A fruitful cooperation between natural and human sciences is feasible. In the transport field, psychological and epistemological expertise is required. Human sciences are best suited to dealing with economic problems and to conduct research on economic topics.

According to a novel idea that is fast spreading to the cognitive area of the scientific world, a balance between economics and environment (including people and their ethos) is possible and necessary. Anarchic economics, based only on profit, should be replaced with economics organized according to a global view of people's requirements.

BIBLIOGRAPHY


Abstract: Public policy and government regulations in North America are placing increasing demands on all forms of commerce, including transportation, to reduce their impact on the environment. Providers of transportation are being required to substantially reduce or eliminate the generation of air pollutants, toxic chemicals and other solid and liquid wastes. These demands are having a substantial impact on the development of new technology for application to North American railroads. This growing environmental awareness and regulatory pressure can provide a competitive advantage to railroads vis-à-vis highways, provided the regulations are reasonable, and provided we can meet the challenges they present with cost-effective technology. Trains powered by diesel locomotives, the dominant power source used by North American railroads, are three to four times more energy efficient than trucks, on a net ton-kilometer basis, with comparable advantages in terms of exhaust emissions. Despite this inherent advantage for the rail mode, government regulators at the local and federal level are in the process of formulating regulations that will require substantial reductions in exhaust emissions from both highway trucks and locomotives.

Railroads, along with other industries, are discovering that the most cost-effective approach to a clean environment is often prevention rather than treatment and disposal. Accordingly, North American railroads are examining all operations and processes to identify which generate environmental pollutants, and how such generation can be reduced or eliminated. Some recent examples include the use of stronger tank cars and safer train operating characteristics when transporting chemicals that are particularly harmful to the environment, changes in diesel locomotive design to reduce the incidence of fuel spillage, new technologies for railroad vegetation control and the development of more energy efficient locomotive diesel engines with reduced exhaust emissions. Beyond these examples the AAR is studying opportunities to further reduce pollution in the railroad industry. Although many changes in railroad technology will initially result in increased capital costs for new equipment, these changes are instrumental to the long-term economic health and viability of the North American railroad industry as it enters the 21st century. The use of new, more environmentally sound processes and equipment will result in the reduction of waste and in many cases improved profitability.
INTRODUCTION

Public policy and government regulations in North America are placing increasing demands on all forms of commerce, including transportation, to reduce their impact on the environment. During its first 20 years, the United States Environmental Protection Agency (EPA) focused its attention primarily on "end-of-pipe" approaches to controlling environmental pollution and on the cleanup of spills that had previously occurred. As a result, US industry has expended enormous effort and expense on treatment equipment and environmental cleanup of contaminated sites. These factors have provided an economic incentive to US industry to emphasize prevention of pollution by changing or curtailing activities that can cause new contamination. This change in emphasis is being bolstered by regulatory attention to the actual processes and materials being used by industry. Providers of transportation are being required to substantially reduce or eliminate the generation of air pollutants, solid and liquid wastes, and noise. The combination of economic incentives and regulatory directives is already having a substantial impact on North American railroad technology and this trend will accelerate as we enter the 21st century.

These issues are affecting railroad technology in a variety of ways and the impact on technology ranges from modification of existing designs and practices to whole new technologies to replace approaches that will no longer be considered viable in a more environmentally conscious society. Some specific examples include: use of stronger tank cars and safer train operating characteristics when transporting chemicals that are particularly harmful to environmental health, changes in diesel locomotive design to reduce the incidence of fuel spillage, new technologies for railroad vegetation control, and the development of diesel locomotives with greater energy efficiency and reduced exhaust emissions. Although many of these changes may pose an added economic burden to railways in the short-term, they are expected to make a positive contribution in the longer term in two ways:

1) Use of processes that generate fewer pollutants will reduce the cost of treatment and disposal of wastes and the associated liability, thereby lowering long-term operating costs.
2) The greater efficiencies inherent to rail transportation vis-a-vis highway can provide a competitive advantage to railroads, provided that environmental regulations are reasonable and that we can meet the challenges they present with cost-effective technology.

