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TEXT AND ACTION

The Operator's Manual in Context and in Court

JAMES PARADIS

This essay was written after I served as an expert witness in two court cases involving construction tools for which adequate instructions had not been furnished. Both instances—one at a building site in Maine and the other at an airplane hangar in Colorado—involved catastrophic injury to workers who had little understanding of the danger of the technology that was being used. That I had worked in construction some years before made the problems and complexities of injury even more palpable. The tools, called studguns by the workers who used them, were widely used to fasten wood frames and various other materials together, including wood to concrete, wood to metal, and so on. They were powerful, efficient tools that had evolved from handguns, which they strongly resembled. Some models, however, were unsafe because the charges that fired the fasteners came in many strengths and, incorrectly selected, could easily send a fastener at bullet velocity through the materials it was meant to hold together. The user often had to guess what charge strength was needed for a given application.

As the cases worked through the court systems in Maine and Colorado, I became fascinated by the many questions that arose concerning how we convert language to human action and decided to explore the ontological blending of human purpose with mechanical devices. Much technical communication is "operational" in nature, verbally modeling actions that must be performable as the result of one's interpretation of the words. This border realm between verbal models and human actions, which has been studied at much greater length by Kaufer and Carley and Bazerman and Russell, is surely one of the most fascinating realms of technical communication. It was an area that had long fascinated me, because of the immense amount of textual operationalism by which our society transmits its expertise. We are awash in procedures, from tax instructions to computerized processes, and the implications, as this essay attempts to demonstrate, are vast.

Some controversy arose in the publishing of this article over its use of the term "studgun" (Sauer). Taking the slang definition of stud as a virile, sexually dominating male, to be the normative meaning, Sauer argued that the essay imagery of studs penetrating materials is sexual and perpetuates a male-dominated reality fashioned in the construction workplace. Although I have found the issues raised in this discussion interesting and worthwhile, I do not agree with this reading. Not only is it too quick in discarding such standard definitions of stud—commonly

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used in construction and structural design—as a nail or rivet, or the upright part of wall framing, but it also ignores the fact that no authorial intention is stated or implied for such a reading in the essay. At the time of the court cases, the term “studgun” was widely used in the construction workplace, probably because the device fires nails or studs, or because one of its most common applications was in building framing for houses. The term was adopted in the discovery testimony leading up to the court case, as well as in the courtroom itself.

James Paradis

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Modern professional knowledge, it has been widely noted, is formally embodied and disseminated in literary networks (Price; Garvey et al.). Studies by Gilbert and Mulkay, Latour, and Bazerman have shown that the socio-rhetorical strategies of publication help to formalize a specialized field, not only by defining its territory and identifying the members of the network, but also by furnishing the means for constructing and maintaining consensus—or, at least, the impression thereof. The rhetorical practices of disciplines have broader social consequences, as well, since expert knowledge is routinely exported to society in innumerable manifestations of modern instrumental control—the codes, procedures, and industrial products that shape, amplify, and direct our daily behavior. Nearly all of these products are transferred from institutional settings of expertise by means of written operational discourse, which helps frame them in terms of relevant actions carried out in social contexts. These texts, which form the basis of most informal and formal training and certification processes, are exegetical, serving to interpret for the lay public the meanings, applications, and procedures by which expert products, whether VCRs, tax codes, or angina medicines, are integrated into the behavioral flow of society itself. The rhetorical

process by which this immense body of expert knowledge is transformed into the basis of subsequent human action is a question of considerable importance.¹

The semantic complexity of everyday life, Alvin Weinberg has argued, is a social problem of Malthusian character. Any individual’s “semantic apparatus” is increasingly taxed as he or she attempts to keep abreast of what Weinberg has called the “proliferation of the semantic environment” that attends unrelenting population and technological growth (2–3, 26). That is, we are physiologically fixed, despite numerous technological aids and props, in an environment of rapid population growth and technological innovation that vastly increase the amounts and complexities of available information.² Innovation, with its ever-evolving intellectual sophistication, is increasingly accomplished within the specialized research networks referred to earlier, as well as in the expert domains of professional schools and in the design clusters of engineering houses. The technological complexity that governs everyday life is thus supported in environments sequestered within their own networks of expertise, out of which products are then “released,” so to speak, to the public at large. The lay person is largely isolated from the professional ori-

gins of technologies, whose procedurally sensitive behaviors are crucial to transacting the business of everyday life—for example, filing complex tax forms, negotiating computer protocols, using new tools with expanded capabilities. Procedurally sensitive processes often require that the operator adhere to specific protocols or operational sequences, which can be counter-intuitive. Millions of operations manuals, protocol books, instructions sheets, guide books, and codes cycle throughout society to steer individuals and their experts through the complexity of our increasingly artificial social environments (Simon 4–5). This vast body of task-oriented literature thus helps to adjust machinery to human norms, or, human norms to machinery, depending upon one’s philosophy of technics.³

The rhetorical export of expertise and its products has some major implications that I would like to examine in the light of two recent liability cases concerning injury by specialized construction tools. In both cases, a major issue was made of the role of operator’s manuals in enabling a user to develop an adequate working knowledge of an unfamiliar power tool. The tool, a direct-acting studgun used to fire nails and other fasteners into various construction materials, was the product of a relatively old firearms technology that had recently been adapted to a new social environment—the construction workplace. Operator’s manuals outlining the principles of use accompanied the studguns, and the question arose of just what role such manuals should play in the user’s mental construction of the tool and how effectively the operator’s manuals in question elaborated the procedurally sensitive processes of safely applying the studguns to various tasks. The formalities of courtroom discovery forced a comparison of the images and norms of the public mind with those of the expert. In effect, the inquiry sought to determine, in the context of tort law and legal liability, the rhetorical role of operator’s manuals in the social construction of a technology. This question ultimately touched on the role of written discourse in constructing a world of “reasonable” actions that could resolve the polarities inherent in almost any technology between mechanical function and social purpose.

Operator’s manuals, I will argue in this study, typically employ four textual elements that attempt to

bind, by means of representative human actions, the worlds of external objects with those of human behavior. First, they construct a written analogue of the tool or process itself. This analogue reduces the tool or process to a series of verbal and visual terms that are, in effect, idealizations substituting for the thing itself. Second, the manual introduces a fictional operator who represents an average or suitably qualified individual. This everyman is the agent, the initiating and guiding force, capable of making a range of commonsense decisions about how to apply the tool. The third textual element of operator’s manuals is environment, the material context of conditions and situations requisite for effective and safe use of the instrument. A fourth textual element of the manual is the action itself. This procedural element can be a loose narrative of representative steps the operator takes to apply the tool. Or, it can be a narrative sequence of precisely defined actions that furnish a behavioral template on which the operator must model his or her actions. Together, these elements help to construct a *teleological* view of reality, by which I mean a reality subordinated to human purpose. The operator’s manual is a conceptual framework that infuses human purpose into mechanical devices or their equivalents, thus aligning the neutral products of technology with the value-laden ends of society. Not all operator’s manuals are effective in constructing this mechanical world dominated by human purpose; yet, even in poorly executed operator’s manuals, these textual elements of object, agent, conditions, and action are all implied. If they are either poorly treated or absent, the operator must invent his or her own version of them in order to pursue a course of action.

As a technology becomes more complex, the rhetorical effort required to sort and reduce its expertise to some course of activity comprehensible to the operator-everyman becomes greater. As the differential between expertise and common sense becomes greater, or as the audience itself becomes more diverse, the demands made upon the operator’s manual increase. We have enough information in our daily environment to operate simple tools like hammers or to carry out basic procedures like mailing letters. But with processes associated with more complex technologies and social institutions—whether

computers or the filing of taxes—we require additional support. Expert advisors who can personally direct us are extremely effective but costly means, because the ratio of human time expenditure to productive activity is so unfavorable. Group training and certification improve this ratio but require substantial institutional support, as well as dislocations and time commitments of the learning operators. Texts improve the ratio still further, because they can circulate the same expertise to the masses. But the inherent linearity and rigidity of written discourse, coupled with the necessary reduction of complex situations to sequential units of simple action, increase the possibility of omission, ambiguity, and misunderstanding. We now need specialists, technical writers and editors, who can anticipate these problems and who can apply rhetorical strategies to achieving operational coherence and simplicity.

In what follows, I begin with a manufactured product—a studgun—and examine the rhetorical frame two operator's manuals attempt to build around it. I explore how instructions for a publicly marketed tool serve to mediate between the expert world of technologists and manufacturers and the lay operator world where the tools are employed. I conclude with a consideration of the same manuals in light of recent legal liability proceedings in order to illustrate how these texts are socially burdened by tort law and the concept of liability, the larger object of which I argue is to impose purpose on the basically neutral world of technology. In this light, the operator's manual can be seen to play a profound role in the effort—sometimes specious—to adapt technology to human ends.

