On presenting a technical paper

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(Received 30 August 1976)

The typed script for a 12-min technical talk is likely to occupy not more than five pages, double spaced, in elite type. Time may limit the presentation to six slides. Lettering on a figure for a slide should be 1/40 the height of the figure.

PACS numbers: 43.10.Ln, 01.30.−y

In a dozen minutes you and I try to squeeze into a technical paper the essential outcome of an effort of several years toward the development of a device or the study of a phenomenon. And we often want to use the same illustrations again in a publication.

A usual technical lecturer reads about 150 words per minute. Thus the double-spaced script (elite type) for a 12-min paper to be read verbatim is likely to be shorter than five pages. If the lecturer speaks without detailed notes his rate may drop to 100 words per minute.

A way to find out how much *you* can say effectively in 12 minutes (or whatever) is to write the text word-for-word in the style in which you are likely to speak. Rehearse the script without hurry. If you cannot deliver it comfortably in the allotted time, cut until you can.

An effective technical presentation is partially read and partially spoken, without apparent reference to a written text. Every term at all uncommon should be defined in the paper. The first time a quantity symbol or an abbreviation appears, give the full name of it.

Read "Guidelines for the planning and preparation of illustrated technical talks" by Harvey H. Hubbard [J. Acoust. Soc. Am. 60, 995–998 (1976)].

Illustrative material, including equations, should be put on slides or other transparencies for projection. A slide should contain but one central idea. Make it simple. Aim at less than four curves per slide.

Reduce to a minimum the coordinate rulings for a graph. But at least provide tick marks on all four sides of the grid, for the person who later wants to read the utmost from the graph. Remember that the space between coordinate rulings should correspond to a decimal multiple of 1, 2, or 5 units of measurement. The multiple should be chosen so that a scale number consists of not more than three digits.

If a title is put at the top of a slide, it should refer to the basic idea. It should not repeat scale captions, nor other data already in the figure.

Any title on a figure should be removed before the figure is submitted for publication. The legend (figure caption) is set in type under the figure, for publication.

A scale caption on a figure must tell the name of the quantity plotted and the unit of measurement. If there is space, spell them out. If not, the name of the quantity may be replaced (in the scale caption) by the quantity symbol which may be found in "American National Standard Letter Symbols for Quantities Used in Electrical Science and Electrical Engineering," Y10.5-1968 or "American National Standard Letter Symbols for Acoustics," Y10.11-1953. The latter is being revised; it will also contain abbreviations which may be substituted for the names of quantities when space is limited; and it will contain unit symbols which may be substituted for unit names when space is limited.

Many of the unit symbols used in acoustics can be found in "American National Standard Letter Symbols for Units Used in Science and Technology," Y10.19-1969. As explained there, it is not correct to attach a letter to a unit symbol to give information about the *quantity* involved. Thus it is never correct to write dB*A*.

A figure can be made suitable for both projection and printing by making the height of the lettering $H/40$, where H is the height of a figure whose width is about $1.3H$. If the letter is sharp and clear, its height may be $H/50$, or even a little smaller. For the figure ultimately destined for publication, the rule is that after reduction to the printed page the height of the letter should be about 1.5 mm. The example below complies.

An outline symbol should be as high as a capital letter. A solid-circle symbol should be $\frac{2}{3}$ the height of a capital letter, namely $H/60$. A line should not pass through lettering or a symbol. Also, a line that would

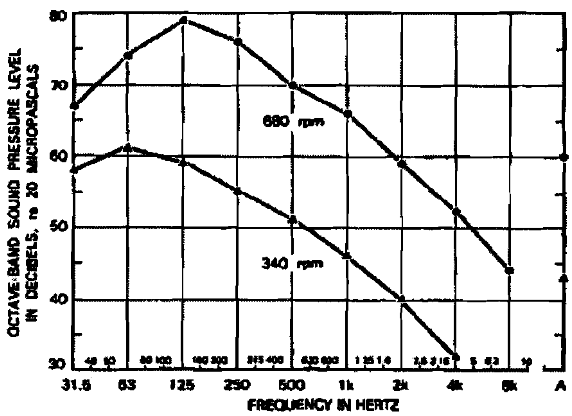

FIG. 1. Octave-band spectra and fast A-weighted sound level due to two double-inlet utility fans, size $5\frac{1}{2}$B, driven at 680 and 340 rpm. Measured 16 November 1976 in a hall whose volume is 75 000 ft^3 and midfrequency reverberation time empty is 1.5 sec.

pass through a solid symbol should be broken away to leave a space around outside the symbol.

