REDUCING THE DECIBELS OF NOISE PRODUCED BY THE WOOD PLANER IN THE SHOP OF THE VOCATIONAL AGRICULTURE DEPARTMENT

A Thesis

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Master of Science

by

Mickey Roger Cunningham

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INTRODUCTION

With the recent passage of federal legislation to control environmental pollution and to insure the safety and well-being of the worker in our society, the realization that noise existed as a contributing factor to environmental pollution descended upon the American public. Likewise, in vocational education, supervisors, administrators, and teachers were made aware of the potential hazards in the school environment which must be removed.

In particular, the sound produced by the wood planer has the potential for endangering the hearing of the shop worker. Wall in 1971 reported that the average noise level generated by the planer in Virginia was ninety-nine decibels of sound.[1] However, the federal legislation established eighty-five decibels as the safety level to which the human unprotected organs of hearing could be exposed to noise for a given time without experiencing damage to hearing.

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[1]R. A. Wall and C. R. Jessee, Evaluation of Occupational Health Hazards in Agricultural Education Laboratories in Virginia (Blacksburg, Va.: Virginia Polytechnic Institute and State University, 1971), p. 7.

Although the legislation has been enforced in industry and will soon be applicable to schools, the problem of noise produced by the planer has not been solved. Thus, the time has come to take action so that the schools may provide a suitable working, training, and educational environment for the student and the teacher.

STATEMENT OF THE PROBLEM

Enclosing the wood planer in acoustical material will reduce the noise level of the operating and surfacing planer to eighty-five decibels or below.

ANALYSIS

In addition to developing an acoustical control for planer noise, this investigation focused on the reasonableness of the cost involved with the study. The researcher wanted to identify procedures whereby vocational teachers could initiate immediate measures to reduce planer noise in the shop. Further, with an interest to alleviate the danger of decibel deafness to vocational teachers and students, this study will be significant when the planer noise has been held to ninety-five decibels, a level which will permit four hours of exposure in a twenty-four-hour period of time without requiring protective hearing devices, and will not cause decibel deafness in most situations to teachers associated with shop instruction in the vocational programs.

DEFINITION OF TERMS

The following terms could have a variety of meanings; therefore, the terms were defined as used in this study.

Acoustical chamber. The acoustical chamber was a box which was four feet and six inches long, three feet and six inches wide, and four feet high. The hip roof on the chamber gave it an overall height of four feet and six inches.

Acoustical hood. The acoustical hood was constructed of twenty-eight gauge, galvanized sheet metal. Acoustical material was cut and glued to the interior of the metal hood. The metal hood was constructed to fit over the top of the planer to absorb noise before it reached the operator's ear.

Acoustical material. This material was a sound absorbing substance used to control, to transmit, or to receive the effects of sound. In this study the acoustical material was a commercially manufactured fiberglass acoustical ceiling tile which was glued to utility board, a fiberboard, by the researcher to make the tile more durable for usage in the shop. The acoustical material was used in constructing the acoustical hood and chamber.

Cutter knife sharpness. The cutter knives of the planer cutterhead were sharpened to commercial standards for sharp blades by a qualified machinist on the staff of the Virginia Polytechnic Institute and State University.

Cutterhead. The cutterhead was the rotating shaft, cutter knives, and bearings of the planer which revolved to perform the surfacing operation of the planer. In this study the cutterhead contained four cutter knives.

Cycles per second. The number of recurrences of a periodic vibration or other wave form activity occurring in the course of one second was called cycles per second.

Decibel. A decibel was a unit of measurement to equate relative loudness of sounds. One decibel was the faintest variation in sound which the average human hearing mechanism was able to detect.

Decibel deafness. The loss of hearing to particular frequencies of sound at established decibel levels as a result of damage to the inner ear mechanism was decibel deafness.

Decibel rating. A decibel rating was the measurement of sound obtained by metering the sound produced by the planer and the reference sound source through the microphone of the sound level meter and reading the scale on the instrument. The decibel rating was a single number noise rating of the sound being produced.

Ear location of the operator. This term was the position determined by the researcher as being the average distance and height of the operator's ear from the front feedbed of the planer when the operator was surfacing stock with the planer. The location as the operator faced the front of the planer was twelve inches from the left corner of the front feedbed and five feet high. All measurements of sound were obtained with the microphone of the sound level meter positioned in the ear location of the operator.

Hardwood. Hardwood was that lumber cut from a broad-leafed flowering tree as distinguished from a cone bearing tree.

Noise. Noise, generally an unwanted sound, was any sound above eighty-five decibels on the A level of sound, audible to man.

Octave band. Octave bands were defined groups of frequencies of sound which may or may not be audible to humans. For this study, the center frequencies of octave bands which were audible to man were used. The center frequencies of octave bands 31.5, 63, 125, 250, 500, 1000, 2000, 4000, and 8000 were used to obtain decibel ratings.

Operating planer. Operating planer implied that the planer motor was running, the cutterhead was revolving, but the planer blades were not performing the surfacing operation for which the planer was designed.

Planer. A planer was an electrically powered, belt driven machine with rotating parts to pull wood into the revolving cutterhead which surfaced the stock and the necessary backup metal to give support to the machine during the surfacing operation. In this study, the planer used was a Powermatic, Model 160-B, with a five horsepower motor which ran on 220/240 volts, 60 cycles per second, and three phase electricity. The planer had a sixteen-inch surfacing capacity when the machine was removing one-sixteenth inch of surface from the wood. This planer was representative of planers in the shops of vocational agricultural departments in the schools of Virginia.

Reference-Source Sound Method. This method of measuring sound compares a source of sound to a known reference level of sound. Industry has used the reference-source sound instrument to analyze the sound level to obtain decibel ratings. The reference sound source machine consisted of a motor, a stand with a one half inch rubber pad, and a centrifugal wheel fan with a variable inlet. In this study, a one and one half inch inlet was used on the centrifugal fan. The instrument was manufactured by ILG Industries, Inc., for commercial usage.

Rubber acoustical pad. The rubber acoustical pad used in this study was a neophrene floor mat one eighth inch thick, three feet wide, and three feet and two inches long with three layers glued together to form the pad. Neophrene was a synthetic rubber with many of the same qualities of real rubber.

Run of grain. The term run of grain implied that the samples of stock had uniform growth rings and absence of damage or disease in the tree when the boards were sawed from the tree.

Softwood. Softwood was the lumber or stock cut from the coniferous, cone bearing, tree.

Sound. Sound was the vibratory disturbance in the pressure and density of a fluid or in the elastic strain in a solid in which the frequency ranges from twenty to twenty-thousand cycles per second which the human organs of hearing have a varied capability of detecting.

Sound level meter. The sound level meter was a commercially manufactured sound measuring instrument used by industry to measure sound in decibels. For this study, the Precision Sound Level Meter, Model 2204, type 1613, commercially produced by *Brüel* and *Kjaer*, a German firm, was used. This instrument measured sound accurately within plus or minus one decibel.

Stock. Stock was a piece of wood intended by a workman for a specific job. In this study, the term referred to hardwood, white oak, room dried, with dimensions forty-five inches long, four inches wide, and three-fourths of an inch thick, or to softwood, Douglas fir, room dried, forty-five inches long, four inches wide, and three-fourths of an inch thick. For simplicity, the terms hardwood stock and softwood stock were used to differentiate between the two types of wood used in this study.

Wood knot. A wood knot was the residue of a limb which grew on the tree and which remained part of the log from which the lumber was cut to make the stock in this study. Knots usually develop cross-grained to the general growth of the tree. Knots were usually harder than the remainder of a board. Therefore, to obtain nearly uniform decibel ratings for each sample of stock, as many knots as possible were removed from the piece of wood. Less than one knot remained in each stock sample, and they were small enough that their influence on the obtained decibel ratings was insignificant.