In this paper we will briefly discuss some specific examples of how environmental issues are affecting change in North American railroad technology.

ENVIRONMENTAL ASPECTS OF RAILROAD ACCIDENTS

Although railroad accidents are generally thought of as a safety issue, there are substantial environmental impacts as well. Spillage of chemicals from tank cars or fuel from locomotive fuel tanks can be harmful to the environment, cause concern to the public, lead to expensive environmental cleanups, and burdensome new regulation of railroad operating practices. Over the interval from 1980 - 1990 US railroads enjoyed a 60% reduction in their train accident rate. However, this decline in accident rate has diminished in recent years. Although further reduction in the train accident rate is desirable and a variety of efforts are underway to accomplish this, it is less clear how to cost-effectively achieve substantial further improvement. Consequently, in some situations it may be more cost-effective to improve the damage resistance of specific pieces of equipment or complete modes of shipment.

Two recent examples of the type of damage caused by transport of hazardous materials include

DAMAGE RESISTANT TANK CARS TO THE ENVIRONMENT

In the past five years there has been a great deal of attention in North America to chemicals that harm the environment. These chemicals that are commonly transported in small groups of chemicals, account for large volumes of hazardous transportation traffic, accounted for over one billion dollars of environmental risk. Typical practices such as the minimum specification for tank car construction and statistical analyses of railroad accidents have been variously designed to tank cars, such as car accidents. These analyses show that the improved packaging for these tank cars has resulted in the cost for transportation of these chemicals could be as high as $8 billion.

The railroads have also been developing comprehensive methods of accident investigation both human health and the environment. A state-of-the-art quantitation risk analysis has been developed for this purpose. This analysis assesses the risk associated with a variety of incidents under a variety of conditions. The results provide the railroads with a tool for management decisions regarding accident risk.

MORE DAMAGE RESISTANT TANK CARS

Another environmental risk associated with employment of locomotives is accidents and the amount of cleanup and waste that are incurred by railroads. Historically, the nationwide impact of locomotive spills is estimated to be about $2 billion. Our work has lead us to believe that the cost of clean up of locomotive spills is annually about $250 million. Also, railroads annually clean up fuel spills from locomotives and locomotive fuel slips revealed that there are many problems in the design of locomotives in accidents. The design of these accidents often includes sight gauges; however, fuel tank...
America are placing increasing emphasis on reducing the damage that can be caused by chemicals from tank cars or fuel pellets. To achieve this, they are placing increasing emphasis on reducing the frequency and severity of accidents. As a result, the demand for better treatment equipment and procedures is increasing. This has led to the development of new technologies, such as the use of stronger materials and more efficient designs, to reduce the risk of spills and accidents.

The AAR has been working with tank car manufacturers and chemical companies to develop more efficient and safer technologies. One example is the use of stronger, more corrosion-resistant materials. These materials can help to reduce the risk of spills and accidents, and they are also more cost-effective in the long run. Another example is the use of advanced monitoring systems that can detect and respond to potential problems before they become serious.

In conclusion, the demand for more efficient and safer technologies is increasing. This demand is being met by the development of new technologies, such as the use of stronger materials and more efficient designs. These technologies are helping to reduce the risk of spills and accidents, and they are also helping to reduce the cost of treatment and clean-up. The development of these technologies is also helping to reduce the environmental impact of tank car accidents. As a result, the railroad industry is making progress in reducing the impact of tank car accidents on the environment.

Damage Resistant Tank Cars for Chemicals Harmful to the Environment

In the past five years, the railroad industry has seen a great deal of attention in North America, in particular because of the potential for some chemicals to harm the environment when spilled. The AAR has been working with various companies to develop more efficient and safer technologies. One example is the use of stronger, more corrosion-resistant materials. These materials can help to reduce the risk of spills and accidents, and they are also more cost-effective in the long run. Another example is the use of advanced monitoring systems that can detect and respond to potential problems before they become serious.

