Breaking Ore, Breaking Bodies: The Wear and Tear of Work at an Alaskan Gold Mill

By
Paul J. White

"Remember the millman" . . . in deciding about the general arrangement of the mill, the spacing of the machinery, the distribution of the floors, the division of buildings, and so forth, [the engineer] must constantly keep in mind the fact that the plant is going to be operated by human beings. These human beings are going to be the prime movers of that great living, pulsating organism that is a modern ore-dressing plant; they are the governors that control and balance one part with the other. These human beings are the most important pieces of machinery in the whole plant.[1]

These words, written in 1913 to implore mill designers to factor in people when planning ore dressing plants, have not lost their potency because their central message was so often ignored. Of the dozens of textbooks issued about milling practice from the late-nineteenth century to the mid-twentieth century, few gave more than passing consideration to the topic of milling labor.[2] Attention focused instead on detailing the latest developments in mechanization and on the machinery promising to crush, sort, and filter material at ever greater economies of scale. Yet, irrespective of the success or failure of these contrivances, the milling plant remained a peopled environment and millwork continued to exact a human toll.

The mining industry has long ranked among the most accident-prone trades, primarily because of the hazards of underground work. Falls, cave-ins, explosions, flooding, and gases were leading causes of fatalities in the industry, and a single incident underground could claim dozens of lives. However, high levels of injury extended to the surface as well, where ore from the underground was not only transported, but

often sorted, processed, and sacked. In the precious-metals industry, much of this activity took place in processing facilities erected on site.

Milling plants promised to transform ores containing high-value, but scantily distributed metals into a concentrated product with relative ease, which, in turn, could make the difference between a prospect and a paying mine. But, as Gelasio Caetani's opening quote highlights, this option once again placed workers in close contact with machines. Notwithstanding his metaphor of a functioning organism, industry statistics readily document how this interfacing scaled up the risk of injury.

From the early twentieth century, milling accidents in metallurgical plants increasingly were documented alongside underground incidents as part of a mining company's reporting obligations. Nevertheless, milling fatalities and injuries were typically given separate consideration in regional and national statistics. This article provides an overview of the key findings from these initiatives before delving into the records of the Alaska Juneau Gold Mining Company (1897-1944). There, an unusual thoroughness in accident reporting between 1928 and 1941 permits a detailed consideration of the causes and frequency of injury in its milling plant (Figure 1).

Of nearly five thousand injuries reported at the company during this period, seven hundred occurred either in, or in proximity to, its gold mill—an average of an injury per week. Analysis of these records not only reveals distinct patterns in mill-related injuries, but also offers insight into factors influencing the occurrence of accidents that ranged from the mill's structural design to

Figure 1. The hulking form of the Alaska Juneau Mill on the shore of Gastineau Channel, with the city of Juneau beyond. By the late 1920s, the mill's tonnage exceeded twelve thousand per day. This image is cropped slightly from an original Winter and Pond photograph, c. 1928. (Courtesy of the Alaska State Library Historical Collections, Juneau, Alaska, ASL-P01-1297.)

the culture of work. Above all, such findings bear witness to the human costs of labor in industrial settings.

Accounting for Accidents

Based on proximity to heavy machinery, high noise levels, and exposure to dust and hazardous chemicals, it is safe at least to venture that work in an ore-processing facility came with elevated risks to health. As occurred in many industrial settings, the increasing adoption of mechanization did little to eliminate workplaces from being significant sources of injury. Indeed, the human-machine interaction tended to create new hazards, and the increasing scale of operation that mechanization permitted could also heighten the severity of wounds. From the 1870s, miners' unions increasingly advocated for improved safety conditions in the workplace, supporting efforts to establish state mine inspectors and pushing for the development of mine safety legislation, among other initiatives.[3]

While the connection between industry and injury was increasingly hard to ignore by the turn of the twentieth century, administrative efforts to gauge this risk in the United States faced considerable challenges. High among them was the voluntary nature of accident reporting, which made many calculations "little better than a guess."[4] The situation gradually improved over the next two decades, in lockstep with the passage of federal and state legislation. Reporting rates increased, for instance, through the data-gathering efforts of the Interstate Commerce Commission and Bureau of Labor Statistics, as well as through the adoption of workmen's compensation laws in a growing number of states.[5]

The documentation of accidents in the mining sector improved noticeably with the establishment of the U.S. Bureau of Mines in 1910. This agency's mandate to investigate mining methods with an eye to preventing injury necessitated knowing more about the frequency and causes of accidents. Agency staff focused first on the causes of underground incidents, but in 1914 the Bureau expanded its efforts to collect information about metallurgical plants and smelters.[6]

The quality of the information gathered through these efforts still suffered from differences in reporting requirements. In 1915, for example, California required that companies file reports for every accident that disabled a worker for a day or involved the visit of a physician, while companies in Colorado filed reports only for injuries causing the loss of work for two consecutive days. Filing deadlines across states also ranged from "immediately" and "promptly" to annually. In this way, higher injury rates reported for some states could simply reflect that they had better reporting programs and not more dangerous mines.[7]

The Territory of Alaska presented additional administrative complications owing to its extensive land area and general remoteness. Sumner Smith, appointed as the territory's first mine inspector in 1911, performed his duties with limited travel funds, no field or clerical assistants, and no physical office. For at least the first five years, Smith set up a desk in the grand jury room of Juneau's courthouse, which he had use of whenever the court was not in session. This ad hoc arrangement lacked a phone line, inhibiting Smith's ability to respond to accidents promptly. Moreover, because he had no lockable cabinets, his inspection files remained open to perusal by anyone.[8]

Under such circumstances, it is not surprising that Smith's initial reports underestimated the number of mining accidents in the Territory. Statistician Frederick Hoffman considered Smith's first report to be more revealing of "the enormous difficulties of adequate government supervision of the mining industry." George Rice, the chief mining engineer for the Bureau of Mines, agreed, noting that Smith's estimated accident rate was four times lower than the national average and "so low as to be suspicious."[9]

The comparability of injury statistics across states improved from 1920, when the Bureau of

Labor Statistics developed a standardized classification system for industrial accidents.[10] The Bureau's categorization came to form the basis for accident reporting in the United States through much of the twentieth century, but it also underwent revisions that reduced the number of reportable injuries. Such changes hindered the ability to interpret accident trends over time, because drops in the number of reported accidents did not necessarily equate to safer working conditions. Part of the problem was that, from 1926, the regulation of national safety standards was largely in the hands of private organizations, which gave many firms an opportunity to "compose their own records on industrial accidents." An excoriating evaluation of the National Industrial Safety Standards Program commissioned by the U.S. Department of Labor in 1970 estimated that national statistics were missing 90 percent of serious, nondisabling workplace injuries. This calculation also excluded occupational diseases that had been left out from even the earliest considerations of injury reporting.[11]

Even had the standardization of reporting worked, the quality of data continued to hinge upon how respondents translated survey directives. Some mining operators interpreted stipulations to report "all accidents," for instance, to mean any incident that came to the attention of a shift boss or foreman, while others construed it to mean an instance that drew blood, or, alternatively, an injury that delayed the performance of a duty. A similar problem of comparability occurred with company-supplied accident rates that presented fatalities and injuries in the most favorable light, be it in relation to number of employees, employees exposed to risk, shifts worked, or tons mined.[12] These and other issues notwithstanding, Bureau of Mines publications by the mid-1920s expressed confidence with the general trends being identified across the industry.[13]

The emerging picture underscored that practically all facets of mining operations outside of deskwork presented elevated dangers. Underground work at precious metal mines claimed 4 fatalities for every 1,000 full-time equivalent workers, which was more than three times the rate of fatalities experienced in ore dressing plants. Miners also suffered injuries more frequently than millworkers, albeit at not quite double the rate (respectively 205 and 136 injuries per 1,000 full-time equivalent workers).[14]

If millwork was less dangerous than laboring underground, however, accident rates were still high. By way of general comparison, the frequency and severity of injuries at metallurgical plants at mid-century remained less than that experienced in mining and quarrying, lumber, and construction, but greater than what occurred in foundries, the manufacture of iron and steel products, meat packing, textiles, and the pulp and paper industry (Figure 2). Accident rates had continued to decline, but millwork kept its position as an injurious occupation relative to other industrial work.[15]

Accident data for the years 1914 to 1932 revealed that the causes of injury differed understandably by the type of job. Underground, the bulk of incidents involved roof and wall collapses, falls down shafts and chutes, and explosives. At smelting works, injuries stemmed primarily from spills of slag and molten metal, followed by those caused by flying and falling objects, haulage systems, falls, and hand tools. Milling plants differed from both, with major causes of death resulting from machinery, falls, suffocation in ore bins, and haulage systems.[16]

Perhaps the Bureau's most revealing finding on milling accidents, however, was the connection made between the frequency of accidents and a plant's general operating characteristics. Mill laborers working ten-hour shifts suffered double the accident rate of those on eight-hour shifts, and facilities operating seasonally had twice the accident rate of those running continuously.[17] Moreover, the frequency of injury in mills employing fewer than 10 workers reached as high as 436 accidents for every 1,000 full-time equivalent

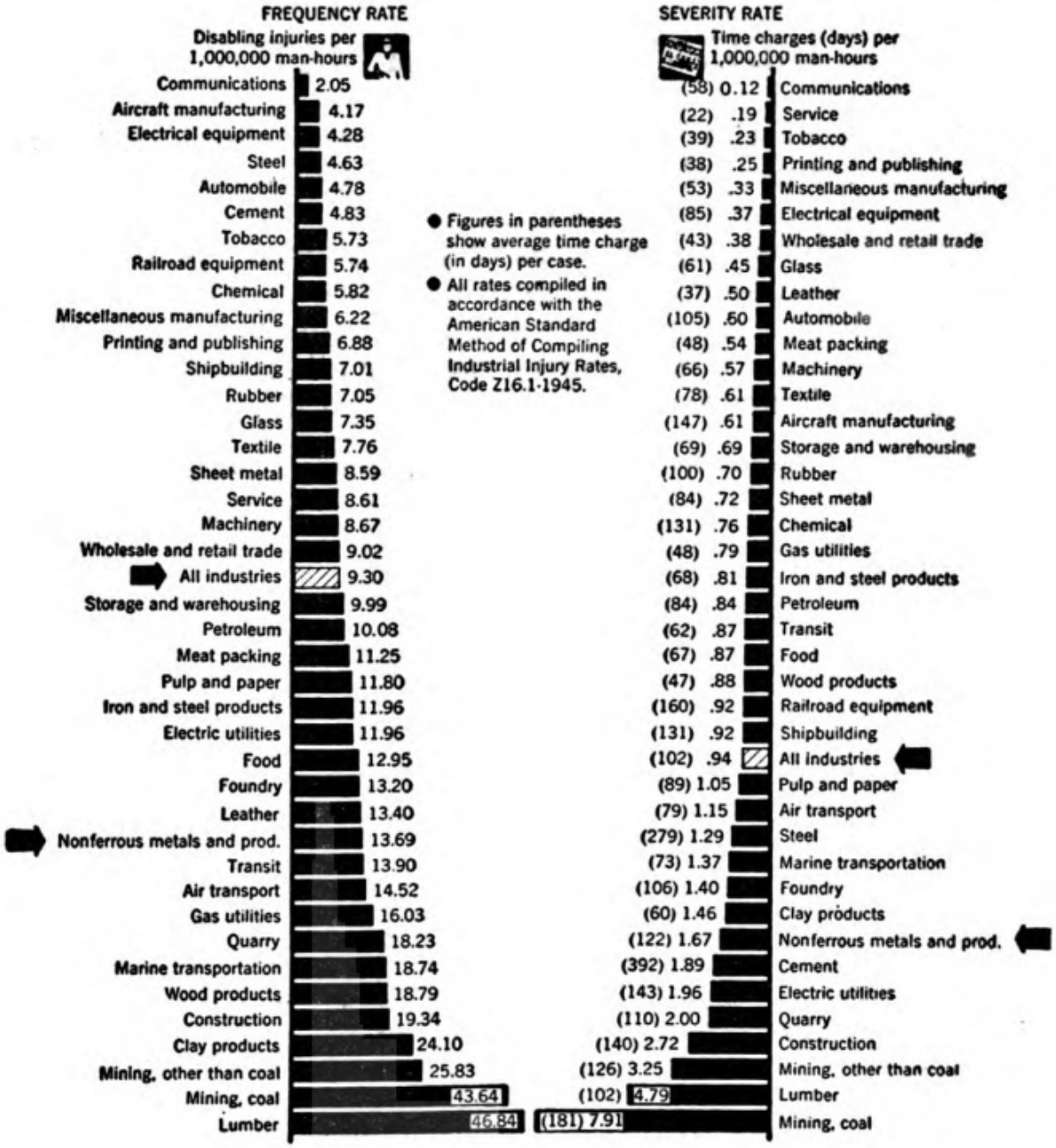

Figure 2. Frequency and severity rates for disabling injuries across a range of industries in 1950, with arrows indicating the position of nonferrous metallurgical plants and the industry average. The rate of 13.69 disabling injuries per million man-hours is equivalent to 33 injuries per 1,000 full-time equivalent workers. (Graphic appearing in: U.S. Bureau of Mines, Accident Prevention in Nonferrous-Metal Processing Plants: 2. Mills and Concentrators*, 18.)*

workers, while facilities with more than 300 people on the payroll had rates of injury less than half this amount (182 per 1,000 full-time equivalent workers).[18] Such findings indicated that smaller operations were riskier endeavors on the whole, but they also highlighted that significant variability existed between plants.

