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Toward a Social Ontology for Conceptual Modeling

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Abstract:

Conceptual modeling is fundamental to information systems requirements engineering. Systems analysts and designers use the constructs and methods of a conceptual modeling formalism to represent, communicate, and validate the contents, capabilities, and constraints of an envisioned information system within its organizational context. The value of such a representation is measured by the degree to which it facilitates a shared understanding among all stakeholders of (1) the organizational information requirements and (2) the ability of the envisioned information system to meet them [Wand and Weber, 2002]. We propose using the social ontology developed by John Searle [1995, 2006, 2010] as the basis for conceptual modeling and present a meta-model based on that ontology.

Keywords

Ontology, conceptual modeling, meta-model

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I. INTRODUCTION

The philosophical discipline of ontology provides a substantive basis for creating a shared understanding among the stakeholders in a system design undertaking [Gruninger and Lee, 2002]. A number of researchers have proposed using ontology as the basis upon which to develop and evaluate conceptual modeling grammars (constructs and rules) and methods [Wand and Weber, 1995, 2002; Gemino and Wand, 2005; Burton-Jones and Meso, 2006]. In general, ontology seeks a definitive and exhaustive classification of *being* (or existence) in a given domain. In this work, we investigate using the social ontology proposed by John Searle [1995, 2006, 2010] as a philosophical foundation for conceptual modeling (see Figure 1).

Conceptual modeling is concerned with representing the requirements of organizational information systems. Organizational information systems are concerned with documenting, monitoring, analyzing, and participating in business activities that affect the performance of an organization. They are concerned primarily, although not exclusively, with “institutional reality,” [Searle, 1995, 2010] a “reality” that is created and maintained by human declarations (collective intentionality) for human purposes¹. In contrast, a “scientific ontology” such as that proposed by Bunge [1977] is concerned exclusively with “objects that exist in space and time.” It is devoid of human intentions and ideas that give meaning to social phenomena. As Searle [2010] explains, “the whole point of institutional reality is ... to create and regulate power relationships between people. Human social reality ... is about people’s activities and about the power relations that not only govern but constitute those activities” (p. 106). Information systems are tools used to document and participate in those activities [March and Allen, 2007].

Searle [2010] makes three claims in his social ontology:

First, all of human institutional reality, and in that sense nearly all of human civilization, is created in its initial existence and maintained in its continued existence by a single logico-linguistic operation. Second, we can state exactly what that operation is. It is a Status Function Declaration [X counts as Y in context C]. And third, the enormous diversity and complexity of human civilization is explained by the fact that the operation is not restricted in subject matter and can be applied over and over in a recursive fashion, is often applied to the outcomes of earlier applications and with various interlocking subject matters, to create all of the complex structure of actual human societies. (p. 201)

Status functions represent bundles of deontic powers. That is, they carry rights, duties, obligations, requirements, permissions, authorizations, entitlements, and so on. Such bundles of deontic powers are often recognized as conceptual objects or roles within an organization or within society in general. The fundamental concept is that, in a social context, people, as agents of an institution, have the capacity to impose “status functions” on objects and people that enable those objects and people to perform functions that they cannot perform “solely in virtue of their physical structure” [Searle, 2010, p. 7]. That is, the performance of such functions require that there be a collectively recognized status that the person or object has, and it is only by virtue of that status that the person or object can perform the function in question.

For example, a physical object that is given the status function *private property* is recognized by people in society as such and is legally protected from being appropriated by another person. Such appropriation is termed *theft* and is punishable by law. No object could impose such sanctions on a person by virtue of its physical structure. It is solely by collective intentionality that private property “exists.” The physical object exists independent of human intentionality or even of human knowledge of its existence [Bunge, 1977]. However, its status as private property requires human intentionality and the imposition of a status function recognized within the social context. In Bunge’s terminology, private property is a “fiction” that exists solely in human minds. Similarly, the president of the United States, a twenty-dollar bill, and a professor in a university are all people or objects that are able to perform certain functions by virtue of the fact that they have a collectively recognized status that enables them to perform such

¹ We note that the Internet of Things (IoT) deals primarily with the tracking of physical objects; however, it is the interpretation of the meaning of their properties that gives the IoT its power. It is, effectively, where Searle meets Bunge.

functions as declaring war, exchanging for goods and services, and voting on a tenure case, respectively [Searle, 2010].