REVIEW OF LITERATURE

The U. S. Government became the legal environmental protection authority by passage of the Williams-Steiger Occupational Safety and Health Act of 1970. The act was changed by the implementation of the Federal Register, Part 1910, August 1971. The federal government by the regulation set forth standards for environmental protection for a worker. Eighty-five decibels of sound became the worker's guide for wearing protective hearing equipment. The Federal Register directed the employer to provide the protective hearing devices.[2] The regulation established the noise pollution control standards in terms of a single number noise rating-decibel.[3] In Personnel Journal the decibel was defined as a scale of measurement for sound in which one decibel was the smallest variation in sound that the human ear could detect.[4] The Journal also cited the federal government's standard by the duration per day (in hours), to sound level (in decibels), to which a person could be exposed without needing to wear protective hearing equipment. In a noise environment of 90 decibels, a person could work 8 hours per day without experiencing decibel deafness to some degree. At 100 decibels, an employee could work 2 hours per day before deafness would occur to

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[2] Department of Labor Federal Register, Occupational Safety and Health Administration, May 29, 1971, part 1910.95, p. 10518.

[3] Ibid.

[4] Personnel Journal, "New Anti-Noise Law Requires Hearing Test and Sound Controls," Vol. 51, April 1972, p. 284.

a degree. Further, at 115 decibel rating, an employee could work only 1/4 hour without ear protection before experiencing some loss of hearing ability as shown in Table 1.[5]

Table 1

Federal Government Standards of Permissible Noise Exposures

Duration per day, in hours	Sound Level (Decibels)
8	90
6	92
4	96
3	97
2	100
1 1/2	102
1	105
1/2	110
1/4 or less	115

In Table 1 above, the single number noise ratings, decibel levels of sound, were easily obtainable by unskilled personnel using unsophisticated equipment, according to DeBiase, but no information about the character of

[5]Ibid.

the noise was determined by the single number rating. DeBiase wrote that the hearing conservation criteria for a workday exposure to ninety decibels was satisfactory when the frequencies of the noise remained between sixty-three and eight thousand cycles per second. DeBiase believed that the federal regulation of standards for safety of hearing should be stated in both sound frequency in cycles per second and sound intensity in decibels.[6] Wall, in Table 2 on the following page, showed that frequencies below 63 cycles per second had a lower decibel rating than did those frequencies above eight thousand cycles per second.[7]

In cases where sound exceeds the permissible decibel level, the employer has two possible actions to take:

1. Those employees subjected to excessive noise ratings must have their hearing tested at regular intervals, at least yearly and at the cost of the employer.
2. Feasible administrative or engineering controls must be utilized to reduce sound to acceptable levels. If such controls fail, personal protective equipment

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[6]John L. DeBiase, "Criteria and Design Specifications for Plant Noise Control," Sound and Vibration, June 1972, p. 33.

[7]Wall and Jessee, Evaluation of Occupational Health Hazards in Agricultural Education Laboratories in Virginia, p. 7.

Table 2

Sound - Planer in Operation - in
Selected Virginia Schools[a]

School	Sound levels - cycles per second								
	Over-all	37.5-75	75-150	150-300	300-600	600-1200	1200-2400	2400-4800	4800-9600
Aver.	99.00	77.85	79.76	90.14	90.9	95.61	97.00	90.33	81.00

[a]Selected data from Table II, Evaluation of Occupational Health Hazards in Agricultural Education Laboratories in Virginia, R. A. Wall and C. R. Jessee, Virginia Polytechnic Institute and State University, 1971.

must be provided and used.

The federal regulation firmly fixed responsibility upon the employer, where sound exceeds the allowable standards, to pay for the hearing test of the employee, and to pay for and to provide the protective hearing devices. Further, the employer must supervise the use of the protective hearing devices when the noise exceeds the standard for safety of the worker's hearing.[8]

Stewart and Hart isolated planer noise to six causes:

1. Board being planed
2. Anvil opposite the cutterhead
3. Machine idle noise-sound vibrations throughout the machine parts
4. Electric motor
5. Planer dust collection system
6. Housing and feedbed vibration.

They found that the main determinant of noise was board size and depth of cut.[9] Stewart and Hart also experimented with changing the cutterhead of the planer. The cutterhead was the cutting surfaces and blades and the blade backup

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[8] Personnel Journal, "New Anti-Noise Law Requires Hearing Tests and Sound Controls," Vol. 51, 1972, p. 284.

[9] John S. Stewart and Franklin D. Hart, "Analysis and Control of Wood Planer Noise," Sound and Vibration, June 1972, p. 26.

metal. They found that by increasing the number of blades in the cutterhead, and by keeping the cutting edges sharp, the planer noise was reduced. They designed a helixical, segmented cutterhead which reduced planer noise by as much as ten decibels if the cutting edges were kept sharp. They found that the helixical, segmented cutterhead maintained constant contact with the stock being planed, and reduced the vibration of the wood against the feedbed. Also, Stewart and Hart found that:

1. As the length of the board increased, vibration increased, but no more noise was produced during planing.
2. As the width of the board increased, the noise (decibel rating) increased as the planer surfaced the wood.
3. By doubling the width of the board in successive increments, 2 inches to 4 inches, 4 inches to 8 inches, and 8 inches to 16 inches, the decibel rating increased six decibels at each doubling of the board.

To complete the study, Stewart and Hart installed the helixical, segmented cutterhead in the planer, and completely enclosed the planer, they obtained a decibel measurement of ninety-two.[10] They did not indicate the material in which

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[10]Stewart and Hart, op. cit., p. 27.

the planer was enclosed, nor the stock which was being surfaced, nor if the decibel measurement was compared to a sound reference source. The study did not indicate if the planer and its exhaust system were the only machines operating in the shop when the measurements of sound were obtained.

Yerges indicated that sound absorbing acoustical materials were a low cost, quick, simple answer to the industrial noise problem. Unfortunately, absorbents do not completely and adequately solve the industrial problem. A panel of absorbents hung low over and beyond the perimeter of a machine absorbed considerable noise. Partial enclosure, to the height of the machine, also reduced the noise level of the machine. Absorbers were useful to confine noise to small areas; however, the greater the number of machines enclosed in each sound absorbing compartment, the less effective the sound absorbing quality of the material. The decrease of effectiveness of acoustical absorbers declined logarithmically with the increase in amount of absorption material. If, however, a decibel rating was just above the allowable standards, acoustical absorbers functioned to reduce the noise to below the Occupational Safety and Health Administration requirements for wearing hearing protectors. In such cases, sound absorption materials were a simple solution to the industrial noise problem.[11]

DeBiase stated that noise ratings could be measured easily by unskilled personnel using unsophisticated equipment, the reference-source method of measuring sound has been a simple measurement used in industry to obtain the sound level of a worker's environment. The reference sound source machine used for the reference-source test was one of the first instruments developed to measure sound which was causing workers to become deaf. Most noise sources, when mounted and supported in the same way relative to surfaces, radiate very nearly the same power when located in large rooms such as a shop.[12]

In view of the federal requirements placed upon industry for noise control, and in view of the fact that the public school shop is the laboratory for the future vocational worker, experimentation and research for ways of controlling planer noise in the shop seemed to be justified. Thus, the purposes of this research were to prescribe procedures whereby teachers could initiate measures to reduce planer noise in the shop to eighty-five decibels or

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[11]Lyle F. Yerges, "The Use of Acoustical Absorbents in Industrial Noise Control," Sound and Vibration, March 1972, pp. 31-37.

[12]John L. DeBiase, op. cit., pp. 29-34.

below, and to alleviate the danger of decibel deafness to vocational teachers and students.

Chapter 2

REDUCING THE NOISE PRODUCED BY THE PLANER

STATEMENT OF THE PROBLEM

Enclosing the wood planer in acoustical material will reduce the noise level of the operating planer to eighty-five decibels or below.

DESIGN OF THE INVESTIGATION

Because a variety of woods have been surfaced in school shops in Virginia by the electric planer, two woods were selected by the researcher's criteria as being representative of the wood used by vocational students for constructing projects. Representative samples of a softwood and of a hardwood were selected by the uniformity of grain in the wood, and the absence of wood knots. Further, this researcher has personally observed that students often use the selected stock for making projects in shop. The representative softwood was Douglas fir, and the representative hardwood was white oak. The stock was prepared to the following specifications:

length: 45 inches
width: 4 inches
thickness: 3/4 inches.

Four pieces of stock for the hardwood and four pieces of the softwood were prepared and smooth surfaced to provide more uniform decibel ratings when the measurements were taken.