Although the number of reported milling accidents declined after the 1920s, as did accidents in other sectors of mining, attention only to national trends glosses over regional variation that bucked this pattern. The report of Alaska's commissioner of mines for 1940, for instance, lamented that Alaska's mines had for years shown no significant improvement in accident rates. To the contrary, both the severity of injuries and the rate of non-fatal accidents had actually increased. The commissioner placed part of the blame on the ineffectiveness of existing mine safety organizations, "especially at the larger mines both lode and placer, where a disproportionate percentage of serious accidents are found to occur."[19]

While this criticism may not have been directly leveled at the Alaska Juneau Gold Mining Company's operation (1897-1944), it is noteworthy that this enterprise was the largest hard-rock mine in the territory at the time, accounting for three-quarters of the lode gold produced. Moreover, a miners' strike there in 1935—just three years after the publication of an issue of the *Engineering and Mining Journal* devoted to the Alaska Juneau Mine which, among other complements, extolled the virtues of the company's safety procedures—cited the lack of safety devices and first aid kits underground among the pressing grievances.[20] According to national statistics, then, the Alaska Juneau's milling plant might be anticipated to be among the safer facilities operating in the country, and yet regional summaries suggested that, in keeping with the rest of the mine, it was one of the significant offenders.

Accident statistics at the national and regional levels clearly leave much to be desired in terms of resolution, and company-specific accident records are also difficult to find. Despite more than one hundred lode-gold mines operating in Alaska during the Great Depression, comparatively few of these companies have administrative records preserved in public archives, and fewer still retain consistent runs of accident reports. A notable exception concerns the records of the Alaska Juneau Gold Mining Company.

Like other mines in the territory, Alaska Juneau's reporting of workplace injuries initially covered only the most serious accidents, and of which few records survive. This is not the case, however, for accidents occurring after March 1928, when administrators reported any accident requiring first aid treatment and assigned each incident a unique case number.[21] Between the inauguration of this system and the close of full-time operations in 1941, accident reports came to fill twenty-eight ring binders, each three-and-three-quarter inches thick. No other historic gold mine in the territory came close to preserving this volume of reportage on incidents across its suite of operations, including its processing plant.

Alaska Juneau's injury records include details about where an incident happened, various facts about the injured personnel, the operating conditions contributing to the accident, and the presence of defective equipment or materials. Such information allows insight into the causes and consequences of milling injuries, as well as into the organizational structure of accident reporting.

Injuries Covered and Concealed

When it commenced operations in 1917, the Alaska Juneau's third and final milling plant helped to spearhead a trend in the precious-metals industry towards the wholesale processing of low-grade ores without preliminary sorting by grade. Despite this conceptual departure, the mill's internal arrangement largely followed established practices of multi-stage crushing and recovery. At its upper levels, jaw crushers broke rock to

the size of cobbles, gyratory crushers reduced the cobbles to pebbles, ball mills ground this material to sands, and rolls and tube mills provided the finishing grind. The recovery circuit concentrated the metal-rich sediments by passing the finely ground material over 150 shaking tables. Some concentrates underwent additional processing to recover gold in an amalgam barrel, but the rest were sacked for shipment to a smelter.[22]

The one exception from routine practice was seen in the employment of a large workforce. Staffing levels exceeded 160 workers per day in the 1920s and increased to 240 workers by 1940. Such numbers had not been part of the original design, but developed as a workaround to a troubling initial performance.[23] In the 1920s, the company installed sorting decks in the upper levels of the mill where teams of laborers hand sorted all the material exiting the mill bins, a step that rejected half the tonnage delivered from the mine. Although employment numbers ran counter to industry trends favoring mechanization, Alaska Juneau's milling operation still earned praise as an engineering marvel for its low operating costs.[24] Notwithstanding this technical achievement, the mill's accident record indicates that improvements to worker safety were not among the innovations.

This study investigated Alaska Juneau Gold

FIELD	NO.	EXAMPLE
Accident ID number	701	*1121*
Name	701	*Bracken, Harry C*
Date of Accident	701	*2/20/1936*
Date Hired	605	*7/26/1914*
Age at Accident	607	*47*
Occupation	672	*Shift Boss*
Nationality	628	*American*
Accident location, General	701	*AJ Mill Rolls*
Accident location, Specific	656	*No. 2 Rolls*
Accident Cause, General	672	*Falls of Persons*
Accident Cause, Specific	535	*Slipped*
Injury Type	696	*Bruise*
Injury Location	696	*Leg, right*
Injury, Specific	696	*Right leg wrenched and bruised about knee*
Accident Description	678	*Injured was starting up #2 rolls, he was standing on top of rolls and was going to step on to roll bearings when his foot slipped and his right leg went between the bearings.*
Due to Carelessness?	113	*No*
Type of Report Filed	701	*EPR (Employers Preliminary Report of Accident)*

Table 1. Fields used by the author in developing a spreadsheet of Alaska Juneau's milling accidents, alongside the number of completable entries, and an example from the accident record for Harry Bracken. (Box 12, no. 1121, MS999, AJ16, Accident Records, Alaska Juneau Gold Mining Company, Alaska State Library, Juneau.)

Mining Company's internal accident records filed between March 1928 and the close of 1941, the company's last year of full operation. Administrators reported 4,973 workplace accidents during this period, of which 701 incidents related in a direct way to milling operations. This tally incorporates accidents occurring within the mill structure proper, beginning with where ore was received at the rotary dumpers, called "tipples," at the top of the building and continuing through to the lowest tabling levels. This count also includes activities associated with tailings disposal (including the maintenance of waste launders) occurring outside the mill building, and work related to the general maintenance of mill structures (including work on water tanks, and the deconstruction of a former milling works).

To maximize the analytical potential of this study, details about personnel (name, age, ethnicity, year hired, occupation), accident location and cause, injury (type of injury, place on the body), and the type of report filed were tabulated into a spreadsheet (Table 1). That few fields were able to be filled completely, highlights that milling accidents were not all treated the same.

Generally considered, the level of detail reported about an incident increased with the severity of injury. Most accident reporting originated with the shift boss filing a report that identified the worker's occupation, type of injury, location and cause of the accident, and the names of witnesses. The foreman followed up on serious incidents with a report that delved further into the accident's cause and the type of care given. Among other prompts, the foreman addressed whether the injured had been using appropriate tools and procedures and if closer supervision could have prevented the incident. Cases involving hospitalization elevated reporting to outside agencies. The Office of the Mine Inspector (later the Office of the Commissioner of Mines) requested that reports of serious accidents be filed within ten days of their occurrence. By the 1940s, the agency also encouraged companies to send initial reports within twenty-four hours to improve the chance that an inspector could investigate the scene.[25] A given case file could also include forms relating to compensation payments, investigations by the mill's safety committee (which could investigate any incident in the plant), surgeons' reports, and correspondence between the company and relatives of the injured or deceased person.

Several distinct forms, therefore, could be generated for a given accident, but few incidents outside of fatalities—of which three cases occurred in the mill between 1928 and 1941—spurred exhaustive clerical work. The bulkiest files concerned cases forwarded to the territorial mine inspector, and these accounted for less than 15 percent of milling incidents. Most accident files included only one or two forms, and with some sections left partially completed or entirely unfilled. Shift bosses, for example, often abbreviated names and occasionally left out employee numbers among other details. Among foremen's reports, particulars about length of service, nationality or race, and conditions at the time of the accident were often left blank.[26] Such lapses highlighted discrepancies between bureaucratic ideals and practice, with desires for expediency evidently prevailing over appeals for completeness.

Although the shift boss typically originated the paperwork on milling accidents, more than two dozen files consisted only of a surgeon's report referencing that an injury had occurred at the "A.J. Mill" or "Mill." This suggests that at least some workers visited clinicians on their own initiative rather than being directed there by the shift boss. Moreover, several omissions on shift boss reports resulted from workers reporting the incident days after the event, in which cases the passage of time had made it difficult to recollect the accident's precise location and cause.[27] This is to say that while the company endeavored to collect information on all incidents requiring first-aid treatment, variability existed in how reporting occurred. One implication is that Alaska Juneau's accident files underrepresented injuries that did

not result in time off work, instances where workers were satisfied with home remedies, and where discomfort ended before workers felt it necessary to report.

It is apparent also that the reporting system used by the Alaska Juneau Gold Mining Company did not account for injuries resulting from long-term exposure to the work environment. Not surprisingly, many industries resisted the formal designation of work-related afflictions as occupational injuries out of concerns for lawsuits. Mining practitioners had long recognized that underground workers suffered disproportionately from silicosis and that mill men became deaf over time, and yet companies resisted classing these as compensable afflictions.[28] Alaska Juneau's mill accident files followed suit, with no files spurred by a worker's breathing difficulties and reports of hearing loss occurring only as it resulted from a specific accident. In this way, accident forms engaged with a narrower range of injuries than what the work environment generated.

Alaska Juneau's reporting "system" nevertheless comprised a patchwork of forms generated by multiple agencies for different purposes—which is to say that multiple bureaucratic ideals were in operation. Forms generated by the Office of the Commissioner of Mines, for instance, sought to establish a baseline frequency of workplace accidents from which to identify common causes, dangerous working conditions, and preventable accidents. Its updating of the reporting form for serious accidents in 1934 added a suite of questions about contributing conditions, be it defective or unsuitable machinery, poor lighting, or lax supervision, among others.[29] Mining companies were not opposed to the safety improvements that could result from these inquiries, yet their incident forms had been initiated in response to accident compensation laws. Here, the immediate concern centered on determining who was at fault in particular cases and what monies, if any, were to be paid. In this way, agency interests in improving worker safety and corporate concerns about liability could emphasize different facts about an accident.

An instructive case comes from the record of a serious milling accident occurring in late 1941. Fredrick Orme, a repair helper, had been hooking a belt onto a moving lineshaft when the belt caught his hand and twisted it around the pulley. The pulley fractured his arm in several places, resulting in an amputation below the elbow. The company's initial report attributed the accident to Orme's carelessness, but a mine inspector sent to investigate the scene identified two factors omitted from the company's account. First, the difficulty of accessing this particular lineshaft had necessitated that Orme place both hands on the belt while standing on a ladder. Just as critically, standing in this position had obstructed Orme's view of the pulley. The company evidently had been aware of these circumstances at the time of its first report, because immediately following the accident the inspector noted the presence of a newly constructed platform positioned underneath the lineshaft (Figure 3).[30]

The company's amended accident report, submitted after the commissioner of mines drew attention to these discrepancies, acknowledged that a "lack of platform may have been contributory" and that "this platform has been provided since the accident." Even so, Alaska Juneau's administrators continued to attribute the accident's principal cause to worker carelessness—stating that Orme was wearing gloves for a task in which it was safer not to have done so, that the belt was sticky with dressing, and that he had been standing in an awkward position. Suffice it to say that millworkers like Orme felt the outcomes of such assessments well beyond the reduced compensation payments that they received.[31] They bore the ultimate cost of a corporate attitude favoring after-the-fact fixes over preventative measures.

Several circumstances nevertheless made assigning blame for a workplace accident a complex undertaking. Some incidents occurred without eyewitnesses and sometimes the injured could

have no recollection of what had transpired. Foremen's reports contended that some injuries resulted from the "natural hazard" of the job, preventable "only by not allowing the workman to do the work."[32] Others charged that the "injured was in too much of a rush, perhaps," at the same time as recognizing that it was customary—at times necessary—to perform tasks on the run.[33] Indeed, most foremen avoided making determinations of responsibility by leaving this part of the form blank.

