A Statistical Survey of Ball Lightning Observations

by

Elizabeth M. Carducci

Submitted to the Department of
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Department of Electrical Engineering and Computer Science
May 18, 1987

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Abstract

Ball lightning is a natural phenomenon which has been the subject of controversy for many years. Since it has never been successfully reproduced in the laboratory and sightings have never been substantiated, many scientists deny the existence of this form of lightning. Data on this phenomenon has been collected through a series of surveys involving subjects who claimed to have seen ball lightning. Through an organized study of this data some evidence might be revealed concerning the probability of existence and the possible nature of ball lightning.

A software system was designed which would most effectively analyze this data. This system consists of a database, a custom designed screen, a master program, and three subprograms. It was necessary that the system be efficient at handling a large database and have the capability to perform simple numerical analysis on this data. This system was successfully implemented and a representative sample of the data was input for testing purposes.

Thesis Supervisor: Charles E. Miller
Title: Technical Instructor of Electrical Engineering and Computer Science

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A special note to my sister and my closest friend, who has always been there for me.

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I. Introduction

Ball lightning has been observed as a luminous ball ranging in color from red-orange to blue or white. It may be up to 20 inches in diameter but is most commonly sighted at about 6 inches. It usually appears after a lightning flash to the ground and moves slowly along the ground or in the air. Some lightning balls disappear quietly while others evaporate with a loud explosive noise. They tend to last several seconds to several minutes. Occassionally, balls of lightning have been reported to follow conductors such as an overhead wire, or to enter a room through an open window.[1]

It is obvious from the above description that there are great variations in the properties these balls of lightning are reported to have. These variations, along with the inverifiable nature of the sightings, have added to the confusion about the exact nature of ball lightning. Based on these properties many theories have been proposed to explain the formation of lightning balls.

Theories Explaining Ball Lightning

Various theories have been forwarded to explain ball lightning. One explanation is a chemical one. It is believed by some that the decomposition of ozone is initiated by the lightning flash and then maintained by the heat of the

reaction. As the ozone and atomic oxygen mixture decomposes to molecular oxygen it emits the light characteristic of ball lightning.[2] This theory has been proposed based on the fact that the smell of ozone has been associated with sightings of ball lightning.

Another theory is that this ball is a mass of recombining ions and electrons - essentially a ball of plasma. This theory is of interest because it indicates that in some way the plasma has stabilized most likely a result of the extremely high temperature. An electrical theory suggests that a high concentration of electrons is formed in the lightning channel. This high concentration of electrons can exist for a sufficient amount of time to account for this phenomenon. The emission of light would be caused by the collision between the electrons and the air molecules.[3]

Many scientists doubt the existence of this phenomena. They believe the ball is an optical illusion caused by the lightning flash. The brightness of the flash causes a residual image to remain on the retina which appears to be a luminous ball.[4] Since this phenomenon has never been reproduced in the laboratory and no conclusive photographs have been taken, there is still much debate over it's existence.

Background

Ideally, when a scientific study is undertaken the procedure of choice is to reproduce the process being examined in the laboratory so that it can be studied under controlled conditions. However, due to the fact that ball lightning has never been successfully reproduced in the laboratory, the only means available for study of this phenomenon is the analysis of actual sightings. Therefore, anyone interested in examination of this phenomenon must survey those who have observed it.

In order to discover more information about ball lightning a survey was distributed to people who claimed to have seen it. Approximately five hundred employees of a Union Carbide thermonuclear plant in Oak Ridge, TN participated in this study. Apparently, this area is a prime location for ball lightning to occur. Since these employees are scientifically knowledgable, this population is an ideal one for this investigation.

The Survey

The survey utilized in this study consisted of two parts. For a sample of this survey see Appendix A. The first part is fairly straightforward and is comprised of both close-ended and open-ended questions. In close-ended questions the respondent is required to choose from a number of responses provided by the interviewer. These types of questions are much simpler to analyze, however there is

a possibility that the participant will become biased due to the limitations presented by predetermined responses. The open-ended questions are more difficult to draw conclusions from, however they provide a powerful means of recording direct observations. Considering the subject matter, it is clear that open-ended questions are necessary in certain cases where the researcher could not anticipate every possible response.

The second part of the survey consists of one question. Each respondent was asked to describe in text form everything that he remembered about the incident. There were no guidelines or restrictions applied to the answers. In this way the participant was able to describe exactly what he observed without considering the format of his response. Once the problem of how to analyze this data is solved, this portion of the survey may provide a great deal of insight into this phenomenon.