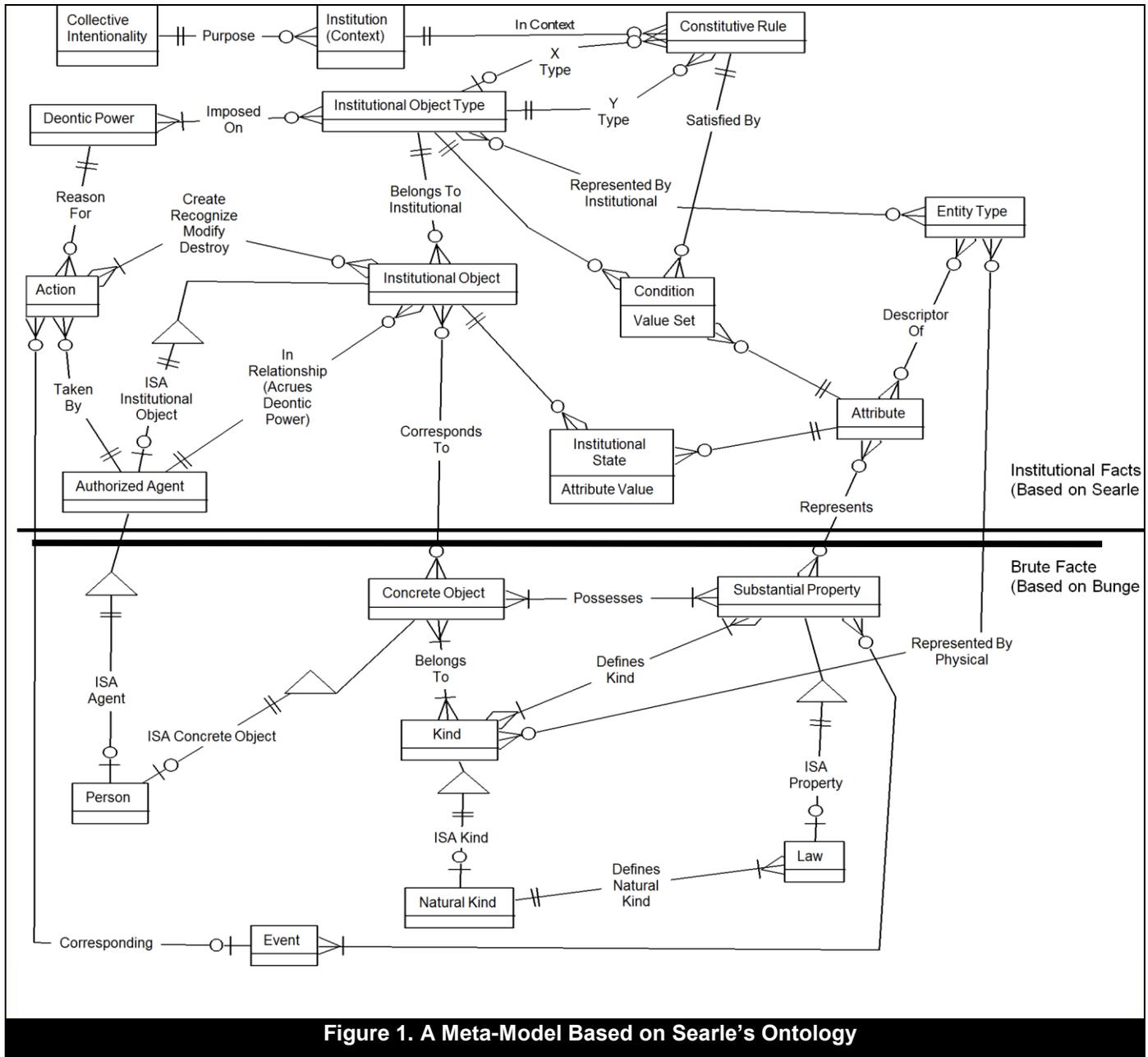


Figure 1. A Meta-Model Based on Searle's Ontology

Consequently, Searle distinguishes two types of facts: brute facts and institutional facts. Brute facts are ontologically objective. They are scientifically verifiable and exist independently of human intentions, purposes, or objectives. For example, concrete objects, such as planets and people with substantial properties such as mass and volume, are brute facts [Bunge, 1977]. Institutional facts are ontologically subjective but epistemologically objective. They have no "substance" but exist by shared human belief and agreement (collective intentionality) within social contexts (institutions). Again, in Bunge's terminology they are "fictions" of the human mind [Bunge, 1977] created by people for human purposes. Searle does not propose the existence of two separate realities, brute and institutional, but rather recognizes that people declare (speak into existence) "fictitious entities," such as money and corporations, and ascribe status functions, such as ownership, to concrete objects for their own purposes. These entities and functions are "fictitious" in the sense that they are not concrete objects or substantial properties, but they exist in the collective minds of people within the context of interest (social institution). They are, however, the basis for all social interaction, and it is their epistemological objectivity that is the basis for social interaction. It is this social interaction that forms the requirements for organizational information systems: ownership (and transfer of ownership), payments, employment, contracts, authorizations, responsibilities, and so on.