THE STUDGUN AS MECHANISM

The studgun is a versatile tool that dramatically improves the effectiveness with which construction workers can drive nails and other fasteners into a multitude of construction materials. The distinctive aspect of the studgun design is its blend of hammer function and firearm technology.⁴ The resulting device, euphemistically known as a “powder-actuated fastening tool,” exploits the mechanisms and dynamics of a gun, with a chamber that receives a projectile

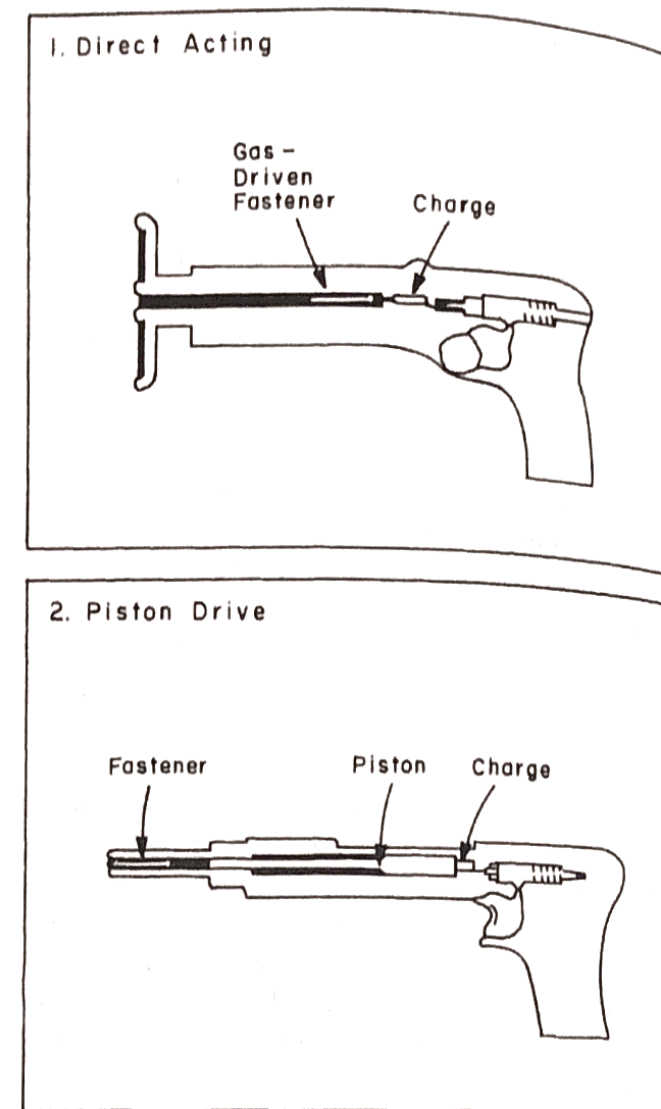


Figure 25.1. Diagram of a studgun: 1. direct-acting, 2. piston-driven

and powder charge, which in turn is discharged with a trigger (see Figure 25.1). Studguns fire a variety of fasteners, including pins (nails) and studs (threaded bolts), into materials as different as wood, hard concrete, and structural steel. The tools range in cost from less than a hundred to several hundred dollars and are marketed by several companies that have developed a variety of studgun models with different capacities, as well as a range of accompanying fasteners, powder charges, and accessories.

There are two types of powder-actuated studguns, the more powerful being the direct-acting or high-velocity tool, which can drive fasteners into thick structural steel or hard concrete. In the high-velocity

tool, a powder charge directs expanding gases against a fastener-projectile. Fasteners in these direct-acting studguns are capable of attaining speeds of high-powered rifles. In contrast, the piston-driven studgun, a low-velocity tool, drives the fastener with a piston that absorbs much of the energy of the powder charge. Piston-driven tools are therefore less likely to force fasteners through construction materials into free flight and are generally safer than direct-acting tools. However, piston-driven studguns do not have the penetrating capabilities of the direct-acting tools and are not as effective for applications in thick steel or very hard concrete.

Both the great virtue and risks of the technology inhere in the range of driving forces studguns can impart to their nail-like and bolt-like fasteners. The variations in fastener design and intensity of powder charge make it possible to apply the technology to such soft materials as construction-grade framing wood and to such dense materials as $\frac{3}{4}$ " structural steel (see Figure 25.2). Fastener thrust ranges across as many as twelve strengths of powder charge. Fasteners vary in materials, length, shaft diameter, tip design, and shaft design, each variation having a dif-

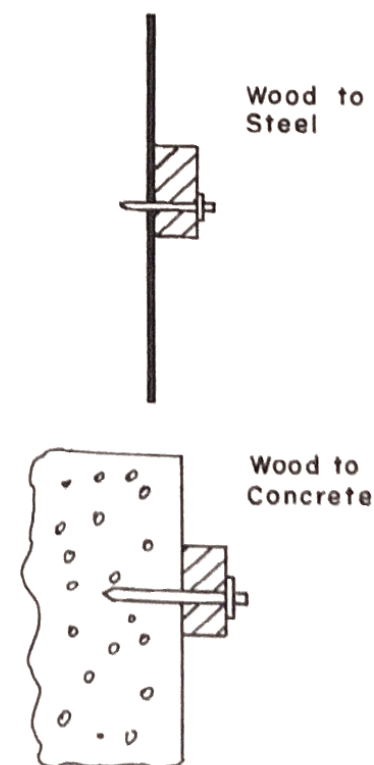


Figure 25.2. Some generic studgun applications

ferent effect on the net penetrating capability of the discharged fastener. In addition, there are ramrod devices for positioning fasteners at various depths in the gun barrel to achieve still different intensities of thrust, and doughnut-like metal disks are available for collaring fasteners, so that they are not driven too far into soft materials.

This great variety of choice, however, brings an enormously complex firearm technology into the social environment of the construction workplace. The numerous options complicate the decision-making process required of the user, for there are thousands of conceivable combinations of studs, powder charges, and base materials. Compared to conventional firearms, which are used in restricted corridors, studgun technology, used in socially active construction areas, is orders of magnitude greater in complexity.⁵ The tremendous force that enables the construction worker to fire nails into concrete or steel is also potentially lethal when used incorrectly or in unknown materials or circumstances. Thus, the adapted firearms technology of the studgun, effectively displacing the common hammer for many applications, has also introduced a difficult to regulate technology into largely unregulated social environments.

This combined studgun effectiveness and danger is nowhere more dramatically illustrated than in the two accidents that formed the subject of this analysis. Both concerned direct-action studguns, in which improper operation on construction sites led to the partial paralysis of one worker and the death of another. Both operators thought they were using the tool correctly, but neither was experienced in the use of studguns. Moreover, the studguns they were using had no safety warnings attached to them, and their respective operator's manuals failed to warn of the specific mechanisms that led to the accidents. Subsequent legal proceedings questioned the adequacy of the rhetorical framework established around the studgun. Questions were raised about the kinds and levels of discourse one would reasonably expect to accompany potentially lethal devices such as the studgun.

In the first case, *Roger Gagne v. Power Anchor Corporation et al.*, a Maine construction worker was trying to frame a window opening in a concrete basement foundation. Other workers had drilled and sledge-hammered a 3' x 4' opening, around which

Gagne and his coworker were now using a studgun to attach a preassembled wooden window frame. A fastener fired from a direct-action studgun passed through the wood, rebounded off some object embedded in the concrete, fish-hooked back out, and struck Gagne, lodging in the back of his neck and causing him injury. Although Gagne possessed an operator's card for the studgun in use, his companion who fired the studgun did not. As the result of the injury, Gagne was unable to return to work.

In the second case, *DuCharme v. Star Expansion Corporation*, an employee of an aircraft company in Colorado, who was helping to construct some shelving on a plant wall, was killed by a stud in free flight after it had passed through three layers of materials. The employee, who had gone around a partition wall to clear the area behind, was struck with a $1\frac{7}{8}$ " stud that had passed through a $\frac{1}{32}$ " piece of corrugated steel, a $\frac{1}{16}$ " steel beam, and the plywood partition wall. The fastener passed through these various layers with such force that it went directly through the body of the victim and was never recovered. In this instance, the stud was being fired with the lowest powder charge available as a test firing, in order to determine the suitability of the application. Neither the operator nor the victim had an operator's license.

These two accidents were full of ambiguity. In each accident, the operator applied the technology in questionable ways. The operator in Case 1 fired the direct-action studgun closer than three inches from the edge of the two-by-four inch wood frame into the concrete substrate. The operator's manual had cautioned against firing "closer than 3 in. from the edge in concrete." In Case 2, the operator fired a low-powder charge into very thin steel, a practice that, although not rejected in the manual as unsafe, was questionable, given the potential force of a high-velocity direct-action studgun. Moreover, neither operator had been licensed to operate his respective studgun. On the other hand, there were no danger warnings on the two studguns in question. No effort had been made by manufacturers to incorporate a semiotics of hazard on the tools, their accessories, or indeed in the manuals. Explicit warnings are one of the most widely followed conventions used in industry to establish an operating context of extreme danger. Neither operations manual mentioned that incor-

rect or casual use could lead to serious bodily injury or death. Nor had either manual instructed users in any systematic way on the methods of selecting the proper combination of stud and powder charge for an application. Thus, the possible arguments concerning the cause of the accidents were diverse.

In the narratives of accidents, causality is always a central issue. As the philosopher Norwood Hanson once observed, the attempt to determine the cause of an accident is a request for an explanation of the event, and a surprising variety of plausible narratives will be established in terms of each explainer's point of view.⁶ An accident involving a studgun might readily be explained in terms of the operator, the environmental conditions, the tool itself, or its procedural guidelines. Were the accidents caused by operator error or by faulty tool design? Was the error a matter of the operator's negligence or of the manufacturer's negligence? Powerful social forces were at work on behalf of each theory. Defenders of the tool would be expected to base their arguments on the industrial integrity of its production and the adequacy of the expertise embedded in the tool's design. Their opponents would be expected to base their arguments on the tool's flawed design, the failure of the manufacturer to warn of operating hazards, and on the unreasonable expectations placed on the operator-everyman in the proper operation of the tool. Such opposing views, established by legal proceedings, would pit the mechanical domain of design expertise against the social domain of human purpose. The territory between these poles becomes the field of argument upon which the various theories of error play.