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accidents, accounting for over 90 percent of the fuel lost on one railroad. Consequently, the greatest opportunity for improvement lies in increasing the puncture resistance of locomotive fuel tanks. The AAR is developing a performance specification for a more damage resistant locomotive fuel tank for use on new locomotives. A principal feature of the new design is a thicker tank that incorporates a system of skid protection to deflect objects that might puncture the tank.

ALTERNATIVE METHODS OF VEGETATION CONTROL

Railroad vegetation control is as important as ever in terms of maintaining a well-drained, safe, high-quality roadbed. Advances in herbicide technology have led to effective products that rapidly degrade after application leaving no residual effect. Nevertheless, public sentiment opposing the use of herbicide treatments along railroad rights of way is increasing and railroads need to consider alternative approaches. Various localities scattered around North America, however, the problem has become acute in the state of Alaska where a moratorium on chemical vegetation control has been in existence throughout the state for several years. In the Canadian province of British Columbia, CP Rail has also been banned from using herbicidal treatments in many areas. In response, CP Rail has developed an experimental system of vegetation control that uses high pressure steam to kill plants growing on the right of way. This system has been tested on many of CP Rail’s lines in British Columbia and was tested on the Alaska Railroad last year as well. These tests have proven that the concept is effective. Unfortunately, the experimental system is generally not cost competitive with chemical treatment. However, CP Rail staff believe that a production model can be developed that would be both faster and more economical to operate, thereby making the system an economically competitive alternative to chemical treatment. If CP Rail can develop an economical system based primarily on steam it will have great promise for the industry.

LOCUMTIVE EMISSIONS AND ENERGY EFFICIENCY

Undoubtedly, the environmental issue that is currently having the greatest impact on North American railroad technology is the drive to improve the energy efficiency and reduce the amount of airborne emissions from diesel electric locomotives. Diesel powered locomotives are the dominant power source used by North American railroads, and on a net ton-kilometer basis they average three to four times more energy efficient than trucks and enjoy a comparable advantage in terms of exhaust emissions. Despite this inherent advantage for the rail mode, government regulators at the local and federal level are in the process of formulating regulations that will require substantial reductions in exhaust emissions from both highway trucks and railroad locomotives. Railroads and locomotive manufacturers will have to achieve substantial reductions in locomotive exhaust emissions in the coming years to meet the regulatory requirements.

Over 99 percent of the more than 20,000 locomotives in the U.S. are diesel-electrics, which burn approximately $13\times10^5$ liters of diesel fuel oil per year. This much energy use results in a significant contribution to air pollution in some metropolitan areas. The best way to reduce railway-caused air pollution is through improved efficiencies in operations and equipment design. This reduces both pollution and costs, thus making the railways more competitive and profitable. From 1980 to 1990, the US Class I freight railroads increased their revenue ton-kilometers per liter of fuel consumed by over 41 percent. This translated into a 25 percent reduction in global warming gases while the railroads moved 13 percent more ton-kilometers of freight.

These accomplishments are but a few of the AAR, railroads, and suppliers' operational measures that will result in substantial changes are: lighter-weight freight in highway trailers on nearly all roads; higher lubrication, higher efficiency and improved train dispatching techniques. With these technologies and operating modifications, a reduction in total railway air pollution emissions will require further reductions. The emissions from the railways is oxides of nitrogen which contribute approximately 50% of the total metropolitan areas and regulations which must be reduced. The railroads will face challenges such as particulate matter, sulfur dioxide, and particulate matter. The rail share of each tends to range between 15% and 20%.

The EPA is developing a new standard for 1999. It will be implemented in stages, beginning with a new standard for 1999. The new standard will require that all diesel engines used for new road vehicle applications be certified to meet approximately 50 percent of the emissions limits that those engines produce today. In 2000, there will be a reduced particulate standard to assure that the maximum emissions of nitrogen oxides from rail engines will be no more than the level of the 1973-1999 engines that will need to be certified. The new standard will allow a much higher level of nitrogen oxide emissions. The engines to be certified for the year 2000 and beyond.