The width of a curve should be about $H/160$; if there are several curves, $H/200$. The width of lines, bounding a grid may be $H/250$. The width of other grid lines may be $H/500$. For more details see "American National Standard Illustrations for Publication and Projection," Y15.1-1959. See also *American Institute of Physics Style Manual*, revised 1973.

Although it is possible to put a table of 20 lines of readable numbers on a slide, the pile of numbers is too great for ready comprehension. Try to limit the number of lines in a table to six; the fewer the better.

Many acoustical graphs depict a level of some kind versus the logarithm of frequency ratio. The scale proportions for such graphs are specified in International Electrotechnical Commission Publication 263-1975. The length for the 10:1 frequency ratio is to equal that for 25 decibels, or 50 decibels or 10 decibels. Intercomparison of original graphs is facilitated by regular use of 2 mm for 1 dB.

Figure 1 is an example of a graph prepared in consonance with the several guidelines described above. It is here reproduced ½ original size.

The legend printed underneath Fig. 1 is intended to answer the universal questions: *who, what, when, where.* To make it meaningful, a measurement of sound pressure level must always be accompanied by *where*, as by saying "50 ft from the centerline of the passing truck."

Difficulties of choosing a frequency for miniature transmitters in fresh water

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(Received 20 December 1976)

It is shown that the choice of a suitable operating frequency for miniature acoustic transmitters depends crucially on a knowledge of absorption and noise characteristics of the water. For application in fresh water, imperfect knowledge of these characteristics can result in incorrect frequency choice giving serious reductions in range capability for the transmitting power available.

PACS numbers: 43.30.Vh, 43.30.Yj

For some time at the University of New Brunswick, we have been engaged in the development of minature battery-powered acoustic transmitters either as simple locator beacons or else for the transmission of information from a sensor. The principal application has been studies involving fish behavior in which transmitters are attached to the fish to be studied. Naturally, minimization of the size of the transmitter is of prime importance.

The size of two major components of the transmitter—the battery and the electric-to-acoustic transducer—are strongly affected by the choice of transmission frequency. First, the acoustic energy, and hence battery energy, required to achieve a particular range is frequency dependent as a result of variations of both absorption and noise level with frequency. Secondly, the size of the resonant dimension of the transducer is inversely proportional to frequency. Thus, the choice of frequency usually involves finding the middle ground between the small transducer but large acoustic output required at high frequencies and the large transducer but smaller acoustic output at low ones.

This frequency choice can be made rather easily if, for a given range requirement and a set of receiver characteristics, the dependence of acoustic output necessary on frequency is known. For the ocean, where absorption and noise are well characterized, such a dependence is easily determined[1] and we have successfully designed transmitters for various range requirements between 200 and 5000 m with transmission frequencies ranging from 20 to 100 kHz. In no case were there any significant discrepancies between predicted and measured ranges.

In fresh water, however, predictions of range can only be approximate because of the lack of comprehensive data on either absorption or noise. In particular, absorption will vary considerably from one body of water to another because of varying amounts of suspended matter which seem to exist in even very clean water.[2] Also, there is no reason to believe that low-frequency noise in lakes and rivers will be identical to that in the ocean. Nevertheless, on several occasions no significant errors have resulted from the assumptions that noise conditions are the same as in the sea and absorption as for distilled water. Recent experience, though, has shown that such assumptions are not always satisfactory.

In order to achieve a very small transmitter for salmon smolt studies, a frequency of 150 kHz was chosen permitting the realization of a transmitter with a useful life of several weeks in a cylindrical package 6×25 mm[2]. Using the assumptions described above, a range in fresh water of about 300 m (i.e., 50 dB of attenuation between transmitter and receiver) was predicted. Preliminary work in a clean lake seemed to confirm this prediction, but during subsequent tests in the area