Research on this problem included measuring the noise produced when surfacing the selected representative hardwood and softwood stock as different acoustical treatments were assembled around the planer. The planer and the chip remover exhaust system were the only machines operating in the shop when the measurements were obtained. All measurements of the noise were taken one foot from the left corner of the front feedbed of the planer as the operator faces the planer at a height of five feet, a position which approximated the ear level of a machine operator. The planer was mounted on a rubber acoustical pad, had an acoustical hood mounted over the planer, supported by the pipe of the exhaust system, and finally enclosed in a sound absorbing acoustical compartment as a part of this study. Decibel ratings were taken as both representative samples of stock were surfaced after each acoustical treatment was fitted to the planer. All stock was fed into the planer at the same location on the front feedbed. The researcher marked a four-inch wide place at the center of the feedbed to insert stock into the planer.

The measurements were obtained from the operation of a planer located in the Agricultural Shop, Virginia Polytechnic Institute and State University. This planer was determined to be representative of those in vocational agriculture shops in Virginia.

DETERMINING REPRESENTATIVENESS OF THE PLANER

Virginia has been divided into six geographical areas for the purpose of supervising vocational agriculture in the state. The established geographical divisions were used in this study to arrange the schools for the selection of a sample of schools to determine the representativeness of the planer used in this study. In this study, all schools in Virginia which offered an agricultural education course were stratified alphabetically by the six geographical areas, alphabetically by county within the areas, and alphabetically by school name within each county. The researcher prepared six lists of the schools, one list of schools for each geographical area of Virginia. The alphabetically listed schools were numbered by areas beginning with one for the first school of each area. The numbering was to aid with identification and selection of the schools to participate in this study.

In Virginia, two-hundred and five schools were identified as offering agricultural courses. From the identified schools, thirty schools were selected at random to receive questionnaires. Based upon the number of schools in each area of the state, a two-digit number was selected from a table of random numbers to represent the schools of each area. The beginning point in the table of random numbers was selected by the researcher being blindfolded, using a pencil and randomly selecting a number. The numbers in the table were read down the column to the bottom and returning to the top of the next column until five schools were selected from each area to compose the sample which received the questionnaire. In total, thirty schools were selected and surveyed. The schools were selected to receive the questionnaire when the number in the table of random numbers corresponded to the number assigned to the school in the alphabetical listing of areas, counties, and schools.

The manufacturer, planer model number, motor horsepower, voltage, electrical circuit, and surfacing capacity were determining factors in establishing the representativeness of the subject planer in the Agricultural Mechanics Shop. Even though there were newer planers as well as older planers in Virginia, the specifications of the manufacturers for surfacing capacity, motor horsepower, and electrical circuitry were similar enough that the planer; Powermatic, model 160-B; was determined to be representative. The experimental planer had a five horsepower motor, and a 220/240 volt, three phase-operation electrical circuit.

The Powermatic planer had a sixteen inch surfacing capacity. The results of the survey were shown in Appendix C. The planers in Virginia were designed commercially to remove an optimum of one-sixteenth inch of surface from the stock for each trip the stock made through the planer's surfacing mechanism.

INSTRUMENTS USED

Reference Sound Source. The reference sound source instrument was used to measure the sound produced by the planer's operation by equating the planer's noise to a known reference scale of sound. The procedure was the reference-source method of measuring sound by relating a produced sound to a known source of sound, by frequency and by decibel rating. The instrument measures sound in fifty or sixty cycles per second, in one-third-octave and in one octave bands. Reference sounds were established in one octave, sixty cycles per second measurements since the federal regulation established the safety standards in decibels of audible sound. This instrument consisted of a motor, motor stand, centrifugal fan wheel, and a one-half inch thick rubber acoustical pad.

Although the individual machines have not been calibrated with each other by the manufacturer, the manufacturer estimated that different instruments did measure within a two decibel tolerance (±1 decibel) with each other when measuring the average mean square sound pressure, source noise. The instrument was commercially produced by ILG Industries, Inc., General Blower Division, Wheeling, Illinois. This instrument has been used extensively in industry to measure the frequency and decibel level of noises produced by industrial machines and equipment by substitution of source sound to a known sound.

Sound Level Meter. To measure the sound produced by the planer and to equate that sound to a sound reference source, the Precision Sound Level Meter, Brüel and Kjaer, Model 2204, type 1613, was used. This instrument had a reliability factor of ±1 decibel at one octave measurements where the decibel measurements were between 10 and 150 decibels. The sound level meter automatically corrected for atmospheric humidity, and condition of the batteries.

Microphones chanelled the sound to the measuring meter on the instrument. The microphones were calibrated for measuring the sound produced by the planer before the selected stock was surfaced for this study. A piston phone, the manufacturer's recommended instrument for calibrating the sound level meter with the microphone, was used to make the calibration test. The piston phone, a component of the sound level meter instrument set, produced 124 decibels of sound by which the microphone and sound level meter were calibrated. The piston phone fitted onto the end of the microphone of the sound level meter for calibration to prevent ear damage to the operator.

PROCEDURES

OBTAINING STOCK SAMPLES

Hardwood Stock. The hardwood stock was cut to uniform measurements from two white oak boards which to the researcher appeared to have the same run of grain, and room dried in the same manner. Room dried was the process where lumber was stored in a heated room and moisture in the wood was allowed to evaporate naturally. To obtain uniform sized stock from the two boards, and to keep wood knots at a minimum, sample size was determined to be forty-five inches long, four inches wide, and three-fourths inch thick. Wood knots were removed from the stock where possible to insure that uniform decibel ratings were obtained when the stock was planed.

Softwood. The softwood stock samples were cut to uniform sizes to equal the hardwood stock samples. The softwood stock size was forty-five inches long, four inches wide, and three-fourths inch thick. The softwood samples were cut from two boards which to the researcher appeared to have the same run of grain, and were room dried in the same room with the white oak stock. The softwood stock were cut from Douglas fir boards.

ACOUSTICAL TREATMENTS

The first measurement of sound taken was the sound source reference measurement for equating the sound produced by the planer in one shop to the sound produced by a similar planer in another shop. The reference source sound machine was mounted atop the planer and operated to obtain the decibel rating and octave band frequencies of the sound as related to the construction of the shop in which the planer was located. The microphone of the sound level meter was located in the position established as the ear location of the operator using the planer. The reference sound source machine was turned off, and the sound level meter was turned off. The condition of the batteries for the sound level meter was checked by the instrument check to insure that the batteries were in good working condition. The instruments were turned on and the test was repeated to insure that the resultant measurements for the two tests were in agreement.

To measure the shop background noise, the shop equipment and tools used for this study were inactivated except the sound level meter which remained on to record the sounds in the shop and building in decibels of audible sound. The sound level meter microphone for these measurements was positioned at the ear location of the operator.

The reference measurement of planer noise was taken by operating the planer to obtain the overall decibel rating of audible sound and decibels for the frequencies composing the overall decibel rating of audible sound. The next measurement of audible sound and frequencies was taken with the planer and exhaust system of the planer operating. The exhaust system was operated alone to determine the operational noise of the planer. All measurements in this study were taken at ear location of the operator.

Treatment 1. The reference sound source machine was operated and the decibels of audible sound and the decibels of the sound frequencies composing the audible sound were obtained.

Treatment 2. The planer was operated without surfacing stock to obtain the reference measurement for the planer at ear location of the operator. The audible sound and its component decibels by the octave band frequencies were measured.

Treatment 3. The shop background noise was obtained in decibels of audible sound.

Treatment 4. The planer and the exhaust system were operated without the occurrence of the surfacing operation to measure the sound level of planer noise in the shop prior to applying the acoustical treatments to the planer.

Treatment 5. The exhaust system was operated to determine the amount of noise it contributed to the operational noise of the planer. Audible sound and the component frequencies of the noise of the exhaust system were obtained.

Treatment 6. The rubber pad was installed under the planer by jacking the planer up by means of a lever placed beneath the feedbed and placed on two automotive hydraulic jacks. One jack was placed in front of the planer, and one jack was placed to the rear of the planer whereby each end of the lever rested upon a jack, and the planer was lifted. The planer was lowered onto the pad, and the jacks and lever were removed. The planer was operated without surfacing stock to measure the decibels of sound produced by the planer and exhaust system.

Treatment 7. The measurements were obtained by operating the planer without the exhaust system running.