A company official did, however, determine responsibility in reports for the serious accidents sent to the Office of the Commissioner of Mines. Prior to 1937, the task of completing reports on serious accidents fell to the company's employment agent, who consulted all pertinent reports on file. From August of that year, however, this job was fulfilled instead by the company's safety engineer.[34] Interestingly, this shift in staffing saw a corresponding adjustment in the assignment of blame. Prior to 1937, most accidents were not

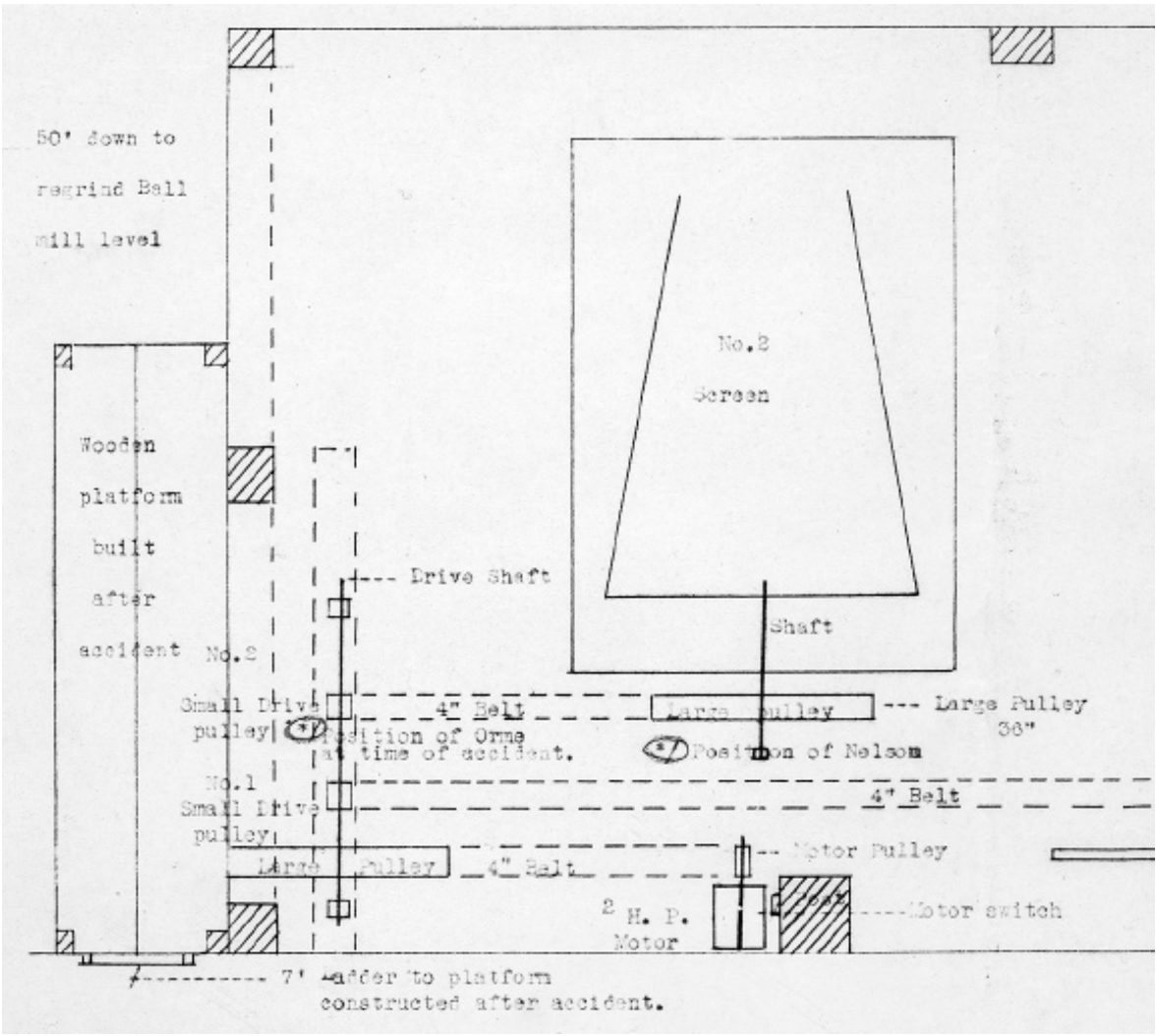

Figure 3. Mine Inspector J. C. Roehm's map of Frederick Orme's accident, showing the positions of Orme and coworker Nelson, drawn as freehand ovals, and "Wooden platform built after accident." (From: J. C. Roehm, "Report of Investigation Pertaining to the Serious Injury of Fred Orme." Courtesy of the Alaska State Library and Historical Collections.)

considered to have derived from worker carelessness. From that August, however, the judgments swung decisively in favor of impugning workers, and with determinations of blame at times counter to the foreman's findings (Figure 4).[35] Irrespective of which assessment edged closer to the truth, this marked change highlights the subjectivity that underlay determinations of blame.

When it comes to historical analysis, then, the interpretation of accident records comes with many provisos. Gaps exist between the information requested and the details recorded, and between the facts documented and those intentionally or unintentionally left out. Although some information missing about employees was recoverable by cross-referencing accident records with employee rolls, other gaps remain difficult to correct for, since internal records often comprise the only documentation that survives.[36]

Problematic as they are, Alaska Juneau's accident records still furnish critical insights into the causes and consequences of injury in its milling plant that go beyond what can be gleaned from national and regional statistics. As explored below, the examination of accident records reveals the mill's most dangerous spaces and most hazardous jobs, among other patterns of injury. This includes highlighting aspects of the general environment that contributed to accidents, as well as deriving insights into the culture of work.

The Imprints of Industry

In an article about the company's safety practices published in 1932, General Superintendent L. H. Metzgar acknowledged that Alaska Juneau's

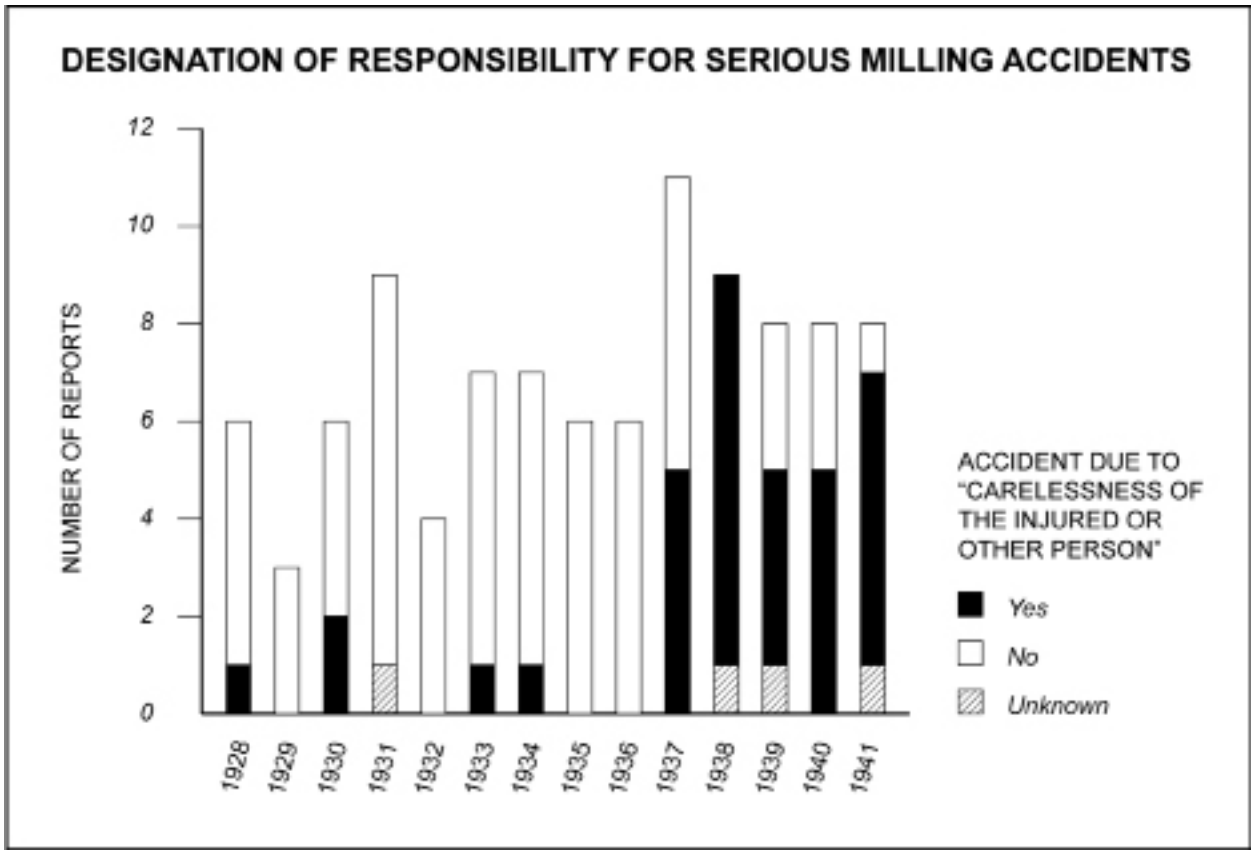

Figure 4. Worker responsibility for serious accidents at the Alaska Juneau Mill between 1928 and 1941. The notable shift beginning in 1937 coincides with a change in the staff member responsible for completing serious accident reports. (Chart by the author.)

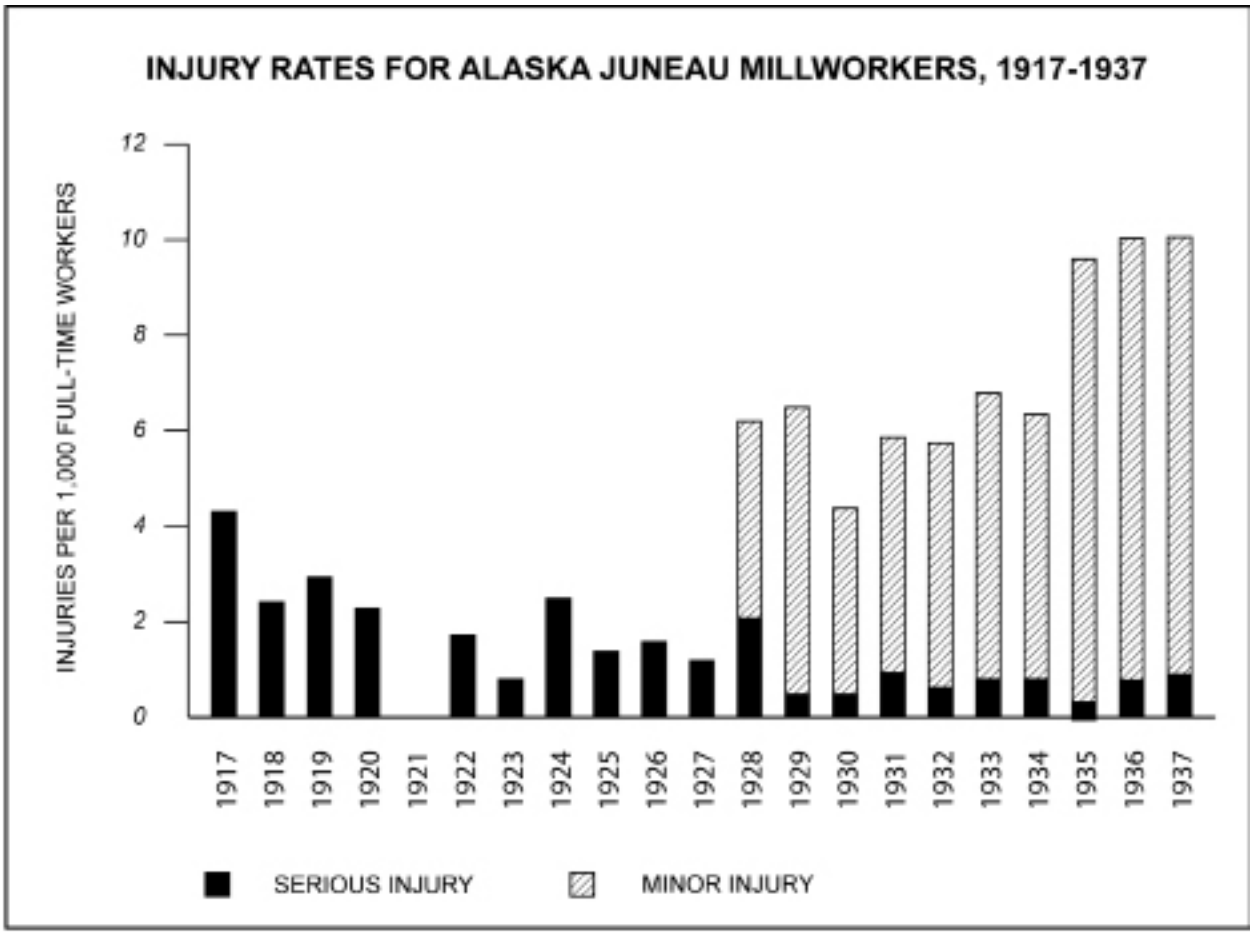

Figure 5. Rates of serious and minor accidents occurring at the Alaska Juneau Mill, 1917-1937, per 1,000 full-time equivalent workers. Prior to 1928, the company only reported serious accidents. (Chart by the author from data in accident reports and monthly summaries of serious accidents, which included the number of shifts worked.)

operations had "slightly more" hazards than average, a circumstance that he attributed to the larger size of the material being moved, the heavier equipment in use, and the greater tonnage being handled per man.[37] Metzgar noted that surface workers were injured at the half the rate occurring underground, and that accident rates in both sectors were trending downward. In 1917, for example, Alaska Juneau's millworkers endured 129 serious accidents per 1,000 full-time workers (higher than the national average), but by 1929 the rate had plummeted to 23 per 1,000.[38] Significantly, such assessments considered only the serious cases, for the total number of recorded incidents was far greater. By 1936, the rate of *all* reported mill injuries, serious and minor, reached 300 per 1,000 full-time workers, equivalent to an injury a week. While the rate of serious accidents stayed low, the frequency of milling accidents was nevertheless increasing (Figure 5).