THE RHETORIC OF ACTION: CONSTRUCTING A WORKING IMAGE OF THE DIRECT-ACTING STUDGUN

In the process of exporting a technology to society, expertise has many possible options, since users can construct working images of a technology in many ways. The casual user can be relaxed about simple consumer technologies in which there is little personal or financial stake other than a few lost hours or dollars. Despite obvious hazards, lawn mowers, familiar objects to the suburbanite or the avid television

watcher, require little assistance to learn how to operate. User strategies can be built upon the stock of generic images that, as Boulding has argued, is shared by society (54-55). Everyone "operates" a screwdriver or flashlight without having to be instructed. In a thriving consumer society, this kind of intuitive operational know-how based on socially shared imagery must be widely available. Many lawn mower purchasers can by mere inspection decode the fraction of the technology necessary to operate the instrument satisfactorily. Hence, the sport of dispensing with the manual: "When all else fails," the saying goes, "consult the manual." The highly accessible technologies common in a consumer society are thus based on a social substrate of shared generic imagery, a kind of Platonic world of idealized forms and processes that is presumably the product of elementary and secondary school education, supplemented by television culture. Commercial designs are built up on these familiar images as part of the so-called idiot-proofing process well known in the engineering sectors of product design, where the ideal is an intuitive design that needs no manual.

Access to more complex technologies, many of which have great institutional impact, usually requires a formal framework of explanation. The public stock of imagery no longer suffices to guide the operator successfully or safely through the necessary operating procedures. These technologies cannot be exploited without a carefully constructed framework of explanation that illustrates the contexts and conditions of effective action. Many technologies of health, explosives, and computers with complex protocols would be unfathomable without the systematic learning made possible by manuals. Frequently, as in health or computer technologies, operators require formal education, training, or on-site apprenticeships. One is licensed to apply the technology, authorized to convert the knowledge of expertise to operations in the public sector.

Written discourse plays a necessary role in the exportations of expertise, whether of simple casual consumer technologies or of complex instruments of institutional proportions. Texts can break down and sort the complex phenomenological reality of events and objects. As a signifying system, language precipitates versions of experience from the complex con-

tents of "reality." These reductions are necessary distortions. They help to establish perspective in simplified points of view that clarify the structure and purpose of artifacts, yet also hide their deeper complexities. Language, as Berger and Luckman have noted, "objectivates [our] shared experiences and makes them available to all within the linguistic community" (68); written discourse renders that experience into a true *object*, independent of time and space (Boulding, 55; Joos, 41-42). Moreover, texts have permanence. Written discourse reduces and fixes human experience so that it may be reprocessed—read, studied, and manipulated as object. "By creating a text 'out there', a material object detached from man (who created and interprets it)," Goody observes, "the written word can become the subject of a new kind of critical attention" (129). Operator's manuals thus recreate the artifact or tool itself in a context of critical analysis, giving us control—or, at least the impression of control—over the imagery for the object or process. In text, we can resolve the technological object into its parts in such a way that it remains dissected, as an organism remains dissected in an anatomy manual. We bring into the textual field and associate as equivalent elements the implement, the operator, the environment, and the operation. This reductionism, in ignoring the vast phenomenological differences in these elements, enables the user to see them as a system and to manipulate them logically. One learns how to operate on the artifact by operating on the text.⁷

If we examine the public rhetoric of studgun technology, we find a number of documents treating the various objects and processes associated with the end action of firing a stud into construction material. These documents fall roughly into two basic groups. The technology has a commercial status and is marketed in a variety of catalogs, price lists, and advertisements. It also has a functional status as outlined in the operator's manuals, treating the assembly, operation, and maintenance of the tools. Studguns, in addition, are typically labeled with a variety of safety warnings and symbols, which reinforce the conditions of operation outlined in the operator's manual. These documents, which define the tool operationally, commercially, and socially, can be at odds when the commercial object of maximum sales vol-

ume is allowed to conflict with the social object of effective and safe operation. Sales literature and operator's manuals can exaggerate function and downplay hazard.

Operating procedures for the direct-acting studgun in the Star operator's manual illustrate several rhetorical conventions of operational discourse. We find, for example, a procedural outline for selecting a power load for the studgun titled "To Determine Correct Power Load." As already noted, not every operator will use this textual formulation to learn how to select a power load, since it is possible to figure out the procedure through training, observation, or, for that matter, guessing. Still, *this textual version governs all studgun usages*, as official rules always govern practice. An operator's manual is company-formulated—an operationally explicit version of how the stewards of the expertise recommend that the public apply the technology. In reducing the power selection process to a protocol, the manual, we assume, invests us with expert behavior. Hence, willy-nilly, it has the status of authority, a status of contract. Each specified iteration must be treated by the lay user as an expert formulation of how one should apply the technology.

Three rhetorical conventions found in operational discourse rather stringently shape the user's action: taxonomies or terminological standards, conditional generalizations, and segmented action sequences. We find all three of these conventions in the prose sample taken from the operations manual of the Star Power Tool Model 100:

To Determine Correct Power Load.

1. The fastener and the power load that should be used for a given installation depends on the thickness of the object being fastened and the nature of the material into which the fastening is to be made.
2. The harder the material the stronger the power load, and the shorter the fastener.
3. Caution: In making an initial test fastening always start with the Green color load, Power level 3. If fastener does not penetrate to required depth, then try the next strength power load until desired penetration is obtained.
4. High Velocity special .22 caliber power loads are available for driving fasteners as follows:

.22 CALIBER STANDARD (WADDED—BRASS CASE)
 #6022-036 Green Power Load—Power Level 3
 #6022-056 Yellow Power Load—Power Level 4
 #6022-076 Red Power Load—Power Level 5
 #6022-096 Purple Power Load—Power Level 6
 .22 CALIBER LONG (WADDED—NICKEL CASE)
 #6022-156 Gray Power Load—Power Level 7
 #6022-176 Brown Power Load—Power Level 8

5. To vary the amount of penetration: (a) Fasteners can be positioned in the barrel by using the ramrod provided with the tool kit. (b) By using .22 caliber crimped loads Power levels 1 or 2.

These conventions reflect a rhetorical preoccupation with accuracy and clarity. Terminological standards establish a morphology of the tool or process that helps us relate form to function. Such a referential language that thousands of individuals can hold in common enables us to share common iterative behavioral priorities of operational discourse. This attempt to create a unity of action among diverse users is based on terminological standards that reduce the possibilities of ambiguity. Taxonomies, typically established within the professional design community, impose conventions that identify components and functions of the implement in question.

For the studgun, these naming conventions extend to parts, accessories, and the various fasteners and powder charges. In the preceding sample, for example, we find a taxonomical table that identifies several kinds of .22 caliber power loads, or shells, organized in increasing order of strength. This schemata ranks the levels of function in powder loads. But such specialized terminology can also be misleading, since its meaning often depends on the user's prior conceptual depth or experience. These conventions usually develop first within a larger framework of expertise that uses them to summarize its own experience. The color distinctions of the green, yellow, red, purple, gray, and brown powder loads can have only limited meaning to the general user. The scheme ranks in a rudimentary sense the increasing powers of charges. But no specific kinds of application are specified for these distinctions. We are not shown a specific instance of how an operator might use the chart to select a powder charge for a given kind of application. No description predicts what will happen if we use a

green powder charge with a 1" stud in 3/4" structural steel. Indeed, for the outsider, the occasional user, such a hierarchy may give a false impression of precision in a selection process that, as noted in Rule 3, is conducted by trial and error.

Procedural discourse always faces this formidable problem of constraining the operator's action within set physical limits. Like the Sorcerer's Apprentice, the operator may initiate actions according to some known procedure that subsequently gets out of hand, because some terminological detail has been forgotten or some conditional detail has been neglected. This problem of control, as Wiener observed in his classic *God and Golem, Inc.*, is inherent in all human artifice, whose effects are difficult to anticipate in totality (63). The operator's manual attempts to establish barriers to undesirable forms of behavior by restricting the terms and conditions of use, but this process requires both insight and considerable rhetorical skill.

Conditional generalizations, for example, attempt to limit an operator's activity on the tool by establishing circumstantial limits within which the tool is effectively and safely operated. In Rule 2 of the prose sample, harder materials are said to require stronger power loads and shorter fasteners. This rule of thumb, which establishes a relationship between materials, power charges, and fasteners, seeks to channel behavior in certain directions. The assertions of Rule 2, however, are based on assumptions that exist outside the text. That is, the full information upon which the generalization has been made is not available in the text. For example, the outsider can only speculate on the meaning of an unqualified distinction such as *hardness*, when no fastener dimension and no specific base material are mentioned. The generalization of Rule 2, in fact, is nearly devoid of content for an outsider, once we recall that the possible combinations of materials, fasteners, and powder charges range in the thousands:

Permutations of Studgun Applications

= Shell Charges (6 levels)

× Fastener Designs (type, length, diameter)

× Base Materials (type, thickness, hardness, condition, combinations)

× Accessories (disks, barrel types, ramrod positions)

Such mechanical complexity, which vastly exceeds that of any firearm, cannot be reduced to commonsensical proportions in textual generalizations of the kind given in the paragraph cited earlier. In the heading of the manual section—"To Determine Correct Power Load"—"correct" is a misleading ideal. For the designated procedure leads to no predictable result, given the myriad possible combinations.

This discrepancy between mechanical complexity and discursive reduction is a problem common to all operational discourse. The reductive text's utility is achieved through a simplification that does not admit the complexity of the phenomenological reality. This differential becomes serious when it burdens the user with guesswork that can result in serious error. In the instance I am discussing the authors fail to make explicit the variety of assumptions insider operators—whether designers or experienced users—routinely apply when selecting fasteners and charges. The language of reduction in the instance of the direct-action studgun does not encompass the detail that the expert operator must master in order to determine an appropriate power load.

Further efforts in operator's manuals to reduce ambiguity and constrain behavior are typically made by specifying action. In this distinctive rhetorical convention of operational discourse, the user is given behavioral templates on which to model his or her actions. These templates usually have a narrative, dramatic quality that unfolds a series of actions in steps through time. The operator's manual becomes a kind of script for the human-machine interface, in which human physiology is unified with machine action to achieve a utilitarian objective—for example, fastening studs to a sheet of steel. Rule 3 of the cited instructional sample directs the operator to begin with the weakest possible charge and to work upward in charge strength until the "desired" penetration is achieved. Such action statements attempt to resolve the technology into a series of discrete operations that direct the human-machine interaction so as to deliver the technology to the user's purpose. Once again in the sample we are examining, the selection process

is underspecified. The shortage of action statements forces the operator to formulate his or her own actions on the extratextual basis of individual judgment. The operator must invent a procedure in the process of applying the tool.