Treatment 8. The planer was operated to remove one-sixteenth inch of surface from the first piece of softwood stock. The sound was measured as the board entered the cutterhead, as the board was near the halfway point on its trip through the planer, and as the board exited the planer. The board entered the planer in the four-inch wide section marked off on the front feedbed of the planer.

After the surfacing operation, a measurement was taken of the planer operating to determine the dulling measurement of the blades in the cutterhead. The difference in decibel rating between treatment 6 and after treatment 8 was attributable to dulling of the blades. The first sample was run through to obtain a decibel rating for each octave band frequency. One trip through the planer for each frequency was necessary to obtain an entry measurement, a midway measurement, and an exit measurement.

Treatment 9. Treatment 8 was conducted except the first hardwood stock was used.

Treatment 10. Treatment 8 was conducted after the acoustical hood was mounted over the planer and secured in place by four sheet metal screws at ninety degree angles to each other placed through the collar on the hood into the pipe of the exhaust system. Softwood sample number two was used.

Treatment 11. Treatment 10 was conducted except hardwood stock number two was used.

Treatment 12. The acoustical chamber was assembled around the planer with all previous acoustical treatments left in tact. The measurements and procedures for treatment 10 were performed except softwood stock sample number three was surfaced.

Treatment 13. The measurements and procedures for treatment 12 were performed except hardwood sample number three was surfaced.

To obtain the measurements of audible decibel ratings and decibel ratings of the octave band frequencies for each piece of stock, three measurements of decibel readings were obtained. One measurement was obtained when the planer began surfacing the stock. Another measurement was taken when the planer was surfacing the stock near the center as the stock traveled through the planer. The last measurement for each trip the stock made through the planer was taken as the planer completed the surfacing of the particular piece of stock. The three measurements obtained from surfacing each piece of stock for each trip through the planer were averaged to obtain the mean decibel reading of the sound produced when surfacing each stock sample. Each sample stock made ten trips through the planer.

Four pieces of stock for hardwood and for softwood were prepared as samples for this study. The fourth sample was prepared to avoid having to make another sample in case the researcher missed collecting data on a particular treatment.

Chapter 3

RESULTS

STATEMENT OF THE PROBLEM

Enclosing the wood planer in acoustical material will reduce the noise level of the operating and surfacing planer to eighty-five decibels or below.

Table 3

Sound Level Measurements in Decibels of Audible Sound

Treatment	Non-surfacing Measurements	Mean of Surfacing Measurements
1	77	-
2	83	-
3	45	-
4	85	-
5	69	-
6	85	-
7	86	-
8	-	102
9	-	106
10	-	97
11	-	101
12	-	94
13	-	98

COST ANALYSIS

The cost of materials used in this study was as shown in Appendix A.

SCHOOLS SURVEYED

The schools throughout the state which received the questionnaires about the wood planer in the shop of the vocational agriculture departments were listed in Appendix D.

DATA OBTAINED FROM THE SURVEY

A total of thirty schools in Virginia were surveyed to collect data about the planers located in the shops of vocational departments in the schools in Virginia and responses were obtained from all thirty schools. The results of the survey were shown in Appendix E.

ESTABLISHING THE SHOP AS A STANDARD

Treatments 1 through 5 were conducted to standardize the shop noise level prior to obtaining the decibel ratings of noise produced when the planer was surfacing wood. Treatment 1 was shown in Figure 1, as the sound source was located on the planer. The decibel ratings of planer noise not attributable to the surfacing operation of the planer were shown in Appendix F, treat-

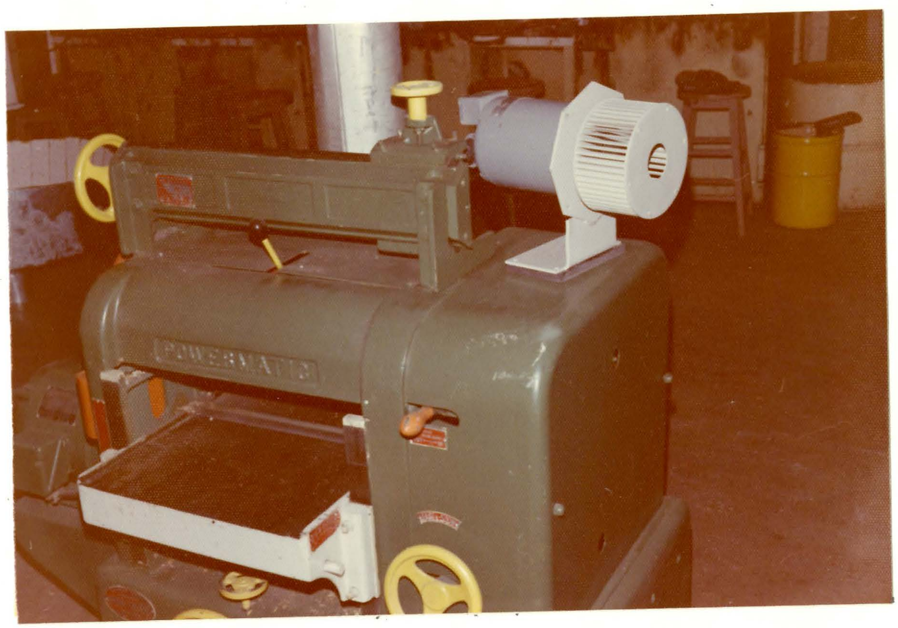

Figure 1

Sound Reference Source Mounted
on the Planer

ments and description 1 through 5.

ACOUSTICAL TREATMENTS

The three decibel measurements of audible noise obtained when surfacing the softwood and hardwood stock samples for acoustical treatments 8 through 13 were reported in Appendix F, Table 2. The three decibel ratings of each octave band, center frequency measurement, obtained from surfacing the softwood and hardwood stock samples for acoustical treatments 8 through 13 were summarized in Appendix F, Table 3.

By averaging the three ratings of audible noise for each acoustical treatment, the mean decibel rating of audible noise was obtained from each surfacing operation as shown in Appendix F, Table 2. The mean decibel ratings in Appendix F, Table 3, were obtained by averaging the three measurements of sound for each octave band decibel rating attained from each surfacing operation in treatments 8 through 13.

The mean decibel ratings of audible noise and the mean decibel ratings of center frequency measurements of the octave bands were entered in Appendix F, Table 1, as the resultant decibel ratings established in this study.

The decibel ratings of planer operating noise and surfacing noise were measured to obtain the audible noise to humans, decibels A level, and were recorded in Appendix F, Table 3.

DISCUSSION OF RESULTS

SURVEY

Of the thirty schools surveyed, eighteen schools had planers which were identical or similar to the planer used in this study. The planers which were similar to the Planer, Powermatic, Model 160-B, varied in their electrical wiring and in the manner in which the power of the electrical motor was transferred to the cutterhead. The Powermatic Planers, Models 160-04 and E-16, had cutterheads which were driven directly from the motor of the planer by gears. Powermatic Planers, Models 160-B and ABFC, used V-belts to transfer the power of the motor to rotate the cutterhead. The four models of planers differed electrically by being wired to operate on single phase or three phase electrical current, and by voltage variations of 115/230, 208, 220, and 220/240.

In twenty-six of the twenty-seven schools, the planer had a five horsepower motor. Only nine planers varied as to manufacturers, or capacity for surfacing.

Data from the questionnaires substantiated that the Powermatic Planer, Model 160-B, used in this study was representative of planers found in the shops of vocational agriculture departments in schools in Virginia.

OBTAINED DECIBEL RATINGS

In determining the nature of sound waves in treatments 2, 4, 5, 6, and 7, the study showed that the planer and the exhaust system had their own distinct operating noise. However, after placing the acoustical matting under the planer, a peculiar result was obtained in treatment 7. The operating noise of the planer and exhaust system was less than the operating noise of the planer without the exhaust system operating. The decibel rating was one decibel greater than the measurement obtained in treatment 6. Several phenomena could have accounted for the resultant measurement. Exhaust system vibration could have been measured at different frequencies by the sound level meter, the elasticity of the rubber mat could have produced an unstable planer mounting, or a possible muffling effect of sound wave frequencies may have occurred in treatment 6.

Treatments 4 and 6 produced the same decibel ratings at the center frequencies of the measured octave bands of the operating noise of the planer and the exhaust system. Therefore, the instability of the planer mounting in treatments 4, 6, and 7 was disregarded.

