The use of hot-mix asphalt in every phase of highway construction has increased fantastically over the past ten years. This has resulted in an equally large demand for new techniques and new equipment. Although the asphalt paving industry was somewhat slow to react initially, the last two or three years have brought about a remarkable change in many of our procedures. The industry had been rather complacent over the past few years because the national tonnage had increased 15% annually over a ten-year period. It seemed that regardless of the activities, or lack of activity, of the industry there was still a great demand for the material. However, more recently, a number of dynamic and energetic individuals have brought about a change from the old tried and true, inviolate procedures to refreshingly new and less complex operations.

When I came to the United States 12 years ago, I was thoroughly impressed with the technological approaches that were obvious in almost every phase of life; in fact, it seemed frequently that advances were being made in many fields far beyond the current requirements. This, however, I found was not a condition that existed in the highway industry. I learned that many state highway operations and public works domains were hidebound by concepts that were quite antiquated, and I also found that it was extremely difficult to have new ideas accepted, no matter whose ideas they were. In many areas of the country it seemed that there was a demonstration within the industry of total non-progressive thinking. It also seemed that all the efforts of AASHO and many other highway organizations appeared to go unrecognized. Particularly in the asphalt paving industry, it was apparent that we had great demands for our products, but it was equally obvious that productivity had failed to increase to meet these demands. I am glad to say that many of these conditions are presently being remedied.

I have heard many experts claim that asphalt pavements could not be laid successfully on soil subgrades, and indeed only five or six years ago the hot-mix asphalt base principle was not universally accepted throughout the United States. But in 1965 a survey of all of the highway departments in the United States demonstrated that each state uses hot-mix asphalt to some degree in its base courses. The actual increase in this practice is largely responsible for our annual increase in tonnage. Now that the use of hot-mix asphalt base has become commonplace, a further development along the same lines has been increasingly accepted during the last 18 months.

Most designers and engineers throughout the country have believed for many years that asphalt pavements could not be laid in layer thicknesses exceeding three inches because sufficient compaction could not be attained. Two progressive thinking individuals, Charles Beagle, Director of Public Works, Woodbridge,
New Jersey; and Carl Minor, Assistant Director of Highways for Planning, Research, and Materials, Washington State, decided not to blindly accept as gospel that compaction could not be obtained in thicker lifts. As a result of their carefully conducted test projects, they have proved otherwise. Since then, the National Asphalt Pavement Association has run control tests under field conditions in College Station, Texas, and we now wholeheartedly support the conclusions that were drawn by Mr. Beagle and Mr. Minor: that optimum compaction can be obtained in hot-mix asphalt pavements laid in single lifts up to at least 18 inches in total thickness. Mr. Beagle has tested pavements with 12 inches, 15 inches, and 18 inches of total thickness and his results and Mr. Minor's have been well published to date; therefore, I do not feel that I need to expound upon them further.

To date, however, we have not developed new equipment to handle thick-life construction because these procedures have not been accepted in all corners of the nation. This, we realize, is only a matter of time, and it is apparent that the various equipment manufacturers are tailoring their future projects to be ready when the time comes. It is quite amazing just how much thought and research go into the development of one new idea and how rapidly the results of that concept can be accepted once the results have been proved. A perfect example of this has been the increased use of thin overlays for preventive maintenance procedures in municipalities and counties, and now in a number of highway departments. In many jurisdictions, these dense-graded hot-mix asphalt have completely replaced the surface treatment or armor coat that was previously used, and the public relations value of this material has been well recognized. I personally involved myself when I was in the public works field in developing a thin overlay mix and laying procedure which was scoffed at by the state highway maintenance engineer. But the same mix and same procedure today account for about 200,000 tons of material per year in the state of Maryland, which for a maintenance procedure certainly cannot be ignored.

Directly within the paving industry we have witnessed the demand for higher productivity being reflected in bigger asphalt plants with bigger driers and higher capacity cold feed operations, but no really revolutionary change has been made in the plant design or mixing concepts.

We have found that in the past many states were calling for too long a mixing time. The Ross Count procedures, which have been tested and run in Pennsylvania and Virginia, have demonstrated that lower mixing times were not only of great advantage to the producer but resulted in a higher quality in the finished product. Many states have reduced their mixing times as a result of the tests run in Pennsylvania and Virginia, which were reported through the National Asphalt Pavement Association's Quality Improvement Program.