THE LEGAL FRAMEWORK AND CONFLICTING INTERESTS

That every operator's manual has a legal significance should come as no surprise. Written discourse is inherently accountable. Evidence that a given technology is a reasonable solution to a problem is a matter of demonstration, in which texts—quite frequently the operator's manuals—will inevitably play a powerful testimonial and illustrative role. The document is a *testament* that the technology can be explained, which is to say made understandable and controllable for the lay user. Language plays a crucial role in this rendering of technology into human terms (Miller). Indeed, rendering public technologies into written procedures is a decisive step in the socialization of a technology. The operator's manual not only assumes a contractual importance in its capacity as written claim, but it also becomes evidence that the expert, who usually has an exclusive hold on the expertise, has sufficiently reasoned out and articulated how it is to be made fit for public use. Hence, manufacturers who neglect to frame their technology in text are open to the charge of negligence.

The legal process has an ancient preoccupation with texts. As Goody has argued, the alliance between the law and the written artifact, which has been nearly universal among cultures, serves to reaffirm the uniformity and stability of the law (153–54, 170). Texts are viewed as more stable than oral discourse; they can be collated and preserved from arbitrary rewording. In modern practice, there is a steady effort to convert experience to text. Depositions are taken, documents are amassed, transcripts of testimony are made, and all these are sorted and arranged in case-books, drawing important elements out from a background reality. This reconstructed reality can now be processed and opened to collaborative exegesis. Narratives are fashioned from these materials as a way of probing causality. This process of objectification is

important in analyzing potentially conflicting accounts of experience, for the material record allows one individual to collate his or her own version of reality with that of others.

In sorting through the merits of the two studgun cases mentioned earlier, the legal process converged on the respective operator's manuals. One of the main strategies for reconstructing the accidents was to assess the way in which the tool, its operator, the conditions of operation, and the recommended procedures were elaborated in the operator's manuals. Each manual, issuing from an authoritative source, whether manufacturer or distributor, was treated as a reference tool with procedural authority over the studgun. Legal analysis naturally focused on these procedural elaborations as a way of assessing the intentions of the manufacturer and the nature and limits of the knowledge made available to the user.

In both the Power Anchor and Star studgun cases, an important part of the legal inquiry concentrated on aligning the material facts of each accident with a "theory" of tool use, as provided in the operator's manual. The events of each accident were compared with the written procedures concerning the relevant action and conditions, in order to determine the degree to which the text anticipated the event. For example, in the Power Anchor accident, where a stud appeared to have fish-hooked off of spalled concrete behind the 2" x 4" frame, all elements of the operator's manual dealing with use of the studgun in such a situation and for such purposes were scrutinized, including the warnings related to such uses. In the Star studgun accident, where a stud had passed through three layers of construction materials, parts of the manual governing studgun charge selection and use on walls and in steel materials were examined for the degree to which they anticipated that kind of event. Hence, a sustained line of inquiry sought to reconstruct the circumstances and events of the accidents by reference to relationships worked out in the manual—the tool, action, conditions, and operator. The operator's manual was thus interpreted within a theory of verisimilitude, in which it was expected to caution against, and thus anticipate, the actual events.

In the legal domain, a variety of specialized concepts composing tort law have institutionalized the

expectation that the relations between operational texts and human actions should be governed by verisimilitude. Of special significance to operator's manuals is the notion that the manual is a *warranty*—both a promise that the fact is as represented and a promise that the information in an instructional publication used for a specific purpose is suitable for that purpose (Walter and Marsteller 165). In the legal context, operational discourse takes on the social and material consequences of liability, outlined as follows in Section 311 of the Restatement (second) of Torts:

(1) One who negligently gives false information to another is subject to liability for physical harm caused by action taken by the other in reasonable reliance upon such information, when such harm results (a) to the other, or (b) to such third persons as the actor should expect to be put in peril by the action taken. (2) Such negligence may consist of failure to exercise reasonable care (a) in ascertaining the accuracy of the information, or (b) in the manner in which it is communicated.

This formulation of Section 311 legalizes our social expectations that the reality constructed in the discourse of operations is both reasonable and expert (Walter and Marsteller). Operational discourse, tort law insists, should attempt to resolve mechanical complexity into commonsense terms that channel human action into benign and useful effects. An injury becomes a material—and operational—emblem of an incongruity between text and action.

Claims made on behalf of the plaintiffs in both the Power Anchor and Star cases were substantially based on theories of verisimilitude determined by textual analysis. The charge in each case developed a commonsense argument that the technology of the direct-action studgun was "unreasonably" dangerous, entailing risks that were unannounced to potential users. For example, the claim against Power Anchor, Inc. was as follows:

Our action on behalf of Mr. Gagne and his wife is based on our contentions that the stud gun is unreasonably dangerous and that its warnings are inadequate for a number of reasons. Notably, we be-

lieve that there was a failure to adequately warn users of the hazards associated with the use of the tool.

In particular, the content, format, and presentation of warnings set forth in the owner's manual are such that they do not call attention to the general hazards associated with the use of the gun in proximity to the edge of concrete surfaces. Further, the warnings attached to the gun itself and contained on the gun's tool box do not begin to bring home to potential users the gravity of the risks engendered by the gun's use.

In this claim, *reason* is normative, a state of conditions that is assumed to govern the individual's encounter with the mechanical complexity of material culture. Reason, taken as a self-evident human faculty, is the norm to which technical complexity must subordinate itself. *Risk* becomes a term used to identify the existence of contingencies that are not subject to operational control or foreseen by commonsense inspection. *Safety*, a matter of the human body, is the condition in which the technological and human—that is, the mechanical and the social—regimes interact without harm to the operator. Reason and safety are thus bound together in the notion of verisimilitude, the notion that things are as they seem in the manual.

In both cases the plaintiffs based their claims largely on an analysis of the studgun as it was represented in the operator's manual. The manual must, as a rational system, be accessible to common sense. Its world therefore must to some degree be *complete* or self-sufficient, understandable on its own terms. However, if the tool is presented algorithmically as a matter of operating protocol, common sense may get in the way. For the point of constructing protocol is to dispense with the complex but often inessential principles behind the procedure. If we had to comprehend fully the rationale of every technology we availed ourselves of, even electric power would be removed from common social use. On the other hand, as procedures become elaborated in detailed protocols, they increasingly leave the realm of commonsense behind. They demand strict compliance and assume a highly problematic responsibility to be accurate and exhaustive. This is a paradox of all

procedural discourse as it is exported to lay social settings.

In the legal context, our rhetorical analysis of the studgun manuals assumes a new significance. For example, the failure of the Star operator's manual to reason out a stud selection procedure is a problem for the user, who has no way of knowing what the implications of his or her uses are. The erratic coverage of the power load selection process, characteristic of the manual as a whole, fails to meet the expectation that the rhetorical system is reasonably self-explanatory. Many of the statements have meaning only when supplemented with "insider" knowledge not contained in the text. Consider Item 5, for example:

To vary the amount of penetration: (a) Fasteners can be positioned in the barrel by using the ramrod provided with the tool kit. (b) By using .22 caliber crimped loads Power Levels 1 or 2.

Nowhere in the manual is it explained how the ramrod works, what "crimped" loads are, or where Power Levels 1 and 2 fit into the scheme of ammunition used to propel the studs. It is not at all clear in what way these factors "vary the amount of penetration." The loose terminology and incoherent syntax, here as throughout the manual, underscore the inconsistency of the taxonomical, conditional, and action statements, which introduce ambiguity rather than reduce it. The result is that the operator is burdened with guesswork as he or she tries to determine a course of action.

The lack of safety warnings was a central issue in both the Star and Power Anchor studgun cases. Neither the Star manual nor the Power Anchor manual warned of the serious hazards attending the use of high-velocity studguns. This omission of prominent, explicit warnings made it easy to assume that the direct-action studgun is just another construction tool, blurring the fact that a gun-like implement, normally regulated with the strictest care, was being introduced into a social environment. Neither manual used the words *hazard*, *dangerous*, *warning*, *death*, *caution*, or *injury*. Nor did they invoke any of the conventions of hazard warnings, used in most competitors' manuals, such as red or amber colors, redundant warnings, highlighting, typography, placement, or illustration—all of which are well established tech-

niques of safety warning (Clement). The rhetorical effect of this bland treatment of hazard was to normalize the technology in such a way as to assert its fundamentally benign character, whereas operator's manuals of many other direct-action studguns used explicit death warnings to reinforce the impression of social emergency.

In the Power Anchor operator's manual, the entire issue of safety was relegated to small print on the next-to-last page in a hodgepodge list of "Safety Rules." The "do not" mentality revealed in this language is authoritarian and nonrational, with none of the saving graces of operationalism's explicit detail and careful sequential logic:

Observe These Safety Rules

Do not load tool until you are ready to fasten.
Never fasten closer than $\frac{3}{4}$ " from the edge in steel.
Never fasten closer than 3" from the edge in concrete.

Do not attempt to fasten into brittle material or hollow material such as tile, hardened steel, solid rock, cast iron, face brick, marble or sheet rock.
Always keep head and body back of the tool when firing.

Operators should always wear safety goggles.
When working on ladders and scaffolds, do not lean out too far thereby putting yourself out of balance. Make sure you brace yourself solidly.
Clean the tool daily.

Always know the material into which you are fastening. Never guess. Check constantly to avoid firing into unsuitable material. Always try the lightest charge first.

Do not use the tool in explosive atmosphere.