Smith [in Smith and Searle, 2003] points out that, consistent with Bunge's notion of nominal invariance [Bunge, 1977], brute facts frequently involve *post hoc* naming conventions. In contrast, naming is *constitutive* of institutional facts: For example, the existence of the planet named Earth is a brute fact, the existence of the state of Utah is an institutional fact. Earth is a naming convention for a physical object (of the type "planet," again a naming convention). However, because Utah was declared to be a "state" in the United States (i.e., "named" as such), it was given the status functions (rights and obligations, etc.) ascribed to states by the United States Constitution. That is, as all other states in the United States, it has a physical location (that we agree to be its state boundaries), but it also has deontic powers (rights, obligations, etc.) ascribed to it that are completely independent of its physical properties. For example, as a "state," Utah has the right to levy taxes and to issue driver's licenses to its residents. It has the obligation of complying with and enforcing the laws of the United States.

Somewhat amazingly, institutional facts are created and maintained by speech acts (declarations) that declare the fact to exist. For example, Utah became a state in the United States on January 4, 1896, by a declaration of the United States government. That declaration is a speech act empowered by the laws of the United States (a set of constitutive rules themselves declared into existence by speech acts) that impose statehood. That declaration was recognized and accepted by the people of Utah and of the United States, and, indeed of the relevant world (context). Without recognition and acceptance, the declaration would be powerless. Consider, for example, the United States Declaration of Independence, the speech act "spoken" on July 2, 1776, that declared the United States to be a "country." England did not recognize or accept that declaration until September 3, 1783, when it "spoke" the Treaty of Paris. Searle notes that recognition and acceptance of institutional facts must often be backed up by force or at least the threat of force, and that it is only by virtue of the acceptance of institutional facts resulting in a shared (objective) epistemology that society "works."

The importance of a shared epistemology—that is, epistemological objectivity—cannot be overemphasized. It is only because of shared beliefs, for example, that a particular piece of paper with certain markings on it "counts as" money and can be used for exchange. If, in fact, a sufficient number of people lose confidence in the institution that has declared such pieces of paper to be money, they will cease to be so and commerce facilitated by them will cease. A less dramatic but no less amazing event occurred in the late 1990s when the European Union converted to the euro and set dates on which existing country currencies would lose their face value. Clearly, on the specified dates, there were no ontological changes to the pieces of paper representing those currencies. Yet epistemologically they changed dramatically. They no longer "counted as" money and could not be used for commerce. As discussed in the following paragraphs, this demonstrates that the meta-objects "above the line" in Figure 1, are epistemologically objective (having deontic power in social interaction) even though they are ontologically subjective (having no physical substance).

Searle introduces the notion of constitutive rules of the form "X counts as Y in context C" as "standing Declarations" that bring institutional facts into existence. Such a rule indicates that an object X has the status Y in an institutional context C. Status functions attach deontic powers (rights, obligations, etc.) to the status Y. And status functions work in society only to the extent they are recognized and accepted. "Rules of games and constitutions of nations are typical examples where the constitutive rules function as standing Declarations. So, for example, the Constitution of the United States makes it the case by Declaration that any presidential candidate who receives the majority of votes in the Electoral College counts as the president-elect" [Searle, 2010, p. 13]. Similarly, the commercial code and organizational policies function as sets of standing declarations that govern the deontic powers of contracts, agreements, and so on among business organizations.

It is by use of language that people have the capacity to create institutional (social) reality by representing that reality as existing. Searle [2010] contends, "We create private property, money, government, marriage, and a thousand other phenomena by representing them as existing" (p. 86). Provided the representation is recognized and accepted in the desired context, the institutional reality becomes "epistemologically objective" and is taken as fact. For example, when a person is hired by an organization, that person (X) "counts as" an employee (Y) in the context of the regulatory system in which the organization functions (C). An employee (status) has specific deontic powers (rights, obligations, etc.) some of which are defined by the social institution (governmental regulations) and some of which are defined by the organization (corporate work, salary and benefit policies). Furthermore, constitutive rules are recursive: an employee (X) "counts as" a salesperson (Y) in an organization by a declarative act. A salesperson accrues additional deontic powers in that they have the right to offer company products for sale to customers. At least one role of an information system is the same as that of written language: to document the existence of status functions assigned to specific objects.

A special case of standing declarations is when there is no explicit (concrete) object X (brute fact) that "stands for" a set of deontic powers, but a "fictitious entity" is created having those deontic powers. Examples include electronic money and corporations. Using the laws of the state of California for the creation of corporations, Searle [2010]

contends, “We can create ... corporations by saying something equivalent to ‘Let there be a corporation!’” (p. 101) and concludes, “In this case we seem to have created a remarkably potent object, a limited liability corporation, so to speak out of thin air” (p. 98). However, and crucially important for conceptual modeling, Searle [2010] further argues “it should be impossible for anything in the real world not to be grounded in the basic facts. ... Money, corporations ... cannot just float on thin air” (p. 180). Thus, the deontic powers associated with status functions in such cases “always bottom out in actual human beings who have the powers in question because they are represented as having them (p. 108).” That is, it is not necessary to have any physical realization of institutional objects such as money or corporations; however, it *is* necessary to have people who are owners of money and representatives of corporations to whom the deontic powers in question accrue.