Beyond indicating a greater prevalence of accidents, Alaska Juneau's records highlight that the mill imprinted distinctive patterns of injury on its employees. In general, millworkers were most affected in their upper bodies, with nearly two-thirds of mill injuries concentrated on the hands and head (35 percent and 27 percent respectively). While national statistics indicate that

underground metal miners injured their hands frequently as well (24 percent), their injuries otherwise targeted the lower body and torso—the parts of the body most susceptible to damage from falls and run-ins with ore cars.[39]

At a finer scale of analysis, however, accident records reveal how a person's occupation and physical position *within* the mill could also affect the frequency, severity, and location of bodily injury (Figure 6). Approximately three-quarters of milling accidents occurred in the upper levels of the structure, where rock delivered from the mine was dumped into mill bins, sorted on conveyors, and run through a succession of crushers. While this was also where most of the staffing was, injuries sustained at these levels also tended to be of greater severity. Almost one-fifth of accidents occurring in these locations involved the filing of serious incident forms, double the rate reported for the mill's lower levels.

The most accident-prone spaces in the mill were the two sorting decks, where workers hand separated ore from waste rock (Figure 7). Workers stationed at different points alongside conveyors picked out quartz cobbles and dumped them into hoppers for further processing. What remained on the belt was ejected from the mill. By the early 1930s, the mill's sorters were handpicking a thousand tons of material daily from the belts. This equated to each coarse-ore sorter physically handling seventy to eighty tons (and each fine sorter twenty to twenty-five tons) of broken rock per shift.[40]

All told, ore sorters accounted for one-eighth of milling accidents recorded between 1928 and 1941. Moreover, racialized hiring practices, in which the company employed Filipinos to fill low-wage positions, meant that Filipino workers suffered the majority of these injuries. Indeed, outside of millworkers identified as "American," Filipino employees appeared in accident files more than three times more often than any other nationality listed.[41]

Eighty percent of sorters' injuries involved the head and hands. Damage to fingers, hands, and wrists came as a direct consequence of handling freshly broken rock on the conveyors. Common situations included cuts from a rock passing along the conveyor bed, or bruises and sprains received when a rock shifted on the belt and rolled onto a sorter's hands. By contrast, most head and eye injuries resulted from rocks bounding down the chute and bouncing off the conveyor belt. By 1928, this pattern of injury was evident enough on the fine sorting conveyor for the shift boss to recommend closing the picking stand closest to the mouth of the chute.[42]

Accident rates at the mill's tipples and on the ball-mill and tube-mill floors were high as well, and incidents at these locations also had a greater chance than those in the mill in general of being serious. The mill tipples had been designed as an efficient ore delivery system for a large-scale, continuously operating facility. Locomotives shunted trains of ore cars to the top of the structure, where tipplemen directed the cars, four at a time, into one of two rotary dumpers. The dumpers held the cars in place as they turned, with each load discharging forty tons of rock into the mill's ore bin. The most common task at the tipples involved uncoupling and recoupling the cars as they entered and exited the tipple structure. These aspects of the job were not altogether different from a trammer's actions underground, and this seems also to have been reflected in the patterns of injury.

As with underground workers, tipplemen received a significant portion of injuries (almost half) to the hips and legs. Bruises, cuts, and sprains were often received in the course of manipulating ore cars or tripping on the tracks, and these common situations at times escalated to more serious injuries. Seven months into his job as a tippleman, Raymond Fuller stepped in front of a moving train and received extreme lacerations to one of his legs. James Hudson lost his foot when it caught between the rails and the rotary dumper, and the turning motion of the dumper also broke John Williams' toes when his foot stuck out

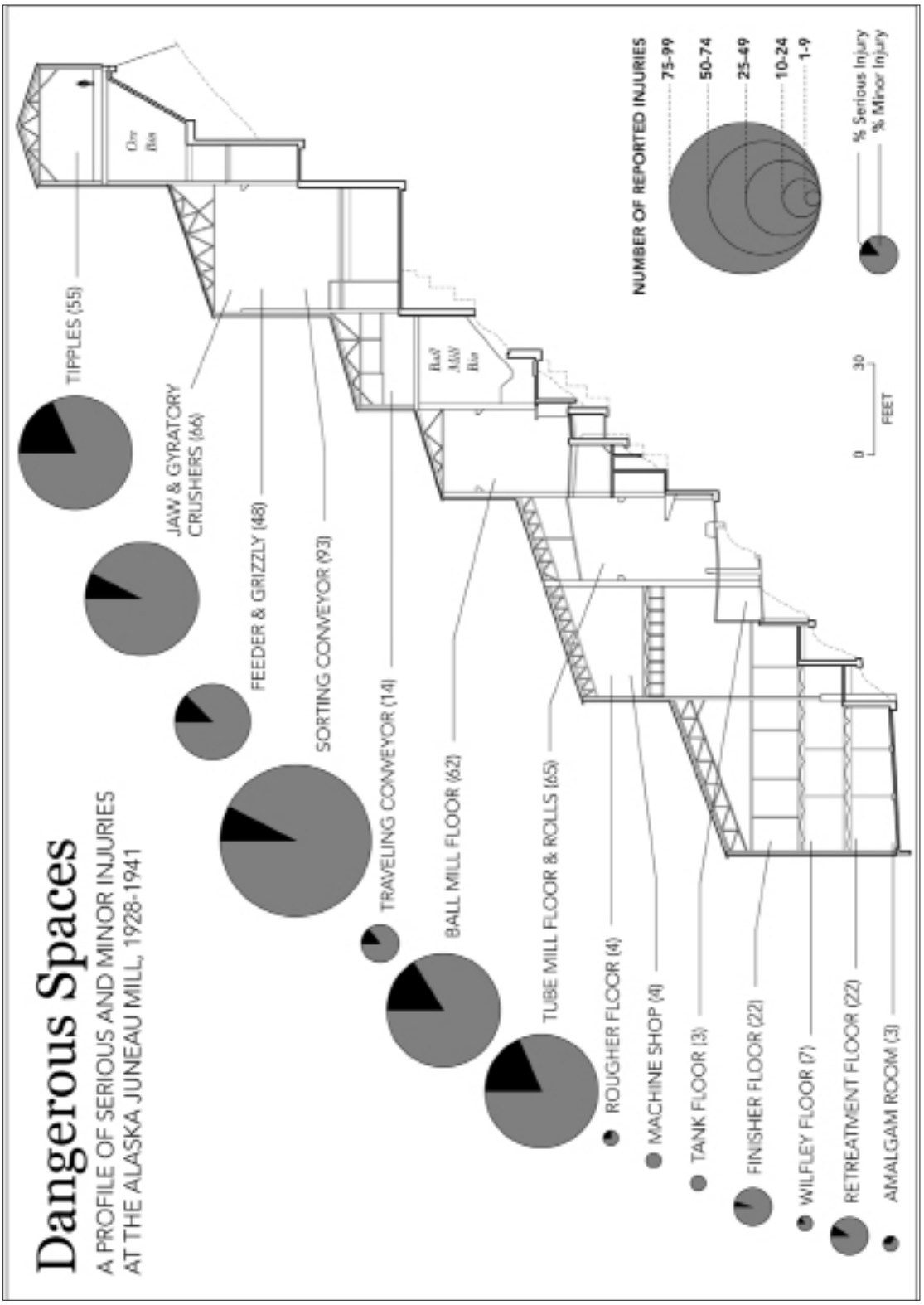

Figure 6. Milling accidents by location and severity. Not included are accidents occurring on stairways or at locations related to milling but outside the primary mill structure. (Drawing by the author.)

Figure 7. Filipino workers scan for quartz ore on one of the sorting decks. Ore sorting removed half of the tonnage delivered to the mill, with sorters rejecting about six thousand tons per day. Material passed by at a steady clip of 2.5 feet per second. (Evelyn Butler and George Dale Photographs, 1934-1982, Alaska State Library Historical Collections, Juneau. Alaska, ASL-P306-0271.)

slightly on the approach plate. Another worker, William Kidd, died from injuries sustained after being squeezed between the rotary dumper's safety guard and an ore car.[43]

The ball-mill and tube-mill levels saw more than 120 accidents occurring over the fourteen-year span of injury records. Machine operators received injuries when changing the speed of feeder belts or throwing new balls into the mill, but the majority of incidents on these floors affected the repairmen who were responsible for changing out mill liners, replacing belts, and cleaning material from underneath the conveyors.[44]

Repairmen accounted for almost 20 percent of all mill accidents on file, and they sustained 40 percent of these injuries on the ball- and tube-mill floors. The repairman's job was especially hazardous, in part, because so many tasks required lifting heavy equipment or working in proximity to moving machinery. Moreover, because the repair crew fixed problems throughout the plant, it dealt with a broader array of hazards over the course of a workday than workers whose occupations kept them at the same station. Being generalists in occupation also left signatures on the body (Figure 8). Repairmen and their helpers received injuries to the hands, head, and legs in approximately equal proportion, and they also suffered a greater percentage of chest injuries than either ore sorters or tipplemen.

Accident records point to distinct patterns of injury to millworkers, but they also open opportunities to see individuals behind the statistics. Close to 30 percent of accidents affected millworkers in their first year of employment, and some millworkers suffered repeated injuries.[45] Shift boss Edward Crowe's tenure at the Alaska Juneau Mill included surviving two falls and being flung against a guardrail by a pulley. Crowe was lucky to escape these incidents with bruises, but he later suffered second-degree burns to his face and wrists when working as an amalgamator.[46]

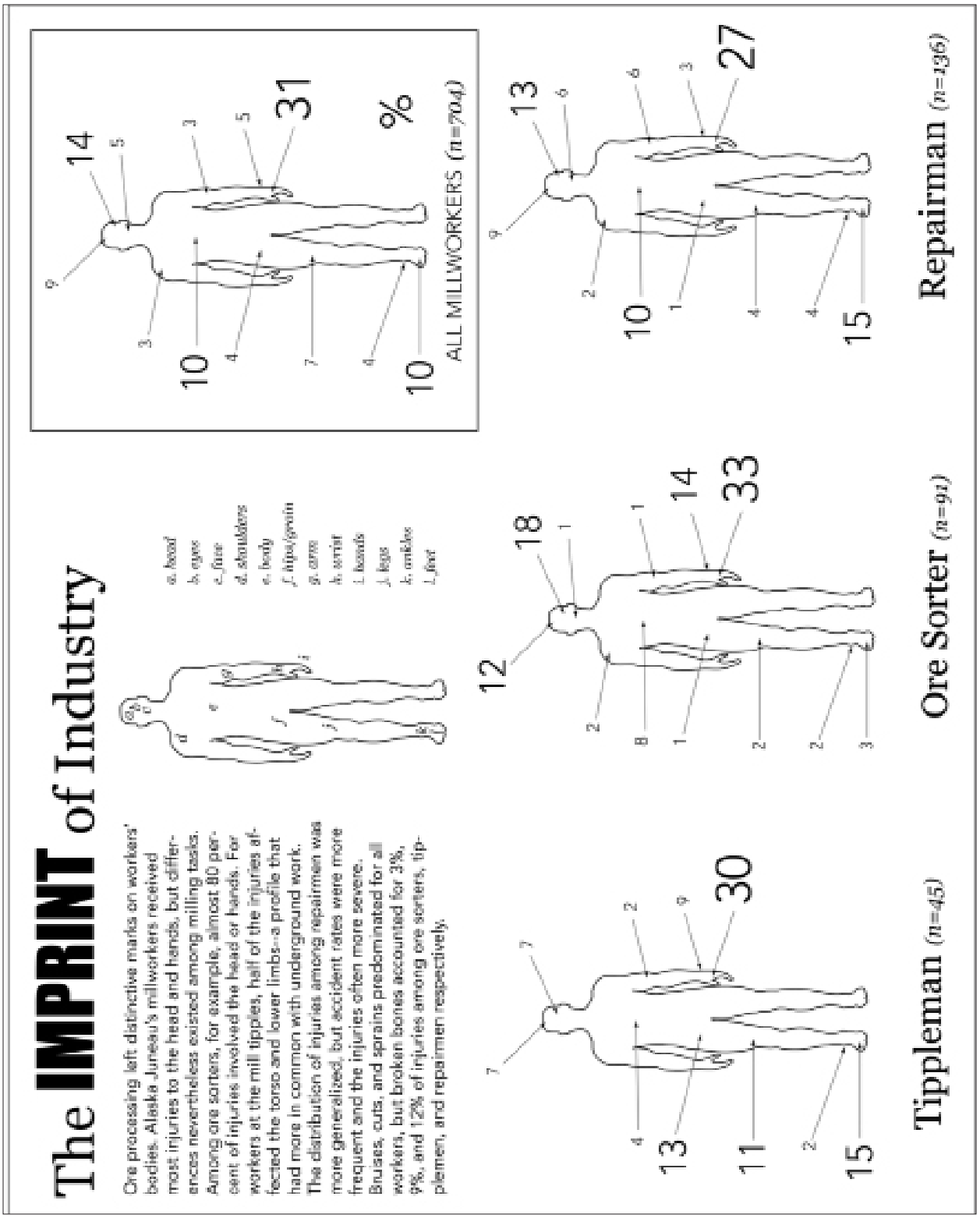

Figure 8. Injury patterns among different mill occupations. (Drawing by the author.)