The slow but sure acceptances of automation within the plant design has not substantially increased productivity in any way, but has certainly established quality controls. Possibilities of human error have been reduced, and continuity in the mixing operation is guaranteed. In the last year, however, a much more revolutionary procedure has been under examination by N. A. P. A. I refer to hot-mix storage. Here again, control tests which have been carried out in Calif.,
Kansas, and Florida, as well as in Europe, have shown that contrary to accepted opinion, hot-mix material can be stored for reasonable periods of time without significant hardening in the materials. The concept of hot-mix storage is not new, but sweeping modifications have been made in the procedure used in placing hot-mixes into the storage hopper and also in the heating or insulating systems in the hopper itself. I predict that over the next few years there will be an increasing use of this type of facility. The advantages to the industry are enormous and these advantages can be passed along to the contracting agency in more rapid construction with higher quality control at no increase in cost.

If you are particularly interested in this segment of my paper, I can elaborate upon the procedures during the question and answer period.

Although, as I have said, there have not been any great or revolutionary changes in the actual production equipment for hot-mix asphalt, there have been significant changes in laying procedures. Of course, over the last few years the automatic screed control has become virtually an integral part of every paving machine used in highway construction. This has improved the riding quality of asphaltic pavements to a very high degree while permitting a slight increase in productivity. Unfortunately, as is the case when any new concept is introduced, many contracting agencies and their employees try to second guess the screed controls and are continually modifying or demanding modifications of their use. Since the screed control was designed to eliminate human error and also to smooth out deformations in previous courses, it should be permitted to act in this way. Because of specified thickness tolerances, however, the operator is frequently required to take the machine off automatic operation and control it by hand. This is an example of short-sightedness: failure to realize the value of the end product. I have personally seen projects that have been literally fouled up by inspectors and engineers who have demanded that above all else, thickness tolerances must be maintained. In this way a blemish which showed up in the subbase appears in the base and also in the surface course; and the machine which could have solved this problem has been totally second guessed. There have also been attempts to improve productivity by the widening of the paving screeds on some machines. This has worked very effectively on some recent projects without any detriment to the pavement. Rolling equipment used in the laying operation has also experienced considerable change over the past few years. The rubber tired rollers with air-on-the-run controls are now a standard part of the construction scene in most areas of the nation, and are largely responsible for all intermediate rolling on every phase of asphalt paving construction. In recent years, vibratory rollers have also come into general use and it is quite possible that over the next few years vibratory rollers with higher impact rolling will be used to an even greater extent on asphalt pavements.

On a recent trip to Europe, I was very impressed to see working on some at the motorway projects full-width asphalt pavers which could handle pavements up to 38 feet wide and which could place single lifts of asphalt up to seven inches thick. This equipment is, in my estimation, far in advance of anything we presently have in the United States, but I have no doubt that we shall produce similar or better units in the very near future. The use of this type of paver will
also involve a complete re-education in related techniques. A machine like this, laying a six-inch thick pavement, 36 feet wide at a rate of 75 feet per minute, would use up approximately 100 tons of asphalt each minute. Incidentally, each one of these figures is conservative. The machine can work faster than 75 feet per minute, and can lay a pavement up to 7 inches thick which could, therefore, increase the amount of hot-mix asphalt laid each minute. If you stop to think about attempting to deliver 100 tons of asphalt every minute to a project, you will see that present methods cannot be utilized and that there will have to be an investigation of other, faster methods of charging the paver. Windrowing of material in advance of the machine is one possibility. Of course, this windrowing concept has already been accepted in a number of the midwestern states as a means of delivery of asphalt to the paving machines that are currently being used there. Though this is largely theory at present, it points up the fact that the contracting agencies and everybody associated with them, as well as the contractors, must be prepared to be flexible in their acceptance or rejection of new developments and techniques.

It is my earnest belief that every arm of the highway industry must anticipate the needs of the industry and make available all data at their disposal even before they are demanded - to enable all interested parties to be aware of what will be required of them. Every agency should circulate all of the relevant information as soon as it is available; and no segment of the industry should hesitate before investigating advantages or disadvantages to any new procedure or technique. There is and has been a tendency of different segments of the industry at various times to neglect their responsibility to the great transportation system of the United States, and we at the National Asphalt Pavement Association are attempting to correct this condition as far as we are concerned.