

Automation and safety on container terminals

Accidents and injuries on the quayside have reduced dramatically over the past 50 years, so how can we continue this trend into the future?

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Fewer injuries to one and all

“An Injury to One Is an Injury to All” is the famous slogan of the International Longshore and Warehouse Union (ILWU) – a powerful union that works the ports on the West Coast of the United States. And until cargo containerization became a widespread practice, working the docks was a remarkably dangerous profession. According to Pacific Maritime Association (PMA) statistics, the injury rate prior to 1960 was between three and four injuries per full-time worker *every year*.

This appalling rate of on-the-job injury dropped dramatically as breakbulk operations were phased out in favor of containerization. By the late 1970s, the annual rate of injury was approximately 15 per 100 full-time workers, some 95 percent lower than the rate prevailing prior to containerization.

Whether the ILWU advocated containerization with sufficient gusto – in keeping with their anti-injury slogan – is a topic for

another paper. This paper focuses on post-containerization safety trends, and explores the possibility of generating further safety benefits by increasing automation at West Coast ports.

Figure 1 summarizes U.S. West Coast (USWC) data provided by the PMA for the period from 1993 to 2009. The PMA tracks cargo moved in terms of tons. Approximately 296 million tons of all types of cargo moved across the USWC ports in 2009. The fraction of that tonnage that has been containerized has climbed steadily over this time period, from approximately 60 percent to 75 percent.

As one might expect, the injury rate has been steadily declining over time. Since 1997, the rate has fallen to and remained below one annual injury per 10 full-time workers (less than one-thirtieth of the rate prevailing in the 1950s). Better safety gear and training account for part of that improvement, and a system is in place to learn from past accidents and modify behavior accordingly,