Objective

These surveys represent a great deal of data relevant to the study of ball lightning. The objective of this study is to provide a simple yet efficient method to analyze the data gathered with these surveys. After a careful examination of a sample of these surveys, a methodology can be outlined which will extract the information of interest to the researcher. Once this methodology is defined a software system can be designed to perform this analysis. This system will be

designed to handle a large amount of data since this is an important factor in an investigation of this kind. This system will then be implemented and tested using a small sample of the larger database.

II. Methods of Analysis

Before design of a data management software system can occur, a specific methodology for data analysis must be developed. To this end research was conducted into valid and reliable means of interpreting survey data. The results are presented in this section and certain preferred methods which are utilized in this study will be highlighted.

One method of analyzing survey responses is simply by counting the frequency of a certain response. In this way the percentage of respondents who indicated a particular response can be calculated. This can be measured on more than one question simultaneously which will result in the selection of those participants whose responses meet all the criteria. This method is very practical in an analysis of close-ended questions and will be utilized in the software to handle the first section of the survey.

Another method of statistical analysis which is used frequently by survey researchers consists of finding the correlation between two pieces of data. This is basically a way of discovering the relationship that exists between seemingly unrelated fields. If two fields correspond so that if one is greater the other is also greater, or if one is answered 'yes' the other is also answered 'yes', then a positive correlation exists between these two fields. If the reverse is true - when one field is

greater the other would tend to be less, then a negative correlation exists between these fields. If no such conclusions can be drawn, the two fields are said to have no correlation. At first consideration this seemed to be a relevant parameter to calculate, however it is usually used to indicate the dependence of one field on another which is not an important or desirable factor to include in the system.

Other numerical calculations are also used to represent the data that was gathered. A common value which is often calculated is the average of numerical data in any particular field. This parameter will prove useful in analyzing certain parameters such as the time and the size of the ball lightning. The second section of the survey, which contains textual data, presents a special problem in survey analysis. A common way to evaluate these passages would be to draw qualitative inferences based on the content of each individual survey. It is preferred, however, to develop a quantitative approach to this analysis.

One way to analyze this type of data is referred to as content analysis. This method consists of looking for important content in a textual passage. Quantitative content analysis is concerned with finding the frequency of occurence of certain content characteristics. This is often accomplished through the development of a category system. One such system, symbol analysis, examines the content of a passage for the appearance of certain important symbols. It is necessary therefore to define and categorize the symbols or keywords which are deemed relevant. For

example, one may want to search for any occurences of the symbol, 'followed wire conductors', in the text. One would then examine the context in which it was written to determine whether it applies to the category of interest. This is the method which will be used to analyze the textual section of the survey.

III. Software system

Design

In designing the software there were certain factors which needed to be considered. The first of these is that this system needed to be capable of handling and storing large amounts of data in an organized and easily assessible fashion. In order to satisfy this criterion the system was developed in DBASE, a database management language. This language was intended for just such a purpose. Although there are certain limitations to using this language due to it's top-down structure, it was quite sufficient in meeting the needs of this particular system.

The next factor of importance was that this system be relatively user-friendly. Since there would be users inputting data who were not familiar with the system and even possibly the study itself, it was necessary that this system could be managed with ease. In order to insure this result, the system was set up in menu format and a custom designed screen was developed. To aid in entering data, this screen was designed so that the numbers would correspond with the survey questions.

The basic design of the system is shown in the block diagram of Figure 1. It would consist fo the database, a custom designed screen, the master program and three subprograms. With the design complete, the system was ready to be