Conservatively, at least 136 other mill employees (30 percent of those with accident reports) had more than one report on file, and 15 workers exceeded Crowe in suffering at least five accidents in the mill.[47]

The most prolifically unfortunate individual was Frederick Harris, a general laborer who by age 24 had clocked nine incidents over the course of four years, 1936 through 1939. Harris received a sprained wrist after just three weeks on the job, when he was hit by a falling crowbar while mucking out rock from underneath one of the gyratory crushers. The following year a conveyor belt cut just above his eye when he bent over to free a jammed tool that he had been using to rake out debris. Later that year he stepped on a nail while removing planks on the finisher floor, and, seven weeks later, sprained his ankle when he slipped on the stairs while going off shift. Over the next two years he strained his back twice when moving materials on the middling floor, and suffered three falls.

His most serious accident occurred in 1939, when Harris lost his balance cleaning a walkway near the crushing rolls. Harris stumbled backward and broke through a guardrail, falling fifteen feet to the concrete floor below. The impact lacerated his face and one of his knees, bruised his head, neck, and shoulders, and sprained both wrists—but he miraculously avoided fractures.[48] This counted as a serious accident in terms of recordkeeping, but all of his other incidents went no further than reports filed by his shift boss and the foreman.

INJURY	NO.	%
Break	58	8.2
Bruise	213	30.3
Burn	17	2.4
Cut	173	24.6
Dislocation	5	0.7
Foreign Object	60	8.5
Mash	30	4.3
Puncture	19	2.7
Scrape	15	2.1
Sprain	114	16.2
TOTAL	704	100

Table 2. Types of injuries experienced by millworkers in the Alaska Juneau Mill. Note that the number of injuries is slightly higher than the number of records because of instances of multiple injuries.

As with Harris's misfortunes, the bulk of milling accidents were not categorized as "serious" injuries, since this technical classification was generally reserved for accidents causing more than fourteen days off work (increased from ten days in 1926). From a qualitative perspective, at least, 8 percent of mill injuries occurring between 1928 and 1941 involved bone breaks, and another 8 percent involved foreign objects in the eye. Bruises, cuts, and sprains accounted for the vast majority of milling injuries (71 percent), with the balance consisting of mashes, punctures, scrapes, burns, and dislocations (Table 2). "Minor" injuries such as sprains, hernias, and mashed fingers could conceivably permit someone to continue working and yet remain difficult to remedy.

Some evidence of enduring problems comes from three documents associated with Harris's various accidents. Regarding a back sprain that Harris received in 1938 when he was 23, the foreman noted that the strain represented an "aggravation of an old injury which the man has had for some time." A surgeon's report written the following year noted that Harris's back injury continued to "bother him some," and a foreman's report noted that Harris had a "weak back" and was under orders not to lift anything heavy.[49]

A similar connection between accidents is implied for John Talswick, who worked as a repairman's helper. In 1931, the fall of a tube mill grate had crushed the end of his big toe. Talswick fractured this same toe the following year when he hit it with a jackhammer. Here, the loss of

sensation from the earlier incident quite possibly contributed to the re-injury. Irrespective, the high incidence of injury recidivism increased afflictions that Crowe, Harris, Talswick, and more than one hundred other employees carried with them on and off the job, and sometimes for the rest of their lives.

The Environment and Culture of Milling Work

Echoing Caetani's opening remarks on the importance of recognizing the place of people in mill design, Alaska Juneau's accident records reveal multiple instances where injuries had been influenced—if not directly caused—by the mill's physical layout. Among the most obvious connections was the mill's arrangement against a steeply sloping site (refer to Figure 1). Hillside locations were often selected for siting milling plants of this era, primarily because they maximized the use gravity to move material inexpensively between machines.

This choice nevertheless required that workers navigate stairways and ladders to access mill levels as part of their daily routines. Slips and falls accounted for 18 percent of injuries in the mill between 1928 and 1941, and more than one quarter of these occurred on the mill's stairs and ladders. Moreover, owing to the mill's "extreme type of hillside construction"—in which the natural slope approached 50 degrees—some falls involved drops of 10 feet or greater, from which workers' injuries understandably became more serious.[50]

Additionally, design flaws included locales in the mill that were poorly lit or required workers to navigate low ceilings. The lighting placement for at least one of the mill's staircases cast a worker's shadow over the steps in front of him, and at least two locations—a catwalk constructed over the finisher floor and the top of a staircase on the traveling conveyor floor—necessitated that workers duck to avoid support beams. These conditions were each the cause of injury.[51]

The most pervasive environmental factor influencing working conditions was operative noise. Several records identify situations in which the general din caused workers to be taken by surprise.[52] The most serious of these incidents occurred to Clinton Mack who, on April 21, 1928, was working his sixth day of a contract to paint the ball-mill level (Figure 9). Shortly before 2:00 p.m., Mack was setting up a block and tackle to raise a paint barrel when a traveling crane pinned him against one of the main support columns. The impact fractured Mack's right hip, crushed his chest, broke an arm above the elbow, and shattered a leg above the knee—a horrendous assortment of injuries that resulted in his death three days later.[53] The crane operator only became aware of the problem when alerted to it by another millworker.[54]

This delayed response was unexceptional. When a conveyor belt flung operator Santiago Villaneuva twenty-five feet over a twelve-foot drop, for instance, his unconscious body was found later by a coworker who had simply felt "something brush past his leg." A shift boss "making his rounds" discovered ball-mill operator John Gronning tangled in a pulley with a broken arm. Robert DeWitt, employed as a painter's helper, suffered a fractured arm, broken femur, and multiple bruises after the bib of his overalls caught on a line shaft coupling while he was chipping scale from I-beams below the ball mill feeder bin. DeWitt was eventually spotted by a ball-mill operator who noticed that the elevator for that section had stopped. DeWitt's supervisor, who had been chipping scale just a short distance away, was unaware that an accident had occurred.[55]

Inarguably, many more accidents would have occurred had the mill not been fitted with a bell system to notify workers of specific hazards and had workers not communicated their intentions through hand gestures. Accident reports indicate that tipplemen motioned to train drivers to start, slow, and stop the movement of ore cars at the tip-

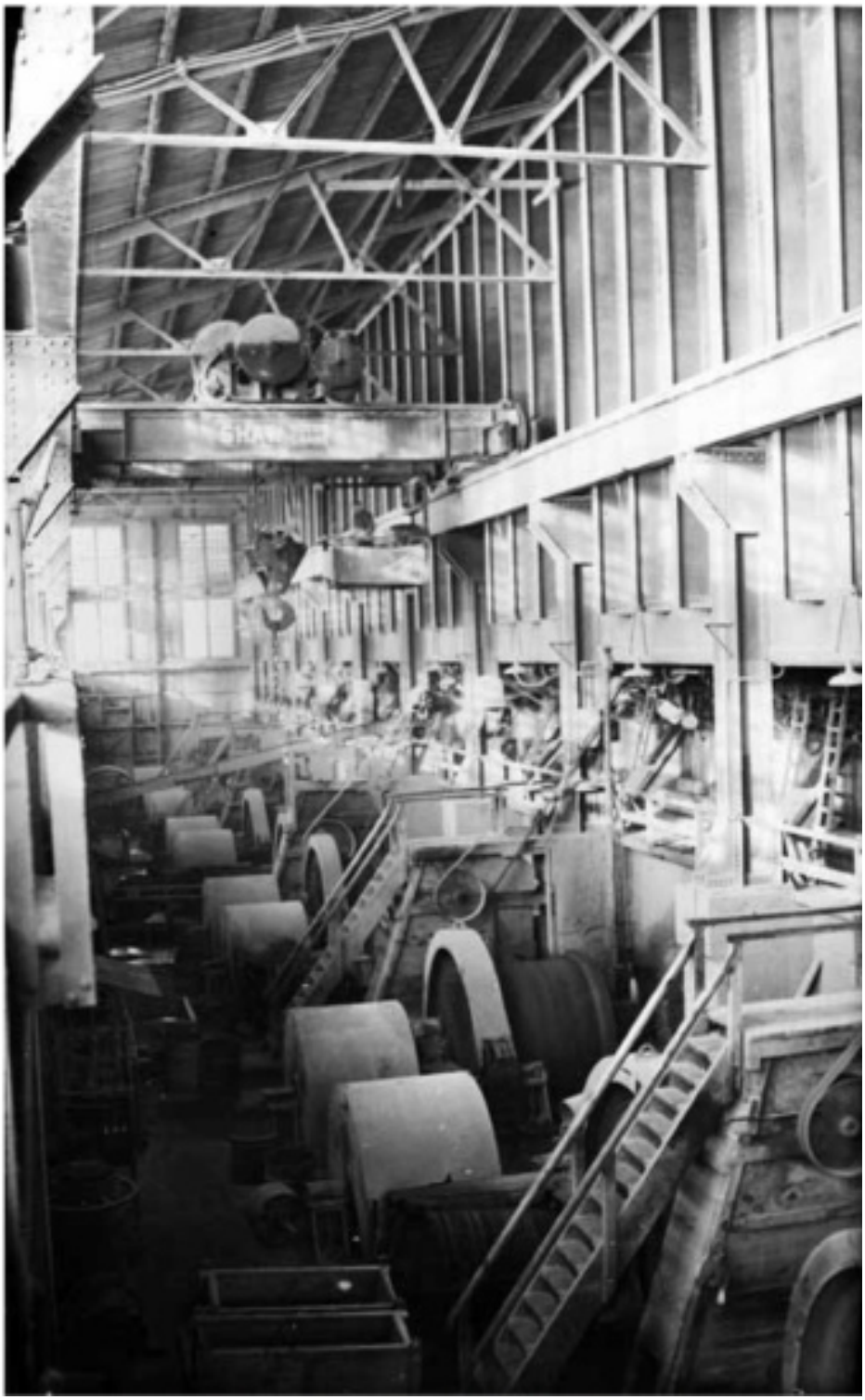

Figure 9. The ball-mill floor at the Alaska Juneau Mill, scene of a fatal accident in 1928. Note the traveling crane and operator at mid-distance, and safety guards covering the ball mill gearing. Note also boxes and equipment on the floor and the steep pitch of stairways and access ladders. (Alaska State Library Place File Photographs, ASL Juneau. ASL-P01-1317.)

