The Evolution of Technical Communication at Lukens Steel, 1810-1925

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Abstract:

Complex technology necessitated increasing levels of literacy among workers and engineers in the late 19th and early 20th centuries. This paper analyzes the changes in technical communication in a single company, Lukens Steel, between the years 1810 and 1925. Until 1870, literacy was not necessary in the workplace; only the owners wrote letters and kept accounting records. By the end of the 19th century, quantitative literacy became increasingly important across the plant as foremen kept records of increasingly complex output. In the early 20th century, verbal and visual literacy became important as foremen and managers communicated by hand-written notes across the plant. By 1915 a new type of worker, the stenographer typist, bridged the gap between levels of literacy and enabled the exponential increase of communication. In the 21st century, literacy is an individual responsibility, so that the teaching of communication has become central to success in the engineering workplace.

Introduction

Technical communication evolved hand-in-hand with complex technology. In fact, complex technology would not be possible without complex methods of knowledge management and exchange. This simple relationship is often overlooked by engineers and engineering students: the ability to communicate affects success in the workplace, and yet teaching technical communication is often pushed to the side of the curricular agenda.

Engineering programs tend to sideline other liberal studies as well. For instance, the history of technology is an elective that few engineers find time for in their crowded curriculum. History has great lessons for us. For instance, in this study of the evolution of technical communication at Lukens Steel, I found that literacy (quantitative, visual and verbal) was, at first, not necessary in the workplace. At the end of the 19th century, quantitative literacy became important as workers and foremen used open hearth furnaces to produce steel ingots to be rolled into boiler plate for the railroad and shipping industries; they had to keep detailed records of defects and rejections in order to produce steel that both met inspection standards and would withstand rapid changes in temperature, further working, and stress. They tried to track the defects and rejections by instituting a system of record keeping that accompanied the material as it moved throughout the factory and noted when flaws were found. Still, this was not verbal literacy, it was (like accounting in general) the antecedent to it. In the early 20th century, foremen, managers and the owners began to communicate frequently via hand-written notes in an intra-plant mail system; literacy had become a necessity to any advanced position within the organization. By 1915 stenographer typists began to work at the plant, producing carbon-copied pages of faultless prose taken directly from the mouths of the men by dictations, the amount of communication exploded. For most of the rest of the 20th century, secretaries bridged the gap between differing levels of literacy and became midwives to technical knowledge. However, in out times, the personal computer made literacy an individual responsibility: each engineer is responsible for their own ability to write, to use graphic imaging programs and to be able to read and process complex data logically. Thus, in the 21st century, literacy is a personal responsibility that can make the difference between being in a cubicle or in a corner office.

The following example is a historical analysis of the technical communication at Lukens Steel, a specialty rolling mill that often fulfilled government contracts for plate steel in marine boilers. The analysis covers the years 1810 to 1925. Lukens was owned and operated by a single family and deposited the majority of their records at the Hagley Museum and Library in the 1960s and 70s. An analysis of the existing records from this time period reveals three main trends: first, prior to the late 19th century there was little written technical communication; at the end of the 19th century complex industrial processes required advanced systems of record-keeping in order to track and try to solve plate steel defects; by the beginning of the 20th century, as the industrial processes became more sophisticated, workers on the factory floor were becoming literate, both visually and verbally, and technical communication occurred, across the plant, by means of informal hand-written letters; and lastly, a new category of worker emerged, the stenographer typist, who exponentially increased the amount of technical communication that was produced after the introduction of carbon paper in 1915. These dates are not significant for industry as a whole or for other businesses: Lukens Steel sometimes introduced changes very slowly.

Why is this important to us in the 21st century? The stenographer typist, later called a secretary, was the main conduit of technical communication for managers and executives for the majority of the 20th century. With the advent of the personal computer, however, the position "secretary" has begun to disappear from the workplace. Managers who once relied on stenographer typists are now required to type themselves. Each engineer is responsible for his or her own documents. Literacy, which had begun to spread in the early 20th century, has become a necessity in 21st.

