Equipment Infrastructure Needs for Customer Satisfaction and Operational Improvement

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To discuss the subject of the future needs of equipment infrastructure, one must have an understanding of three things: the identity of tomorrow's customers, their requirements, and how the overall rail environment will look in the next century. Although the understanding of these three items requires a certain amount of clairvoyance, the author believes that sufficient focus on these issues can be obtained to at least provide some general assumptions about the future equipment needs of the rail industry.

In articles in the *Journal of Commerce*, Rip Watson indicated who the customers will be and discussed the diversity of their requirements. On May 26, 1993, he discussed the bulk commodity customer (*1*): "As shippers demand more efficient service, and management as well as investors demand better return on investment, railroads and suppliers have been stretched to redesign coal and grain equipment to loads as large as 120 tons a car."

The next day he discussed the intermodal market (*2*): "The contrast between rapid growth in intermodal rail traffic and lack of growth in the fleet of trailers and containers that carry it is prompting fears of a record equipment shortage during the normal peak period this autumn."

On one hand, bulk commodity customers will remain with railroads and will require increasing capacity and reliability at decreasing rates. On the other hand, new customers should enter the market. Their requirements may be such that purchases of equipment may not be limited to what one now visualizes when someone uses the term "freight car." These two expectations are presented to underscore the wide range of customers that the rail industry must learn to serve if it intends to survive in the 21st century.

From the customer's viewpoint, everyone in the railroad industry should be familiar by now with the just-in-time concept. With inventory control at such a high visibility level, this may also implicitly mean "just the right amount." For example, United Parcel Service and its competitors have developed a significant market by providing quality shipping of single, small items. Although it is doubtful that the Railway Express Agency will reappear any time in the near future, the impact of the just-in-time/just-the-right-amount philosophy on new equipment designs will be significant.

The rail industry must provide the diverse services that Watson wrote about if it intends to be a growth industry. It must continue to serve bulk customers with increasing efficiency. It must develop new and faster ways to provide intermodal service, and it must learn how to cost-effectively serve the small-volume owner-operated businesses that have been driven away from the rail transportation market. All of these things must occur in a transportation environment in which revenue per unit volume will be steadily declining because of competitive pressure.

Before specifics in the equipment infrastructure are covered, some basic generalities concerning the rail environment in the next few decades will be discussed. This environment will undoubtedly include passenger traffic. Although it is romantic to talk about high-speed passenger trains, a more realistic view comes from an examination of the goals of high-speed passenger transportation. The author believes that there are two goals: reduce the overall transit time and retain a cost structure that provides a competitive advantage for the rail mode.

From the rail passenger's viewpoint, there is much room for improvement. Reduction of transit time by rail could be achieved in much of North America with a horse-drawn railcart, since service is presently nonexistent in many areas. As much as the magnetic levitation proponents want to see their dreams become reality, the most likely interim step will be to expand passenger service over existing lines. Equipment for this expanded service will be constructed using current designs similar to the equipment that is now running at speeds of up to 125 mph. If rail passenger traffic is to be revived in the United States, it will happen in this fashion because of the unbearable costs of a more advanced, untried technology. The current search of the National Railroad Passenger Corporation (Amtrak) for a train similar to the Swedish X2000 that has been on tour in the United States underscores the validity of this hypothesis.

Why is this point important to the overall future of freight equipment? Simply put, the freight equipment will be sharing track of similar design as the passenger equipment. Because passenger transportation is, by its nature, a just-in-time delivery system, the freight equipment operating in the same environment must be reliable in order to minimize delays. It must also provide reduced dynamic loads to avoid rapid or catastrophic track degradation in conjunction with passenger traffic. For these reasons, an understanding of future freight equipment cannot be developed without consideration of the total rail environment.

Even if passenger traffic does not affect freight transport, one should realize that the goals of rail transportation, whether freight or passenger, are essentially the same. What do freight customers want? They want to reduce the overall transit time while retaining a cost structure that allows them to maintain a cost competitive advantage. This is exactly what passengers want. Thus, there is no real difference between passengers and freight customers. With this understanding, the specifics of freight vehicles in the 21st century may now be explored.

To place this analysis in proper perspective, the long-term needs of rail customers should be viewed as practically unforeseeable, which will force the rail industry to focus on the methods used to design and implement new equipment. A rapid response will be required from not only the equipment design team but from individual railroads to quickly place new, innovative equipment designs in service to meet the needs of new customers.

The existing record of railroads is not good. An arguably worst case in point is that of Roadrailer. This technology languished for many years because no market existed and because railroad operating personnel did not accept it. Only today, with the advent of Triple Crown Services, is a profitable interchange market beginning to develop for this equipment. Future equipment design and implementation cannot take as long or the rail industry will be bypassed by its trucking competition.