Searle [2010] concludes, “...ontologically speaking, to create a minimal institutional reality you need exactly three things: (1) human beings, (2) intentionality, including collective intentionality including the capacity to impose functions on objects and people, and (3) language capable of Declarational speech acts” (p. 109). Institutional facts are created using language (declarations) and extra-linguistic conventions (e.g., policies and regulations). These extra-linguistic conventions are themselves created by language. The utterance of the appropriate language (declaration) in appropriate circumstances, possibly with accompanying actions, results in the creation of the institutional fact. The speaker (agent who creates the institutional facts) typically requires a special position or special condition, also created by language. For example, a tenured faculty member raising his or her hand at a faculty meeting “counts as” a vote in favor of granting tenure. The collective set of votes “counts as” a recommendation of the faculty to grant or deny tenure. Such a recommendation (institutional fact) can hold significant consequences for the faculty member in question.

One of the consequences of the existence of “fictitious entities” (such as corporations) for conceptual modeling in information systems is that, in general, we cannot conceptualize classes as collections of preexisting institutional objects. In Searle’s words [2010]:

Notice that for some of the cases we have discussed, such as creating a corporation, we cannot have a universally quantified rule that ranges over a domain of preexisting objects. And more interestingly, we cannot even have an existentially quantified form to the effect that there is some *x* such that *x* is [an institutional object such as] a corporation, because by hypothesis there is no preexisting *x* which becomes the corporation (pp. 119-120).

The implication is that we must first conceptualize the class as a set of deontic powers and declare the class to exist before it can be populated with instances. Similar arguments can be made for cases where status functions are imposed on concrete objects. For example, we cannot look for objects that are employees of an organization until the collection of deontic powers that constitute the class “employee” has been created (e.g., obligation to work, right to be paid). The “role” of employee is imposed on collections of people *post hoc* by declaration; that is, by an intentional speech act performed by an authorized agent, within the context of the business organization. Similarly, we cannot look for objects that are products of an organization until the collection of deontic powers that constitute the class “product” has been created (right to be offered for sale at a price, obligation to be delivered when ordered, obligation to warrant serviceability). The “role” of product is imposed on objects by declaration (e.g., product catalog listing, product descriptions, and price). That imposition is part of the organizational communication process that is foundational to organizational information systems [Kent, 1978].

II. USING SOCIAL ONTOLOGY TO GUIDE CONCEPTUAL MODELING

The promise of ontology as a foundation for conceptual modeling has been that ontology can help us better model a domain [Weber, 2012; Wand and Weber, 2002; Wand, Storey and Weber, 1999; Gruber, 1995] and thereby result in better information system designs [Simon, 1996; Hevner, March, Park and Ram, 2004]. Although examining ontology has given us some guidance in this area—for example, when to use optional attributes in diagrams [Bodart, Patel, Sim, and Weber, 2001], how to model part-whole relationships [Shanks, Tansley, Nuredini, Tobin, and Weber, 2008]—general guidelines about how to conceptualize a domain remain elusive. We believe that for institutional reality, the structure of Searle’s ontology provides such a guide for modeling a given domain [March and Allen, 2007].

As discussed above, the basic formula for Searle’s social ontology is stated as: *X* counts as *Y* in context *C*. At the lowest level of social construction, *X*s are brute facts. They are ontologically objective and entirely subject to scrutiny. *Y*s are social constructions that impose upon *X* a collection of deontic powers (obligations, rights, privileges, authorizations, etc.). Deontic powers are institutional facts. That is, they exist because they are recognized and accepted by common agreement. *C* is the context that bounds the semantics and deontic power of the *Y*s.

Consider again the brute fact of a person raising his or her hand. Normally, this act does not create any institutional fact; it is ascribed no deontic power. If, however, the person doing the hand raising is a member of a corporate board and is sitting in a board meeting, and the person conducting the meeting has just said, "Those in favor of approving the motion raise your hand," then the X (raising the hand) counts as Y (a vote in favor of the motion) in context C (the board meeting). In this case, the person leading the meeting has an objective: to determine whether the motion should be approved or not. Applying Searle's formula recursively, the set of votes (the Xs are now institutional facts rather than brute facts) counts as the voting result (Y). A voting result has deontic powers: determining whether the motion is approved or not. A voting result (X) that satisfies the constitutive rule "receives a majority of votes" counts as an approval (Y), which imposes deontic powers—it obligates the organization to the terms of the motion, such as approving or disapproving a budget or an acquisition, the use of a particular audit firm, changes to accounting methods, and so on. Of course, before a vote can be taken, the bundle of deontic powers designated a "motion" must be defined, and the constitutive rules for creating a motion must be recognized and accepted within the organization (institution). Frequently Robert's Rules of Order are used as the set of constitutive rules for the speech acts necessary for the creation of motions, votes, and approvals.