By analyzing the decibel ratings obtained from the octave band, center frequency measurements in treatments 4, 6, and 7, frequency variations at all frequencies in treatment 7 except the 8000 cycles per second octave band appeared lower than in treatments 4 and 6. The uniqueness that a one decibel increase at one frequency could offset the decrease in decibel ratings in a number of lower frequency ranges could be attributed to a muffling effect of the lower frequency sound waves by the higher frequency sound waves. In such a case, the vibration would be attributed to the exhaust system; however, the muffling effect could have been related to the logarithmic nature of decibel ratings of sound.

INCONSISTENCY OF DULLING EFFECT MEASUREMENTS

In treatments 4 and 6, the noise level of the operating planer was 85 decibels. After treatments 8 and 9, the noise level of the operating planer was 82 decibels. The decrease in operating noise of the planer was due to the interaction of the weight of the planer, and its surfacing operation to settle the planer into the rubber matting. The resilient property of the rubber beneath the contact points between the planer and the rubber mat was reduced. After treatment 8, surfacing of softwood stock, the acoustical rubber matting began to absorb a measurable amount of sound.

ACOUSTICAL HOOD TREATMENTS

In treatment 10, the acoustical hood reduced the average noise level of surfacing softwood from 102 decibels of audible sound to an average of 97 decibels of audible sound. The noise absorbed by the acoustical hood was sufficient to increase the time an operator could surface softwood stock to three hours in twenty-four hours without the need for wearing protective hearing devices as compared to 1 1/2 hours duration for the noise level without the hood in accordance with Table 1.

In treatment 11, the acoustical hood reduced the average noise produced by the planer's surfacing hardwood from 106 to 101 decibels of audible sound. In Table 1, this reduction of noise increased the surfacing of hardwood time of the planer for the operator exposed to the noise without protective hearing equipment from 1 hour to 1 1/2 hours in twenty-four hours.

The following figures illustrated the acoustical hood treatments. The acoustical hood, as mounted over the planer in Figure 2, depicted the location of the sound level meter during the surfacing of the stock for treatments 10 and 11. In Figure 3, the acoustical material was shown as glued to the underside of the acoustical hood. The planer displayed in Figure 4, showed the rear view of the acoustical hood which absorbed noise as the stock exited the planer.

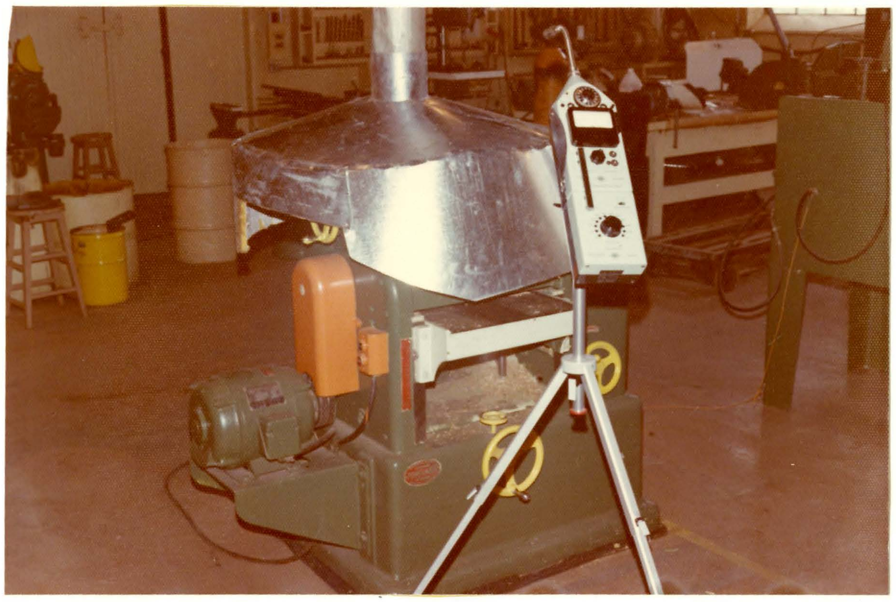

Figure 2

Acoustical Hood and Precision
Sound Level Meter

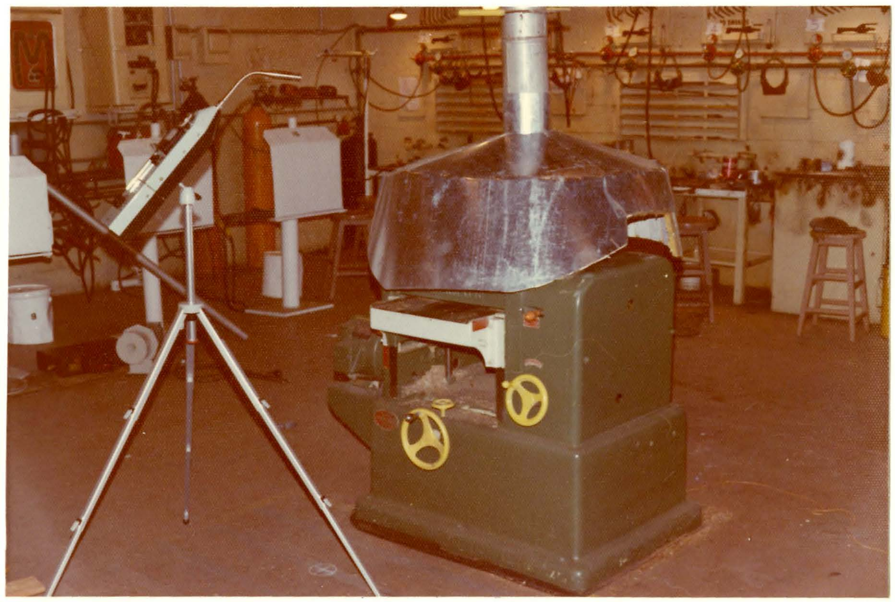

Figure 3

Acoustical Material on Underside of the Acoustical Hood

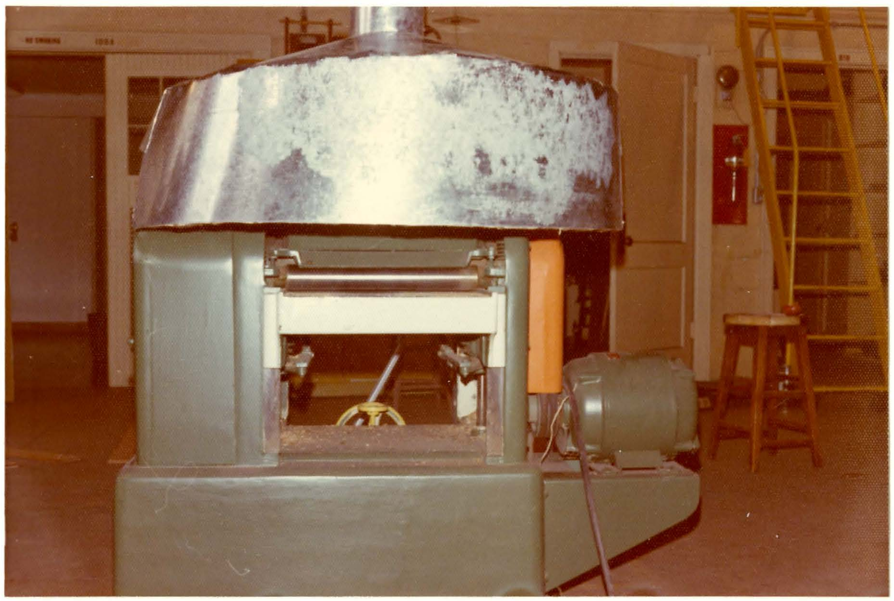

Figure 4

Rear View of Acoustical Hood
Mounted on the Planer

ACOUSTICAL CHAMBER TREATMENTS

In treatment 12, surface softwood, the acoustical chamber absorbed the noise from surfacing the softwood stock from 102 to 94 decibels of audible sound. The acoustical chamber in treatment 13, surfacing hardwood, reduced the noise level from 106 to 98 decibels of audible sound.

