The Future North American Locomotive Cab
Managing Today With a View to the Future

Jeffrey Moller

Assistant Vice President Transportation Systems & Practices

Association of American Railroads

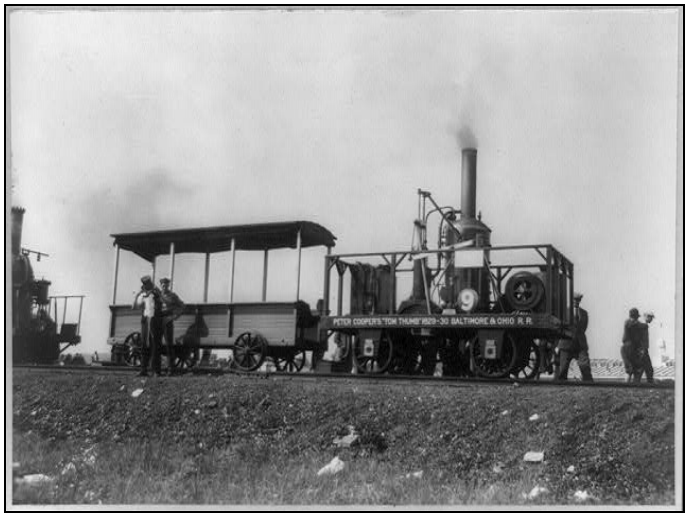
SUMMARY

This paper summarizes information presented at the 2013 Mid-Year Meeting of the Transportation Research Board's Railroad Operational Safety Committee (AR070) that was held on July 30, 31, 2013 in Omaha, Nebraska. The meeting included a discussion of the evolution of cab design from the earliest locomotives to the present, current efforts to integrate advanced train control and energy management systems into current cabs and a review of human factors and ergonomic principles that can guide future designs. Representatives from railroads, researchers, manufacturers and labor are forming a new industry cab committee and will be using these principles to devise the next generation of North American locomotive cabs.

INTRODUCTION

In the earliest days, locomotive cabs showed little awareness of what we now call *Human Systems Integration* which, in simplest terms, is a consideration of the abilities and needs of the operator when devising a work environment. As locomotives evolved and became more complex, one can see efforts to better organize the controls and increase the comfort and safety of locomotive crews. The last significant design standard for North American locomotive cabs occurred in 1972 and the industry is now undertaking an effort to produce a new standard design.

THE EARLIEST LOCOMOTIVES



The builders of the earliest locomotives gave little consideration to the needs of the operating crew. There was no cab to protect from wind or the elements and no provision for seating or even lighting to see the controls or illuminate the track ahead. Many activities such as feeding the boiler and operating the brakes called for strong physical effort.

Figure 1 - 1927 Replica of 1830 Locomotive "Tom Thumb"
Open Source from Wikipedia

In this electric locomotive cab from 1915 the controls follow contemporary steam locomotive design. The various controls were placed wherever most logical from a manufacturing perspective. A brake valve, for example, was located near to where its piping entered the cab with little thought as to the relationship of the throttle and brake handles (or the engineer's knees). However one can see beginning efforts to instil some order into the design. Note the group of gauges placed together and illuminated by a light bulb underneath the round black cover.

Forward visibility in this locomotive was a significant improvement over steam locomotives with their long boilers. Locomotive like this one operated until the early 1970's and in their later years were equipped with windshield wipers and a rubber-mounted window in a steel frame instead of the wooden sash.

Figure 2 – 1915 GE Electric Locomotive - Chicago, Milwaukee, St. Paul and Pacific Railroad
Used with Permission

In 1934 in the depth of the economic depression the Chicago Burlington & Quincy Railroad ordered a stainless steel diesel-electric-powered 3-car "Streamlined" train in an effort to stimulate passenger business. Union Pacific Railroad also ordered an aluminum trainset that was delivered about the same time. Notice the instrument panel is becoming more prominent and there is now a windshield wiper. However, other controls are still placed haphazardly. See the gages high on the left of the wall and the brake valve on the right would still bash one's knee if they are not careful. Finally it would not be comfortable to sit on that backless seat for hours at a time with part of the engine equipment beyond a thin metal wall just to the rear.

Figure 3 - 1934 EMC Diesel Electric Locomotive - Chicago Burlington & Quincy Railroad
Used with Permission

MASS-PRODUCTION

This is the cab of one of the nearly 3,500 *General Purpose* GP 9 locomotives built by EMD between 1954 and 1963; many remain in service today. This cab is a typical example of the design pre-dating the standard AAR "Clean Cab" as discussed below. Moving the large red lever to the left controls both power and dynamic brake depending on the position of the selector lever (above and to the right). Various other controls are more neatly organized than on earlier locomotives. Although the controls are carefully designed to facilitate operation in either direction this locomotive has two separate control stands – the engineman can be seen operating from the other side of the cab.

Figure 4 – EMD GP 9 Locomotive, Circa 1955
Used with Permission

Note, however the location of the radio and speedometer which appear to have been added wherever they could after the locomotive was built. Before the Clean Cab design discussed below, additional boxes containing end-of-train devices and distributed power controls were added to such cabs.

CURRENT NORTH AMERICAN LOCOMOTIVE DESIGN

In 1972 the AAR Clean Cab design became the standard design. Major features included a separate throttle and dynamic brake levers with different shapes, and air brake and dynamic brake levers arranged so that a movement to the left increases braking effort. Other design features include rounded surfaces on various cab features to reduce injuries, and a large door handle to prevent pinching the fingers.