Availability and reliability are two factors that will have a great impact on the future design of equipment. For freight transport, equipment makes an average of two trips per month. Indeed, the average rail haul is measured not in hours, but in days and, unfortunately, sometimes in weeks. This time often depends on equipment reliability. Future equipment must be designed to have almost no downtime. It must also be designed to provide quick turnaround. Car cleaning and other preparations must be considered during the design phase. In some cases, use may be improved by providing sufficient flexibility to allow backhauling of a different commodity. These are extremely difficult requirements, but they cannot be dismissed simply because of their difficulty.

Train size and makeup will significantly affect the future. Equipment designs will be influenced by the type of trains that are used. According to conventional wisdom, a train as long as is physically possible should be run to take advantage of the reduced crew costs. The trucking industry makes a living hauling 60-ton loads. The railroad industry must learn to provide the same type of service to its customers. This means shorter, perhaps customer-dedicated, trains with car designs specifically tailored to the customer's product. Impossible, you say? The railroad industry has learned to do this with bulk commodities such as coal and grain; it must now learn how to expand this idea to other commodities.

Attention must be paid to sizing new equipment properly. The more flexible the car, the better. Development of a variable-sized car should be considered. This does not mean an expandable car. One example is an articulated car design that would allow for rapid change in the number of platforms.

In the area of truck design, a whole world of development awaits. Almost the entire North American rail fleet rides on a truck design that is well over 100 years old. Its forte is its ability to negotiate bad track with little maintenance. Although some track fitting this description still exists, for the most part the three-piece truck is not needed for this purpose today. Instead, the rail industry is moving toward an excellent track structure over which high-speed trains operate.

Most three-piece trucks in service today do not receive sufficient maintenance to operate in this environment. Traditionally, they have been maintained on a time basis. As the demands for improved equipment use increase, this time-based maintenance philosophy will not keep pace with equipment use requirements. For such equipment, maintenance must be done on a mileage basis.

Often, no visible signs of truck maintenance deficiency are apparent. Insufficiently maintained trucks are found only after costly lading damage or derailment. Temporary solutions, such as elastomeric dampers, have been applied to allow for operation at higher speeds. These devices trade good curving performance for high speeds. It is unclear whether the overall maintenance costs of these devices will be affordable in the long term. In any event, it should be readily apparent that the North American rail environment needs an entirely new truck design.

Ride quality will, without a doubt, be a major driving force for customer satisfaction in the next century and must be the central focus of the truck design effort. Some sacrifice in performance in the area of track geometry deviation negotiation may be necessary. The new truck must provide improved vertical ride quality and effective lateral control for high-speed operation.

The braking system for this new truck likewise needs to be of radical design. The present pneumatic control system has several disadvantages. Signal propagation time is too long and erratic for the length of typical North American trains, causing unpredictable, uneven braking and consequent excessive longitudinal accelerations and mechanical problems. The air supply for both power and control comes from the same damp, dirty source. This causes reliability problems with the control valves, particularly during rapidly changing ambient weather conditions. A better solution would be to separate the control air supply from the braking power air supply. This solution would ameliorate some of the reliability problems with the control equipment, but would not affect the signal propagation times.

The best solution would be use of an electrical signal for control. This solution would open the door for a feedback path to the controller to ensure that the commanded operation has actually occurred. This signal path may also be used for passing other important messages along the trainline. These messages might include truck performance information, such as roller bearing temperature and alarms, wheel slip/slide warnings, control of remote or distributed power units, and automatic cutout and reporting of defective braking components.

Scheduled maintenance should be addressed when future equipment design is discussed. Consideration should be given to a universal truck-mounting scheme with all braking components installed entirely on the truck itself. This would allow a unit exchange of a truck under any type of equipment without requiring connection of more than the power braking air and the control signal and without adjustment of brake rigging and side bearings, which would be done with the truck removed from the vehicle in a dedicated truck repair shop. Scheduled maintenance could then be performed rapidly.

In addition, a slackless coupling that works as quickly and as easily as the existing interlocking coupler system is needed. Such a coupling system should incorporate the power braking air supply and the electric control buss. This coupling would provide benefits for maintenance as well as longitudinal ride quality, isolation of single platforms of articulated cars on line of road if necessary, and the car-sizing requirements previously mentioned.

Unscheduled maintenance must be kept to a minimum. If regular maintenance can be performed quickly and reliably with a unit exchange philosophy, train delays due to mechanical failure should seldom occur.

Thus far, the issues of track and equipment have been discussed separately. The reader should not be deluded into believing that these two items can each be addressed in a vacuum. Before one can begin discussion of the design needs of either track or vehicles, one must consider the effects of the vehicle and track system as a whole. Although some industry efforts recognize this need today, as evidenced by the Vehicle/Track Systems program of the Association of American Railroads (AAR), few practical tools exist that allow the entire system to be considered at one time during design efforts.