Furthermore, deontic powers create reasons for action (e.g., obligations) and expectations for actions from others (e.g., rights). The person (X) who is the chair of the meeting (Y) is obligated to initiate voting when certain conditions are met (e.g., a member of the board has "called the question"). Each person (X) who is a board member (Y) has the right to cast a vote. The reason for taking the action "raise your right hand" is to engage the right to vote in favor of or in opposition to the motion. Understanding how these deontic powers are created and fulfilled is at the heart of understanding a domain for conceptual modeling.

We propose analyzing how deontic powers are created and fulfilled as the foundation of using Searle's ontology to guide conceptual modeling. Analyzing a domain is then a matter of the recursive application of the formula "X counts as Y in context C" with a particular interest in the institutions and constitutive rules they define; the purposes of the system; the objectives to be accomplished; the bundles of deontic powers required to accomplish them; and the objects, agents, actions and events (speech acts) upon which those deontic powers accrue. Referring to Figure 1, we propose the following process:

1. Identify the Institutions that form the context of the system under analysis. Institutions exist by virtue of *collective intentionality* to fulfill a purpose. For example, business systems exist within governmental institutions, such as national and state governments, and regulatory agencies, such as the Securities and Exchange Commission (SEC) and the Public Company Accounting Oversight Board (or PCAOB) and the business organization itself. For states that have adopted it as law, the Uniform Commercial Code (UCC) specifies constitutive rules and deontic powers associated with commercial transactions (institutional objects) such as sales, leases, negotiable instruments, bills of lading, letters of credit, and so on. It also establishes conditions on the constitutive rules that create commercial transactions such as signatures and authorizations. Business organizations typically establish corresponding constitutive rules and additional conditions that define how such objects are created and managed within the organization. Conceptually, "business rules" are constitutive and represent bundles of deontic powers. One advantage of basing an analysis on Searle's work is the recognition that business rules are constructed and can be changed. The question business organizations must address is the context level at which the rule is defined. Organizations can change their internal business rules at will (e.g., granting credit or charging interest on overdue accounts) but they cannot change regulatory rules (e.g., customer's credit card cannot be charged until goods are in shipment). Changes to regulatory rules require actions by regulatory agencies. Organizations can lobby such agencies, but they cannot make changes unilaterally.
2. Identify institutional objects and authorized agents (roles) to which deontic powers are ascribed. These include offers, agreements, or assignments of responsibility that accrue, for example, rights, obligations, authorizations, and permissions required to achieve an objective within the domain of discourse. Institutional objects may have related concrete objects. If so, these should be identified. For example, an organization may require a paper copy of a sales order that includes a customer signature to authorize the transaction. Alternately, an institution may require an electronic document with an electronic signature to authorize the transaction (i.e., magnetized particles on a hard disk). Both the piece of paper with its markings and a section of a magnetic disk with magnetized particles on it are concrete objects. Either may be used by an organization to represent the institutional object sales order.
3. Determine the nature of the deontic powers, the constitutive rules, and the agents authorized to create these objects and roles. Deontic powers provide the reason or authorization for taking actions that create, recognize, modify, or destroy an institutional object by declaration. A salesperson, for example, is an authorized agent having the authority to create sales orders (institutional objects). A salesperson is a person



(bottoms out in a brute fact). However, the role of salesperson is an institutional object type created by a constitutive rule within the organization. Conditions for hiring a person as a salesperson may include passing a background check and certain educational requirements. These are defined by the organization as an institution.

4. For each institutional object, determine the agent or agents to which the deontic powers accrue. When a sales order is created, for example, different deontic powers may accrue to different authorized agents, both within and outside the organization. These may include warehouse personnel, shippers, invoicing clerks, customer receiving agents, and customer accounts payable agents. Each of these agents is authorized or obligated to take some action, the result of which is the creation of another institutional object. For example, warehouse personnel create a shipping document, the shipper creates a bill of lading, and so on.
5. Determine the actions taken as a result of the attribution of deontic powers. Warehouse personnel accrue the authority to pick, pack, and ship the ordered goods. Doing so creates a shipment or bill of lading. The customer's receiving agent must have the authority to accept delivery of goods. Doing so creates a confirmation of receipt of goods. Such a confirmation authorizes the invoicing clerk to create an invoice. The customer's accounts payable department accrues the responsibility to pay for received goods (payment is conditional on receipt of goods) resulting in the creation of a check (an institutional object having the deontic power to transfer money from the customer's bank account to the seller's bank account).
6. Produce entities (types) for each institutional object type identified.
7. Identify the attributes that represent facts about institutional objects identified.

Consider, for example, a customer placing an order with a vendor. The vendor's catalog specifies the products and prices for available products. These are speech acts (declarations) that constitute "offers" (institutional facts) by the vendor (an obligation to sell those products at those prices). The vendor accepting an order placed by a customer is a speech act (declaration) that results in the creation of a sales order that entails specific rights and obligations (what Geerts and McCarthy [2002] term *commitments*). The vendor is obligated to deliver goods and the customer is obligated to pay for the goods as specified in the deontic powers of the status function for a sales order. The sales order itself is a "fictitious entity" that exists only in human minds. It is typically represented in physical or electronic writing (paper document or computer record) to enable the management of the transaction. An information system plays the role of written language in documenting the existence of these institutional objects, the agents who created them, and the actions taken.

