past, at least in a form for use today.

Past practice for determining safety factors was purely empirical. However, during the past 50 years, substantial progress has been made in the probabilistic determination of safety. Today, the mathematics of probability can be used by code writing authorities to achieve more uniform levels of safety, thus decreasing the cost of bridges. State-of-the-art on this subject will also be discussed at the forthcoming January TRB meeting; those presentations will outline steps for further progress.

My next subject is serviceability and maintenance. The trend toward development of load factor-type design methods focused past research particularly on the question of strength. Now that the AASHTO Specifications include load factor design, everyday design practice is showing that it is not enough to consider strength alone. Bridge performance - day in and day out, such as response to overloads - is often the limiting design factor rather than strength. While this isn't new to you, it's a point neglected by researchers in the past. In future, a considerable research effort must be devoted to questions of bridge serviceability. This will automatically lead to research on bridge maintenance. Inspection, evaluation, repair and replacement of existing bridges are other areas that urgently need attention from our research community.

Let's spend a minute or two on the question of structural design specifications for bridges. The principal criteria used today in the United States are the AREA Specifications for Railroad Bridges and the AASHTO Specifications for Highway Bridges. Both have been around for some time; both have grown substantially as knowledge regarding bridge behavior has expanded. While both specifications originally included only allowable stress designs, the first load factor type procedures were introduced during the last decade. I can see 3 areas of structural design that would benefit from specification research: (1) logical rearrangement of the specification format to simplify its use, (2) elimination of duplicate design methods and, (3) incorporation of probabilistically derived strengths and load factors.

Finally, I'll make a few remarks on prefabrication and construction. As a steel industry employee, I've been following with interest and dismay the growth of imports of steel bridges. In 1976 and 1977 several major steel bridges were awarded to foreign fabricators. The 20,000-ton Luling Bridge over the Mississippi, now under construction in Louisiana, is the prime example. While this general topic is outside our Conference's scope, at least one of its aspects has a direct bearing: research on advanced fabricating methods leading to greater productivity.

Let me cite the aircraft industry as an example. Some 20 years ago, under the Department of Defense's leadership, the industry conducted a major project on automated detailing and fabrication of aircraft parts. The result was an early use of computers and a substantial increase in productivity. Although bridge fabricators have accomplished similar steps on their own, it's my belief that any expanded bridge research program must include studies of manufacturing and construction problems, including those of standardization and mass production. A rapid replacement of obsolete bridges with prefabricated units would be of particular benefit to the county systems.

Moving now to the bridge rehabilitation and replacement programs, initial steps have been taken for both railroad and highway bridges. The Northeast Corrdior railway improvements, to be discussed later in this program, include over $300 million for bridge rehabilitation and replacement. Special bridge replacement funds have been authorized for the Federal Aid Highway System in the total amount of $835 million for the period 1972 through 1978. This year, the administration recommended to Congress that the authorization for this program be increased substantially.

These bridge replacement funds are included in the upcoming Highway Act. The House bill allows $2 billion for this purpose at a matching ratio of 80% federal and 20% local funding. The Senate bill, including a recent amendment, would authorize $525 million at a 70/30 ratio. Current versions of both proposals include a provision that 15 to 30% of the funds be spent on bridges not on the Federal Aid Highway System.

The total cost of rehabilitating highway bridges alone has been estimated at well in excess of $25 billion. Thus, even with increased funds, the replacement problem promises to be with us for some time.

In view of this long-term timetable and accumulated backlog of bridge research needs, it appears to me that the bridge rehabilitation and replacement program could derive substantial benefits from stepped-up bridge research. Indeed, we would be remiss if we would not take advantage of the economies that can be gained through better knowledge.

Many of the problems are common to all bridges. Many of the solutions are also common to all bridges. Accordingly, I want to complete my remarks with a call, a call for substantially increased bridge research to be accomplished through a Joint Transportation Bridge Research Program. This program should include both highway and railway bridges and should involve all sectors of the bridge fraternity. Such joint Transportation Bridge Research Programs will maximize this needed effort and bring our best resources to bear on the needed solutions.

KEYNOTE ADDRESS

A. Scheffer Lang, Association of American Railroads

I am not usually given to quoting people, but I ran across a quotation the other day that struck me immediately, because it sums up so well what the Transportation Research Board is all about. The quote is attributed to a Dr. Thomas Arnold, who said: "...it is clear that in whatever it is our duty to act, those matters also it is our duty to study." It seems to me that admonition is what a conference like this is all about: people who design and build and maintain bridges, studying them.

