profitable opportunities could be realized by extending runs substantially without having to make a self-defeating sacrifice in the quality of signals resulting thereafter for distribution. That suburb a few miles beyond the end of your present trunk, that little town 8 miles out from your community where 96% of the residents have been clamoring for service for years, perhaps that military base 16 1/2 miles each of your tower, for which you could get the contract to wire all 3200 dwelling units, but which has seemed as unreachable as the sun because of its distance and its large distribution area after that .. all of these opportunities can now be turned to money-making actualities with long line cable extensions carrying many channels many miles with such an extremely low build-up of noise and distortion that the quality of signals at the input and the output of the long line seem nearly identical.

As we have said, many of today's long line applications, under our new reference standards of length, are for situations involving relatively short "long runs". But let's take the theme of this panel this morning and see what might be on the horizon when we are "Looking Ahead". Chairman Henry of the Federal Communications Commission recently reminded an audience that "America is being wired for sight and sound". America is a very large country, ladies and gentlemen, and it is studded with thousands of sizeable communities. As television is itself extended as a many-faceted medium, its transmission will surely be extended in degree and to points which we can barely anticipate today. And just as surely, the unique advantages of multi-channel closed circuit cable transmission will be recognized and exploited to carry video and audio information at RF frequencies over greater and greater distances.

A number of you, after the close of this convention, will be visiting the World' Fair in New York, where you will be fascinated by exhibits which project your attention into the future of our world, our scientific achievements and our human society. If I may be permitted onesmall personal commercial reference, I would like to refer to our company's exhibit at this "World"s CATV Fair" here in Philadelphia. A 16-foot mural in our display depicts a long RF coaxial cable transmission line carrying the signals from New York, the World's Fair City to our hotel here in Philadelphia, our convention city. We had this mural made up in the spirit of good fun and of a colorful demonstration taking some artistic license. While the close circuiting of World's Fair events to the Bellevue-Stratford Hotel by this means would undoubtedly fall into the category of a simple tour de force with questionable practicality, the point I want to emphasize seriously is that this feat can be accomplished - now - with new transmission achievements that are available to you all and which may in the very near future open great new areas of opportunity, and profit to each of you.

Thank you very much. (Applause)

MR. W. K. HEADLEY: Since the session opened you may not believe it, but you have heard six speakers and are about to hear the seventh. So I think it's fitting now, remaining more or less in your places, to take a short seventh inning stretch. (Pause) We have talked about the growing need for longer and longer point-to-point transmission. Another facet, of course, which many of you are facing today is the requirement of the larger and larger distribution system. The next discourse you will hear on that subject is entitled, "Problems of Signal Distribution in Large Communities". Here to cover that subject for you in Heinz E. Blum, Vice President in charge of Engineering at Entron, Incorporated.

MR. HEINZ E. BLUM: Gentlemen, the excellent presentation of my co-panelists might have given you the impression that certain manufacturers have specialized in the work of individual system components. However from the association with my friends in the associate membership group I know that all of us have experience embracing the entire field of CATV. Therefore in my following presentation I shall not mention the model designations nor the name of the company with which I am associated. Incidently I'm associated with Entron Incorporated and we have a display at this side of the room showing a system and a workable picture presentation on receivers at the end of a 20 mile system.

The CATV industry has, in the past, applied the engineering principles and the technical know-how of related sciences and industries. It is a part of the electronic equipment manufacturing and of the communication installation industry and has adopted - with modifications, of course - techniques which are being used by these industries. This fact is probably known to everyone familiar with the CATV industry, and it is stated here only to reiterate that CATV equipment and system design follows the same laws and principles with which other fields have to cope.

The CATV system's operator makes it his business to deliver to his customers, through his elaborate distribution system, signals which will produce a television picture on a standard TV receiver which the customers will find "acceptable." In the absence of industry-wide standards it is up to the equipment and system designer to determine exactly what the characteristics of the signal must be to produce an "acceptable" picture.