Pre-Industrial Technical Communication (1810-1870)

Prior to the industrial revolution, there was little need for written technical communication: workers communicated directly with each other on the factory floor and the technology was simple enough that knowledge could be passed by watching and learning. The first writing necessary to the daily running of an iron works was accounting: most ironworks kept a system of furnace journals to record daily transactions. In the case of Lukens Steel, day books, journals, ledgers and letters were all that was necessary to the operation of the business.

In general, accounting practices predated written communication. Day books were usually written in every day, recording transactions as they happened. Journals were intermediary books between day books and ledgers: they consolidated the transactions under subject name headings and were updated on a regular basis. Ledgers, updated once a year, summarized the financial data for specific accounts and had an index for the subject names at the beginning. The three books were often cross-indexed with numbers representing each subject name. Since legal tender was scarce and many agreements were made on trust or by trading, the accounting books were seldom balanced.

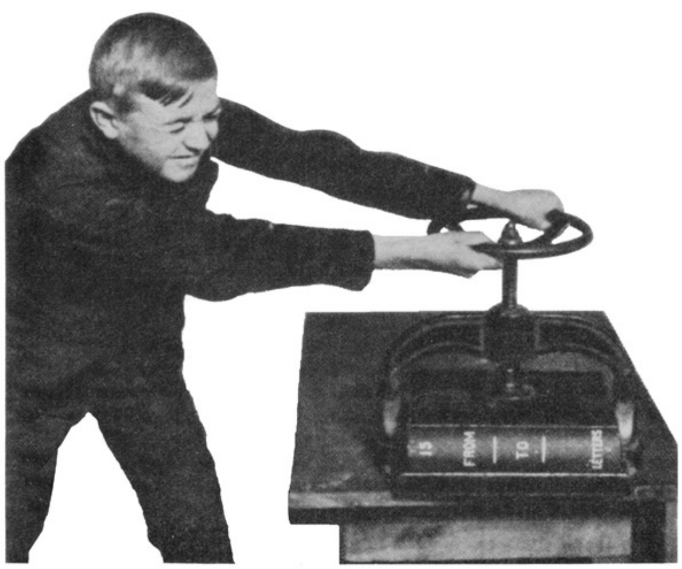
Business agreements and order specifications were done in person or by letter. Most of the letters that can be seen in the Lukens archives are about bargaining for the price of materials, especially bar iron, but some contained technical specifications. When letters were written by hand and paper was scarce, business owners often saved only incoming letters, usually in pigeon holes in desk shelves (Fig. 1).

Figure 1 – Incoming Correspondence and Receipts. In the early 19th century, incoming letters and receipts were kept in pigeon holes in cabinet desks.

As the firm prospered, they began keeping copies of all outgoing correspondence, including bills and receipts, in letterpress books. The process for copying a letter into a press book is complex:

> A letter freshly written in a special copying ink was placed under a dampened page while the rest of the pages were protected by oilcloths. The book was then closed and the mechanical press screwed down tightly. The pressure and moisture caused an impression of the letter to be retained on the underside of the tissue sheet. This impression could then be read through the top of the thin paper (Fig. 2). [1]

Businesses used letterbooks not only to record their transactions and store their correspondence, but because "in legal circles it was accepted as a true copy of the original." [2] Many such letterpress books are stored in archives but are of varying quality. Some are clear and legible, others are faded, blurry and nearly impossible to read. Letterpress technology was cumbersome and imperfect but it remained a standard tool at Lukens Steel until 1903.



2.1 A letter press in action. *(Catalogue for Yawman and Erbe, 1905. Hagley Museum and Library.)*

Figure 2 – Making a Letterpress Copy. Each piece of correspondence, while the ink was still wet, was placed between two blotters and pressed onto a sheet of tissue paper.