A. Scheffer Lang

But there is a larger lesson that can be learned

here, one that goes more directly to what research is all about. I want to tell you what I think that larger lesson is.

A few years back I became involved with the program of "high speed ground transportation" research and development in the Deaprtment of Commerce. It was an unusual program, and one that caused us to ask ourselves a lot of questions about "research" and what it really is. We found that for starters one has to make some sort of distinction between "basic" and "applied research." Our interests were pretty clearly in applied research; and that is the interest of most of you here at this conference, too.

"Applied research", we decided, was nothing more than part of a structured problem-solving process. Well, a problem is something we have when we think there is a better way; a way to do things or a better state in which things might exist. "Problem solving" is the process of finding and implementing that better way. Applied research is the "finding" part of that problem-solving process.

I was involved with the High Speed Ground Transportation Research and Development Program for three-and-one-half years. I learned a lot more about applied research before I was through. The most important thing I learned was that just knowing how to look for better ways to do things and looking for them was not enough. You have to know what you are looking for.

We had all sorts of whiz-bang researchers working on our problems (and offering to work on our problems) who, it turned out, produced little or nothing of any use to us. They produced little or nothing of use, because they never understood what they were looking for, even though they were skilled "lookers".

I am sure that all of you can cite similar experiences. There is a lesson in those experiences.

Finding a better way requires knowing what "better" is when you see it. It is not enough to be looking. Only people who really know what "better" looks like will (1) find it themselves, (2) recognize when someone else has found it, or (3) recognize that no one has yet found it.

What all that says is that the people who have the problems are the people who should do applied research on them; if, that is, you want that applied research to be effective. That does not suggest that each one of us should personally do all of his own applied research. What it does suggest is that each one of us should be involved in the process of looking for better ways to do our job.

It also suggests that no one should be doing applied research unless there are people who have the problems directly involved in the specification and management of that research. Again, you need people who really know what "better" looks like.

Another way to put this is, "You cannot let someone else do your applied research for you."

I have to tell you that there are a lot of folks in Washington who have not yet gotten that message. They want to do your research for you. And there are folks outside of Washington who are willing to sit back and let the folks in Washington try to do their research for them.

It does not work very well, if it works at all.

It is worth noting that the National Cooperative Highway Research Program, probably the most effective research program in any area of transportation, avoids this mistake pretty well. The NCHRP program puts the researchers (that is, the professional "lookers") together with the people who have the problems (in this case, the state highway departments). It works; as it should.

Well, all of that is what this meeting is about. All of that is what the Transportation Research Board is about.

"....in whatever it is our duty to act, those matters it is also our duty to study".

AASHTO SUBCOMMITTEE ON BRIDGE AND STRUCTURES: PAST, PRESENT AND FUTURE

Sidney L. Poleynard, Louisiana State Department of Transportation and Development

Many of you have expressed a desire to participate in a national bridge conference of this type for several years. We, the members of the Operating Subcommittee on Bridges and Structures of AASHTO have certainly been in agreement with the idea. And we are pleased to take an active part in the program.

Sidney L. Poleynard

I have been asked to make a few comments about our bridge committee, past, present and future. Little explanation is needed as to the make-up and purpose of the committee, since most of you, including our friends from abroad, are familiar with the AASHTO Specifications for Highway Bridges. Briefly, the membership is composed of a representative from each state, District of Columbia, Puerto Rico, the U.S. Department of Transportation and some provinces of Canada. The committee meets in 4 regional meetings each year at various locations in the country. All interested individuals, industries, associations and societies are invited to attend.

Now, where did all this begin? As most of you know, the early highway bridge engineer either had worked for a railroad or was greatly influenced by professors who had designed or constructed bridges for railroads. Certainly, because of need, the railroads in the name of the American Railway Engineering Association (AREA) had a beginning that predated AASHTO by many years. This was fortunate because both the engineers involved and their specification experience, particularly on steel bridges, was a great help to the early highway bridge engineer- and still is, I might add.

Although the Office of Public Roads, the predecessor of the Bureau of Public Roads and, now the Federal Highway Administration (FHWA), had prepared "Typical Specification for the Fabrication and Erection of Steel Highway Bridges" in 1913, the development of the country and the rapid increase in the numbers of trucks and automobiles after World War I gave the bridge engineer a mission we have been working at ever since, -- namely to cooperate with the different states and federal departments and other associations, societies and institutions with a view to assisting in establishing uniform standard methods of design, construction and maintenance and in standardizing as much as possible the various kinds of construction used in connection with highway