The delivery of the ordered goods is an action that must be performed by the seller. The reason for the action is the obligation inherent in the sales order. Paying for the delivered goods is an action taken by the buyer. The reason for the action is the obligation inherent in the ordering and receipt of the ordered goods. However, although the obligation exists, people have free will to violate their obligations. Some violations are punishable by law; others are not. Laws are also institutional facts that have deontic powers. But people still have free will to violate them. Punishment by the collective (society) is a reason for not violating them.

Recursively analyzing the sales order activity using Searle's ontology forces questions such as, Who has the authority to create a sales order? What are the conditions that must be satisfied for the creation of a sales order? What are the deontic powers (rights, obligations, etc.) entailed by a sales order? and Who is represented to have the deontic powers entailed by a sales order? The answers to these questions likely involve a web of power relationships, some of which may need to be represented in the information system and some of which may be considered to be outside the scope of the information system, but all of which are part of the social ontology in which the business organization operates. Auditors, for example, are concerned with documenting deontic powers and authority relationships when opining on the adequacy of the control structure within an organization.

Because all institutional facts are "spoken" into existence, there must be an agent who has the authority to do so. In the context of a sales order, there are a number of possibilities. An organization may choose, for example, to empower its salespeople to create sales orders. However, that power may be conditional on, for example, the buyer being an "authorized customer." Authorizing a person or corporation to be a customer requires the authority to create the institutional fact "person or corporation (X) counts as customer (Y) in the organization (C)." That power may be limited, for example, to the finance department. Because the finance department is a "fictitious entity" created by the organization, the power to create authorized customers must "bottom out" with a person or persons within the finance department. Furthermore, salespeople may have conditional authority to create orders for such customers, for example, up to a specified dollar value. This type of power structure is common for organizations that sell complex, high-value products on credit; that is, to issue invoices for delivered orders.

Alternately, the organization may decide to empower an information system with the ability to create sales orders. Conditions may include pre-payment via credit card or an electronic signature verifying that the customer agrees to the terms of the order. This type of power structure is common for organizations that sell simple commodity products over the Internet.

The deontic powers entailed by a sales order include the obligation on the part of the seller to deliver the ordered goods and the obligation on the part of the customer to pay for delivered goods. These are specified by the regulations of commerce inherent in the business context. However, organizations may specify additional deontic powers, including such obligations as delivery dates, FOB point, product quality, interest due if not paid within a specified length of time after delivery, and so on. Each represents a reason for action within the organizations obligated by the order—for example, pick, pack, and ship the goods in a timely manner; inspect the goods upon delivery; pay for delivered goods; and so on. Of course, they are also status functions accrued to people within each organization. For example, the obligation to deliver the goods requires actions on the part of authorized agents of the organization, the authorization itself being a status function.

III. APPLYING THE META-MODEL TO SALES ORDER PROCESSING

By collective intentionality, the government of the United States has created the institution of commerce within the United States for the purpose of economic prosperity and the collective benefit of its citizens. That institution defines regulations represented by constitutive rules by which commerce is governed. In addition, specific business organizations create policies and procedures for governing how the organization participates in commerce. Consider, for example, a distribution business: the company purchases goods from its vendors and sells them to its customers. For brevity we focus on the revenue cycle of the business: selling goods to customer and receiving payments for those goods (partially represented in Figure 2).

A sales order is an institutional object of the type *sales order* having associated deontic powers: obligation of the seller to deliver goods (action) and the right of the seller to receive payment (action) for those goods once delivered. A sales order is an institutional object type. The obligation to deliver goods is **imposed on** institutional objects of that type. But how are such obligations constructed? What is it that “counts as” a sales order and imposes such deontic powers? As Searle (2010) suggests, all such obligations must “bottom out” in physical reality but obtain their deontic powers by constitutive rules.

Within the context of a seller organization, institutional object type *sales order* (Y_1) has deontic powers obligating the seller to take the action *deliver ordered goods* (A_1). Further, a “certain piece of paper with specific printing and writing on it” is a *concrete object* (CO_1) that **corresponds to a completed sales order form** instance *institutional object* (IO_1), which **belongs to institutional** object type *completed sales order form* (IOT_1). The policies and procedures of the company include the constitutive rule (CR_1): institutional object type (IOT_1) completed sales order form (**X Type**) counts as institutional object type (IOT_2) sales order (**Y Type**) in context of the company (C_1).