Prediscursive technical communication – oral and physical – was all that was necessary in the pre-industrial manufacturing process. The technology was stable and the methods of communication were simple and advanced and explicit knowledge exchange was not necessary. However, towards the end of the 19th century, things began to change. In the case of Lukens Steel, their turning point was when they installed open hearth furnaces to make their own steel ingots for rolling. This was when quantitative literacy became important – they had to keep detailed records because the processes were so complex.

The Emergence of Record Keeping in the Workplace

During the early and mid-19th century, Lukens was technologically conservative. They changed processes only when they had to. After the Civil War, however, they built their first steam-powered mill in 1870 and then, in 1890 moved to advanced technology, building two open hearth furnaces and a 120-inch rolling mill. The main customers for their product were two highly-regulated industries – Lukens rolled boiler plate for the shipping and railroad industries. Their product was subject to inspection and the owners of the factory were active in setting the inspection standards. However, the multiple processes that were necessary to take iron from ore to ingot to rolled plate that they began to have to track data to find patterns of defects. This required new paperwork – record keeping. Their set of books expanded from daybooks, journals, ledgers and letterbooks, to tonnage sheets and books (originating with individual foremen and compiled in the office), defect sheets and books (originating with multiple formen in charge of parts of the processes and compiled in the office) and other books such as car record books (tracking freight), puddle-mill books (the older technology overlapped the newer), bound inventories or plant equipment and payroll sheets and books. Some of these of records were kept by individual foremen in pocket-books and then added their data to larger ledgers. Overall, record keeping paved the way for further use of paper in the manufacturing environment.

The records discussed in this section are not technical communication, but they demonstrate an increased reliance on paper to document and store data and a need for an increasingly large staff of clerks to manage it. They also demonstrate that there was a need for quantitative literacy on the factory floor. The car record books were essential for keeping track of incoming materials, outgoing product and costs incurred on different railroads. The puddle mill books were a form of journal that recorded daily information about the workers, tonnage, and other activities. The tonnage and defective records were essential in trying to collect data to control the quality and quantity of output in both the open hearth furnaces where the steel was made and the plate mills where it was rolled. The other miscellaneous record keeping, such as inventories and payroll sheets, show an increasing, if haphazard, method of trying to rise above the individual memory and create a corporate one.[1]

Technologically, the most important floor documents kept on the factory floor were the open hearth defective records. Mill foremen and inspectors kept extensive notes of various problems, some of which originated in the open hearth furnaces, some of which came from the rolling process, and some of which came from shearing. These records originated with individual foremen who kept the information on sheets (Fig. 3). These were then submitted to the office and compiled into larger, bound ledgers. This defective reporting allowed them to attempt to trace the cause of each defect to its source.

Figure 3 – Loose Defect Records From the Factory Floor (1894-1899). At the end of the 19th century, Lukens began keeping records of the plate defects and their sources.

All of these books were the end product of multiple routines of record keeping by people on the factory floor and many of them have fingerprints and handprints on them. They are similar to the day book, journal, and ledger, in that they record data into a transitional location before entering the final results into ledgers. However, they are different in that it was a works-wide record keeping project, rather than the work of a single clerk or owner. The processes were becoming more complex and more people had to participate in the written record keeping in order to gain the knowledge necessary to analyze and control the industrial environment.

The Growth of Literacy on the Factory Floor

At the turn of the 19th century, the social discourse community at Lukens steel exploded from comparative silence into a multiplicity of voices as workers became more literate and the number of circulating documents increased. Most of the types of communication already described – data collection, record keeping, correspondence, etc., – continued on, but also there were board meeting minutes, handwritten notes between department heads, drawings and blueprints, boiler testing documents, published articles in trade journals, product descriptions and testing documents (letters, drafts, meeting minutes, transcriptions of arguments, papers and publications). This was no longer solely the voice of the owner or partners – many people in the plant participated – and it is where technical communication emerged and grew at Lukens Steel.