There is no effort to provide any explanatory rationale for the rules. They are simply grouped together and dispatched at the end of the manual. This neglect to place any priority on human consequence reduces the user to a nonentity.

How can we explain these lapses in procedural specification, hazard warnings, and safety recommendations? One cannot ignore the fact that the operator's manual is a rhetorical field on which different, often inconsistent interests vie for accommodation. The tool is a different object to the various constituencies whose professional ends are in some

way or other bound up with it. To the engineer or designer, the studgun is an expression of functions that have been tested within the quantitative context of such specialized fields as mechanical design, materials behavior, and ballistics. This insider invokes his or her vast mental library of images and processes to supplement any fragmentary discourse in the manual. The capitalist, on the other hand, thinks of the same tool in terms of production, marketing, and finance—questions that have far-reaching monetary consequences. The tool in the operator's manual has a commercial significance. The operator sees the studgun as a utilitarian object whose purpose is to drive studs with speed, force, and accuracy. We must expect that these different groups will conceptualize the studgun within the different frameworks of their professional interests (Hanson, 32–33). Hence, the objective that an operator's manual render a consistent, self-contained public version of a given technology may well be defeated by the larger reality that powerful institutional interests are vying for definition of the technology.

Certainly rhetorical ineptitude helps to account for the failure of safety warnings in the Star and Power Anchor manuals. In neither case had experienced manual writers overseen the manual writing process, and the engineers and marketing personnel who wrote the manuals were inept at rationalizing and operationalizing the technology for inexperienced users.⁹ Design and marketing interests appear to have dominated composition and production of the manuals, since there was little evidence of a systematic manual writing effort from the user's point of view. In the context of legal inquiry, the kinds of rhetorical failures seen in the samples we have examined proved to be decisive arguments that direct-action studgun technology, framed as it was in inconsistent and often incoherent language, was misrepresented. Failure to place priority on language and clarity is also a failure to give special emphasis to the social function of operator's manuals. These lapses are consistent with a rigid positivist model of knowledge, in which the written discourse is considered an unwieldy approximation of a deeper material truth that is better understood in physical or mathematical terms. The relation between text and action is treated as unreliable. Language devalued leads to such half-

truths as "No one reads manuals, anyway," or "Any tool can be dangerous if improperly used," or "You can't warn of every possible improper use."

CONCLUSION: THE METAPHYSICS OF OPERATOR'S MANUALS

The operator's manual, we can conclude from the Power Anchor and Star cases, is a critical part of the machine-human interface by which technologists may help to accommodate humans and technology. But this accommodation remains problematic. As Norbert Wiener once noted, "A goal-seeking mechanism will not necessarily seek *our* goals unless we design it for that purpose and in that designing we must foresee all steps of the process for which it is designed, instead of exercising a tentative foresight which goes up to a certain point . . ." (63). The rhetorical process of preparing the operator's manual obliges the expert to imagine the consequences of operation and to lay these out for the user. It is a crucial step in the socialization of expertise. We can only maintain that individuals are responsible for their actions if we enable the rational individual to take charge of the growing presence of technology. We can only insist that operators retain legal responsibility for their actions if we provide them the means to understand the human consequences of their behavior.

As individuals avail themselves of the specialized knowledge modern society has spawned, the "semantic environment" (Weinberg, 2–3) becomes an information marketplace in which expertise is constantly reconstructed in behavioral terms of action for the nonexpert. This procedural discourse, however, is not without its social problems. As a given technology becomes more complex, it becomes harder to understand and to manipulate according to the dictates of common sense. The exportation of complex technologies is increasingly achieved by the detailed operationalizing of human behavior in the immense body of procedural literature that accompanies industrial products. But, as we have seen, there is a conflict between obligatory procedures of operationalism and the exercise of independent human reason.

Procedures without any accompanying rationale become imperative and defeat our social (and legal)

expectations that human activity be governed by reason, human judgment, and initiative. In all strictly procedural discourse, a tension will arise between the instrumental need to be algorithmic and the legal obligation to be reasonable. On the one hand, we ask the operator to relinquish his or her individual inclination so as to conform to some algorithmic activity; on the other hand, we expect these principles governing our behavior to be reasonable, not arbitrary. As higher-level experts set the conditions of instrument assembly, operation, and maintenance and serialize them in repeatable unit human actions, the lay user may increasingly be faced with a situation in which he or she no longer understands the potential consequences of specific actions. And if, as was the case in the two manuals we have considered, the procedures are incomplete, the operator may well be obliged to use guesswork and to operate unknowingly on the margins of safe use.

In many instances, this problem of complexity can only be mastered by the training of individuals who can then comprehend the reasoning behind the procedures. Training programs were pronounced as obligatory in the two manuals we have examined, but, in fact, the programs were not readily available and there was considerable doubt as to their quality.⁹

NOTES

1. A discussion of operationalism is found in Percy W. Bridgman's *The Logic of Modern Physics*, which made successful completion of specified tasks the criterion of positive knowledge. Studies in popularization such as those in Shinn and Whitley have examined the dynamic of publicizing science. See also Dobrin, who analyses instructional literature from the standpoint of speech-act theory.
2. The problem is not solely one of increasing quantities of information per population increase, for, as Boulding notes (55), technological innovations in print, broadcast, and communications media have vastly increased the potential information disseminated per unit individual. One newscaster, salesperson, or partisan can communicate with millions.
3. The literature on the engineered life is considerable. See Florman and Ellul for opposing views on the direction of the machine-human accommodation.
4. Although studguns came on the market in the

Moreover, the manuals we have examined remained the central instruments of the training.

As Simon has argued, the technical object must be rescued from the control of the specialist and related to the broad social environment (176). This question is a significant one for all individuals involved in the processes of production—the designers, the producers, and the writers. In the operator's manual, the producer, from the initial design and manufacturing orientation toward objects to a new orientation toward human thought and behavior. The operator's manual constructs this anthropocentric ethos in which material things are subordinated to human purpose. Simon speaks of the tool and its environment as object and mold. "An artifact," he argues, "can be thought of as a meeting point—an 'interface' in today's terms—between an 'inner' environment, the substance and organization of the artifact itself, and an 'outer' environment, the surroundings in which it operates" (9). But *environment*, as we have seen, must also be seen in terms of social circumstances and *artifact* must also be considered to include the rhetorical instruments. The neglect of these instruments can have terrible human consequences, not to mention serious legal implications, as we have seen in the Power Anchor and Star instances.

United States in the late 1940s as construction tools, they were originally developed and patented in England during World War I by Robert Temple, who was attempting to adopt firearms technology to constructing devices for attaching lines with lighted floats to the hulls of submerged enemy submarines, which could theoretically then be spotted on the surface (Schillings). Temple patented a modification of the device in the United States in 1921 as an "explosively actuated penetrating means." Later, Temple proposed using his explosively actuated device as a means of fastening sheets of steel to damaged ship hulls at sea. In the United States, after the war, Temple developed a variety of studgun applications for the construction industry. A piston-driven version of the studgun was also developed as the cattle stunner for the assembly-line slaughter of livestock. These tools have undergone a steady evolution from the late 1940s to the present.

5. This complexity can be glimpsed by simply multiplying the variations: *types of stud design* × *varieties of powder charge* × *kinds of materials of application*. This can easily come to $20 \times 8 \times 20 = 3,200$.
6. Hanson recounts how an aircraft downed in a storm will find plausible causal explanations in disciplines as diverse as those of the mechanic and the psychologist.
7. Popular lore sometimes holds that no one reads manuals, but we must recall that manuals do not have to be read by everyone or even by the majority. A manual's content can be drawn into the operating community by individual readers who instruct others on how the tool should be used. Such local experts, the so-called gate-

keepers (Allen), propagate the information in the operating environment.

8. The authors of the two manuals even failed to incorporate all the recommendations of the *American National Standard Safety Requirements for Powder Actuated Fastening Systems* (ANSI), a standard reference document that suggests important rhetorical and semiotic usages to be taken into account by individuals preparing manuals on studgun technology.
9. In one instance, training consisted of a brief orientation and a true-false test given by the renting agent, which no one had ever failed.

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WRITING AND DATABASE TECHNOLOGY

Extending the Definition of Writing in the Workplace

BARBARA MIREL

When I wrote this article in 1996, vintage Web—the Mosaic browser—was only three years old. My interview participants were still on mainframes, which spewed out the four-foot-high piles of reports that lined their office floors. Interactive data visualizations, data cubes, and enterprise resource management systems did not yet exist for easier data retrieval, analysis, and sharing.

I mention these technological changes because they may be the most obvious explanations why the relatively unconventional view in my article—treating data reports as an important form of technical communication—is today fairly common. Granted, the specific quarterly accounting reports are not a major concern of technical communicators. But the larger issue of helping people access, integrate, interpret, and present data—lots of it from across the Internet or within intranets—has become a central focus in our field. Virtual workspaces and laboratories abound, and they often primarily display charts and tables of data. Designing online workspaces, help, and Web sites for people's data-intensive tasks is incorporated into many Web design courses in today's technical communication curricula.

Technological advances may have precipitated this evolution but they are not able on their own to do the hard work of making these workspaces, help, and Web sites truly useful. This is a rhetorical issue. No magic formula exists for presenting data usefully for exploratory analysis and decision making.

When I wrote this piece, I emphasized data—finding, arranging, laying out, transforming, analyzing, and communicating it for actual workplace goals and for such discretionary decisions as "How should I reallocate resources to avoid cost overruns?" Today, creating useful support for these strategic ends is still an open design question, one I continue to investigate. But I have come to realize that a focus primarily on data or information architecture is insufficient.

Instead, the unit of analysis needs to be the processes of solving specific types of problems in context in particular domains. In studies I have since conducted with scores of domain specialists, I have found that these users need better support for many core actions and strategies they devise to get coherently from "here to there" in complex electronic information spaces and situationally determined investigations. To discover and design for these needs, interviews are less primary than on-site, longitudinal observations and field-based prototype testing. I have also shifted my attention from static data reports to interactive data visualizations.