Retrofit kits will probably be the most common way to achieve these standards. These kits will probably include, retarded fuel injection timing control. Options may also include improved turbochargers, different cylinder heads, and other modifications to the engine. New engine designs will have more strict limits on the optimization of the entire engine. This will include the use of exhaust after treatment, combined with the high horsepower level of the engines. Further out, EPA regulations could mandate that it be possible that diesel fuel may not be acceptable unless the manufacturers have tested the engines for the year 2000 and beyond.

Conclusions

The examples discussed above are available to reduce railroads' impact on the environment. The AAR has been able to reduce pollution in the railroads.
the result of a cooperative energy research program of
railroads, that developed a variety of technologies and
implemented throughout the industry. Some of the
railway, lower-resistance axle bearings, conversion of
rail cars to containers on stack cars, wheel flange-rail
joints, improved train handling,
diesel engines, ac traction, improved train handling,
and improved track structure. Because most of
the changes are only partially implemented, we expect to
improve energy efficiency for many years to come. In spite of the
three from efficiency improvements, air quality regulators
primarily from the exhaust stack. The principal pollutant
is nitrogen oxide (NOx), which is a precursor of ozone--smog. The
range 2 to 4 percent of the total NOx generated in many U.S.
consider this amount to be a "significant" contribution.
ways are not significant generators of other pollutants,
sulfur dioxide, carbon monoxide, and hydrocarbons. The
is about 0.1 to 0.5 percent.

regulatory plan for locomotives that will probably go into
unusual in that it will require railways to retrofit engines
NOx by approximately 33 percent. New engines will have
lower NOx limits than the level that typical locomotive
NOx limit for new engines will be lowered again and
be a matter limit. The railways are working with EPA to try
emissions reduction is obtained without raising the cost of
that freight traffic shifts to the highways. The AAR,
ners are working together to develop retrofit kits for the
the EPA requirements, remain reliable, and not lose
manufacturers are working on their own to design new

clude increased aftercooling capacity for turbocharged
timing, and either electronic fuel injection or improved
for some engines are: higher pressure fuel injectors,
high piston rings, and changes in the piston crown shape.
to include all of the above technologies, plus a general
system aimed at reduced NOx and particulate matter
and reliability required for future railway competitive-
ions may require some kind of exhaust catalyst. It is
not be allowed in mobile applications in the future, so that
develop commercially acceptable alternatively fueled
nt future, AAR, railroads, manufacturers, and the US
the National Laboratories are attempting to form
the mover technologies. Alternatives in the early stage of
developments, alternative-fueled diesel engines, and oxygen

this paper represent just a few of the opportunities
impact on the environment while at the same time elimi-
nan a study to identify and evaluate further opportunities
industry with particular attention on car and locomotive

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servicing and repair facilities. Although many of the changes to railroad technology discussed in this paper will result in increased capital costs, they will be essential and indeed instrumental to the long-term economic health and viability of the North American railroad industry. Railroads recognize that the use of new, more environmentally sound processes and equipment will result in reduction of waste and in many cases improved profitability. Regulators must recognize that railroads are a part of North America's solution to environmental problems and that it is not in the public interest to impose regulations that do not take into account the industry's ability to absorb the costs. Cost increases to the railroad industry could shift traffic to less environmentally friendly modes of transportation such as trucks, thereby resulting in a net increase in the pollutants emitted to the environment. Working together, railroads and regulators can develop solutions to environmental challenges facing the industry so that the public interest is served through orderly development of a safe, environmentally sound and economical rail transportation system for North America.

SESSION C3

MESURE ET IDENTIFICATION DU BRUIT

NOISE LOCATION & MEASUREMENT

SCHALLMESSUNG UND SCHALLIDENTIFIZIERUNG