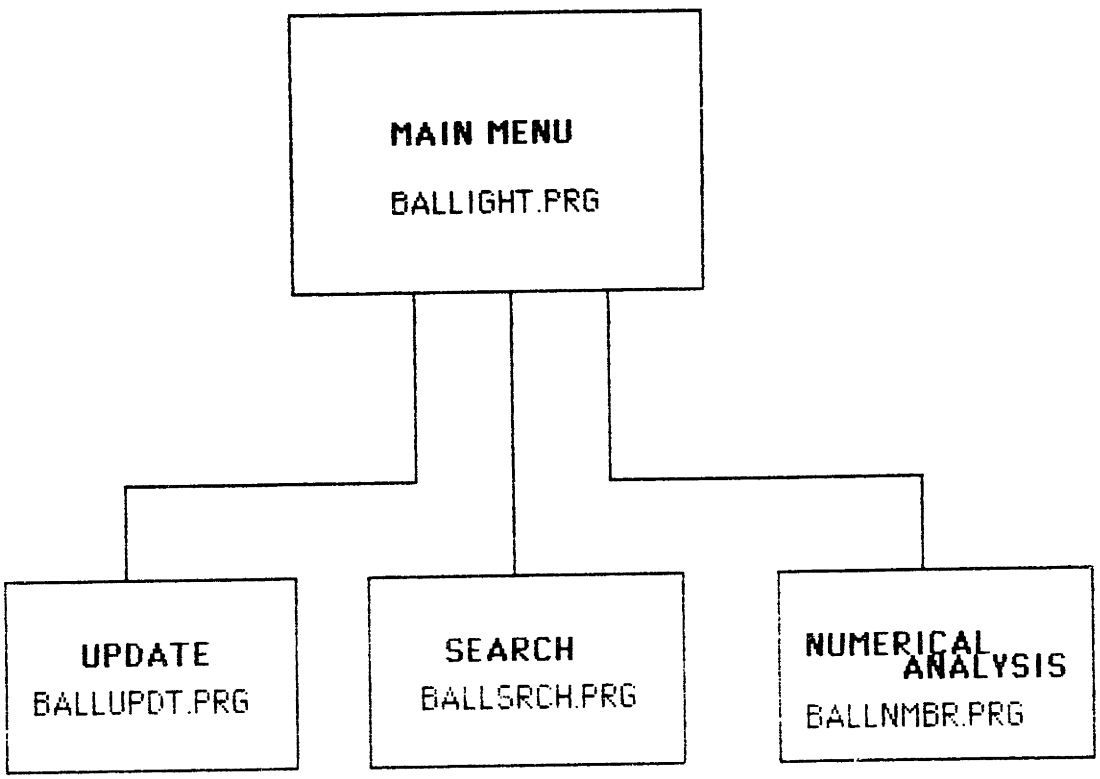

Figure 1. Block diagram of ball lightning database system

implemented.

Implementation

The first step in implementing the system was to build the database. The database file, BALLIGHT.DBF, consists of records 787 characters long. Each record represents one survey, and is divided into 41 fields. A list of fields, their data type (character, numeric, logical, or memo), and parameters on allowable inputs is given in Table 1. There is also an explanation of what each field corresponds to. In general, each field represents one question although there are more fields than questions. This is due to the fact that certain fields need to be edited by the coder in order to create uniformity between records. This uniformity allows meaningful data to be extracted when the field is searched or sorted. This is true of the fields TIME and SIZE. These fields are coded consistently with the units being seconds and inches respectively, regardless of the units given in the actual response. Therefore, a field is provided to record the actual response of the participant. The last ten fields, TEXT. . .TEXT10, are character fields of 60 characters each. These fields are intended to store the second section of the survey. The coder is responsible for limited editing when entering this data. For example, certain words such as determiners (the, a, etc.) are unimportant to the context of the passage.

Field Name	Type	Width	Decimal
REPORTNO	Character	3	
SIGHTING	Numeric	1	0
LIGHTFLASH	Numeric	1	0
TIME	Numeric	5	0
TIMEUNIT	Character	20	
DECAY	Character	10	
SIZE	Numeric	5	0
SIZEUNIT	Character	20	
DIMENSION	Character	10	
SIZECHANGE	Numeric	1	0
QUICKLY	Numeric	1	0
GRADUALLY	Numeric	1	0
SOUNDS	Numeric	1	0
NAMESOUND	Character	20	
EFFECTS	Numeric	1	0
SCORCH	Numeric	1	0
MELT	Numeric	1	0
MAGNETIC	Numeric	1	0
NONMETAL	Numeric	1	0
ELECSTATIC	Numeric	1	0
XRAY	Numeric	1	0
ACTIVATION	Numeric	1	0
SUNBURN	Numeric	1	0
ODOR	Numeric	1	0
NAMEODOR	Character	10	
OTHER	Character	20	
PTDISCHRGE	Numeric	1	0
MOVEMENT	Character	25	
COLOR	Character	20	
HEAT	Numeric	1	0
VISUAL	Numeric	1	0
TEXT	Character	60	
TEXT2	Character	60	
.	.	.	
.	.	.	
TEXT10	Character	60	

Table 1. List of fields and their parameters - BALLIGHT.DBF

Also, there may be certain information with could be expressed in a more concise and meaningful fashion. For instance, in one survey the participant wrote, "My father, and mother, and I were eating breakfast when . . .". The only worthwhile information to be gathered from this phrase is that the incident occurred over breakfast so that this fragment would be most efficiently coded as "incident occurred in morning." This approach, however, requires that the coders be trained to recognize what information is important and relevant to the study.