As discussed above, deontic powers (D_1) are **imposed on** institutional object type sales order (IOT_2), obligating the seller to take the action *deliver ordered goods* (A_1). The action *deliver ordered goods* (A_1) requires a *corresponding event* that moves physical goods from the seller to the buyer (E_1). That event changes substantial properties (e.g. physical location) of a set of concrete objects—that is, those physical goods (e.g., CO_4 , CO_5 , etc.) that correspond to institutional objects (e.g., IO_4 , IO_5 , etc.) of the *institutional object type product* (IOT_2). Institutional object types *sales order*, *invoice* and *product* are **represented by entity types** (ET_1 , ET_2 , ET_3) having the same descriptions as their corresponding institutional object types (entity types are not shown in Figure 2). Note that not all institutional object types need necessarily be represented as entity types. For example, it is unlikely that *completed sales order form* would be represented as an entity type; *sales order* would likely be sufficient. Similarly, product types would likely be represented using attributes of the entity product (although certainly such subtypes could be represented as entity types).

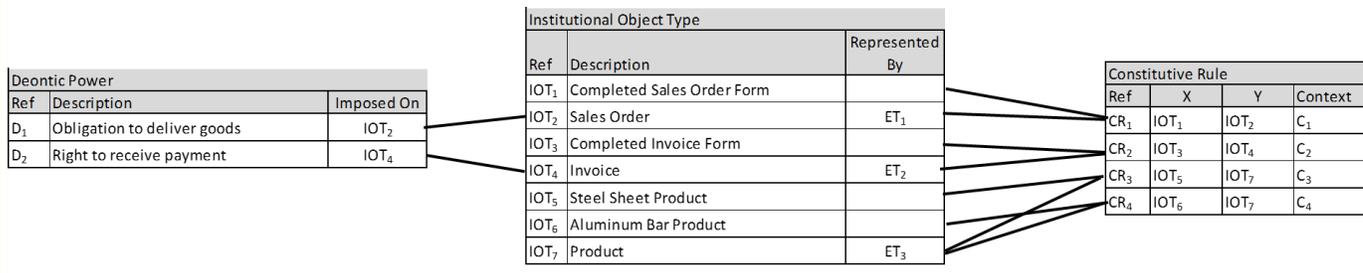
The action *deliver goods* (A_1) enables an authorized agent to create an institutional object *completed invoice form instance* (IO_3) that belongs to the institutional object type *completed invoice form* (IOT_3), which, by constitutive rule, counts as institutional object type *invoice* (IOT_4), which gives the seller the right (deontic power) to *receive payment* (Action A_2) from the buyer (correspondingly the buyer has the right to receive goods and the obligation to pay, conditioned on the receipt of goods). Of course, the institutional object *completed invoice form instance* (IO_3) corresponds to a concrete object (CO_3): a piece of paper on which the printing representing the particulars of the invoice are written (or to a sequence of bits on an electronic medium that represents that information).

Each action must be **taken by** an authorized agent who **is an** institutional object that **belongs to institutional** an institutional object type that has the right (deontic power) to take that action (not shown in Figure 2). Ultimately each

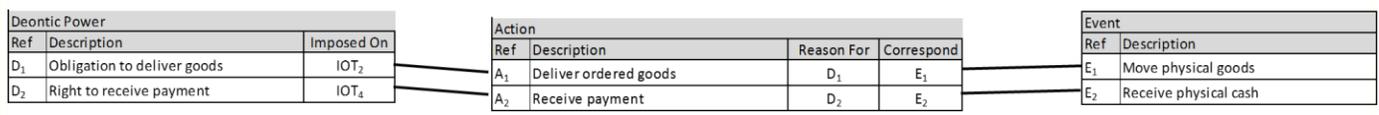
authorized agent is a *person*. That is, institutional object types represent different roles that people play within the organization. A person who “counts as” a warehouse supervisor, for example, has the deontic power (authorization) to move physical goods (concrete objects corresponding to products) from the warehouse to a truck for delivery to a customer in response to an order that has been placed (and authorized by another person in the role of account manager).



a. Mapping between *concrete objects*, *institutional objects* and *institutional object types*



b. Mapping between *deontic powers*, *institutional object types* and *constitutive rules*



c. Mapping between *deontic powers*, *action* and *event*

Figure 2. Partial Instantiation of the Meta-Model

Physical goods are concrete objects that have substantial properties such as location, size, weight, color, texture, chemical composition, and so on. Substantial properties can be represented by attributes that give them meaning (e.g., we understand the meaning of *weight* in terms of forces required to move an object). However, frequently attributes are simply ascribed to institutional object types for institutional purposes and do not correspond to substantial properties. Ownership, for example, is not a substantial property, but is an institutional fact, an attribute ascribed to concrete objects for the purpose of economic and social intercourse. That is, transferring ownership of a concrete object from one organization or individual to another is a declarative act that does not necessarily involve any substantial property of the concrete object. Although physical movement of the concrete object may accompany such a declaration, the transfer essentially corresponds to deontic powers: rights and obligations relative to the concrete object in question. And those rights and obligations are enforced by the contextual institution (e.g., government or regulatory agencies). The actual point at which ownership is transferred is typically specified as an attribute of the order. For example, *FOB destination* specifies that ownership is transferred when the goods reach their destination; *FOB origin* specifies that ownership is transferred when the goods are shipped. *FOB point* is an attribute without a corresponding substantial property; however, it has a significant impact on seller and buyer responsibilities if, for example, goods are damaged in shipping.