Since improvements to the plant were continual, communications about construction became essential. Workers, foremen and managers used drawings and blueprints in the design and construction process. The documentation of testing exploded: there were at least four forms of testing at Lukens – testing as part of the manufacturing process; in-house testing of plant equipment; scientific testing for the purposes of discovery; and the works manager, Charles Lukens Huston participated in the creation of national boiler plate standards. As a result, more of the workers in general had to be more literate and managers became a requirement for management.

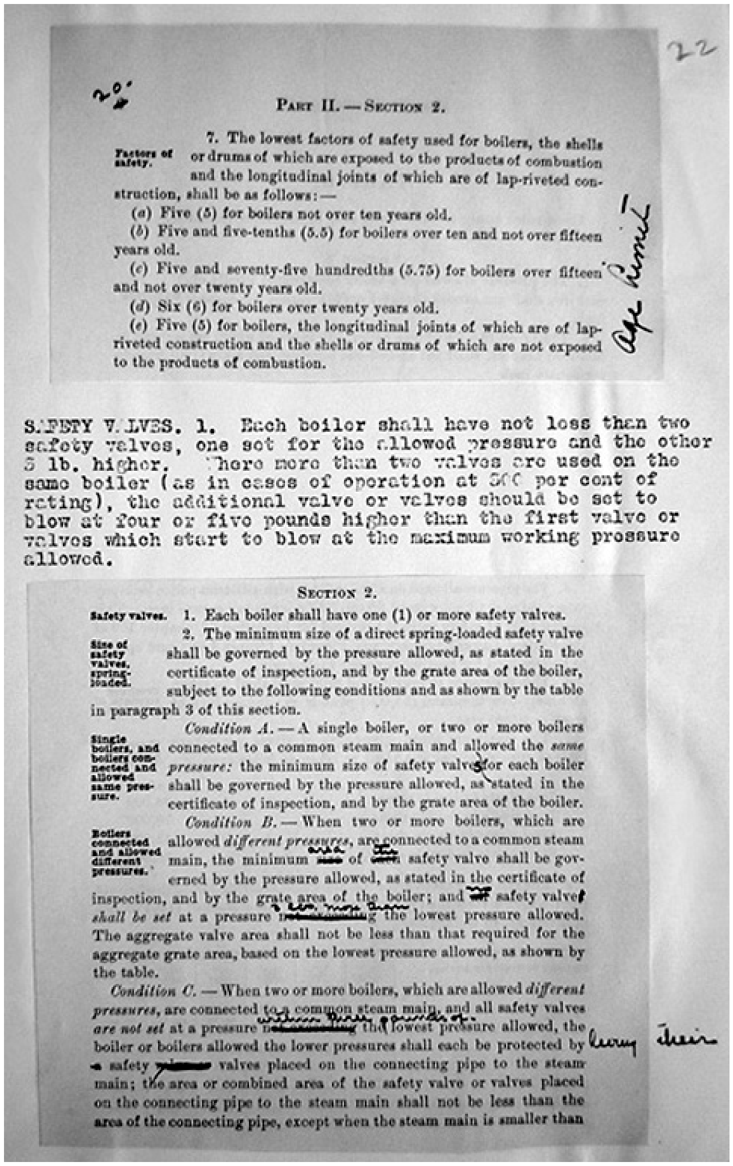
The forms of correspondence changed significantly. The unwieldy letterbooks ended in 1903 as the plant physically grew (letterbooks had to be processed in a single location). Between 1904 and 1911

Charles Lukens Huston, the managers and the foremen communicated via a series of handwritten, folded notes that had the name of the recipient on the outside. Carbon paper was not widely used until about 1912. [3] Although the typewriter had been introduced in 1885, it had been tied to the main office and the production of the letterbooks, but when carbon copying became available, typing moved out of a central location and into smaller offices, distributed offices across the plant. Typing was not a common skill so a new class of worker appeared, the stenographer typist, who could produce multiple copies of documents. This increased the length of the communications and allowed the managers and foremen to exchange information more rapidly and accurately. The handwritten notes sometimes covered two or three pages, but they were six inches by nine inches with large writing. The letters that now emerged were one to six pages of single-spaced text. This increased the sheer amount of knowledge that was circulated at Lukens Steel and in the outside world.