Another coding convention was made for the close-ended questions. The responses to these questions were limited to yes or no, however many participants indicated that they were not sure or they left it blank. These fields were generated as of the numeric type for ease of sorting and searching. For this reason these questions were coded numerically: 1=yes, 2=no, 3=no answer, 4=not sure.

The next part of the system to be implemented was the custom designed screen. The code to set up the screen is contained in BALLSCRN.FMT and the screen itself is saved in BALLSCRN.SCR. This screen was developed to be used during the editing and appending of records to the database. It was designed to be compatible with the questionnaire to facilitate the task of the coders. All of the fields for the first section are contained on the first screen and are numbered to correspond with the survey. The text fields are displayed on the second screen and are set up to receive data in one continuous stream.

The master program, BALLIGHT.PRG, is basically a main menu. It presents the user with four choices to update, to search, to perform numerical analysis, or to exit. The program will then transfer control to one of the three subprograms or to to DBASE command dot prompt, depending on the user's response. The three subprograms and their descriptions are given below. The actual code is listed in Appendix B.

BALLUPDT.PRG - The master program will pass control to this subprogram when the user chooses to update the database in the main menu. This program allows the user to append to, to delete from, and to edit the database.

BALLSRCH.PRG - This subprogram is called when the user chooses to search the database. This program allows the user to search a variable number of fields up to the number of fields in one record. Once the user specifies the number of fields he wishes to search on, the user will be prompted to enter the field name and the search condition for each search that he specified. Then depending on the field which was specified the program will either set up an exact search or an embedded search. It will then display the record number and survey number of each record that satisfies

all the search criteria.

BALLNMBR.PRG - The main program transfers control to this program when the user indicates that he would like to perform numerical analysis on the data. The user can then choose to count the frequency of a particular response or to average the responses in a given field.

IV. Results

After completing the implementation, a small sample of the larger database was entered to test the capabilities of the system. This was an important step in determining whether the system met the original objectives and design specifications. These tests showed that the system was successful in fulfilling the objectives of handling a large database efficiently and of performing simple numerical analysis on this database.

The results of the tests were inconclusive due to the small sample size that was used. In order to gain results with any statistical meaning a large population must be analyzed. There were some trends which surfaced, however, which may be an indication of a more accurate trend in the entire sample. For example, the plot of time vs. count (Fig. 2, p.22), shows the reported duration of the ball lightning was usually between 1 and 5 seconds. The plot of size vs. count (Fig. 3, p. 22) does not show any consistency in the reported size of the lightning ball. The output generated by the system,tabulating the number of records for a given time value and the number of records for a given size along with their averages, is given in Appendix B.

The search routines in BALLSRCH.PRG allow the user to conduct searches on one or more fields. An example of the output for searches of both kinds is given

in Appendix B. Listed first is the output generated by a search on time, then the output generated by a search on color, and finally the output generated by a search on both time and color simultaneously. These are just a few examples of the data that can be extracted using this system.