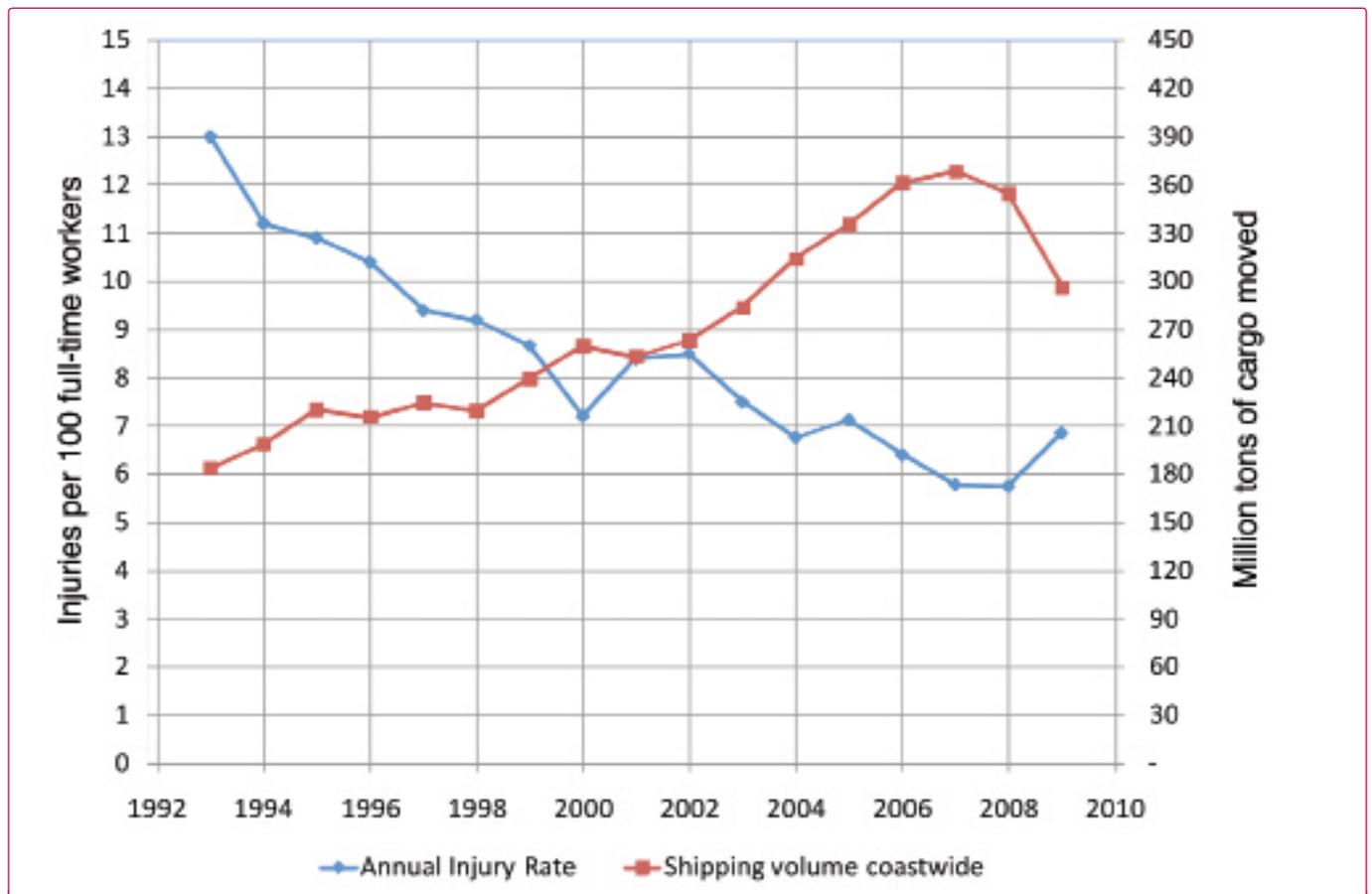


Figure 1. USWC Shipment Volume and Injury Rates (Source: PMA).

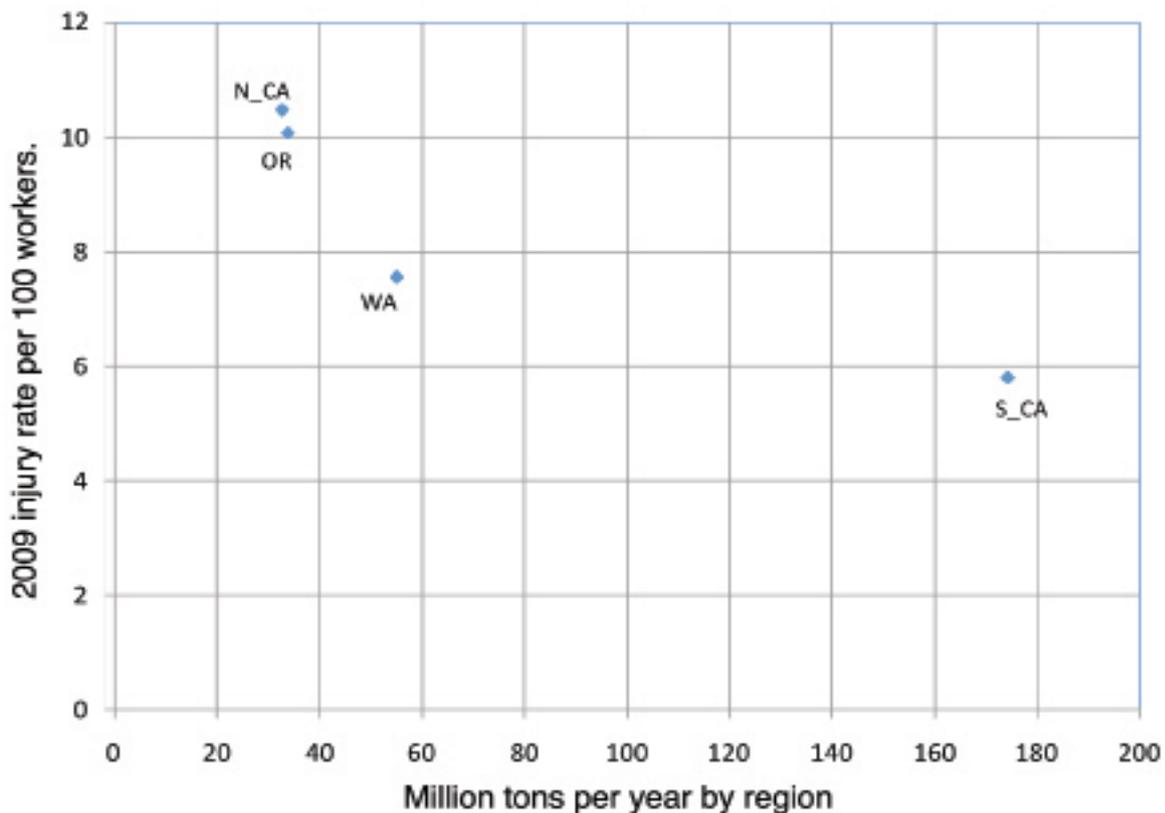


Figure 2. Injury rate by region.

which should result in a continuing drop in injuries on the job. Progressively higher rates of containerization (versus breakbulk cargo) may also be a factor in driving down the injury rates.

Safety in (tonnage) numbers?

The decline in injury rate has not been uniform, however, and it is interesting to examine years when it went up to try to explain why increases might have occurred. Two years stand out in particular: 2001 and 2009. One thing these years have in common is that volume dropped in each of these years compared to the previous year.