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The rhetorical dimension of useful support—whether static or interactive—is that usefulness hinges on defining the right categories and structuring the right displays with the appropriate amount of adaptability for the right context, purpose, medium, and users. It hinges on accounting for constraints, conditions, and contingencies.

Yes, many things have changed since I wrote this piece. But one that has not is the crucial need for a rhetorical understanding of data-intensive communications for complex problem solving. I still believe that technical communicators are uniquely qualified to bring this valuable rhetorical stamp to software and Web projects. And it seems more important than ever that our cousins in Human Computer Interaction (HCI), interaction design, and information science and our teammates in software engineering recognize and take advantage of this strength.

Barbara Mirel

A major change is transforming the American workplace. Thanks to distributed computing, nontechnical employees in every department can manage their own data and compose data reports for important business purposes. These reports, which answer business problems or concerns, present information retrieved from electronic databases. Service supervisors, for example, often need to decide about salary increases for technicians. Most helpful to these supervisors are reports on technicians' yearly productivity, with supervisors figuring productivity from electronic data on technicians' number of service calls, their average response times, the time spent per call, and the revenue brought in. Typically, supervisors will organize such data into tables, most likely listing the names of technicians in the rows and the measures of productivity across the columns. In this essay, the term *data report* refers only to printed reports that are composed of tables of numbers, words, or both. I focus on tabular reports because they are the most common, though not by any means the only, form or medium for data reporting.

Reports consisting of data tables are vital to virtually every function in a business: marketing uses them for data on customer demographics and purchasing patterns; budgeting displays tables of revenue and expenses; production reports scheduling and maintains inventory through tables; and sales uses this form to present precise data on past, present, and prospective customers. Sometimes these report writers create tabular displays of data for their own needs (making themselves their own readers); at other times, reports may be intended for other read-

ers. In either case, the fundamental purpose of a data report remains the same: to answer a business concern with relevant data organized to support a reader's interpretive needs and strategies for turning that data into information and knowledge.

The organizational value of data reports for recordkeeping and problem solving cannot be stressed enough. Yet reports have value only if report writers are able to generate a form and content that directly address a pressing business problem. Unfortunately, at present, many businesspersons lack this proficiency. Surveys show that managers are extremely frustrated at having to spend, on average, 500–750 hours per year (one-third to half of their year's work) searching for the information they want (Delphi Consulting Group, 1989–93). Often, this searching involves restructuring data reports that other people have written so that the tables truly answer their business questions. Despite such frustrations, little attention is given in either business or in technical and professional writing classes to building people's skills in writing effective data reports.

In developing and drafting data reports, writers transform raw data (discrete "facts") into meaningful information for a given context, audience, and organizational purpose, and they communicate it in a way that fosters the production of knowledge. This transformation is a rhetorical activity. Yet data reporting as a rhetorical action is rarely taught in technical and professional writing classes. Instead, if people at work formally learn about data reporting at all, it is in computer training courses, which teach users how to execute data retrieval and reporting functions. This

training stresses technological over rhetorical skills and knowledge, mistakenly assuming that knowing how to operate a technology is commensurate with knowing how to use it to its full advantage to achieve a purposeful exchange of information.

Data reporting demands a dynamic interplay between a writer's rhetorical and technological skills. As such, it has a legitimate place in technical and professional writing classes. As part of the curriculum of technical and professional writing classes, data reporting will help students develop communication skills that are fast becoming indispensable for exchanging information in business settings. These skills involve, first, using information technologies as media of invention (in addition to actual drafting), with database applications being the source for gathering, filtering, and selecting information and arranging it into meaningful patterns for a given purpose and context. Second, these skills involve being able to present tabular data as the sole content of a communication, part of the emerging trend shaped by electronic writing to communicate networks of relationships rather than linear prose (Bolter, 1991).

In this essay, I explore the unique skills and knowledge that data-report writers need to learn in order to produce effective data reports. Analyzing the dynamic relationship between rhetorical and technological skills and strategies, I argue that if data reports are to serve readers' needs for recordkeeping and problem solving, then writers' technological skills must serve their rhetorical aims and strategies.

To analyze the interactive rhetorical and technological competencies involved in data-report writing, I first present a framework for understanding the communicative dimensions of data reporting. Then, I present results of a study in which I interviewed twenty-five nontechnical project administrators in a research laboratory, scientific and business specialists who regularly use financial data reports for their project accounting tasks. I link the qualities that these respondents look for in reports to the interactive rhetorical and technological skills and strategies that writers should employ to develop a report with such qualities. I conclude by proposing general approaches for teaching data reporting in professional and technical writing courses in order to prepare students for this increasingly common form of communication at work.

DATA REPORTING AS COMMUNICATION

In data reporting, computers enhance communication and knowledge. But too often data reporting is treated as objective fact giving. Historically, data tables have been associated with scientific rationality—impartial facts, free from the suspect subjectivity associated with rhetoric and communication. But this asocial view of tabular data ignores the inescapable rhetorical intentions and practical consequences of retrieving and reporting data. Many recent researchers, therefore, reject an objectivist view of such communications, arguing that facts are not simply transferred from senders to receivers. Rather, in written information, knowledge is constructed through relationships between readers and writers and the experiences each brings to the interaction (Winograd & Flores, 1986; Doheny-Farina, 1992; Norman, 1986; Cypher, 1986; Lave, 1988; Waern, 1988). This relationship-based view of constructing knowledge casts a new light on the writing of data reports.

Many composition specialists examine computer literacy and electronically produced information through this constructivist lens. Unfortunately, they generally omit databases and nonlinear tabular communications from the technologies they examine, technologies such as word processing, desktop publishing, electronic conferencing, and e-mail (Handa, 1990; Holdstein & Selfe, 1990; Hawisher & LeBlanc, 1992). Some research in rhetoric, visual design, and human factors, however, does focus on database-related communications. This research reveals that (1) key rhetorical strategies inform data searches, retrievals, and reporting; (2) rhetorical and technological skills mutually support and shape each other; and (3) designs for functionally effective tables must facilitate readers' strategies for answering business questions. I will discuss each of these issues in turn.

KEY RHETORICAL STRATEGIES INFORM THE SEARCHING FOR, RETRIEVAL OF, AND REPORTING OF ELECTRONIC DATA

Sullivan (1986) concludes that rhetorical invention is the defining feature of electronic data searches. In a study of bibliographic databases, she finds that searchers must have the following skills, all of which involve invention processes:

- knowing the meaning of the “invisible” data that are stored in the system (discovery);
- focusing on what is at issue in a communication situation (stasis); and
- determining the most effective topical orientation of a particular purpose (*topoi*).

Rhetorical invention also comes into play in reporting data. Boehm-Davis et al. (1989) find that the most important factor in designing effectual data reports—even more important than the format of a table—is for writers to select and present only the information integral to their communication situation. In regard to formatting, these researchers find that writers do not experiment with enough formats. Consequently, they rarely produce the best format for their exact purposes. Rhetoricians similarly advise writers to avoid predefined, static templates for data tables and instead dynamically fit their intentions to the rhetorical patterns that they choose (Comprone, 1993).

As an overview of four qualities necessary for effective data reports, Zmud (1978) identifies characteristics that are all implicitly rhetorical, as noted in the parentheses:

- quality of information (selecting appropriate and relevant data);
- accuracy and sufficiency of information (selecting the right scope and detail);
- quality of format (sequencing, ordering, and chunking information effectively); and
- quality of meaning (evoking emphasis, patterns, and relations through logic and layout).

SKILLS IN RHETORIC AND DATABASE TECHNOLOGIES SUPPORT AND SHAPE EACH OTHER

A number of studies show an inextricable link between rhetorical and technological strategies in data searching and retrieval. Researchers find that unless people know (or in rhetorical terms, invent) (a) the meaning of electronic data, (b) the significance of data relationships, and (c) the right level of detail for a question, they will have difficulty understanding the basic program logic of search principles and data

structures (Linde & Bergstrom, 1988; Chen & Dhar, 1990). Correspondingly, searchers’ rhetorical strategies are incomplete without a concomitant technical knowledge, since electronic databases dictate the paths that people must follow in defining and searching for data (Sullivan, 1986).

DESIGNS FOR FUNCTIONALLY EFFECTIVE TABLES MUST FACILITATE READERS’ STRATEGIES

Developing effective tabular displays of data should lead writers to research on visual rhetoric by Tufte (1990), Bertin (1983), Cleveland (1985), Wright (1984), Holmes (1984), Dragga and Gong (1989), Kostelnick (1989), and Barton and Barton (1993). Bertin especially emphasizes the need to design tables to answer actual questions that readers will ask. He identifies three distinct levels of questions and answers. In the “elementary” level, readers’ questions are answered by finding a single element in a table; in the “intermediate” level, by relating two or more elements; and in the “overall” level, by seeing the overall trends suggested by the data reduced to and represented by a single element. Bertin argues that the goal for designers is to choose a tabular image that answers the majority of questions the information is capable of generating.

Tufte also stresses functionality in designing tables, arguing that simplicity as an aesthetic preference is not the best strategy for displaying information. Dense rather than simple tabular displays are often necessary to give readers a big- and small-picture view of information, making many choices and comparisons possible. According to Tufte, designers should realize that the effectiveness of a table does not depend on how much information it includes, but on how information is layered and ordered to facilitate readers’ interpretations.

As this survey of current research suggests, developing effective data reports requires writers, on the one hand, to be adept at rhetorical strategies for invention, arrangement, and delivery, and, on the other hand, to understand the logic and capabilities that a program offers for defining, searching for, and retrieving data and for organizing it into printed reports. Recent research examines only separate aspects of data reporting, such as the rhetoric of tabular

displays, the rhetorical underpinnings of data searches, and technical skills related to retrieving and reporting information. I aim to unite these aspects into an integrated view of the competencies involved in composing tabular texts that communicate critical information for readers’ work. This integrated view aims to capture what it means for writers to develop data tables that are situated, purposeful business communications and what preparation would help them in technical and professional writing classes.