Drawing was also an essential part of the manufacturing and production processes. In the past, it was regularly taught in engineering programs. It was a required course in the sophomore and junior years at West Point in 1832. [4] Combined with descriptive geometry, drawing made up 32 percent of the required curriculum for the mechanical engineering degree at the Massachusetts Institute of Technology in 1867. [5] The *Transactions of the American Society of Mechanical Engineers* published at least five papers about it between its founding in 1880 and 1901. Drawing was taught because engineers used drawing to clarify their ideas and communicate them to others. Drawings were also used for construction planning; often the drawings themselves became the specifications for the work that followed. As Eugene Ferguson notes: "When the designers think they understand the problem, they make tentative layouts and drawings, analyze their tentative designs for adequacy of performance, strength, and safety, and then complete a set of drawings and specifications. The second process revolved around the finished drawings and specifications. Those drawings and specifications will be the formal instructions that guide their work." [6] Lukens used drawings as a group brainstorming device (many of their letters and notes are covered with informal sketches), as a formal building device (for the plant) and to create and patent new rolling and flanging machines.

The testing required for product inspections, plant maintenance, research and creating national standards generated a great amount of technical communication using text, drawings, and photographs. Although Lukens had been active in testing since 1875 when Dr. Charles Huston (father of Charles Lukens Huston) purchased a testing machine and published two articles on the properties of iron in the *Journal of the Franklin Institute*, little evidence of this early testing exists. After 1900, there was a flood of testing documentation. There were four general types of testing: in-house testing of plant equipment (generally of boilers and stacks); testing as part of the manufacturing process (prior to inspection); testing as scientific experimentation (often resulting in presentations and publications); and testing as part of an social discourse community that emerged in order to create industry standards.

In 1899, the American Section of the International Association for Testing Materials was formed and began developing standards for steel quality. The setting of standards had been underway by various agencies and professional groups but no single entity was devoted to the cause. The American Society of Civil Engineers, the American Society of Mechanical Engineers, government and large manufacturers had been setting their own standards so when the American Section of the International Association for Testing Materials proposed a set of steel standards for everything from railroad track to building beams and wheels to axles, the ASCE and the ASME immediately joined the dialogue and the resultant social discourse community became a broad, ongoing exchange between manufacturers, users, and experts as they negotiated standards and published the results. Charles Lukens Huston served on a number of these committees, frequently commenting on and revising standards documents (Fig. 4).



PART II. — SECTION 2.

Factors of safety. 7. The lowest factors of safety used for boilers, the shells or drums of which are exposed to the products of combustion and the longitudinal joints of which are of lap-riveted construction, shall be as follows: —

(a) Five (5) for boilers not over ten years old.

(b) Five and five-tenths (5.5) for boilers over ten and not over fifteen years old.

(c) Five and seventy-five hundredths (5.75) for boilers over fifteen and not over twenty years old.

(d) Six (6) for boilers over twenty years old.

(e) Five (5) for boilers, the longitudinal joints of which are of lap-riveted construction and the shells or drums of which are not exposed to the products of combustion.

SAFETY VALVES. 1. Each boiler shall have not less than two safety valves, one set for the allowed pressure and the other 5 lb. higher. Where more than two valves are used on the same boiler (as in cases of operation at 300 per cent of rating), the additional valve or valves should be set to blow at four or five pounds higher than the first valve or valves which start to blow at the maximum working pressure allowed.

SECTION 2.

Safety valves. 1. Each boiler shall have one (1) or more safety valves.

Size of safety valves, spring-loaded. 2. The minimum size of a direct spring-loaded safety valve shall be governed by the pressure allowed, as stated in the certificate of inspection, and by the grate area of the boiler, subject to the following conditions and as shown by the table in paragraph 3 of this section.