Concrete objects can be classified into *kinds* and *natural kinds*, based on commonality of substantial properties [Bunge, 1977, Wand and Weber, 1995]. Laws are properties that govern the substantial properties of concrete objects (defining, for example, what substantial properties a particular concrete object can possess). For example, an organization may classify concrete objects that correspond to its products (institutional object type) into those that are liquid and those that are solid. This may be a meaningful classification used to create an entity type in the data modeling sense [Chen, 1976]. However, more frequently entity types are constructed based on institutional facts and are **represented by institutional** object types. A sales order, for example, is a common entity type in an organizational information system. In a particular company, the policy (rule) may be that a sales order is created by a declarative act “completed sales order form” (X) counts as “sales order” (Y) in the context of this company (C) and, although the declaration “bottoms out” in “a certain piece of paper with specific printing and writing on it,” it is the fact that the constitutive rule exists that creates a “sales order” when a “completed sales order form” is produced. Further, it is the meaning communicated by the physical symbols on the paper—that is, language—that forms the basis for the constitutive rule and its enforcement by government. In a different company, the policy (rule) may be that a customer speaking the words “I place this order” and a salesperson speaking the words “I accept this order” are sufficient to create an instance of the institutional object type “sales order.”

Continuing with the sales order entity type, attributes are ascribed to it, such as terms of payment, FOB point, ship-to-address, products and quantities to be delivered, date on which the order was placed, promised delivery date, and so on. None corresponds to substantial properties: a sales order is an institutional object, a bundle of institutional facts surrounding the agreement that is a sale. Of course, because the details of a sales order are recorded on “a certain piece of paper with specific printing and writing on it,” it is possible to track substantial properties of the corresponding concrete object, such as the placement of symbols on the paper or a change in its location. These, may or may not be consequential in the execution of the actions taken because of the imposed deontic powers.

The institutional state of an institutional object is the set of attribute values associated with the set of attributes that are descriptors of the entity type representing the institutional object type of that institutional object. The institutional state of a sales order instance, for example, is the set of values of its attributes: (terms of payment, “1% 10 Net 30”), (FOB point, “destination”), (ship-to-address, “401 21st Avenue South, Nashville, TN 37203”), and so on. Finally, a constitutive rule may have formal conditions that must be fulfilled. For example, a completed sales order form may be required to include values for all attributes of the corresponding sales order entity type before it can “count as” the **X Type** in the constitutive rule that creates the **Y Type** sales order—that is, in the constitutive rule: completing a sales order form (**X Type**) “counts as” creating an institutional object of type *sales order* (**Y Type**) in context of the company.

IV. CONCLUSIONS AND FURTHER RESEARCH

This article has presented an examination of Searle’s social ontology as a foundation and guide for conceptual modeling. There is still much work to be done both to identify relevant questions and to arrive at compelling answers for the development and evaluation of a useful methodology based on this ontology. We believe, however, that the meta-model and the posed process represent a step in the right direction. Searle’s ontology builds on Bunge’s foundation of concrete objects with substantial properties, but recognizes that institutional facts and the deontic powers accrued to authorized agents by constitutive rules form the basis of social interactions. The contribution of this work is in expanding the conceptualization of information systems from a “state tracking mechanism” [Wand and Weber, 1990, p. 62] to an explanation of the social and power relationships that underlie social intercourse. We believe this is an important step in developing a theoretical foundation for conceptual modeling. Of particular significance is the transition from thinking about conceptual modeling as the representation of “reality” in an ontological sense to thinking about conceptual modeling as the representation, construction, and management of “deontic powers” in an epistemological sense. This transformation highlights the active role that information systems play in implementing organizational policies and procedures [March and Allen, 2009].

Future research will investigate methods and techniques to identify bundles of deontic powers and institutional objects and how these map to brute facts as represented in Bunge’s ontology. We believe this will have significant impact on research in the Internet of Things (IoT), where researchers: (a) seek to understand how substantial properties of concrete objects and the events that change them can be interpreted to provide useful information [Dlodlo, Foko, Mvelase and Mathaba, 2012; Gibbs, 2013; Goncalves, 2012] and (b) seek to embed within concrete objects deontic powers; that is, to construct concrete objects that are “activity-aware, policy-aware and process-aware” [Kortuem, Kawsar, Fitton and Sundramoorthy, 2010, p. 45]. Kortuem et al. [2010], for example, describe smart tools that monitor construction workers’ exposure to dangerous vibrations and have embedded rules that enable them to alert workers if legal limits are exceeded. Clearly such tools can be empowered to shut down rather than merely inform.

We hope that our work will facilitate a discussion of mechanisms for bringing together the physical and social constructions that must be managed as organizations seek to more effectively use information technology for human purposes.

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