First, the signal must be such that it can be processed by the customer's TV receiver to yield a likeness of the originally transmitted picture. It must consist of a carrier of a receivable frequency modulated with synchronization, video, color burst, and audio information as standardized by the Federal Communications Commission (FCC). Secondly, it must be of sufficiently high level so as to override, at the TV receiver, any other present and undersirable signals - such as noise - to such an extent that the undesirable signals do not interfere with the desirable ones. Thirdly, the signal must not contain undesired information - such as noise, intermodulation distortion, harmonic distortion, or "beats" - of a level which interferes noticeably with the desired information. Various organizations have established experimentally upper limits of the magnitude of undesired information which can be tolerated as part of the desired information. One of the most extensive research projects was carried out by the Television Allocations Studo Organization (TASO), who, in its 1959 report to the FCC, established, for example, that a signal-to-noise ratio of 42 db has such a small effect on picture quality that viewers rate as excellent pictures having such a signal-to-noise ratio. Therefore, a signal-to-noise ratio of 42 db can be established as design goal for a CATV system. Similar tests and experiments lead to the establishment of a 48 db signal-to-cross-modulation limit. We can intelligently design systems of various sizes at the best possible cost only with such a set of performance standards.

Considering the trunkline problems for large area CATV distribution first, we can see that our established performance standards can be obtained by the following procedure;

1. Determine maximum length of trunkline.
2. Compute trunkline attenuation at Channel 13 for various cable types.
3. Divide the total attenuation by the spacing (operational gain) of the amplifier to be used. The operational gain is generally specified by the amplifier manufacturer for best noise figure, cross modulation, and automatic level control performance.
4. Check whether the system meets the earlier established performance standards by the 3 db per - amplifier-doubling method, which means that every time the amount of cascaded amplifiers is doubled, the signal-to-noise ratio decreases by 3 db, and the output level of each cascaded amplifier must be reduced by 3 db to maintain the same level of cross modulation distortion.

Going through these steps, the maximum number of cascadable amplifiers can be determined.

For instance, at the present state of the art, systems of up to approximately 2000 db attenuation can be constructed utilizing 64 repeater amplifiers. Using a cable having an attenuation of 1.45 db per 100 feet (Foamflex 1/2" or equivalent at Channel 13), a total trunk length of 2000 ÷ 1.45 = 137,931 feet = 26 miles can be constructed. Better cable already available can be used for even longer trunklines.

It can now be readily seen that a further increase in trunkline length can only be realized if and when cables with lower attenuation and amplifiers having higher output handling abilities and lower noise figures are available. At the present time, it appears unlikely that much lower noise figures can be achieved and the development is moving primarily in the direction of amplifiers with higher output handling abilities.

With increasing system size the questions of reliability and obsolescence become more important. While some reliability studies have already been made, much more work in this particular area has to be done to determine the most economical initial-cost-to-maintenance ratio.

The Intercontinental Submarine Cable System and its problems can be cited as an example of a long communication system so similar to the systems with which we are familiar. The latest system which was put into service in 1963, provides communication means for 128 3 kc wide channels in both directions over a single coaxial cable. Transmission in one direction is carried in the frequency band of 108 - 504 kc and in the other direction in the band of 660 - 1052 kc. The total cable transmission loss is approximately 9000 db at the highest frequency. One hundred eighty (180) remotely powered and tube equipped repeater amplifiers with tilted response curves are utilized to offset this cable loss.

The signal-to-interference ratio of each repeater amplifier is at least 90 db. Applying our 3 db per-amplifier-doubling method, we arrive at a 67 db signal-to-interference ratio for the entire system.

Every tenth repeater amplifier has a manually adjustable gain and tilt control, which was set when the cable was laid. No further automatic gain or tilt control is required since the system is installed on the ocean floor where the temperature is constant at 3° C or 37° F.