Single boilers, and boilers connected and allowed same pressure. *Condition A.* — A single boiler, or two or more boilers connected to a common steam main and allowed the *same pressure:* the minimum size of safety valve for each boiler shall be governed by the pressure allowed, as stated in the certificate of inspection, and by the grate area of the boiler.

Boilers connected and allowed different pressures. *Condition B.* — When two or more boilers, which are allowed *different pressures*, are connected to a common steam main, the minimum size of each safety valve shall be governed by the pressure allowed, as stated in the certificate of inspection, and by the grate area of the boiler; and the safety valve *shall be set* at a pressure not exceeding the lowest pressure allowed. The aggregate valve area shall not be less than that required for the aggregate grate area, based on the lowest pressure allowed, as shown by the table.

Condition C. — When two or more boilers, which are allowed *different pressures*, are connected to a common steam main, and all safety valves *are not set* at a pressure not exceeding the lowest pressure allowed, the boiler or boilers allowed the lower pressures shall each be protected by a safety valve valves placed on the connecting pipe to the steam main; the area or combined area of the safety valve or valves placed on the connecting pipe to the steam main shall not be less than the area of the connecting pipe, except when the steam main is smaller than

Figure 4 – "Preliminary report of Committee to formulate standard specifications for the construction of steam boilers," American Society of Mechanical Engineers (1912). This document was passed back and forth between participants in the creation of a national boiler code. Each reviewer made comments from which the final version was created.

The years between 1900 and 1915 saw an increase of using technical communication in almost every aspect of the manufacturing process. They kept the same accounting and record keeping systems they had used in the past, but added to them continually. Workers began to correspond within the plant, first with hand-written notes and then in perfectly-typed multiple copies, using a new class of worker, the stenographer typist. They used hundreds of drawings as specifications for their own construction, for problem solving, for designing new machines and as specifications for patents. In the area of testing, the use of writing grew the most rapidly. In the 19th century, there was little record of testing procedures but after 1900 there were in-house testing documents, test documents as part of the manufacturing process, records of scientific tests, published articles of the results and voluminous records of group efforts to create standards for this and other industries. Writing went from a peripheral activity to a central one, necessary to the success of the industry. This explosive growth took place in less than fifteen years.

Conclusion

At the founding of Lukens Steel in 1810, there were one or two people corresponding with the outside world by letter. During the Civil War years, there were about four people writing in the letterbooks. After the addition of the first steam-powered mill in 1870, there are between ten and twelve different hands writing in the letterbooks. By the early twentieth century, when they used open hearth furnaces for steelmaking, most managers were communicating within the plant by writing. However, by 1915, there are so many different hands, voices and methods of communication in the social discourse community surrounding the production of plate steel, that it is difficult to grasp the whole.

Charles Lukens Huston, the plant manager, interacted frequently by writing. When his letters were written by hand, they were short and his handwriting difficult to decipher. Thus, although he himself was literate, it was a challenge for others to read his writing. That changed when he had a stenographer typist who was able to take verbal dictation and create multiple-page, multiple-copy documents that were nearly flawless. Managers and foremen from other parts of the plant had access to stenographer typists as well. This new class of worker was able to bridge the gap between literate and semi-literate workers. From that point on literacy was mediated by stenographer typists – they were the midwives of technical communication.

The stenographer typist, later called a secretary, was an essential worker both at Lukens Steel and in most other businesses throughout most of the 20th century. It was not until the advent of the personal computer that each worker began to rely on their own typing and writing skills. Thus, the need for engineers to learn technical communication is greater now than it was in the past. Technical communication literacy consists of being able to type and communicate clearly, to create basic graphics for documents and to use the most common word processing programs. In the beginning and middle of the 20th century, secretaries and, later, technical writers were responsible for some of this work. In the 21st century, however, engineers are responsible for their own typing, writing and graphics skills and advanced literacy is a prerequisite for success.

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