From 2008 to 2009, the total coastwide tonnage declined 16 percent, yet the injury rate increased 19 percent. This seems to suggest some type of safety-in-scale effect at marine terminals. Figure 2 plots injury rate by region for each of the four regions tracked by the PMA: Southern California, Northern California, Oregon, and Washington.

Figure 2 reinforces the notion that increased volume somehow equates to increased safety. The Southern California region has by far the largest volume, and also the lowest rate of injury, of the four PMA regions. Rainy weather does not seem to be a major factor affecting the injury rate, since rainy Washington has a lower rate of injury than sunny Northern California. The level of containerization does not seem to be a major factor either. Heavily containerized Northern California shipments had a similar injury rate as bulk-heavy Oregon, which operates at the same overall tonnage volume.

So what factors drive down the rate of injury as volume increases? Perhaps there are certain fixed sources of injury, such as vessel mooring. A vessel undertaking 500 container moves requires the same amount of line handling, and offers the same opportunities for injury during line handling, as one doing 5,000 moves in a single port call. Perhaps yard tractor drivers and other workers develop a safer work pattern on vessels that are doing a high number of container moves per call. Or perhaps the typically

larger, more modern terminals in Southern California benefit from safer design features.

Perhaps when volumes decline, the demographics of the work force change as older workers with more seniority are now forced to do the physically tougher jobs that were done in busy times by younger (and presumably fitter) workers with less seniority. Perhaps the economic stress of a downturn in cargo volume motivates some workers to apply for injury-related benefits to cover lesser injuries that are ignored in good times (when desirable overtime work may be more plentiful). This paper offers no concrete answers to these intriguing questions, but hopefully does offer inspiration for further study and improvement – particularly for USWC ports north of Los Angeles.

Automation equals safety

Terminal automation is often touted as a way to achieve substantial safety benefits. Both yard cranes and terminal transport equipment can be fully automated, although none of the yard equipment used on the USWC was automated in 2009. In order to estimate the potential decrease in injuries due to automation, it is important to examine the categories of workers that were injured at USWC ports in 2009.

Table 1 shows the number of injuries by worker category, as well as an estimated reduction potential for two different circumstances. Column (a) shows the potential reduction in injuries at a terminal working with automated stacking cranes (ASCs) and manned shuttle carriers such as APMT's Virginia Terminal. Column (b) shows estimated reductions for a container terminal working with ASCs and automated guided vehicles (AGVs) such as the Euromax Terminal in Rotterdam. (Note: Reduction percentages are the author's best estimates based on mainly anecdotal data.)

Tractor Driver: With AGVs in place no tractor drivers are needed, and therefore all associated driver injuries are eliminated. With manned shuttle operations, approximately half the number