By using the acoustical chamber to absorb the noise of the planer's surfacing operation, an operator who was not utilizing protective hearing equipment could surface softwood stock for four hours in a day, or he could surface hardwood stock for two hours during a day. Without the advantage of the acoustical chamber, the resultant decibel ratings of sound measured in this study would limit the operator to surfacing softwood stock for 1 1/2 hours or to surfacing hardwood stock for 1 hour as reported in Table 1 before the operator experienced some hearing damage.

Figures 5, 6, and 7 illustrated the acoustical chamber treatments. The microphone of the sound level meter in Figure 5 represented the ear location of the operator throughout this study. The acoustical material as assembled in Figure 6 displayed the acoustical chamber used in treatments 12 and 13. The Precision Sound Level

Meter in Figure 7 was recording the operating noise of the planer enclosed in the acoustical chamber.

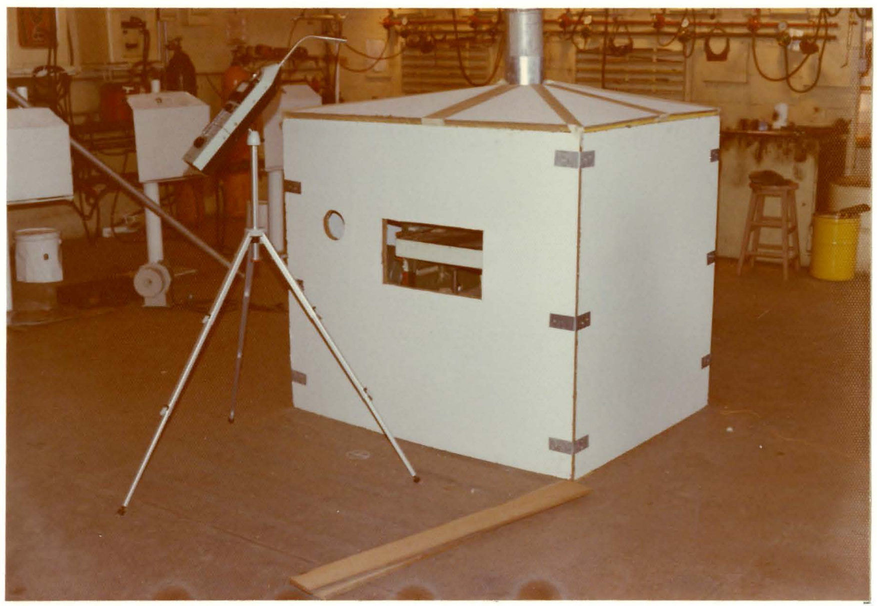

Figure 5

Microphone of Sound Level Meter at
Ear Location of the Operator

Figure 6

Acoustical Chamber Assembled
around the Planer

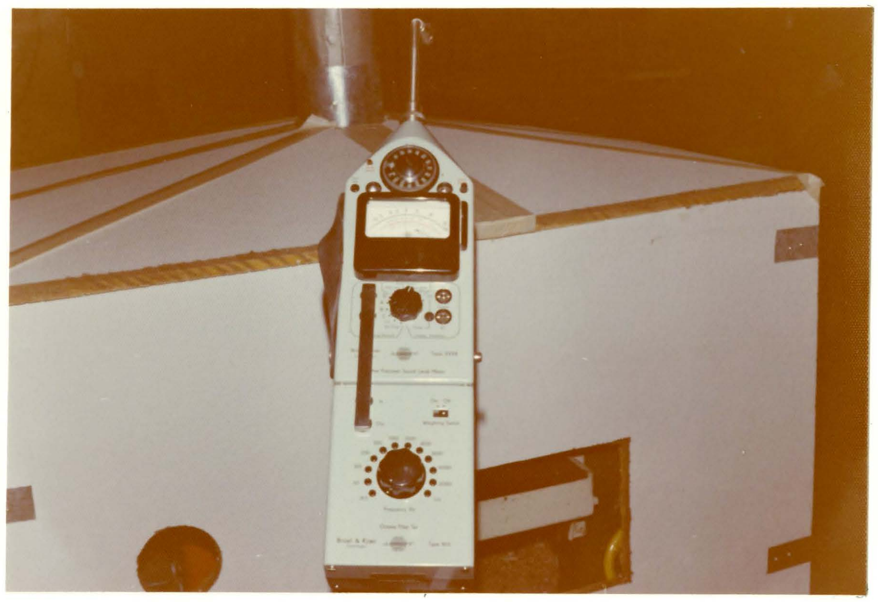

Figure 7

Precision Sound Level Meter Recording
Planer Operating Noise

Chapter 4

SUMMARY AND IMPLICATIONS

STATEMENT OF THE PROBLEM

Enclosing the wood planer in acoustical material will reduce the noise level of the operating and surfacing planer to eighty-five decibels or below.

SUMMARY

The Reference-Source Sound Method was used to establish the shop as a standard for this study. The sound output of the reference-source sound machine was measured by the Precision Sound Level Meter in decibels of audible sound and in decibels of sound for various octave band frequencies. Since the shop was established as a standard, the results of this study may be compared to results obtained from future studies.

Although Stewart and Hart isolated the dust collection system as a major source of planer noise, the net effect of the dust collector, exhaust system in this study, was to reduce the overall planer operating noise. Differences in decibel ratings of sound for the octave band frequencies were obtained when planer operating noise, and the combined operating noise of the planer and exhaust system were measured. When operating the exhaust system with the planer, the major increase in the operating noise of the machines was at the octave band frequency of 31.5 cycles per second. The noted decrease in the operating noise of the machines was at the octave band frequency of 500 cycles per second.

Wall showed that the lower frequency sounds did not have as high a decibel rating as did higher frequency sounds. Therefore, when the planer and exhaust system were operated simultaneously, the decreases in the higher frequency sounds more than offset the increases of lower frequency sounds. The operating noise of the exhaust system caused a muffling effect on the audible sound of the operating noise of the planer. A similar measurement was obtained when the exhaust system was operated. At the octave band frequency of 125 cycles per second, the exhaust system operated at 70 decibels; however, the overall decibel rating of audible sound for the exhaust system was 69 decibels. Significantly, with safety standards specified in decibels of audible sound, exposure to certain frequencies within the sound could possibly be more dangerous to hearing than exposure standards indicated.

According to DeBiase, the federal safety standards for sound levels should have been specified in decibels of sound by frequency in cycles per second, and by sound intensity in decibels of audible sound.

The results obtained from this investigation showed an inconsistency between decibel ratings of audible sound and decibel ratings of sound at various octave band frequencies. Although the inconsistency discovered was below eighty-five decibels, the same effect could occur at decibel ratings above eighty-five decibels of audible sound. Therefore, if the purpose of the safety standards were to alleviate the possibility of decibel deafness to people, this study indicated that DeBiase's conclusions were correct.

The following treatments were used in this study:

Treatment Number	Description
1	Reference Sound Source
2	Planer operating only
3	Background sound of shop
4	Planer and exhaust system operating
5	Exhaust system operating only
6	Rubber mat- planer and exhaust system operating
7	Rubber mat- planer operating, no exhaust system
8	Treatment 6 surfacing softwood
9	Treatment 6 surfacing hardwood
10	Treatment 8 w/acoustical hood
11	Treatment 9 w/acoustical hood

Treatment Number	Description
12	Treatment 10 w/acoustical chamber
13	Treatment 11 w/acoustical chamber

The results of this study showed that the acoustical rubber pad reduced the operating noise of the planer by one decibel. The acoustical materials decreased the overall noise associated with surfacing softwood stock from 102 to 94 decibels of audible sound. Further, the noise level of surfacing hardwood stock was reduced from 106 to 98 decibels of audible sound.

CONCLUSIONS

The following conclusions were reached as a result of this study:

1. The rubber matting used in this study did not possess the necessary acoustical qualities to reduce significantly the noise level of the operating and surfacing planer.

2. The acoustical hood reduced the overall noise of the surfacing operation by five decibels of audible sound.

3. The average difference of decibel ratings of audible sound for hardwood, white oak, exceeded the same rating for softwood, Douglas fir, by four decibels.

4. Surfacing of hardwood stock produced more noise at all octave band frequencies than surfacing softwood stock except at the frequency of 31.5 cycles per second.

5. Although the stock samples were selected to achieve nearly uniform measurements of sound, the decibel ratings of hardwood stock and softwood stock were inconsistent and fluctuated slightly.

