ATMOSPHERIC EFFECTS ON SONIC BOOM A PROGRAM REVIEW

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The program goals were determined after consideration of the weaknesses in our understanding of atmospheric effects on sonic boom waveforms left in the wake of the cancellation of the U. S. SST in the 70's, and the advancements in acoustics and atmospheric science since that time. For example, a considerable body of knowledge on molecular absorption had been built up in the acoustics community over the last 15 years and this had not been incorporated into the sonic boom theory. Further, it was felt that the understanding of atmospheric turbulence had also advanced considerably during that time period. Therefore, key elements of the current program are the development of an improved atmospheric absorption model, and an improved atmospheric turbulence model. The advances made in computer power over the last 15 years were also considered, and will be utilized to remove restrictions on the analytical model for turbulence effects on sonic boom waveforms. Although the majority of disturbing sonic booms will not occur at focuses or caustics, it was felt that this was an area that required further understanding, thus it to will be looked into.

Finally, in order to insure that the current effort, which is basically analytical in nature, retains a firm grasp on reality, a data base of sonic boom waveforms and associated weather data is being compiled, and a set of scale model experiments is being planned to guide the overall effort.

PROGRAM GOALS

- Improved Atmospheric Absorption Model
- Improved Atmospheric Turbulence Model
- Improved Model For Turbulence Effects On Boom
- Understanding of Boom at Focuses and Caustics
- Readily Available, Easily Accessible Data Base for Model Validation
- Scale Model Experiments for Model Validation

WORK IN PROGRESS

I am forced to break the work in progress into two mutually exclusive sets. Obviously the first breakdown that might occur to you is work that is done, and work that remains to be done, however, a different grouping is used here. Due to various constraints some of the people doing work under this program are not able to make presentations. Thus, if I do not very briefly recap their work, it will go unnoticed. This would provide a distorted view of the total program. Thus we may introduce the two groupings alluded to earlier. The "Hidden Agenda", and "Papers to be Presented". Since each of the later group will have their time to present their work I will concentrate on the former group. This group consists of Professor David Blackstock, of The University of Texas, who is working on some scale model experiments, and Mr. Dominic Maglieri, of Eagle Engineering, who is working on a data base of sonic boom waveforms.

WORK IN PROGRESS

- **HIDDEN AGENDA**
  - Model experiments - D. Blackstock
  - Data Base - D. Maglieri

- **PAPERS TO BE PRESENTED**
  - Relaxation and Turbulence Effects - A. Pierce
  - Turbulence Modeling and Turbulent Scattering Theory - K. Plotkin
  - Rise Time Correlations of Sonic Boom Data - H. Bass

HIDDEN AGENDA - BLACKSTOCK

Some things of interest to us for the sonic boom problem are neither analytically tractable nor easily investigated in full scale experiments. Examples include the field at a focus, or at a caustic, which evade analysis at the current time because of the breakdown in the essentially linear methods used, and the essential nonlinearity of the problem, and which are difficult to measure in a large scale experiment because of the limited spatial domain over which the relevant phenomena occur and the difficulty of predicting precisely where this domain exists. These phenomena are ideally suited to investigation in small scale experiments, and this is the task being undertaken by Professor Blackstock, who has proposed a scale model experiment to:

- Test the waveform freezing theory
- Obtain measurements at a focus
- Obtain measurements of diffraction into the shadow
- Obtain measurements of turbulence induced waveform distortion
- Determine the role of nonlinearity

At the current time Professor Blackstock is in the midst of designing the experiments.

HIDDEN AGENDA - BLACKSTOCK

University of Texas - Austin

Scale Model Effects of Stratification and Turbulence

- Test of waveform freezing
- Measurement at focus
- Measurement of diffraction into shadow
- Measurement of turbulence induced distortion
- Determination of role of nonlinearity

DESIGN OF EXPERIMENTS IN PROGRESS

For most things full scale experiments provide the best experience for developing physical insight, and provide the only acceptable means of theory validation. Therefore a readily available and easily accessible data base of existing sonic boom waveforms would be a valuable resource. Dominic Maglieri, of Eagle Engineering is in the process of putting together a data base of sonic boom waveforms obtained in the 1960's. This is a unique data set because it will provide actual digitized waveforms from which we may calculate not only rise times, but also Fourier transforms to obtain the frequency spectra of the waveform. This later is probably required to determine acceptability. In any case, the figures are as shown here, 39 flights, 53 sonic boom runs, and 330 sonic boom signatures on which to test our theories.

HIDDEN AGENDA - MAGLIERI

EAGLE ENGINEERING

Develop data base of all XB-70 sonic boom waveforms with relevant meteorological data.

Total Number of:

Flights	39
Sonic Boom Runs	53
Sonic Boom Signatures	330

UTILIZATION OF SONIC BOOM DATA BASE

This chart is reasonably self explanatory, and provides several things a data base may be used for. As mentioned earlier, it will provide test cases for the new theories being developed, in many cases the only test cases acceptable to some. Further, the data may be used to obtain physical insight, or an empirical approach to sonic boom prediction. Finally, the Fourier transform of the signal is required to determine the acceptability of sonic boom waveforms, and those waveforms residing in the data base have real atmospheric effects imposed upon them.

UTILIZATION OF SONIC BOOM DATA BASE

- Provide reliable and acceptable test cases for model validation
- Provide physical insight for the development of theoretical models
- Provide basis for empirically based prediction methods
- Provide means for examining acceptability of sonic boom waveforms modified by turbulence etc.

PAPERS FOLLOWING

The final group is here to defend themselves. I'll introduce them in turn. Thus I turn the podium over to Dr. Allen Pierce who will discuss his theory of molecular absorption, and recently initiated efforts to determine the effects of turbulence on the sonic boom waveform.

PAPERS FOLLOWING

A. PIERCE - ABSORPTION & TURBULENCE
K. PLOTKIN - TURBULENCE & ABSORPTION
H. BASS - TURBULENCE EFFECTS

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