METHODOLOGY

To study the rhetorical and technological skills involved in data reporting, I analyzed readers’ reported responses to the actual data reports that they receive and use at work. From these responses, I inferred some of the knowledge and skills that writers should have to develop effective data reports.

RESPONDENTS

I interviewed twenty-five project administrators in a national research laboratory who regularly read and, at times, customize data reports to conduct their cost-accounting responsibilities. All participants are regular report readers who are competent in and receptive to computing. They belong to fifteen different divisions, with each division having projects with somewhat different accounting needs and structures. Twelve respondents are scientific specialists who actively conduct research in addition to managing projects. The other thirteen are full-time administrators whose area of expertise is business and accounting.

THE REPORT AND ITS USES IN CONTEXT

I gathered information on readers’ responses to a report that they receive each month. This report is generated from a mainframe financial system by Information System (IS) specialists. Respondents use this report, the Detailed Charge Report, for tracking costs, managing accounts, and assessing budget overruns. This report itemizes all charges to each project account for the month and the year to date. The Detailed Charge Report, a complex table,

presents nine types of charge information for each listed purchase or service (see Appendix A). As Appendix A shows, the report gives readers very few cues for interpreting different codes or distinguishing the meanings of such terms as “commitments” and “encumbrances.”

Respondents are able to create and order customized versions of this report by using a PC look-alike program that interfaces with the mainframe financial system. This interface program gives laboratory users an opportunity to tailor their report to their needs by selecting only the data that they want and by organizing it to suit their interpretive strategies.

INTERVIEW QUESTIONS AND ANALYSIS OF RESPONSES

My semi-structured interviews usually lasted an hour. I asked respondents (1) to identify their purposes for reading the Detailed Charge Report; (2) to describe their strategies for accessing and analyzing the cost data in the report; (3) to evaluate the content and form of the report in relation to their needs and purposes; and (4) to discuss ways in which they derive the information that they want when the report fails to meet their needs. Five of the twenty-five respondents voluntarily walked me through their processes for accessing relevant data from the report, for turning it into a usable form, for interpreting it, and for making decisions.

To analyze responses, I examined participants’ combined responses for patterns in their strategies and purposes for analyzing the report, for their satisfactions and dissatisfactions with the report, and for their methods of overcoming problems with it. To explain differences among responses, I looked at the structure of individuals’ projects and project accounts and their expertise in accounting and computing.

My analyses show that respondents uniformly are dissatisfied with the Detailed Charge Report for six main reasons that I will discuss in the next section. Yet only a third of the respondents seek to overcome their dissatisfactions by using technological knowledge and skills to customize the report with the interface program. Finally, all of the respondents use the report for the same general purposes, but they access

and analyze data differently on the basis of the specific structures and demands of their projects.

RESULTS: READERS' RESPONSES TO DATA REPORTS

Each month, respondents use the Detailed Charge Report to answer four central cost-accounting questions: (1) Are all the charges legitimate? (2) Where do high or unusual charges come from? (3) What are the differences between actual and budgeted costs? And (4) which accounts are likely to run over budget (and how should resources be allocated to avoid that overrun)?

As the report now stands, respondents have a hard time answering these questions. Without exception, they are dissatisfied with the report, with at least 20 percent of them criticizing it for the following reasons:

- *Information overload*: the report has too much data.
- *Overly narrow content*: it does not give a big enough picture of cumulative months.
- *Random data*: it does not group or emphasize data for easy interpretation.
- *Unprocessed data*: it does not calculate key relationships such as variances between actual and budgeted costs.
- *Unintelligible data*: it labels rows or columns with terms that have unclear meanings (such as "commitments").
- *Unpresentable data*: it has low legibility and layouts with little difference between figure and ground.

To overcome their dissatisfactions, three respondents rearrange the Detailed Charge Report by using the interface program. All of the administrators in my study are experienced with this program (using it to order routine and ad hoc reports), but only three of them understand how to take advantage of its capabilities. They know how to use its functions to select only certain accounts or categories of costs and to rearrange the row headings of the table so that the data are layered to suit their cost-accounting strategies.

Five other project administrators also customize the report but use their PC databases to do so instead of the interface program. Each month, these adminis-

trators rekey the data from the Detailed Charge Report into their private programs and generate Charge Recalling Tufte's insights about tables often need to be dense but well layered, these PC-customized reports may have more information than the Detailed Charge Report, but they are more functional because information is arranged specifically for readers' cost-accounting logic (see Appendix B).

The six respondents who rearrange the Detailed Charge Report (either with their own PCs or with the interface program) have become report *writers* as well as readers. Unfortunately, the other respondents believe that they lack the necessary technical know-how to customize the report. These individuals have domain and task expertise and, concomitantly, a keen sense of their rhetorical needs for reported data. But they lack a complementary expertise in the technology, without which they cannot transform the information they receive into the information they desire.

DISCUSSION: STRATEGIES FOR EFFECTIVE DATA REPORTING

As Comprone (1993) argues, if deliberate rhetorical intentions are not represented in reports, the reports will "cover a topic" without fulfilling their purpose of helping readers to answer their questions with a minimal amount of effort. The Detailed Charge Report, as a generic report produced by the IS department, manifests few rhetorical intentions. Yet it has rhetorical consequences—unfortunately, many negative ones. Readers are dissatisfied and resent being burdened with unnecessary extra work.

In this national laboratory, as is common in many organizations, the centralized mainframe system for reporting is in the process of being replaced by a decentralized computing environment, thereby passing responsibility for reporting from the IS specialists to individual employees in each department. Once respondents and others like them work in the new client/server environment, they will have an even greater need to manipulate the technology to retrieve data and design tabular reports for their rhetorical purposes. For many respondents, this technological medium is a stumbling block. According to their comments in interviews, what they lack is the knowl-

edge to help them adapt various generic software functions (all of which they learned in inhouse training courses) to their individual cases of tailoring reports to their instrumental goals and analytic strategies. They need to know how to translate their rhetorical aims into a technologically produced document.

To develop effective data reports, writers must learn the database capabilities that enable them to achieve their rhetorical aims for invention, arrangement, and delivery. For each of these aims, Table 26.1 summarizes associated rhetorical and technological strategies. In the following subsections, I discuss these aims and strategies in more detail, providing supporting examples from my study and from other common instances of data reporting.¹

THE AIMS AND PROCESSES OF INVENTION IN DATA REPORTING

As with all composing, the success of data reporting depends on fundamental invention processes, namely writers becoming familiar with a subject, identifying

issues and questions that concern readers, understanding the topical orientations that address these concerns, and selecting content accordingly. Table 26.2 presents rhetorical and technological strategies related to invention.

In my study, respondents' dissatisfactions with the Detailed Charge Report can be traced to many invention issues. The report does not select and display key data relevant to readers' needs. For instance, it gives a fine-grained level of detail on exact monthly and year-to-date costs that are important for readers' recordkeeping and cost-tracking purposes. But it does not include higher-level figures on variances between budgeted and actual costs or on budget overruns, crucial for evaluating spending and deciding on future budgeting. Without these reported higher-level figures, readers have to compute them themselves.

Many respondents want other content as well, such as more verbal description about purchases and services and clearer distinctions between a charge classified as a commitment and one classified as an encumbrance. To avoid causing readers such prob-

Table 26.1. An Overview of the Aims and Strategies of Data Reporting

Aims	Rhetorical Strategies	Technological Strategies
Invention	Discover and select meaningful data with an appropriate scope and level of detail.	Understand program definitions of data, relations among data, and ways to write searches to get desired data.
Arrangement	Structure data into tables that support readers' interpretive strategies.	Use program formatting and calculating capabilities to provide tables with clear entry points, relevant data, and related data close to each other.
Delivery	Visually lay out and layer information so that printed reports give readers ready access, appropriate emphasis, and perceptible groupings.	Customize layouts and coordinate them with printer controls and configurations and, if necessary, with other software.

Table 26.2. Strategies for Invention

Aims of Invention	Rhetorical Strategies	Technological Strategies
Discover appropriate data.	Analyze readers' questions.	Understand the meaning and structure of data stored in a given program.
Select and retrieve appropriate data.	Define all the information that will answer readers' questions.	Create appropriate search statements. Know the logic of data structures and the data that can and can't be joined. Search repeatedly and incrementally and calculate data if necessary. Display search results and evaluate their accuracy and relevance.

lems, data-report writers should understand readers' actual questions, explore the full range of knowledge needed to answer them, and select data accordingly.

To implement these rhetorical choices, report writers need many technical competencies in database applications. Yet databases are one of the most complicated technologies for lay users to manipulate for their specific purposes (Date, 1992). One technological competence required for report writers is knowing the meaning and structure of the data stored in their system. For example, if for budgeting purposes writers want to develop a report on profits for the current year, they need to know which data in their program represent profits. Are profits stored as one precalculated figure, or must writers retrieve and relate many data, such as revenues, costs, overhead, and so on? Writers need to learn how the everyday terms and meanings they use for their business concerns correspond to the names, measures, and relationships among data in the system.

In the same vein, writers need to understand if the connections among data that make sense, practically, for solving a business problem are technically feasible. If, for instance, a company is losing money on a product because certain customers continue to buy it without paying for earlier purchases, then a sales representative needs to know who these customers are. What seems practically simple—a report listing all sales of an item, the sales for which payments are delinquent, and the names of delinquent customers—is actually technically complicated and, in some instances, technically infeasible. It is only feasible if the data are set up in a special way to allow writers to retrieve data from different databases. In conceptualizing and setting up databases, nontechnical report writers often need expert help.