6. The acoustical material was most effective in absorbing the sound of the surfacing operation of the planer when the stock was enclosed by the acoustical material.

7. As more acoustical material was assembled around the planer, the operator was exposed to less noise.

8. As established by the level of significance for this study, acoustical treatment 12, surfacing softwood with the acoustical chamber assembled around the planer, was significant at 94 decibels of audible sound.

9. The acoustical chamber reduced the average overall noise of the surfacing operation for softwood and hardwood by eight decibels.

10. Safety standards as established in decibels of audible sound did not reflect accurately the nature of the planer noise to which the operator was exposed.

11. The acoustical treatments investigated in this study did not reduce the noise level of the surfacing and operating planer to eighty-five decibels of audible sound.

12. The acoustical chamber reduced the operating noise of the planer from 83 to 74 decibels of audible sound.

13. In treatment 12 the acoustical chamber increased the duration of exposure to planer noise for the operator from 1 1/2 hours to 4 hours. The increase in exposure time permitted the operator who was not wearing hearing protectors to surface softwood for four hours before damage to hearing would occur.

14. The acoustical chamber as used in treatment 13 increased the exposure time from 1/2 hour to 2 hours which an operator, without a protective hearing device, could surface hardwood before experiencing some decibel deafness.

IMPLICATIONS

The frequencies of sound, 1000 cycles per second and above, were more difficult for the acoustical material used in this study to absorb. Another layer of acoustical material or a layer of material impenetrable by sound could have been added to the acoustical chamber to remove more of the high frequency noise. However, the concept mentioned by Yerges, by which to approach the problem of unacceptable noise levels was to make the shop an acoustical chamber by installing acoustical material on the walls of the shop. Then, smaller acoustical chambers could be used not only to absorb planer noise, but also to confine planer noise to a small area in the shop.

Yerges' recommendation related to a condition observed in this study. As the stock being surfaced entered the planer under the acoustical material assembled about the planer, the decibel level of the noise was reduced until the stock began exiting to the rear of the planer. Had acoustical material been placed on the wall, more of the high frequency sound to which other people in the shop were exposed would have been absorbed. Further, had the acoustical hood and the acoustical chamber been constructed at a height higher than the ear location of the operator the decibel rating of the noise which reached the operator's ears would have been much lower because of the acoustical barrier between the direction of travel of the noise and the operator's ears. Such an acoustically designed device would require the surfacing operation of the planer in the vocational shop to become a two-man function. Methods to insure communications, and safety requirements between the operator and his helper would have to be developed. A system of metal mirrors could be used to allow coordination between the two workmen employing the planer. However, for a limited number of dollars for supplies and a few hours of labor, the noise level in the shop could be greatly reduced by using the concept of the acoustical chamber within an acoustical chamber.

RECOMMENDATIONS

The following recommendations were made as a result of this study:

1. That the nature of the sounds in the shop be identified precisely for all tools and machines used in the shop.

2. That the manufacturer of tools and equipment publish data about the noise specifications of the machines to be included with the machines at the time of sale.

3. That safety specifications be established in decibels of audible sound and in decibels of sound at the various octave band frequencies of that sound.

4. That further study be conducted to investigate the usage of commercially constructed acoustical pads to reduce planer noise which results from contact between the planer and the shop floor.

5. That further study be conducted to evaluate the effectiveness of the acoustical chamber when sixteen-inch wide stock is being surfaced by the planer.

6. That further study be conducted to investigate the effectiveness of an industrial grade of acoustical material to absorb planer noise.

7. That further study be conducted using the acoustical chamber and the acoustical hood to absorb shop noise produced by other tools and machines.

8. That the results of this study be included in Agricultural Mechanics instruction at this University.

9. That vocational educators in Virginia be made aware and instruct the students enrolled in vocational programs of the damage which excessive noise may cause to a person's hearing.

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APPENDIX A

Cost of Project Supplies

APPENDIX A. Cost of Project Supplies[a]

Description	Unit	Unit Price	Amount	Cost $
Acoustical tile, 2' X 4'	Bx	$11.81	2	23.62
Contact cement	Gl	5.05	2	10.10
Corner bead, dry wall	Pc	.32	4	1.28
Mat, rubber	Ft	.08	10	.80
Rivet, pop	Bx	.99	1	.99
Sheet metal, coated 28 gauge	Sh	1.69	1.5	2.54
Stove bolt, 3/16" X 1 1/2"	Pk	.25	7	1.75
Utility board, 4' X 8' X 3/8"	Sh	2.33	5	11.65
Washer, flat, 3/16"	Pk	.25	2	.50
			Total	$53.23

[a]Note: Prices shown here reflect 10% educational discount from the retail prices.

APPENDIX B

Manufacturer's Specifications for Reference Sound Source

APPENDIX B. Manufacturer's Specifications for Reference Sound Source

1. Construction: Unit consists of motor, stand, and 6 1/4" diameter, forward curved (multi-speed) centrifugal fan wheel with restricted inlet, but no fan housing, as follows:

   A. Motor: 17-05-066A. 3400 RPM, 1/4 Hp., 2.6-1.3 Amp. 115-230 volts, 1 Phase, 60HZ

   B. Stand: 1807-1104A for fan with 1/2" rubber pad

   C. Wheel: 1812-9008A (from B 12 Centrifugal Fan) modified for 2" opening on inlet.

2. Physical Size: Overall dimensions are 10 7/8" high, 13 3/8" long, and 8" wide.

3. Weight: 27 1/2 lb.

4. Mounting: Placed on concrete floor.

5. Air Density: .0750 lb./ft^3 Change from .0750 to .0650: .6 dB.

6. Operating Voltage: 115 v at 60 HZ. Change from 100 to 130 v: .7 dB.

7. Operating Speed: 3410 RMP ±20 or ±.1 dB in any band.

8. Sound power output as determined by several tests at Armour Research Foundation by the reverberation room technique was as follows. Individual units are not cali-

brated. Estimated tolerance between Reference Sound Source units is ±1 dB in any band at the same RPM.

REVERBERANT ROOM METHOD
Calibration RE 10^{-12} Watts

Octave Band	Series 2 USASI S1.6-1967 CENTER	L_W	ACCURACY	FREE FIELD METHOD ASHRAE USASI S1.6-1967 SOUND POWER LEVEL-dB RE 10^{-12} Watt
1	63	76.5	±1.5	82
2	125	77.0	± .5	81
3	150	78.0	± .5	81
4	500	79.0	± .5	81
5	1000	79.0	± .5	81
6	2000	79.5	± .5	81
7	4000	78.0	± .5	79
8	8000	76.5	±1.5	78

9. Application: May be used to determine the sound power output of equipment by the substitution method.

APPENDIX C

Survey for Determining the Representativeness of the Planer

COLLEGE OF EDUCATION
VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY
Blacksburg, Virginia 24061

DIVISION OF VOCATIONAL-TECHNICAL EDUCATION

February 26, 1973

MEMO
TO: Certain Teachers in Virginia

FROM: Mickey R. Cunningham

SUBJECT: Request for Planer Data

I am conducting a research project using acoustical material to absorb the noise produced by the shop planer. I need to determine if the planer on which I am conducting my experiment is representative of those in the vocational agriculture shops in Virginia.

Please provide me with the following information about your planer.

Brand Name: ________________________

Model: ____________________________

Motor Horsepower: __________________

Check One: _______3 Phase; _______1 Phase

Volts: _____208; _____220; _____220/240; _____Other

Capacity-width of surfacing: _______ inches

Your Signature: ___________________________________

Please fill out the questionnaire and return it at your earliest convenience.