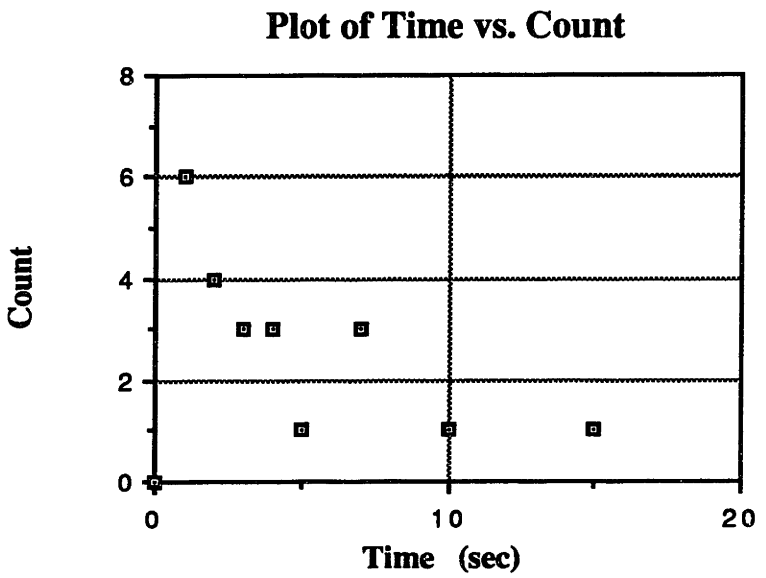

Figure 2. Scatterplot of Time versus Count

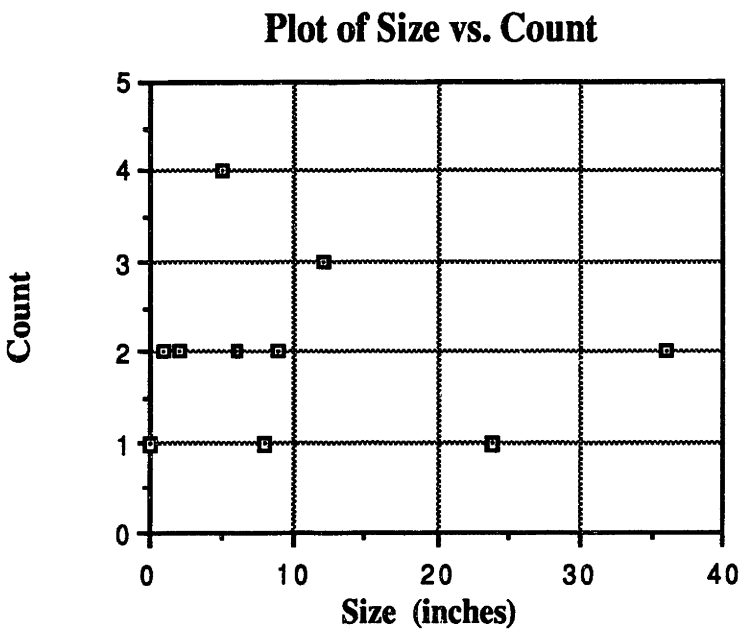

Figure 3. Scatterplot of Size versus Count

V. Conclusions and Recommendations

Conclusions

After running various tests, it is evident that the system which was developed is more than adequate in meeting the design. The system is efficient at handling the large database associated with a study of this nature. It is sufficient at performing the simple numerical analysis needed to tabulate the survey results. It is also user-oriented which is beneficial in a system such as this designed to be used by many people with limited experience. Therefore, this project can be considered successful in fulfilling its original objectives.

Before concluding, however, there are some comments which must be made concerning the study as a whole. The first element to be considered is the validity of these surveys in respect to the study of ball lightning. One good point about this survey is that the sample is very large considering the percentage of the population that has actually seen ball lightning and would recognize it as such. Another factor in its favor is that the population which was sampled was drawn from a community which was technically oriented. This should provide observations which are more reliable. There are also problems associated with this data . The most obvious problem is that many of the respondents expressed the fact that they were recalling an event they had observed many years previously. Some participants stated that

they had sighted the ball lightning over twenty years ago or in their childhood. This data would seem to be less reliable since the memory of an event loses clarity over time. Also, as a child an event such as this might be exaggerated in magnificence. Unfortunately, the respondents were not asked to specify the date of the sighting in relation to the date at which they completed the survey. If they did not volunteer this information there is no way to predict how reliable the data is.

Another comment which must be made concerns the date when most of this data was taken. These surveys were compiled approximately twenty years ago. As a result, even though there are names on some of them, there is little chance that any of the responses can be validated or clarified if necessary. In a survey which contains so much textual data this is a great disadvantage.

In conclusion, the system which was developed as a part of this project is sufficient to analyze the data collected through these surveys. After using this system to examine this data some inferences may be made concerning the nature of ball lightning, however, the importance and validity of these findings is debatable due mostly to the issue of the possible inaccuracy of the survey data.

Recommendations

Based on the conclusions which were drawn about the system, and the data in particular, the following recommendation is made. First, the data which has been gathered already should be analyzed using the system that was developed. From this analysis any theories which might be supported should be documented. Once this is done, the study should be repeated. The surveys should be redistributed to a different population after certain points are clarified. For example, the date of the sighting is an important factor which should be included on the questionnaire. The analysis can then be repeated with the new data. After this process has been completed, if any of the original theories are also supported by the second analysis they would appear to be findings which would hold great validity. These results would surely be relevant in the study of ball lightning.