It is interesting to note that the organization which has developed the transistor and which has done a tremendous amount of research in the semiconductor field has decided that - at the present time - vacuum tubes will better serve the purpose of reamplifying communication signals in a system of remotely powered cascaded amplifiers. This system has been built for commercial applications and initial cost, maintenance cost, reliability and performance have been carefully weighed to obtain the most profitable system.

It is of particular interest to the CATV Field that long systems are not only feasible, but are already in operation after all known engineering aspects have been carefully considered.

With full confidence in its reliability the CATV industry can again make use of techniques previously developed for other communication purposes.

There is one field, however, in which the CATV industry has been unique, and this is the field of VHF signal distribution to cable connected receivers. A large amount of receivers have to be connected so that each one derives the best possible picture quality from the CATV System without introducing any interference into the system. Cities were divided into sections and clean signals were brought via the trunkline to central distribution points in each section. At the central distribution points the signal was taken from the trunk line and fed into distribution amplifiers where it was brought up to a level suitable for distribution and where, at the same time, isolation between distribution and trunklines was obtained. The distribution amplifiers then fed the signal into the distribution cable to which the individual subscribers were connected. Due to the choice of the frequency spectrum within which the signal was distributed, it was possible to utilize simple tap-off devices for subscriber connection. Increased demands for more programs and, therefore, a wider frequency spectrum of the transmitted signal necessitated a more sophisticated method of subscriber connection. This method of the matched multiple subscriber connection device has the advantage of not unnecessarily disturbing the distribution system and the signals carried thereon. Now it becomes possible to space these connection devices as closely or as widelyapart as required by the density of the subscriber population. The distribution line length can now be determined by signal level calcaulations alone without the previously necessary considerations for response curve deterioration and mismatch due to non-matched elements in the line. It becomes advantageous to feed the highest practical signal level into the distribution lines to avoid unnecessary reamplification in these distribution lines. The high level distribution amplifier has become the signal source for many thousands of distribution line miles. Heavily populated, as well as large areas, can be served effectively.

Multi-dwelling buildings obtain their signals from these new connection devices and because these signals are of predetermined quality, as well as of predetermined and stable level, they can be amplified for in-building distribution, if necessary. The initial calculations of signal-to-interference level must include the distribution amplifiers as well as the trunkline repeaters if the previously established performance standards are to be satisfied. This will require that distribution originating amplifiers or bridging amplifiers have to be operated below their individual maximum output level to deliver clean signals to the subsequent extender or in-building distribution amplifiers.

Large area CATV distribution can be economically and effectively achieved only after thorough analysis of all problems involved, but - and this is the main fact - these problems can be solved.

Equipment manufacturers supplying the CATV industry have succeeded in providing the hardware for the ever increasing demand to improve the services which our industry provides. These services are not only recognized but also greatly appreciated by an ever increasing number of our fellowman.

It can safely be assumed that future engineering developments will help the further growth of the CATV industry. Thank you very much. (Applause)

MR. GEORGE J. BARCO: The man who is presiding over this morning's session, is the associate representative on our Board of Directors of the NCTA. In the ten years it has been my pleasure to serve on that Board, I have not known of anyone who has been a finer gentleman, or who has made a more able representative for his associate members, or who has made a greater contribution to the industry, in such a short time. You should also know, that Bob Tarlton and I are most grateful to him for taking on the entire responsibility for the preparation of the program Monday afternoon on the all band conversion, as well as this morning's program. May I ask you to join me in publicly expressing to him our appreciation for his very fine efforts. (Applause)

MR. W. K. HEADLEY: Thank you George. This being Thursday, and after Wednesday night, Tuesday night and Monday night and so on, if I had enough blood left I would be blushing. As I said at the outset of this meeting, because it is so loaded with speakers and our time is limited, we have not had question and answer periods for each of the speakers, but because each of them represents companies who are exhibiting here, again I would ask you that you would direct your questions to them either after the meeting up here or in their respective exhibit booths.