Once databases are created, report writers have to know how to frame their searches for information in statements that a program will accept and process. Writing search statements involves abiding by the syntax of a program and, at times, becoming creative with its search logic. For example, creativity comes into play if a small-business owner wants a report on all of the customers with whom she did not do business that year. She cannot simply search for and retrieve this information from the program because it isn't stored in any one field. Rather, she has to "play" with the data she has to get the information she

wants. For instance, she may search her order database, list all the customers who placed orders in the past year, and select from her customer database those people who are *not* on the order-placing list.

Finally, report writers' technological strategies include assessing whether the data they retrieve are in fact the right data for their purposes. As research on human factors reveals, database users rarely check the answers yielded by a search, "failing to search for other levels of data which could supplement or contradict that already found" (Katzeff, 1988; Waern, 1988, p. 181).

THE AIMS AND PROCESSES OF ARRANGEMENT IN DATA REPORTING

One of the greatest challenges for report writers is to choose an appropriate organizing logic for tables that are multifunctional. As Bertin (1983) argues, designers must creatively organize tables to "answer any question, whatever its type and level . . . in a single instant of perception" (p. 99). Data-report writers have to experiment with single and combined organizing logics for tabular data displays and multiple drafts. They need to know, as in a case from my consulting experiences, that data reports for marketing purposes may take as many as five drafts of a table before a report convincingly shows a supervisor that, against common sense, it is best to target a very small group of low-volume customers because they generate the highest revenue. Relevant rhetorical and technological strategies for arrangement are presented in Table 26.3.

Rhetorical purpose should determine whether the best display is a table or some other graphic form. In my interviews, respondents agree that tables are most appropriate for their accounting needs. But they criticize the arrangement of the tables in the Detailed Charge Report. The preset order of columns results in separating data that these readers want to compare. For example, monthly charges and fiscal year costs with everything figured in (commitments and encumbrances) are many columns apart. Yet this comparison is critical for managing costs. Just as important, row headings do not accommodate the "cut into the data" that some respondents want to take because of the unique structures of their projects. One administrator, for instance, is frustrated with the report for

Table 26.3. Strategies for Arrangement

Aims of Invention	Rhetorical Strategies	Technological Strategies
Structure data to accommodate readers' needs.	For reference purposes, order and layer data so that even dense displays have an apparent organizing logic. For problem-solving purposes, classify readers' questions by Bertin's level and order and reduce data to answer as many questions as possible.	Adapt formatting capabilities for multiple rows and columns of varying sizes. Use calculating functions to define and display the data relevant to readers' needs (e.g., variances). Display format results to evaluate if they meet readers' needs.

grouping data by accounts (listing each account and the charges it has accrued) instead of by items (listing each item and the various accounts that have ordered it).

Readers can redesign the row groupings to get this desired arrangement if they use the *sort* function of the interface program. But, as noted earlier, few respondents understand the uses of this technical capability. When developing reports in an electronic medium, writers' rhetorical intentions for arrangement are inseparable from their technical skills in implementing them. Database interactions for formatting are often conceptually complex, especially if writers want to experiment with a number of options before choosing the best one for ordering, sequencing, and grouping information. Regrouping data or viewing multiple options at once may require writers to use and combine commands in novel ways. Just as tricky are such customized formatting efforts as inserting verbal descriptions or altering some, but not all, parts of a table.

THE AIMS AND PROCESSES OF DELIVERY IN DATA REPORTING

Delivering information in effective visual designs involves giving readers easy access to the data and data relationships relevant to their concerns. Table 26.4 summarizes rhetorical and technological strategies relevant for delivery.

Reports used for reference usually display large amounts of data in a small amount of tabular space. Legibility is paramount. Factors contributing to legibility include the size and width of columns, space between rows, and typography. These factors also help to reduce the homogeneity of a table and to heighten readers' perceptions of groupings.

Reports used for problem solving need designs that draw readers' attention to key information and that help them to distinguish important types and groupings of information. Table displays should create for readers paths through the table so that readers perceive particular groupings of data as individual "locales" that they may access at random and read as

Table 26.4. Strategies for Delivery

Aims	Rhetorical Strategies	Technological Strategies
Visually present tables with appropriate emphasis, access points, and interpretive cueing.	For reference purposes, create legible visual forms and perceptually highlight key groupings. For problem solving, use white space, typography, headings, location, and positioning to draw attention to key relationships and to give easy access to elements.	Understand and use program capabilities for page layouts, including writing small programs or macros for customized features. Adapt printer controls to desired page designs. Display layout results to evaluate if, once printed, they meet readers' needs.

self-contained information. Type size, style, and variation are vital for emphasizing specific elements and relationships; positioning and locating data support people's conventional strategies for reading left to right and top to bottom. One of the most powerful ways for report writers to highlight differences among data and data relationships is to use vertical and horizontal white space and headings advantageously.

In the Detailed Charge Report, respondents report difficulty in finding the data elements that they need, partly because the report lacks sufficient typographic variation, white space, and perceptible headings. These delivery shortcomings also make it hard for readers to find their places in the table again if they look away for a moment. Better rhetorical strategies for graphic design would help. But, as with arrangement strategies, delivery choices require corresponding technical skills. Improvements in database, spreadsheet, and word-processing programs now make it easy for writers to move, resize, add, and delete rows and columns. Yet for some desired page designs, writers still need to write small programs or macros, for example, for numbering every other line (a function that seems simple but actually requires a program to go through many conditional steps). Writers also have to set printer controls appropriately and, in some cases, link data to more powerful layout systems, such as desktop publishing or high-powered word-processing programs. Using other programs is often the best way for writers to experimentally compose and view a variety of graphic presentations and select the best ones for their purposes.

IMPLICATIONS FOR TEACHING AND FURTHER RESEARCH

In sum, for invention, arrangement, and delivery, writers of data reports must dynamically relate rhetorical and technological strategies to produce accessible and purposeful tables of information. The effectiveness of data reports, as judged by readers in an actual communication context, hinges on writers having chosen and implemented conceptual and visible displays that answer readers' concerns and questions.

Undergraduate students, as prospective report writers in future careers, would benefit greatly from a rhetorical orientation to data tables and reporting,

an orientation that technical and professional writing courses are uniquely capable of providing. The design of a detailed curriculum for teaching data reporting in technical and professional writing courses is outside the scope of this study. Yet, as illustrated in Tables 26.1 through 26.4, this study does provide a foundation for defining issues that curriculum designers should address.

Curricula may focus on various workplace situations in which tabular data are typically communicated, having students analyze diverse audiences for these reports and the different levels of questions that readers are likely to pose to the data. This focus will extend students' rhetorical skills beyond linear prose paragraphs to graphic forms. Such forms will challenge students to write with a purpose in a design that offers readers multiple entry points and interpretative paths. Students also will experiment with various structures and layouts for tabular data displays and evaluate choices against communication purposes. These forms of communication are common practice in organizational life, yet they are rarely addressed in technical and professional writing classes.

Assignments may start somewhat simply, with students designing standard communications for hypothetical contexts that are limited in scope and purpose. Assignments should become progressively more rhetorically and technologically complex. To link rhetoric and technology, however, students need to learn concepts and operations of database applications relevant to their rhetorical aims and intentions. Teachers of technical and professional writing courses may be daunted by the prospect of simultaneously teaching the necessary rhetorical and technological skills and knowledge, especially if they have little database expertise. Since data reporting requires interdisciplinary competencies—competencies in rhetoric and in database systems—collaborative teaching between writing and computer science or information systems teachers would be advantageous.

As attested to by the respondents in my interviews, the technology may become a major obstacle for students attempting to develop data reports. By working together, writing and computing teachers may create pedagogically sound approaches for moving students through report-writing situations that require increasingly complex rhetorical and technolog-

ical skills and strategies. Collaborations may range from actual team teaching to situations in which writing teachers prepare data-reporting cases and computing teachers design data sets and easy-to-use formatting and printing functions that may facilitate students' computing interactions for these cases.

To better understand the rhetorical and technological competencies involved in data reporting, researchers need to investigate the ways in which various features and functions of database applications enhance or constrain rhetorical choices, including the effects of advances in program capabilities and interfaces on reporting. In addition, more studies should focus on report writers and actual readers in natural work settings, closely assessing the qualities that

characterize effectiveness for different types of data reports and the processes involved in producing them. As mentioned earlier, studies of actual readers and writers need to extend long enough for researchers to iteratively test writers' choices and revisions against readers' actual uses of a document. Finally, composition specialists need to extend their research beyond computer-based writing and computer-mediated communication. They need to include the effects of electronic data retrieval and nonlinear reporting on the production of knowledge in actual workplace situations. Findings from such studies will enrich the ways in which teachers prepare students to succeed in communicating in computerized workplaces.

NOTE

1. Because this analysis of invention, arrangement, and delivery is based on insights from my study, it relates to

complex data tables for recordkeeping and problem-solving purposes in real work settings.

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Appendix A: Sample Page of Detailed Charge Report

Element	Reference #	Identification	Status	Cost this month	Cost this FY	Commitment	Encumbrance	FY costs + Com. & Encu.
Axx Graphics	xxx xxxx xxxx	projectionist		395.00	395.00			395.00
	xxx xxxx xxxx	binding		235.15	235.15			235.15
Ayy Shop Work	xxx xxxx xxxx	electrical	3	156.00	335.00			335.00
	xxx xxxx xxxx	install	3	167.35	167.35			167.35

Appendix B: Sample Report Customized with a PC Database

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	FY total	Budget	Variance
act															
name															
name															
PD absence															
Total															
name															
name															
Effort															
Total															
travel															
shop															
purchases															
M&S															
Total															
comptg															
waste															
mgmt.															
GLS															
Totals															
TOT.															
BDOGT.															
VAR.															

Starting Point for Analysis