List of References

1. Singer, Stanley. The Nature of Ball Lightning. NewYork: Plenum Press, 1971, page 3.

2. Viemeister, Peter E. The Lightning Book. Cambridge: MIT Press, 1972, page 130.

3. Malan, D. J. Physics of Lightning. London: English Universities Press, 1963, page 7.

4. Ibid, page 7.

5. Pool, Ithiel de Sola. Trends in Content Analysis. Urbana: University of Illinois Press, 1959, page 9.

Appendix A: The Survey

"Ball Lightning" has been considered by numerous capable scientists as having objective reality and several physical models have been proposed to explain the phenomenon. In view of its possible interpretation as a stable plasma configuration and hence importance in the thermonuclear field the following questionnaire is submitted. Please fill out and return to the undersigned. Any additional comments you make will be appreciated.

1. Have you ever seen "ball lightning"? Yes_____ No_____
2. Did it occur only after a lightning flash? Yes_____ No_____
3. Approximately how long did it persist? _____
4. Did it decay slowly or suddenly? _____
5. What size or range of size was the ball? _____
6. Did the size of the ball change? Yes_____ No_____
   (a) quickly Yes_____ No_____
   (b) gradually Yes_____ No_____
7. Did any unusual sounds accompany the phenomena or its disappearance? Yes_____ No_____
8. Did it cause any unusual disturbance or leave any after effects? Yes_____ No_____
   (a) objects scorched? Yes_____ No_____
   (b) objects melted? Yes_____ No_____
   (c) magnetic objects disturbed? Yes_____ No_____
   (d) non-metallic objects disturbed? Yes_____ No_____
   (e) electrostatic effects? Yes_____ No_____
   (f) photographic film (x-ray) effects? Yes_____ No_____
   (g) activation effects? Yes_____ No_____
   (h) other? Yes_____ No_____
9. Did you notice any point type discharges? Yes_____ No_____
10. Did it move randomly in space, follow conductors, remain in general contact with surfaces, or was it air-borne part of the time? _____
11. What color and color changes were noted? _____
    _____
    _____
12. Did you have any special visual effects during or after the event? Yes_____ No_____
13. Comments and suggestions:

December 7, 1960

You are one of about 500 Union Carbide Nuclear Company employee. indicating that you may have observed ball lightning. Would you be kind enough to describe in writing and as completely as possible the event (or events) without reference to the questionnaire originally distributed. This is to insure that any observations not initially reported can be included in the evaluation of each case. Please refer to Report No. 105 and return to:

J. R. McNally, Jr.
Room 335
Bldg. 9201-2
Y-12

Appendix B: Output

TIME VALUE	NUMBER OF RECORDS
0	0
1	6
2	4
3	3
4	3
5	1
6	0
7	3
8	0
9	0
10	1
11	0
12	0
13	0
14	0
15	1
16	0

AVERAGE OF TIME =
3.91

SIZE VALUE	NUMBER OF RECORDS
0	1
1	2
2	2
3	0
4	0
5	4
6	2
7	0
8	1
9	2
10	0
11	0
12	3
13	0
14	0
15	0
16	0
17	0
18	0
19	0
20	0
21	0
22	0
23	0
24	1
25	0
26	0
27	0
28	0
29	0
30	0
31	0
32	0
33	0
34	0
35	0
36	2

AVERAGE OF SIZE =
22.55

```
SEARCH FOR  time=1

Record#  REPORTNO
      1  1
      5  14
      2  4
     20  40
     22  53
     14  6

         6 RECORDS OUT OF          22
```

```
SEARCH FOR  'orange'$color

Record#  REPORTNO
      1  1
      4  13
      6  18
      7  21
      8  23
     20  40

         6 RECORDS OUT OF          22
```

```
SEARCH FOR  time=1 .AND.'orange'$color

Record#  REPORTNO
      1  1
     20  40

         2 RECORDS OUT OF          22
```