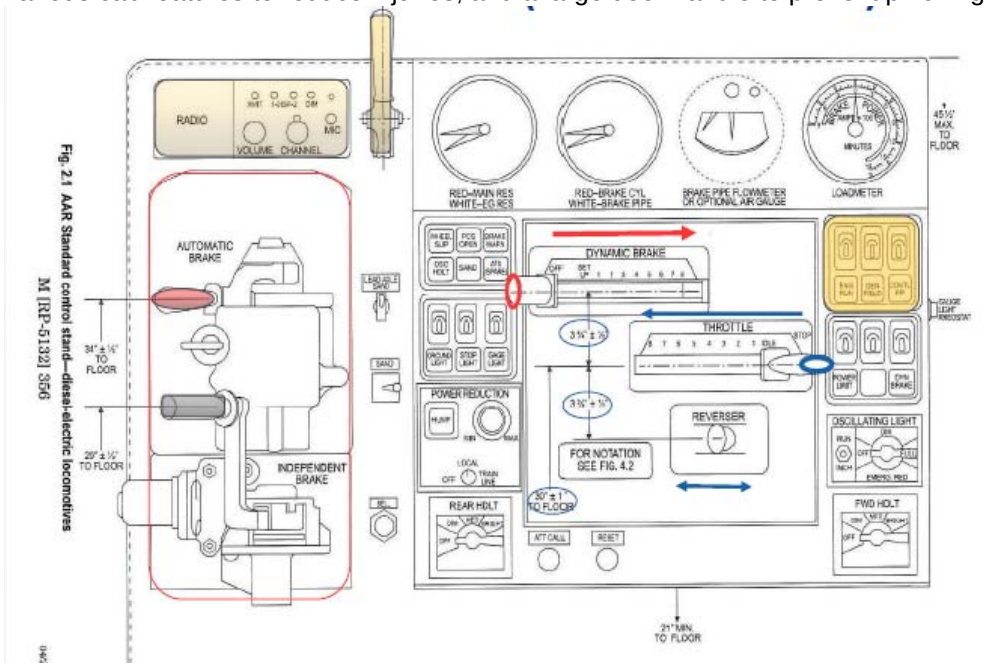


Figure 5 - Standardized Cab Controls – Specification AAR RP-5132
Image Courtesy of EMD

Figure 6 – An Example of Current Cab Design
See Source Below (Control Stand Final Report)

This GE locomotive is an example of current production still showing the main features of the 1972 AAR Clean Cab design. The dynamic brake and throttle handles are separate and have different shapes so they can be readily identified in the dark and they move in opposite directions. Analog gauges have been replaced by video screens; the top of the control stand where the man is leaning has been lowered to increase visibility to the left side of the cab and out the window. Various other devices such as the radio are recessed into the control stand or in the area above the windshield (not seen in this picture).

This design has performed well for more than 40 years but modern technology now provides the freedom to move in new directions.

CURRENT RESEARCH INTO ADVANCED DESIGNS

Figure 7 – Heads Up Display
Photo Courtesy of RSSB

A major challenge faced by designers is how to integrate various complex operating and traffic control outputs into a meaningful arrangement. Presenting the operator with many busy display screens might cause them to spend too much time in a “head down position” monitoring the various systems rather than looking out the window observing signal aspects watching for level/grade crossings, trespassers, etc.

One possible approach would be to project important data right onto the windshield or use of a clear small window suspended in front of the operator, a heads-up display (HUD).

This technology has been used in aviation for decades and is beginning to find its way into automobiles. The above image is from a feasibility study using a driving simulator by UK’s Rail Systems Standards Board. Researchers arranged to display speed, air brake information, the wayside signal system (green “sunflower”) and the location of the next wayside signal (small box superimposed over the left rail)

Driver feedback indicated they liked the system and further research could explore what information elements should be displayed on the HUD and how can it be best applied in the harsh rail environment. Additional information about this study can be found in the following paper:
http://www.rssb.co.uk/SiteCollectionDocuments/pdf/reports/research/T513_rpt_final.pdf

Figure 8 - A Mock-up of a Possible New Design
See Source Below (Control Stand Final Report)

Aside from different approaches to displaying data, technology also presents an opportunity to explore different approaches to the design of switches and controls. Above is a photograph of a mock-up design that may point the way to tomorrow's locomotive cabs. Here the throttle and dynamic brake are now operated by the same lever. A similar arrangement is already installed in a large number of North American locomotives that have a desk top control arrangement so this proposal would probably not require a major adjustment for today's operators. However, designers may want to take advantage of today's technology where the major controls such as the throttle and brake no longer operate large mechanical or electro pneumatic controls. These have been replaced by smaller electric switches; a small "joystick" installed in a seat arm could now perform the same function.

As discussed above, a major challenge will be designing the content of the displays so that they provide enough information to the operator without creating additional workload or distraction.

The above photograph and other information can be found in the following report:

http://ntl.bts.gov/lib/42000/42200/42298/NGLC_Control_Stand_final_report.pdf

CONCLUSION

Locomotive cab design has made significant strides in the almost 200 years of railway operation. Today's cabs are comfortable and well-designed, allowing an operator to operate the controls and view the route ahead while operating in either direction. The many boxes draped around the cab that used to contain radios, speedometers, end-of-train devices, etc. have been organized and consolidated into a logical arrangement.

However, with the replacement of old-style electromechanical controls and with the introduction of advanced train control systems, energy management systems and distributed power, alternative methods should be explored to better maximize information found in the various systems and provide the necessary feedback to the operator.