MRC

APPENDIX D

List of Schools Which Were Surveyed

APPENDIX D. List of Schools Which Were Surveyed

School Number	Name of the School	County/City
Appalachian Area		
1	Bland High School	Bland
6	Woodlawn Intermediate School	Carroll
9	Ervinton High School	Dickerson
29	Rich Valley High School	Smyth
37	Patrick Henry High School	Washington
Blue Ridge Area		
4	New Castle High School	Craig
8	Giles County High School	Giles
14	Christiansburg High School	Montgomery
18	Blairs Junior High School	Pittsylvania
20	Dan River High School	Pittsylvania
Central Area		
4	Scottsville High School	Albemarle
8	Charles City County High School	Charles City
30	Nelson Senior High School	Nelson
32	Northumberland Junior High School	Northumberland
37	Richmond County Intermediate School	Richmond

School Number	Name of the School	County/City
Eastern Area		
2	Central High School	Accomack
7	Essex High School	Essex
10	Greenville High School	Greenville
11	Greenville Junior High School	Greenville
29	L.P. Jackson High School	Surry
Northern Area		
5	Valley Vocational-Technical School	Augusta
6	Wilson Memorial High School	Augusta
13	Highland High School	Highland
18	Luray High School	Page
30	Strasburg High School	Shenandoah
Southside Area		
4	Appomattox County High School	Appomattox
5	Appomattox Intermediate School	Appomattox
6	Bedford Educational Center	Bedford
27	Park View Junior High School	Mecklenberg
32	Prince Edward County High School	Prince Edward

APPENDIX E

Data from Survey

APPENDIX E. Data from Survey

School Number	Planer Name	Model	Motor Hp	Phase	Volts	Capacity (Inches)
Appalachian Area						
1	Powermatic	180-04	5	1	220	18
6	Powermatic	180-04	5	1	220	18
9	Delta		5	3	208	16
29	Powermatic	160-04	5	1	220	16
37	Powermatic	160-B	5	3	208	16
Blue Ridge Area						
4	New Castle High School had no planer.					
8	Powermatic	E-16	5	1	220	16
14	Powermatic	180	5	3	208	18
18	Powermatic	E-16	5	3	208	16
20	Powermatic	160-B	5	1	220	16
Central Area						
4	Powermatic	225	6	1	220/240	24
8	Powermatic	E-16	5	1	220	16
30	Powermatic	160-B	5	3	208	16
32	Powermatic	160-04	5	1	115/230	16
37	Delta		5	1	220/240	12

School Number	Planer Name	Model	Motor Hp	Phase	Volts	Capacity (Inches)
Eastern Area						
2	Powermatic	E-16	5	1	220	16
7	Powermatic		5	3	208	20
10	Powermatic	E-16	5	3	220/240	16
11	Powermatic	E-16	5	3	220	16
29	Powermatic (Planer/Saw)		5	1	220	6
Northern Area						
5	Valley Vocational-Technical School had no planer.					
6	Wilson Memorial High School had no planer.					
13	Powermatic	E-16	5	1	220	16
18	Powermatic	E-16	5	1	220	16
30	Powermatic	ABFC	5	3	220/240	16
Southside Area						
4	Crescent	P-18	5	3	208	18
5	Powermatic	160-B	5	3	220	16
6	Delta	R254	5	3	220/230	18
27	Powermatic	E-16	5	3	208	16
32	Powermatic	E-16	5	3	220	16

APPENDIX F

Results of Treatments

APPENDIX F. Results of Treatments

Table 1. Decibel Measurements of Planer Noise

Treatment and Description	Overall (dBA)[a]	Dulling Effect	Octave Band Mean Decibel Ratings Center Frequencies (Cycles per Second)								
			31.5	63	125	250	500	1000	2000	4000	8000
1. Reference Sound Source	77		69	75	73	71	70	71	70	69	67
2. Planer operating only	83		53	67	71	87	85	78	75	71	74
3. Background sound of shop	45										
4. Planer and exhaust system operating	85		62	66	73	88	82	79	74	73	75
5. Exhaust system operating only	69		60	63	70	67	65	64	61	58	54
6. Rubber mat-planer and exhaust system operating	85		62	66	73	88	82	79	74	73	75
7. Rubber mat-planer operating, no exhaust system	86		54	61	69	86	85	75	75	73	76
8. Treatment 6 surfacing softwood	102	82	79	70	73	82	82	86	92	89	88

[a]dBA - decibel of audible sound.

Table 1 (continued)

Treatment and Description	Overall (dBA)	Dulling Effect	Octave Band Mean Decibel Ratings Center Frequencies (Cycles per Second)								
			31.5	63	125	250	500	1000	2000	4000	8000
9. Treatment 6 surfacing hardwood	106	82	58	75	77	86	89	90	91	93	88
10. Treatment 8 w/acoustical hood	97	79	60	66	70	79	81	85	87	85	82
11. Treatment 9 w/acoustical hood	101	79	64	70	71	82	87	89	88	92	84
12. Treatment 10 w/acoustical chamber	94	74	62	67	69	78	78	80	82	80	88
13. Treatment 11 w/acoustical chamber	98	74	60	68	73	85	84	88	92	89	88
After completion of surfacing operation and removal of acoustical hood and chamber		82									

APPENDIX F

Table 2. Experimental Data for Treatments 8-13 for Overall Audible Sound

Treatment Number	Overall (dBA)[a] Begin[b]	Midway[c]	Exit[d]	Mean[e]
8	102	103	101	102
9	100	108	109	106
10	100	92	100	97
11	100	104	98	101
12	92	96	93	94
13	102	98	94	98

[a]dBA - decibel of audible sound

[b]Begin-begin surfacing operation on the stock

[c]Midway-board was midway through the surfacing operation

[d]Exit-board exiting from the surfacing operation

[e]Mean--the average of the three decibel ratings obtained by surfacing the stock samples. The mean decibel ratings were the figures used in this study.

APPENDIX F

Table 3. Experimental Data from Treatments 8-13 for Octave Band Frequencies

Treatment Number	Octave Band Decibel Ratings Center Frequencies (Cycles per Second) 31.5			63			125			250			500		
	B[a]	M[b]	E[c]	B	M	E	B	M	E	B	M	E	B	M	E
8	79	79	79	70	70	70	73	73	73	82	82	82	81	83	83
Mean[d]		79			70			73			82			82	
9	58	58	58	75	75	75	77	77	77	86	86	86	89	89	89
Mean		58			75			77			86			89	
10	60	60	60	65	67	66	70	70	70	78	80	79	80	81	82
Mean		60			66			70			79			81	
11	64	64	64	71	67	71	71	70	73	80	80	86	86	84	90
Mean		64			70			71			82			87	
12	62	62	62	67	67	67	69	69	69	78	78	78	78	78	78
Mean		62			67			69			78			78	
13	60	60	60	68	68	68	73	73	73	85	85	85	84	80	88
Mean		60			68			73			85			84	

[a]B-begin surfacing operation on the stock

[b]M-board was midway through the surfacing operation

[c]E-board exiting from the surfacing operation

[d]Mean--the average of the three decibel ratings obtained by surfacing the stock samples.

Table 3 (continued)

Treatment Number	Octave Band Decibel Ratings Center Frequencies (Cycles per Second)											
	1000			2000			4000			8000		
	B	M	E	B	M	E	B	M	E	B	M	E
8	86	86	86	92	92	92	89	89	89	88	88	88
Mean		86			92			89			88	
9	90	90	90	91	91	91	93	93	93	88	88	88
Mean		90			91			93			88	
10	84	86	85	88	86	87	88	79	89	84	78	83
Mean		85			87			85			82	
11	90	85	91	86	87	94	92	89	96	85	83	85
Mean		89			88			92			84	
12	78	80	82	82	80	85	80	75	84	90	85	89
Mean		80			82			80			88	
13	89	85	90	91	86	99	90	85	91	92	85	88
Mean		88			92			89			88	

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REDUCING THE DECIBELS OF NOISE PRODUCED BY THE WOOD PLANER IN THE SHOP OF THE VOCATIONAL AGRICULTURE DEPARTMENT

by

Mickey R. Cunningham

(ABSTRACT)

Usage of acoustical material to reduce the shop planer operating and surfacing noise to eighty-five decibels of audible sound revealed that the acoustical treatments would reduce the noise level in the shop. Eighty-five decibels of sound was the established federal safety level at which continuous exposure of the unprotected ear to the noise would not cause decibel deafness.

The sound reference source machine was used to establish the shop as a standard for the obtained measurements, and the Precision Sound Level Meter was employed to measure the decibel ratings. An acoustical hood, and an acoustical chamber were the two major treatments utilized to reduce the planer operating and surfacing noise. Selected softwood, Douglas fir, and selected hardwood, white oak, stock samples were surfaced by the planer to obtain the decibel ratings. The measurements of sound varied as to the type of wood samples, decibels of audible sound, and decibels of sound at various octave band frequencies.