance of the interpretive flexibility of a strategy tool (e.g., Jarzabkowski & Kaplan, 2015); my study extends this research by showing how design performances provide generic strategy tools with increased capacity to spawn generative potential to change organizational routines and realize organizational goals.

Limitations and Future Directions for Research

This theoretical model was inspired by a single case study of an extreme case; the unique empirical context facilitated the identification and development of new theoretical concepts and relationships. The four resulting limitations of this study establish boundary conditions for my theory, yet also provide opportunities for future research.

First, I studied design performances related to a specific type of artifact—a software artifact based on a mathematical algorithm. This type of artifact differs significantly from other artifacts, such as standard operating procedures or pieces of equipment. The project related to the development of this game-theoretic artifact provided an excellent empirical context in which to develop theory about design performances because organizational actors had to engage in explicit modeling to construct it. However, theoretical concepts generated from my particular empirical context—such as the inscribing practice of distributing agency—may be more salient and relevant for organizational routines that involve artifacts that leverage algorithms. In the future, researchers can investigate whether other types of artifacts have different inscribing practices and whether these different inscribing practices might impact routine dynamics in a different manner.

Second, I studied the design of an artifact in the context of a pilot project rather than in the context of an ongoing routine. The nature of the pilot project provided an excellent opportunity to discover design-related concepts because it is an extreme case (Pettigrew, 1990) of how organizations use dedicated spaces to introduce exogenous changes to routines (Bucher & Langley, 2016). However, in the future researchers should investigate how design performances and the act of inscribing practices influence routine dynamics if design performances are more tightly connected to the ongoing performance of routines.

Third, in this study, design performances were clearly visible to the actors in the focal organization, Metropol. However, in the development of many software or technology solutions, designers reside outside of the organizations that perform the routines such solutions are intended to address. For example, software packages such as Enterprise Resource Planning systems often have technological infrastructures that cannot be changed by organizations. Although organizations may still need to enact design performances to apply such off-the-shelf software to specific contexts, these design performances may generate less reflective talk about abstracting grammars of action or exposing assumptions compared to those in which designers and users more closely communicate. In the future, researchers can examine whether this property of design performances stimulates different degrees of

activation for each of the four mechanisms theorized in this paper.

Finally, my study does not directly theorize the more confrontational political dynamics associated with the design activities of Metropol and Algo-Security that unfolded from the deployment of new technologies that reshaped role relations (i.e., Barley, 1986; Zuboff, 1988). This study involved intensive interaction between a focal organization (Metropol) and an external service provider (Algo-Security) that reflected two different communities of practice with various approaches to the routine. In my findings, political dynamics between these two entities were muted; the two organizations worked together to achieve common objectives. This feature of my research setting facilitated theory development because the nature of the design performances motivated actors to work hard to bridge differences in their understandings through open communication. However, confrontational political dynamics may play a more significant role in the design of artifacts in other contexts. For example, in the future researchers may investigate whether the concepts and theoretical relationships depicted in this study change if the design work is performed completely within an organization. Alternatively, scholars can investigate whether the composition of the project team structurally influences the design process.

CONCLUSION

In this paper, I have explored how organizations design artifacts to change routines. My investigation has yielded novel insights about the strategic activities organizations engage in to control their environments. My empirical and theoretical findings show that design is a complex and intricate process that involves dynamic interactions among artifacts, organizational actors, theories, and routines. Armed with this theoretical understanding of design from a practice perspective, scholars may be able to provide an improved conceptual infrastructure that managers can use to generate "live" routines (Cohen, 2007)—and, ultimately, healthier organizations.

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APPENDIX 1

Algo-Security's game-theoretic approach to security scheduling can be illustrated with a simplified game (see Figure A1). In this simplified game, there are two targets of interest (Target 1 and Target 2). The defender can choose to send a security resource to defend either Target 1 or Target 2. Similarly, the adversary can elect to attack either Target 1 or Target 2. The payoff matrix reflects the costs and benefits realized by the defender and the adversary based on the outcomes of different strategic choices. For example, in this simplified game matrix, if the defender elects to protect Target 1, and the adversary chooses to attack Target 2, the attack succeeds: the defender's payoff is –2, and the adversary's payoff is 2. Conversely, if the defender chooses to protect Target 1 and the adversary elects to attack Target 1,

the attack is unsuccessful: the defender's payoff is 1, and the adversary's payoff is –1.

Algo-Security's game theoretic modeling incorporated additional parameters that increased the complexity of the model.[3] In their models, the defender moves first by scheduling resources to protect particular targets. While preparing for an attack, an adversary monitors the defender's actions and seeks to exploit predictable defense patterns. In the simplified example above, if the defender always protected the most important target (Target 2), the adversary will observe this and always attack the less important target (Target 1). Consequently, in Algo-Security's models, defenders employ mixed strategies by choosing to defend different targets periodically. In the simplified example, the defender might deploy resources to protect Target 1 half of the time and Target 2 the other half of the time. Mathematically, the defender can calculate the optimum mixed strategy, and when the attacker observes the defender's patterns of resource deployment over an extended period and responds optimally, the players achieve game-theoretic equilibrium. Other factors of complexity modeled include the ability to incorporate assumptions such as uncertain payoffs (i.e., a defender may not know how much an attacker values different targets) or multiple adversary types (i.e., a common criminal might have different payoffs than a terrorist).

For simple exercises, such as Figure A1, a security provider could mathematically calculate the optimal defender mixed strategy. However, in real-world security situations, these calculations become quite complex. For example, if a security organization has 10 resources they can use to protect 100 targets, it must choose a strategy from a possible 1.73×10^{13} potential strategies. Sifting through this large quantity of potential actions to identify the optimal defender strategy creates a massive computational challenge for security providers. Algo-Security's game-theoretic scheduling algorithms modeled the scheduling decisions associated with patrolling routines as a mathematical optimization problem.

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[3] Algo-Security used Bayesian Stackelberg game-theoretic models. In Bayesian games, the parties have incomplete information about each other's payoffs; in Stackelberg games, one player moves first and the other players move sequentially.

FIGURE A1
Simple Example of a Game Matrix for Security Scheduling.

* Payoff values described below		Adversary	
		Target 1	Target 2
Defender	Target 1	1, −1	−2, 2
	Target 2	−1, 1	2, 0

* The payoff values reflect a cost or benefit of a successful or unsuccessful attack. For example, in the table above, if the defender chooses to assign resources to protect Target 1 and the adversary attacks Target 1, then the defender realizes a payoff of 1 and the adversary realizes a payoff of −1. If the defender chooses to defend Target 1 but the adversary attacks Target 2, then the defender realizes a payoff of −2 and the adversary realizes a payoff of 2. In this simple example, we see that the defender and attacker both place a greater value on Target 2 than on Target 1.