Appendix C: Software

```
*****************BALLIGHT.PRG
*** Ball Lightning Database Management System
*** EMC 5/5/87

SET TALK OFF
SET BELL OFF
SET STATUS OFF
SET DEFAULT TO C

USE BALLIGHT INDEX BALLSRVY
GO TOP

CHOICE = 0
DO WHILE CHOICE <>4
     CLEAR
     TEXT
                BALL LIGHTNING MAIN MENU

                 1. UPDATE database

                 2. SEARCH a field

                 3. NUMERICAL analysis

                 4. EXIT
     ENDTEXT

     @ 16,20 SAY "Enter choice " GET CHOICE;
      PICTURE "9" RANGE 1,4
     READ

     DO CASE
          CASE CHOICE=1
             DO BALLUPDT
         CASE CHOICE=2
             DO BALLSRCH
         CASE CHOICE=3
             DO BALLNMBR
     ENDCASE

ENDDO

CLOSE DATABASES
SET TALK ON
SET STATUS ON
RETURN
```

```
**********BALLUPDT.PRG
*** Subprogram of main menu:BALLIGHT.PRG
*** EMC 5/9/87

CHOICE=0
DO WHILE CHOICE <> 4
CLEAR

    TEXT
            BALL LIGHTNING - UPDATE DATABASE

                1. ADD new records

                2. DELETE existing records

                3. EDIT existing records

                4. RETURN to Main Menu
    ENDTEXT

    @14,20 SAY "Enter Choice " GET CHOICE;
      PICTURE "9" RANGE 1,4
    READ

    DO CASE

        CASE CHOICE = 1
            SET FORMAT TO BALLSCRN
            APPEND
            CLOSE FORMAT

        CASE CHOICE = 2
            NEWREC = .T.
            DO WHILE NEWREC
                CLEAR
                RN = SPACE(3)
                @12,15 SAY "(Press RETURN to exit)"
                @10,10 SAY "ENTER NUMBER OF SURVEY TO BE DELETED " GET RN;
                PICTURE "999"
                READ
                IF RN = " "
                    NEWREC = .F.
                    LOOP
                ENDIF
                SET EXACT ON
                LOCATE FOR REPORTNO = '&RN'
                RECNUM = RECNO()
                COUNT WHILE REPORTNO = RN TO FINDREC
                IF FINDREC = 0
                    @ 20,10 SAY "SURVEY &RN IS NOT IN DATABASE"
                    @ 22,10 SAY "Press any key to try again'
                    ?CHR(7)
                    WAIT " "
                    RECNUM = 0
                ENDIF
                IF RECNUM > 0
                    GOTO RECNUM
```

```
            CLEAR
            @10,0 SAY "DELETE THIS SURVEY ?"
            ?
            DISPLAY REPORTNO
            ?
            WAIT "Yes or No (Y/N)" TO ANS
            IF UPPER(ANS) = "Y"
                DELETE RECORD RECNUM
            ENDIF
        ENDIF
    ENDDO
    COUNT FOR DELETED() TO NUMDEL
    WILLPACK = "N"
    DO WHILE WILLPACK = "N" .AND. NUMDEL>0
        CLEAR
        ? "Records to be deleted . . ."
        ?
        DISPLAY REPORTNO FOR DELETED()
        @ 22,10 SAY "Delete these records? (Y/N)";
            GET WILLPACK PICTURE "!"
        READ
        IF WILLPACK <> "Y"
            DELREC = 0
            @ 22,10 SAY "Recall which one (by record #)";
                GET DELREC PICTURE "999"
            READ
            IF DELREC > 0
                GOTO DELREC
                IF DELETED()
                    RECALL RECORD DELREC
                    NUMDEL = NUMDEL - 1
                ENDIF
            ENDIF
        ELSE
            SET TALK ON
            PACK
            SET TALK OFF
        ENDIF
    ENDDO

CASE CHOICE = 3
    NEWREC = .T.
    DO WHILE NEWREC
        CLEAR
        RN = SPACE(3)
        @ 12,15 SAY "Press RETURN to exit"
        @ 10,10 SAY "ENTER SURVEY NUMBER TO BE EDITED";
            GET RN PICTURE "999"
        READ
        IF RN = " "