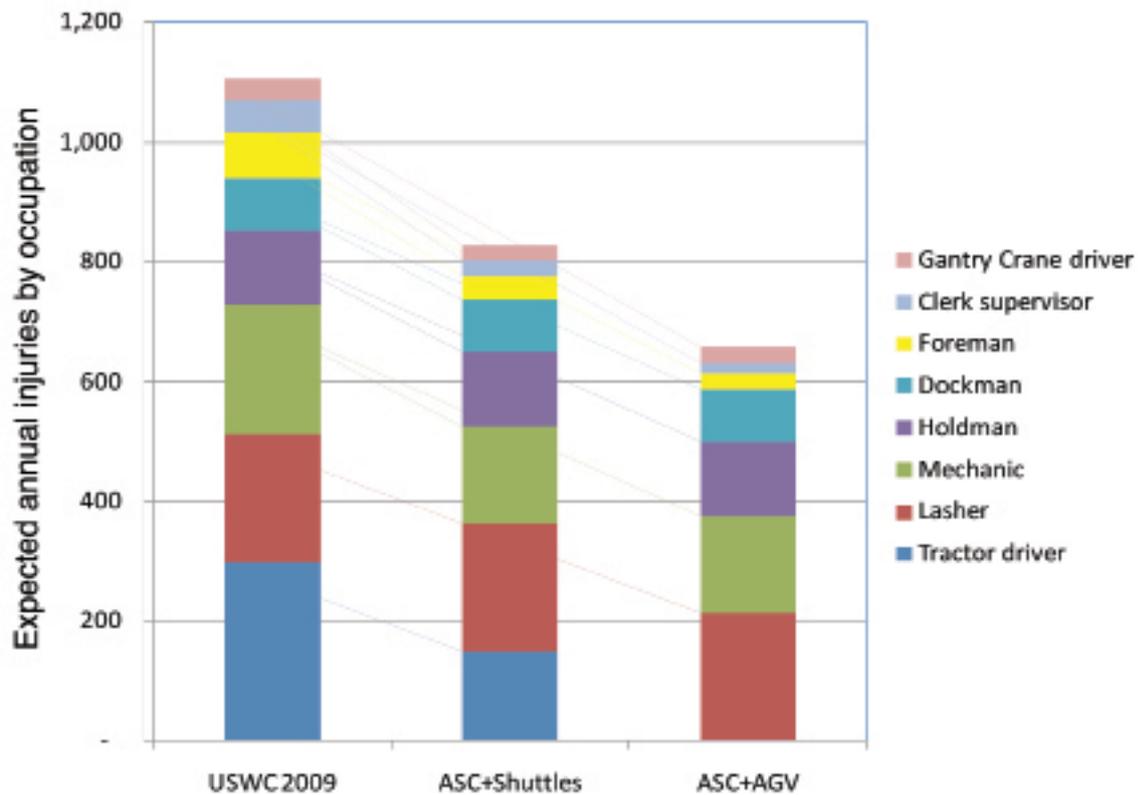


Figure 3. Injury reduction potential of automated terminals.

of vehicles would be required compared to a conventional terminal, so injuries could be expected to decline by half as well.

Mechanic: In either case, there are fewer vehicles and less overall maintenance activity required due to the more regular pattern of operations. Spreaders, for example, require much less maintenance in automated terminals because the automated cranes always set containers down gently. A 25 percent reduction in injuries is estimated, based on anecdotal evidence from representative terminals.

Foreman and clerk supervisor: The number of supervisors required is a function of the overall number of workers engaged at a facility. With automated terminals and automatic container positioning, far fewer supervisors will be required, and injury rates should decline accordingly. Therefore the estimated reduction in injuries to supervisory staff is 67 percent with AGVs, or 50 percent with shuttles in place.

Gantry crane driver: This refers to both rubber-tired gantry (RTG) and quay cranes, with quay crane drivers accounting for the majority of the hours. Since all RTG driver positions will be eliminated, any associated injuries will be eliminated as well. The need for top-pick drivers will also be eliminated. Although top-pick drivers are not listed on the most frequently injured list and their hours are not tracked in this category, presumably they incur some injuries that will be eliminated by converting to ASCs. An overall reduction rate of 50 percent reflects the elimination of all injuries to both RTG and top-pick drivers, but no change in injury rate to gantry crane drivers.

Even if a USWC terminal is converted to a highly automated design such as that used at Euromax, no change is expected in the number of lashers, holdmen or dockmen. These are people who are handling mooring lines, securing the containers on the ship, and installing or removing inter-box connectors (twist-locks). These are strenuous jobs that frequently result in muscle strain or other injuries if the worker is not fit or is using improper technique.

If the factors from Table 1 are applied to a hypothetical future scenario – with all container ports on the USWC converted to ASC-based terminals – injuries would be reduced as shown in Figure 3.

Conversion from existing manual operations to full automation (including AGVs) could potentially reduce injuries by approximately 40 percent. A 25 percent reduction in injuries is expected from conversion to an ASC/shuttle-type terminal. These reductions equate to a prevention of approximately 450 and 290 injuries per year respectively across the entire USWC.

One promising technology for further injury prevention is the use of automated mooring with vacuum devices, as opposed to using traditional ropes. Figure 4 compares traditional mooring with vacuum-based automated mooring technology; the exposed workers in the left image are simply unneeded – and therefore not at risk – when better technology is used.

Approximately 2 percent of the total longshore hours were charged to line handling in 2009. Complete conversion to

TABLE 1: 2009 INJURIES BY CATEGORY, AND POTENTIAL FOR REDUCTION VIA AUTOMATION

	2009 Injuries	Estimated Injury Reduction (%) with:	
		Column (a) ASC+Shuttles	Column (b) ASC+AGV
Tractor driver	298	50	100
Lasher	214	0	0
Mechanic	216	25	25
Holdman	124	0	0
Dockman	88	0	0
Foreman	77	50	67
Clerk supervisor	53	50	67
Gantry crane driver	35	50	50



Figure 4. Manual versus automated mooring.

automated mooring should have the potential to reduce injuries by at least 2 percent, compared to 2009 levels.

Dockmen who are responsible for twist-lock handling account for 8 percent of the injuries listed in the PMA's top eight categories shown in Figure 3. But devices such as the PinSmart machine developed by RAM Spreaders may be able to significantly reduce the labor required to install and remove twist-locks from containers, thereby eliminating many of the associated injuries.

Safety on the docks of the U.S. West Coast has come a long way in the past 50 years, and further improvements are still readily available through the use of automation. However, with no automation on the horizon for on-ship lashing or equipment repair (another essential activity that is burdened with high injury rates), some level of injuries will continue to occur on container terminals. Continuous vigilance and increasingly thorough training will be required to reduce the injuries incurred performing these types of manual tasks.

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