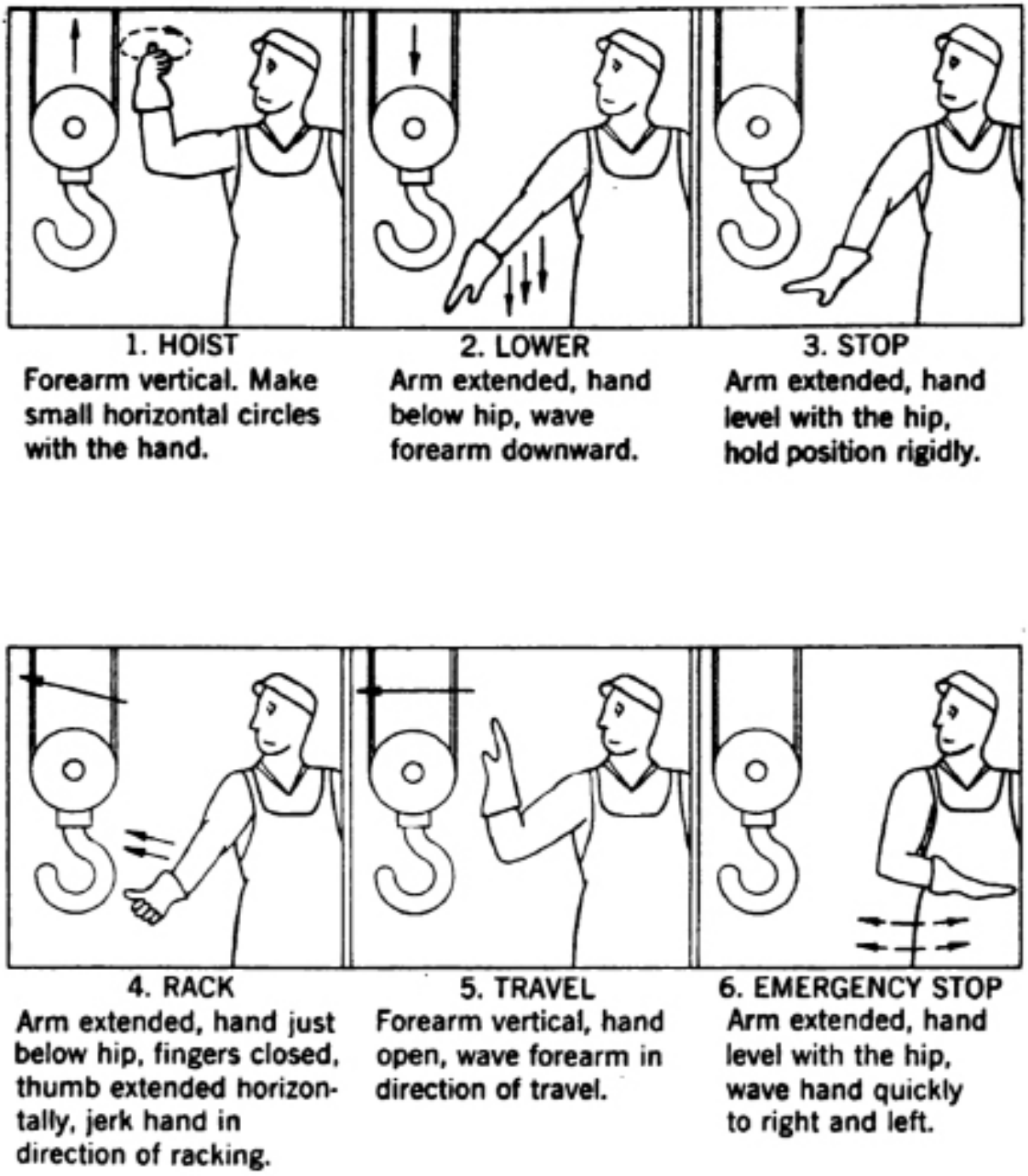

Figure 10. Signaling facilitated, though did not guarantee, safe communication between mill operators. The system implemented at the Alaska Juneau Mill may have included this set of standard crane signals, published in a midcentury manual on milling safety. (Source: U.S. Bureau of Mines, Accident Prevention in Nonferrous-Metal Processing Plants, 2: Mills and Concentrators*, 379.)*

ple, and that laborers on other floors gestured to crane operators as they conveyed equipment and other materials across the working floor (Figure 10).

While it remains unknown if the bell signals followed general standards or were local to the company's operation, the mill's safety systems evidently suffered problems with implementation.[56] Shortly before Clinton Mack's fatal accident, coworkers had cautioned him "about being careful," but no one had notified the crane operator of Mack's whereabouts. Raymond Fuller, who severely injured his leg at the mill tipples when stepping in front of a train, had forgotten that he had just signaled the driver to go ahead. Fellow tippleman Everett Hendrickson received injuries when he became wedged between an ore car and the guard for the rotary dumper, and this occurred because he signaled too late for the train to stop shunting the cars forward.[57]

At least two milling accidents stemmed from workers misreading hand gestures. In 1930, Edward Johnson was replacing liners in a tube mill when a crane operator mistakenly thought he had been signaled to turn the mill. The subsequent movement caused a loose mill liner to drop onto Johnson's foot, severing four toes at the first joint. Five years later, a repairman identified as E. E. Johnson received a cut on the head when replacing a worn shaft on the ball mill floor. His partner, standing above him, had signaled for Johnson to catch a clutch part. Johnson interpreted the gesture as a request to look for something on the floor, and when he bent over to search for it was hit on the head by the casting. Even the mill's bell system could be ambiguous. Laborer Frank Edwards sustained significant damage to his hearing when he interpreted a detonation signal (to clear a blockage) to refer to another location in the mill rather than directly above him.[58]

Such incidents also occurred within a broader culture of work that saw millworkers conducting some tasks at a hurried pace and often laboring in proximity to moving machinery. Although safety guards protected workers from equipment like ball-mill and tube-mill gearing, such protections tended to be custom-made solutions and not applied universally among the facility's equipment.[59] Lineshaft belts and idler pulleys on conveyors were generally left exposed. Workers' access to safety equipment also varied. Ore sorters on the coarse sorting belts received cotton gloves with leather palms, while those picking on the fine sorting belts used cotton gloves fitted with rubber tips. Some, but not all, millworkers were supplied with safety goggles, and at least one injury had been made more severe because the company had run out of safety supplies.[60]

The company also lacked guidelines for maintaining clean workspaces. A safety inspector visiting the plant in 1941 observed spare parts scattered on various mill floors, with some piles placed "dangerously near moving parts and heavily charged electric starting switches and rheostats." The inspector found tidy workstations only in the machine shop, "where apparently the machinists themselves do this voluntarily rather than on instructions from the men in charge."[61]

Among the more telling indicators of the overriding attitude was how actions like closing the picking stand closest to the hopper, building a platform to improve access to machinery, and repairing hand railings had all been conducted in the wake of accidents. Complicating matters were cases such as that of Fredrick Orme, where the company contended that his decision to wear safety gloves while placing a belt on a lineshaft contributed to the accident.

It remains unclear whether the Alaska Juneau Gold Mining Company required workers to stop equipment prior to performing repairs, but many accidents occurred where this had not been done. A particularly telling example was that of Aniceto Magdaluyo, who suffered a crushed thumb and finger when using a bar to hook out a rock from a running idler pulley. Magdaluyo admitted to his shift boss that he knew the action was dangerous and that he had been careful, "but it

just got me."[62] Magdaluyo's accident had not occurred in novel circumstances—many workers received injuries performing this task the same way—and his conduct may have been unofficially condoned because it generally saved time. After all, stopping equipment required coordinating actions between millworkers and also threatened to disrupt a facility designed for continuous operation, in which stoppages to one area could quickly impact other areas of the mill circuit.

Milling injuries resulted also from workers circumventing protocols and guidance. Fred Daniels lost his hand, forearm, and eyesight when he disregarded his coworkers' warnings and returned a fourth time to reposition sticks of powder lit to clear a blockage near one of the jaw crushers. Howard Hayes, a helper in the assay office, lacerated his right eye when, contrary to instructions, he chipped a metal plate toward himself and was not wearing goggles. At the tipples, Earl Boese crushed his thumb when teaching a new recruit how to couple cars without the iron bar that the company had supplied for the task. When Charles Johnson fell ten feet in the act of repairing a roof, the foreman contended that closer supervision would not have prevented the accident because Johnson had "his own way of doing things." Glenn Martin cut his head on an overhead beam when he jumped over a safety barrier protecting a lineshaft, and Mike Ugrin cracked two of his ribs during an unsuccessful attempt to rotate a sling load of pipes while standing on a stack of boxes and holding a stick.[63]

Such reports of failed efforts, which range from unfortunate to tragic, seem underwritten by a common desire to hasten tasks, as well as a cavalier attitude evidenced both by managers and employees. It is not surprising, then, that the most frequent violation of safety guidelines occurred on the mill's staircases, where, according to one shift boss, "the men have a habit of running down the steps as they go off shift."[64] Half of stairway accidents occurred at the shift change, and eight reports specifically mentioned that the injury came from a worker tripping or slipping while racing down the stairs.[65]

These incidents affected nearly all classes of employees, from coarse- and fine-ore sorters, to ball-mill operators, general laborers, repairmen, and workers on the flotation floor. While the injuries were relatively minor (ranging from sprained ankles to bruised hips and a dislocated shoulder), the frequency of their occurrence offers a telling insight into the laboring experience. Irrespective of where one labored in Alaska Juneau's mill, the highlight of the shift came when clocking out. Indeed, while the majority of workers came back to the job the next day, on an annual basis, one-quarter of the mill's workforce opted not to return.[66]

Redressing Milling Legacies

The onset of the industrial era, which spurred the intensification and mechanization of production across an expanding number of trades, not only radically transformed notions of the working day, but also caused a marked uptick in workplace fatalities and injuries. Contemporary observers noted that this trend occurred also for industries such as mining that already had long-established reputations for being hazard prone. Yet safety practices at mines, both underground and on the surface, proved slower to establish than the pace of these perilous developments. During the late nineteenth century, for instance, fatality rates in coal and metal mines in the United States were three times higher than those in Europe, but the collection of industrial accident statistics so necessary for developing national safety standards remained rudimentary.[67]

When the Alaska Juneau Gold Mining Company began a detailed program of accident documentation across its operations in 1928, federal efforts to collect national data on mining accidents were still comparatively recent. Indeed, Alaska Juneau's documentation efforts occurred just three years after researchers at the U.S. Bureau of Mines had first expressed some confidence

that their data gathering efforts for metallurgical plants had identified actual accident trends in the industry.

Although Alaska Juneau's accident records ignore some occupational afflictions known to have attended millwork, the incidents recorded nevertheless permit detailed insights into the nature of injury. Accident case files document in grim and visceral detail the ways that millwork regimens inflicted harm upon the body. The frequency and severity of milling accidents was eclipsed by what occurred underground, but ore dressing wrought patterns of injury distinct from underground work, and at times particular to a given job. Accidents were influenced by the actions of workers as well as administrators, and shaped also by the very structure of the plant. Alaska Juneau's accident records reveal ways that safety guidelines were at times enforced, at times absent, and at times ignored.

Arguably, however, their most significant contribution is their ability to move us beyond the charting of statistical trends to observe personal histories. Instances of injury recidivism highlight that accidents accumulated for some individuals, but also that injury did not exclude people from milling jobs.[68] Such attention reveals a fuller picture of industrial work experiences by re-humanizing spaces recognized more often for their machines than for the people employed to keep that machinery operational.

Paul White is an Associate Professor of Geography at the University of Nevada, Reno, with two decades of experience in the archaeological documentation of mining sites in North America. His research interests center upon the social, technological, and environmental transformations associated with mining, including how historical relationships perpetuate colonial relations in the present. He has worked also as a consultant for the U.S. Environmental Protection Agency and conducted safety-hazard assessments on abandoned mining lands. His book, The Archaeology of American Mining *(2017), which synthesizes fifty years of archaeological scholarship, received the Mining History Association's 2019 Clark Spence Award.*

The Alaska Juneau Gold Mining Company's records reside at the Alaska State Library and Historical Collections, Juneau, Alaska. The author expresses his sincere thanks to the collections staff, which accommodated his numerous document requests during research visits conducted in 2015 and 2018, and via correspondence in 2020. His thanks, also, to staff at the National Archives, College Park, Maryland, and at the Department of Special Collections at Stanford University, and for comments made by an anonymous reviewer.