Two examples of this problem follow. The first is the experience that Amtrak had with its initial installation of concrete ties on the Northeast Corridor. The wooden crosstie is forgiving of high dynamic track loads. The concrete tie is not. Its extra weight and stiffness create a barrier where more of these dynamic loads are concentrated instead of being dissipated in the ballast, subgrade, and wooden tie. Not only does the concrete tie suffer, the added stiffness increases the magnitude of the vertical vibrations on such track, which can in turn affect sensitive lading.

The second experience was the inception of the use of chocks instead of chains for restraining automobiles. The chains effectively short circuited the automobiles' suspension. This meant that the automobiles experienced essentially the same vibration as the railcar. With the use of chocks, the automobile suspension became a part of the equation. Much to the chagrin of shippers and receivers alike, more than one case of destructive resonance has been found.

To circumvent this problem, analytical tools need to be developed that will incorporate all parts of the rail environment from the subgrade up to and including the lading characteristics. This will allow an easy method to evaluate new designs of track, vehicles, and lading containment methods during the design phase. Items that should not be ignored in the development of these new tools include wheel and rail profile interaction, angle of attack, and dynamic wheel impacts.

Reduction of the dynamic track loading needs to be a joint goal of both the equipment and track designers. This was successfully accomplished by British Rail in the design of its IC225 intercity equipment. The benefits in this area are difficult to quantify but are empirically obvious. Irregular track leads to higher dynamic forces in the equipment and lading. Not only must the designers of the rail equipment take this into account, but the designers of sensitive lading must do likewise. If a poor vehicle suspension system contributes to the degradation of the track, a high maintenance infrastructure results.

If the author could wave a magic wand and instantaneously develop the perfect rail vehicle, it would have the following characteristics:

- The car body would be considered much like the 40-ft oceangoing container is considered in today's intermodal service. Instead of being placed on a chassis, it would be placed on a universal rail wheel truck. This would not be done as a matter of course as is done with the container, but would be used to provide rapid maintenance, similar to a pit stop at a Formula 1 automobile race.
- The intercar connector would be slackless and be able to be disconnected quickly and without tools. It would incorporate automatically all trainlined functions, both air and electric, during operation.
- Each truck would have its own electrically controlled braking system that would include an antilock, wheel slip/slide detector to prevent wheel damage and reduce wheel maintenance. The truck would require a connection to the power braking air and a connection to the electric trainline data buss.
- Maximum dynamic wheel forces would remain at levels below those presently encountered with existing 100-ton equipment. New 125-ton designs would be included.
- The design of this new vehicle system would have only one requirement from today's freight equipment—the track gage would remain at 56½ in.

Although some of these ideas may never become reality, the following steps must be taken to ensure that future rail equipment meets or exceeds the requirements of the railroad industry and its customers, thus ensuring the survivability of the rail industry:

- A new slackless connector to provide all trainlined functions, including the power braking air and the electrical signal buss, must be designed.
- Hardware and communications protocol for the signal buss must be designed. One essential item will be to develop a scheme for each buss resident to automatically determine its position on the buss and thus its position in the train.
- A high-speed, low-maintenance truck with smooth ride quality from the standpoint of both the track and the lading must be designed. It should be completely maintainable when removed from the rail vehicle.
- A new truck-mounted, electrically controlled, antilock braking system must be designed. This system should be capable of dissipating the braking powers of the heaviest cars within the limitations of the materials.

At the recent AAR Future Search Conference discussed by Roy Allen elsewhere in this conference proceedings, the rolling stock working group suggested the following actions:

- Joint teams of customers, railroads, and car builders should be formed for the timely development of new equipment.
- The AAR mechanical committees should develop relevant and accurate performance standards to ensure safe, reliable interchange operations of new equipment without impeding rapid innovations.
- In conjunction with the development of the total system design analytical tools mentioned earlier in this paper, life-cycle cost tools should be developed to achieve the lowest overall costs for new equipment designs. This tool should not ignore the nondollar quantifiable and qualitative impacts.

As was stated previously, if the railroad industry does not rapidly develop methods to provide customers with the service and equipment that they require, the competition will. With the energy efficiency that the rail industry can provide, there is every reason to prevent it from joining the ranks of other dead or declining industries.

REFERENCES

1. Watson, R. Railcar Diversification Matches Market Trends. *Journal of Commerce*, May 26, 1993, p. 9B.
2. Watson, R. Intermodal Rail Growth Strains Equipment Fleet. *Journal of Commerce*, May 27, 1993, p. 1A.