Notes:

1. Gelasio Caetani, "The Human Side of Milling," *Mining and Scientific Press* 107, no. 21 (1913): 804.
2. A standout is H. W. MacFarren's *Practical Stamp Milling and Amalgamation*, 2nd ed. (San Francisco and London: Mining and Scientific Press and Mining Magazine, 1910): 148-59.
3. Mark Wyman, *Hard Rock Epic: Western Miners and the Industrial Revolution, 1860-1910* (Berkeley: University of California Press, 1979), 186-200; Alan Derickson, *Worker's Health, Workers' Democracy: The Western Miners' Struggle, 1891-1925* (Ithaca: Cornell University Press, 1988), 155-88.
4. Frederick L. Hoffman, "Industrial Accident Statistics," *Bulletin of the U.S. Bureau of Labor Statistics 157* (Washington, D.C.: USGPO, 1915): 7-8.
5. The gist of early worker compensation laws entitled workers to have companies pay for medical expenses and lost wages, with the proviso that workers then forfeited rights to sue their employers. Corporations supported the passage of such laws because compensation payments proved to be cheaper and more predictable than court settlements. It was thus in the economic interests of businesses to maintain accident records that documented the type of injury, place of occurrence, proximal cause, and degree of worker responsibility. Price V. Fishback and Shawn Everett Kantor, *A Prelude to the Welfare State: The Origins of Workers' Compensation* (Chicago: University of Chicago Press, 2000), 197-203; Jonathan D. Karmel, *Dying to Work: Death and Injury in the American Workplace* (Ithaca: Cornell University Press, 2017), 24.
6. Public Law 179, May 16, 1910. "An Act To establish in the Department of the Interior a Bureau of Mines." 61st Congress, Sess. II, Chapter 240, Section 5, p. 370; Albert H. Fay, "Accidents at Metallurgical Works in the United States During the Calendar Years 1913 and 1914," *U.S. Bureau of Mines Technical Paper 124* (Washington, D.C.: USGPO, 1915).
7. U.S. Department of Labor, *Bulletin of the U.S. Bureau of Labor Statistics 157: Industrial Accident Statistics*, Appendix I: Requirements to Accident Reporting in the Various States (Washington, D.C.: USGPO, 1915): 174-5; Albert H. Fay, "Metal-Mine Accidents in the United States During the Calendar Year 1913," *U.S. Bureau of Mines Technical Paper 94* (Washington, D.C.: USGPO, 1914), 5-7. See also: Albert H. Fay, "Report of the Committee on the Standardization of Mining Statistics," *U.S. Bureau of Mines Technical Paper 194* (Washington, D.C.: USGPO, 1918), 9.
8. Sumner S. Smith, "The Mining Industry in the Territory of Alaska During the Calendar Year 1915," *U.S. Bureau of Mines Bulletin 142* (Washington, D.C.: USGPO, 1917), 5, 9-10; Smith, "The Mining Industry in the Territory of Alaska During the Calendar Year 1916," *U.S. Bureau of Mines Bulletin 153* (Washington, D.C.: USGPO, 1917), 6-7.
9. George S. Rice to Director, 24 Apr. 1912, RG70, Records of the Bureau of Mines, Box 65-1912-473001, NARA, College Park, MD; Frederick L. Hoffman, "Mine Safety in Southeastern Alaska," *Engineering and Mining Journal* 97, n. 13 (1914): 654.
10. U.S. Bureau of Labor Statistics, "Standardization of Industrial Accident Statistics," *Bureau of Labor Statistics Bulletin 276* (Washington, D.C.: USGPO 1920).
11. Daniel M. Berman, *Death on the Job: Occupational Health and Safety Struggles in the United States* (New York: Monthly Review Press, 1978), 42; for a summary of Jerome Gordon's report findings to the U.S. Department of Labor, see: Representative William D. Ford (MI), "Millions of Industrial Injuries a Year," *Congressional Record* 116: 20 (4 Aug. 1970), E27344-E27347.
12. Accidents presented in relation to the number of employees *exposed to risk*, for example, worked high labor turnover to a company's advantage. This metric pitted the number of accidents against the total number of persons employed over the course of a year, even if the number of positions at the mine remained the same. Statisticians settled on hours of exposure using a "full-time equivalent" worker as a more honest metric. This converted injuries in relation to an employee who worked three hundred shifts per year. The mathematical conversion from part-time worker to full-time worker involved dividing the total number of shifts that a company reported for the year by three hundred. By midcentury, statisticians abandoned this metric in favor of presenting injury statistics per million hours of exposure. Hoffman, "Mine Safety in Southeastern Alaska," 654. Regarding differing definitions of "all accidents," see: Fay, "Accidents at Metallurgical Works," 6.
13. The first mention of milling statistics being "thoroughly representative" begins with: William W. Adams, "Accidents at Metallurgical Works in the United States During the Calendar Year 1925," *U.S. Bureau of Mines Technical Paper 412* (Washington, D.C.: USGPO, 1927): 2-3. At that time, survey return rates had increased, and results generally affirmed that statistics collected in the early years reflected the type and frequency of injuries that millworkers faced.
14. Accident statistics did not include injuries where the worker continued working or returned to work by the next shift. William W. Adams, "Accidents at Metallurgical Works in the United States During the Calendar Year 1927," *U.S. Bureau of Mines Technical Paper 458* (1929): 4, 35.
15. See: Bureau of Labor Statistics, *Handbook of Labor Statistics, 1929 Edition, Bulletin of the U.S. Bureau of*

Labor Statistics 491 (Washington, D.C.: USGPO, 1929), 254-72.

16. Compiled from annual Bureau of Mines technical papers "Accidents at Metallurgical Works in the United States" for the years 1914-1932. Machinery accidents derived less from crushers or recovery equipment than from "other machinery," a category that included motors, belt drives, and other equipment responsible for moving material between different sections of a plant.
17. William W. Adams, "Accidents at Metallurgical Works in the United States During the Calendar Year 1930," *U.S. Bureau of Mines Technical Paper 530* (Washington, D.C.: USGPO, 1932): 25-9.
18. In terms of raw numbers, returns for 1923 indicated that the smallest milling plants (employing 1-9 workers) saw 810 people perform 165,530 shifts, during which time they suffered 241 injuries. Applying the formula for "full-time equivalent workers," the shifts could have been performed by the equivalent of 552 "full time" workers. For comparison purposes, then, 552 workers in small mills experienced 241 injuries over the course of the year, which was the equivalent of 436 injuries per 1,000 full-time workers. William W. Adams, "Accidents at Metallurgical Works in the United States During the Calendar Year 1923," *U.S. Bureau of Mines Technical Paper 374* (Washington, D.C.: USGPO, 1925): 28.
19. B. D. Stewart, *Territory of Alaska, Report of the Commissioner of Mines to the Governor for the Biennium Ended December 31, 1940* (Juneau: Alaska Territorial Department of Mines, 1941), 59. The prior report noted an elevated accident rate at lode gold mines, for although employment there in terms of manhours constituted 38 percent of the labor in Alaskan mining, lode gold miners comprised respectively 69 and 64 percent of mining fatalities and injuries. B. D. Stewart, *Territory of Alaska, Report of the Commissioner of Mines to the Governor for the Biennium Ended December 31, 1938* (Juneau: Alaska Territorial Department of Mines, 1939), 26.
20. Metzgar, "Safety, Welfare, and Labor Compensation," 489-93; David Stone and Brenda Stone, *Hard Rock Gold: The Story of the Great Mines that were the Heartbeat of Juneau* (Juneau: Juneau Centennial Committee, 1980), 68.
21. Regarding first-aid treatment generating an accident record, see: L. H. Metzgar, "Safety, Welfare, and Labor Compensation," *Engineering and Mining Journal* 133, no. 9 (1932): 489. When initiated in March 1928, the numbering system ran from 1 to 1000, with numbers then beginning anew. However, in October 1935, when the number of reported accidents reached 1,000 for the second time, the company opted not to reset the numbering clock. Thus, accident number 450, if occurring prior to 1932 reflected the 450th accident since 1928. But accident 450 that took place after 1932 was actually the 1,450th accident occurring since 1928. The potential confusion was reduced because the company also filed accidents by year.
22. Anon., "The Alaska Juneau Mill." *Engineering and Mining Journal* 103, no. 13 (1917): 526-8; P. R. Bradley, "Milling Practice at the Alaska Juneau Concentrator," *U.S. Bureau of Mines Information Circular 6236* (Washington, D.C.: USGPO, 1930), passim.
23. Numbers derived from Monthly Report of Labor Conditions forms filed in MS999, "Alaska Juneau Gold Mining Company Records, 1880-2000," Series 1, AJ16-1, Accidents Box 24, 25, and 26, Alaska State Library, Juneau. For a brief accounting of these problems, see: P. R. Bradley, "History, Organization, and Outlook," *Engineering and Mining Journal* 133, no. 9 (1932): 461; W. P. Scott, "Milling Methods and Ore-Treatment Equipment," *Engineering and Mining Journal* 133, no. 9 (1932): 476-7; Bradley, "Milling Practice," 3.
24. T. A. Rickard. "The Alaska Juneau Enterprise," *Engineering and Mining Journal* 114, no. 5 (1922): 180. The move was not without its detractors. After touring the plant in 1926, Bart Thane, who had pioneered the mass-milling of low-grade gold ore at the Alaska Gastineau Mine, noted disparagingly in private correspondence that the Alaska Juneau mill was "full of operators." By his reckoning, the company's decision to hand sort thousands of tons of rock each day was "responsible, more than anything else, for the failure of their enterprise." B. L. Thane to D. C. Jackling, 14 Aug. 1926, M0093 Daniel C. Jackling Papers, Private Files, Box 19, folder 6, "Relations with other companies, Alaska Mining & Power Company-Alaska Juneau Mining Company—General" (1915-1916), Department of Special Collections, Stanford University Libraries.
25. An "Initial Report of Serious Accident" form made its first appearance in Alaska Juneau's accident files in 1941. Designed for expediency, the form included fewer question prompts, asking only for the name of the injured, occupation, location of accident, extent of injury, and a brief description of the accident. Accident record for James K. Hudson (7 Feb. 1941), Box 26, no. 3581, MS 999, AJ16 Accident Records, "Alaska Juneau Gold Mining Company Records 1800-2000," Alaska Historical Collections, Alaska State Library, Juneau (hereafter MS 999, AJ16, AHC).
26. Some sections regarding personal information were marked on the form with an asterisk, indicating that they were "to be filled in at office." Whether this was the official responsibility of the foreman or of other administrative staff remains undetermined. However, those forms that included this additional information appear to have been filled out in the same handwriting as that of the foreman.

27. Typical scenarios involved reports of small cuts, eye inflammations, or back strains presenting continuing discomfort for days after the incident. The delayed reporting suggests that minor injuries were to some level expected, or considered not worth the bother of reporting to supervisors.
28, In his review of stamping practice, H. W. MacFarren noted that "the larger mills cause the majority of men to become deaf in time." MacFarren, *Practical Stamp Milling and Amalgamation*, 2nd ed. (San Francisco: Mining and Scientific Press and Mining Magazine, 1910): 158. Procedures for measuring and regulating occupational noise levels were not formalized until after the mid-twentieth century. See: Madeleine Kerr, Rick Neitzel, OiSaeng Hong, and Robert T. Saraloff, "Historical Review of Efforts to Reduce Noise-Induced Hearing Loss in the United States," *American Journal of Industrial Medicine* 60, no. 6 (2017): 569-77; Floyd E. Thurston, "The Worker's Ear: A History of Noise-Induced Hearing Loss," *American Journal of Industrial Medicine* 56, no. 3 (2012): 367-77.
29. The earlier "Employer's Preliminary Report of Accident" form emphasized equipment problems, with questions on the name of machine, under whose control it operated, whether it was out of order or unsuitable, and any special instructions given to the employee. The "Employer's Report of Serious Accident" form replaced these with questions about the principal cause of the accident, the name of the injured's supervisor, and "whether or not any known physical condition in or about the mine or plant where the accident occurred, such as unsuitable or defective machinery or appliances, lack of proper safeguards, inadequate ventilation or illumination; or other working conditions, including laxity of supervision, was a contributing cause of the accident." For examples, see accident records for Simplico Perlas (15 Apr. 1933), Box 7, no. 161, and George Crowe (10 May 1934), Box 9, no. 474, MS 999, AJ16, AHC.
30. The foreman's accident report recommended making this modification, but this detail was left out of the report submitted to the territorial mine inspector. Accident Record for Fredrick Orme (1 Nov. 1941), Box 28, no. 3912, MS 999, AJ16, AHC.
31. The commissioner of mines stated that the company's initial report "not only entirely omits but denies any known physical condition in or about the plant" as a contributing factor, B. D. Stewart to J. A. Williams, 8 Nov. 1941, Accident Record for Fredrick Orme (1 Nov. 1941), Box 28, no. 3912, MS 999, AJ16, AHC. Regarding compensation, the Territorial Act of 1917 determined payment for the loss of an arm for a man in Orme's situation (married with one child) to be $2,700. Orme received $315.54, a payment well short of the amount that would have been awarded had fault been determined to rest with the company.
32. Accident reports for O. C. Jacobson (4 Apr. 1939), Box 21, no. 2620, and Frederick Harris (8 Mar. 1939), Box 21, no. 2554, MS 999, AJ16, AHC.
33. Accident reports for Thomas Bennet (19 Apr. 1937), Box 15, no. 1529, and Leroy West (2 April 1939), Box 21, no. 2610, MS 999, AJ16, AHC.
34. From 1928 through July 1937, serious accident reports were compiled by Hector McLean. From August 1937, this responsibility fell to safety engineers W. A. Gallamore (1937), W. M. Byington (1938–1941), and Collis Druley (1941–).
35. For one accident caused by a faulty handrail, the foreman deduced that "responsibility rests on everyone who works about this place, including the injured—and all those in charge," but the serious accident report filed to the mine inspector assigned blame to the worker. In another instance, where a worker lost a foot at the tipples, the accident report blamed worker carelessness, although the foreman noted that there was "no way to use guards in this place." Accident reports for Frederick Harris (25 Jan. 1939), Box 21, no. 2480, and James Hudson (7 Feb. 1941), Box 26, no. 3581, MS 999, AJ16, AHC.
36. Crosschecking accident records with employee rolls recovered details about nationality, year employed, and age at the time of injury for dozens of cases. Employment cards seem to have been generated for most seasonal workers. For example, the *Juneau Alaska Daily Empire* (7 Sep. 1920) reported that "a number of the young boys of the Island who have been sorting rock at the Alaska Juneau mill during their vacations, resigned their jobs Saturday to be ready for the opening of school this morning." Of three individuals named in the article, two had employment cards on file, indicating that they were fourteen years old at the time. As this also indicates, omissions also occurred. Indeed, crosschecking reveals that two dozen mill workers injured between 1928 and 1941 had no corresponding employment cards on file—a situation stemming from inconsistencies either in recordkeeping, preservation, or both. An additional complication is that some employees working contemporaneously had similar names. AK Mine Employment Records Index (1914-1944). Digital index on file at Alaska State Library and Historical Collections, Juneau, Alaska.
37. Metzgar, "Safety, Welfare, and Labor Compensation," 489-90.
38. Here I use rates per 1,000 full-time equivalent workers to allow comparison with national statistics. Metzgar's account compared accidents per 10,000 shifts, of which the equivalent ratios for 1917 are 4.3 per 10,000 and, for 1936, 0.8 serious accidents per 10,000 shifts. These numbers differ slightly from a graphic in Metzgar's publication, because Metzgar combined milling data with other, less hazardous, surface work. Data derives from Alaska Juneau acci-

dent reports in combination with published summaries for serious accidents. Monthly data on shifts are missing for three months in 1919 and one month in 1935. See AJ15-1, "Summary of Serious Accidents, 1916-August 1938," MS999, AHC.

39. A comparison with Alaska Juneau's underground workers was not conducted for this study. Patterns of injury for underground miners derive from national statistics for metal-mines. Albert H. Fay, "Metal-Mine Accidents in the United States during the Calendar Year 1914," *U.S. Bureau of Mines Technical Paper 129* (Washington, D.C.: USGPO, 1916), 82.
40. Sorters additionally removed large waste rocks from the belt because these otherwise created blockages in chutes and conveyors. Scott, "Milling Methods," 476-7. Also see: Anon., "Alaska Juneau Milling System," *Engineering and Mining Journal* 131, no. 8 (1931): 369.
41. Places of origin listed under "Race" could be identified for 627 records. Nationalities included Austria, Belgium, Canada, Denmark, England, Finland, Germany, Greece, Ireland, Japan, Korea, Mexico, Montenegro, Norway, Philippines, Russia, Scotland, Serbia, Sweden, Switzerland, and Yugoslavia. The company identified native-born as Americans, though classifying Native Americans separately as "Indian." After Filipinos, the ethnic group with the next greatest number of accidents on file were Norwegians, who worked predominantly as machine operators and repairmen.
42. See accident report for Albert Clark (22 June 1928), Box 1, no. 108, MS 999, AJ16, AHC.
43. Accident reports for Raymond Fuller (13 Nov. 1937), Box 16, no. 1762; James Hudson (7 Feb. 1941), Box 26, no. 3581; John Williams (15 Jan. 1941), Box 26, no. 3546; and William Kidd (11 Sep. 1931), Box 4, no. 782, MS 999, AJ16, AHC.
44. For examples of operator injuries, see accident records for Lynn Pope (2 Feb. 1940), Box 24, no. 3132; and Charles Skuse (11 Apr. 1936), Box 13, no. 1162, MS 999, AJ16, AHC.
45. Accident rate calculated for workers hired after 1928. Of the 419 accidents for which hire dates could be identified, 119 records (28.5 percent) occurred within a millworker's first year.
46. Accident reports for Edward Crowe (13 June 1931), Box 4, no. 741; (6 Sep. 1933), Box 7, no. 262; (9 Apr. 1935), Box 11, no. 799; and (12 June 1937), Box 15, no. 1587, MS 999, AJ16, AHC.
47. This number errs on the conservative side for workers with similar names creates ambiguities. In at least one case, a worker suffering an amputation appears in a later accident. An accident left Edward Johnson without the end of four toes on his left foot in 1930 and, three years later, a second incident mangled three fingers of his left hand. Accident records for Edward A. Johnson (29 Jan. 1930), Box 3, no. 484, and (30 Oct. 1933), Box 7, no. 311, MS 999, AJ16, AHC.
48. Accident records for Frederick B. Harris (4 May 1936), Box 13, no. 1187; (11 Mar. 1937), Box 15, no. 1489; (27 May 1938), Box 15, no. 1568; (6 Oct. 1937), Box 16, no. 1715; (6 Jan. 1938), Box 17, no. 1940; (23 Mar. 1938), Box 17, no. 1940; (2 Sep. 1938), Box 19, no. 2234; (25 Jan. 1939), Box 21, no. 2480; (8 Mar. 1939), Box 21, no. 2554, MS 999, AJ16, AHC.
49. Accident reports for Frederick Harris, (6 Jan. 1938), Box 17, no. 1940, and Foreman's Report, and (25 Jan. 1939), Box 21, no. 2480, MS 999, AJ16, AHC.
50. Quote from Bradley, "Milling Practice at Alaska Juneau," 1.
51. See accident reports for Bill Windsor (28 Oct. 1940), Box 25, no. 3435; Samuel Daniels (13 July 1935), Box 11, no. 854; and Claude Peters (30 Oct. 1936), Box 14, no. 1368, MS 999, AJ16, AHC.
52. For some typical examples, Francis Sterling received a cut over the eye when hit by a piece of quartz flung by one of the hand sorters on the picking belts who overshot the bin; carpenter Sylvan Greiner had his left leg broken by a wooden plank thrown down a chute by workers above him; and Carl Gustafson, working as a repairman's helper, suffered a fractured toe when a coworker dropped a heavy metal plate on his foot. Accident reports for Francis Sterling (24 July 1937) Box 15, no. 1637; Sylvan Greiner (6 Nov. 1938) Box 20, no. 2355; and Carl Gustafson (27 Dec. 1941) Box 28, no. 3971, MS 999, AJ16, AHC.
53. Accident report for Clinton Mack (21 Apr. 1928), Box 1, no. 102, MS 999, AJ16, AHC.
54. Shift Boss' Report of Personal Injury, Clinton Mack (15 June 1928), Box 1, no. 102, MS 999, AJ16, AHC.
55. Accident records for Santiago Villaneuva (25 Sep. 1930), Box 3, no. 608; John Gronning (23 Nov. 1929), Box 3, no. 449; Robert DeWitt (8 July 1939), Box 22, no. 2767, MS 999, AJ16, AHC.
56. Hand gestures were among common solutions implemented in many milling plants by the early twentieth century. See for instance, H. W. MacFarren, *Practical Stamp Milling and Amalgamation* (San Francisco, Mining and Scientific Press, 1910): 158-9. Although it remains unclear whether gesturing in the Alaska Juneau mill followed a formalized series of signs, a later Bureau of Mines' publication on accident prevention in processing plants noted how "accidents due to misunderstood or defective signals or signaling systems for starting or stopping machinery occur frequently enough to constitute a separate group [of causes]." U.S. Bureau of Mines, *Accident Prevention in Nonferrous-Metal Processing Plants: 2. Mills and Concentrators* (Washington, D.C.: USGPO, 1954): 112.
57. Accident reports for Clinton Mack (21 Apr. 1928), Box 1, no. 102; Raymond Fuller (13 Nov. 1937), Box 16, no. 1762; Everett Hendrickson (31 Aug. 1941), Box

28, no. 3827, MS 999, AJ16, AHC.

58. Accident records for Edward Johnson (29 Jan. 1930), Box 3, no. 484; E. E. Johnson (19 Jan. 1935), Box 10, no. 698; Frank Edwards (1 Feb. 1931) Box 4, no. 675, MS 999, AJ16, AHC.
59. Indeed, even at midcentury, a Bureau of Mines' publication providing photographic examples of well-protected machinery noted that the guards had not been provided by the manufacturer, but fashioned onsite. Bureau of Mines, *Accident Prevention in Nonferrous-Metal Processing Plants*, 118-26.
60. Scott, "Milling Methods and Ore-Treatment Equipment," 477. For mention of running out of supplies, see accident record for E. D. James (10 May 1939), Box 22, no. 2679, MS 999, AJ16, AHC.
61. J. C. Roehm, "Report of Investigation Pertaining to the Serious Injury of Fred Orme, and Other Conditions in the Alaska Juneau Mill, November 1, 1941," Accident Records, Box 28, no. 3912. Several accident reports imply untidy work stations, with boards and nails discarded on the mill floor, broken glass, and an unrepaired hand railing all becoming sources of injury. See accident records for William Maier (3 Nov. 1931), Box 5, no. 955; Patrick Mullen (29 Dec. 1939), Box 23: no. 3072; Jerry Powers (12 Sep. 1936), Box 13: 1322; Bert Ruotsala (14 Dec. 1931), Box 5: no. 843; Jack Sey (28 July 1939), Box 22: no. 2817; James Sey (6 Apr. 1938), Box 18, no. 1974; and S. Young (7 Jan. 1932), Box 5: no. 855, MS 999, AJ16, AHC.
62. Accident report for Aniceto Magdaluyo (25 Oct. 1941), Box 28, no. 3908, MS 999, AJ16, AHC.
63. Accident reports for Fred Daniels (15 May 1941), Box 27, no. 3702; Howard Hayes (8 April 1937), Box 15, no. 1515; Earl Boese (12 Jan. 1940), Box 24, no. 3098; Charles Johnson (19 May 1930), Box 3, no. 547; Glenn Martin (7 Nov. 1941), Box 28, no. 3917; Mike Ugrin (16 Aug. 1938), Box 19, no. 2208. Johnson was fixing the roof of Treadwell's famed 700 mill, which the Alaska Juneau operation owned but had mothballed. Hayes had received an injury to his left eye five years earlier when replacing liners in one of the tube mills. The accident report suggests he may have initially attempted to wear eye protection because the foreman's report recommended providing goggles with screens rather than glass lenses because they would not fog up. Accident report for Howard Hayes (16 Dec. 1932), Box 6, no. 67, MS 999, AJ16, AHC.
64. Accident Report for Don Williams (8 July 1940), Box 25, no. 3294, MS 999, AJ16, AHC.
65. See accident reports for Owen Campbell (31 Dec. 1938), Box 20, no. 2439; James Doogan (7 Aug. 1935), Box 11, no. 896; Fortunato Fulgencio (15 May 1938), Box 18, no. 2034; Frederick Harris (6 Oct. 1937), Box 16, no. 1715; Benjamin Hogins (2 Apr. 1938), Box 18, no. 1957; Roy Williams (11 Dec. 1936), Box 14, no. 1413; and Bill Windsor (28 Oct. 1940), Box 25, no. 3435, MS 999, AJ16, AHC.
66 Labor turnover rates derived from 1936 and 1940, the two years for which the full complement of monthly reports are present in files. Rates reported in these years were respectively 27.7 and 26 percent for the mill, and 54 and 58 percent for underground workers. Numbers taken from "Monthly Report of Labor Conditions" found interspersed in accident files. See accident records, Boxes 12-14, and 24-26, MS 999, AJ16, AHC.
67. Daniel J. Curran, *Dead Laws for Dead Men: The Politics of Federal Coal Mine Health and Safety Legislation* (Pittsburgh: University of Pittsburgh Press, 1993), 50-2.
68. Here I echo Turner and Blackie's findings from a study of disabilities in early British coal mines, in which the authors concluded that "the experiences of those whose bones were broken, whose bodies were crushed, 'lamed' or maimed, or who entered old age prematurely as a result of being 'worn out' by their labours or by the shortness of breath brought on by lung disease, matter just as much to mining's history as those who lost their lives." David M. Turner and Daniel Blackie, *Disability in the Industrial Revolution: Physical Impairment in British Coalmining, 1780-1880* (Manchester: Manchester University Press, 2018): 200.