            NEWREC = .F.
            LOOP
        ENDIF
        LOCATE FOR REPORTNO = '&RN'
        RECNUM = RECNO()
        COUNT WHILE REPORTNO = RN TO FINDREC
```

```
            IF FINDREC = 0
                @ 20,10 SAY "SURVEY &RN IS NOT IN DATABASE"
                @ 22,15 SAY "Press RETURN to try again"
                ? CHR(7)
                WAIT " "
                RECNUM = 0
            ENDIF
            IF RECNUM > 0
                GOTO RECNUM
                SET FORMAT TO BALLSCRN
                READ
                CLOSE FORMAT
            ENDIF
        ENDDO

ENDDO

RETURN TO MASTER
```

```
**********BALLSRCH.PRG
*** Subprogram of BALLIGHT.PRG
*** EMC 5/11/87

CLEAR
STRING = ' '
UFLD = ' '
NUMBR = 0
RECS = 0
LASREC = 0

@ 8,10 SAY "SEARCH ON HOW MANY FIELDS? ";
    GET NUMBR PICTURE "99"
READ
IF NUMBR = 0
    RETURN TO MASTER
ENDIF

DO WHILE NUMBR > 0
    ACCEPT "SEARCH ON WHAT FIELD? " TO FLD
    ACCEPT "LOOK FOR &FLD EQUAL TO WHAT? " TO COND
    UFLD = UPPER(FLD)
    NUMBR = NUMBR - 1
    IF NUMBR = 0
        LOOP
    ENDIF
    IF UFLD="REPORTNO" .OR. UFLD="DECAY" .OR. UFLD="DIMENSION"
        STRING = STRING + "&FLD='&COND'   .AND."
    ENDIF
    IF UFLD="TIMEUNIT" .OR. UFLD="SIZEUNIT" .OR.;
            UFLD="NAMESOUND" .OR. UFLD="NAMEODOR" .OR. UFLD="OTHER";
            .OR. UFLD="COLOR" .OR. UFLD="MOVEMENT" .OR.;
            LEFT(UFLD,4)="TEXT"
        STRING = STRING + "'&COND'$&FLD   .AND."
    ENDIF
    IF UFLD#"REPORTNO".AND.UFLD#"DECAY".AND.UFLD#"DIMENSION";
      .AND.UFLD#"TIMEUNIT".AND.UFLD#"SIZEUNIT".AND.;
      UFLD#"NAMESOUND".AND.UFLD#"NAMEODOR".AND.UFLD#"OTHER";
      .AND.UFLD#"COLOR".AND.UFLD#"MOVEMENT".AND.;
      LEFT(UFLD,4)#"TEXT"
        STRING = STRING + "&FLD=&COND .AND."
    ENDIF
ENDDO

IF UFLD="REPORTNO" .OR. UFLD="DECAY" .OR. UFLD="DIMENSION"
    STRING = STRING + "&FLD='&COND'"
ENDIF
IF UFLD="TIMEUNIT" .OR. UFLD="SIZEUNIT" .OR. UFLD="NAMESOUND";
            .OR. UFLD="NAMEODOR" .OR. UFLD="OTHER" .OR.;
            UFLD="COLOR" .OR. UFLD="MOVEMENT" .OR.;
            LEFT(UFLD,4)="TEXT"
        STRING = STRING + "'&COND'$&FLD"
ENDIF
IF UFLD#"REPORTNO".AND.UFLD#"DECAY".AND.UFLD#"DIMENSION".AND.;
  UFLD#"TIMEUNIT".AND.UFLD#"SIZEUNIT".AND.UFLD#"NAMESOUND";
  .AND.UFLD#"NAMEODOR".AND.UFLD#"OTHER".AND.UFLD#"COLOR";
  .AND.UFLD#"MOVEMENT".AND.LEFT(UFLD,4)#"TEXT"
    STRING = STRING + "&FLD=&COND"
ENDIF
```

```
ACCEPT "SEND OUTPUT TO PRINTER? (Y\N) " TO PRNT
IF UPPER(PRNT) = "Y"
    SET PRINT ON
ENDIF
?
? "SEARCH FOR &STRING"
?
DO WHILE .NOT. EOF()
    LIST REPORTNO;
        FOR &STRING
ENDDO
COUNT FOR &STRING TO RECS
COUNT FOR SIGHTING=1 TO LASREC
?
? STR(RECS) + ' RECORDS OUT OF '+ STR(LASREC)
?
SET PRINT OFF
? "Press any key to exit"
? CHR(7)
WAIT ' '

GO TOP
RETURN TO MASTER
```

```
*******************BALLNMBR.PRG
*** Subprogram of BALLIGHT.PRG
*** EMC 5/11/87

SET DECIMALS TO 2
CLEAR
STRING = ' '
HIGH = 0
AVG = 0

CHOICE = 0
DO WHILE CHOICE <>3
    CLEAR
    TEXT
                BALL LIGHTNING NUMERICAL ANALYSIS

                    1. AVERAGE a field

                    2. COUNTS for a field

                    3. RETURN to main menu
    ENDTEXT

    @12,20 SAY "Enter choice " GET CHOICE;
        PICTURE "9"
    READ
DO CASE
CASE CHOICE = 1
  ACCEPT "AVERAGE WHAT FIELD? " TO FLD
  ACCEPT "IS THERE ANY CONDITION? (Y\N) " TO YN
  IF UPPER(YN) = "Y"
      ACCEPT "FIELD FOR CONDITION? " TO FILD
      ACCEPT "LOOK FOR &FILD EQUAL TO WHAT? " TO COND
      IF UPPER(FILD)="REPORTNO" .OR. UPPER(FILD)="DECAY" .OR.;
          UPPER(FILD)="DIMENSION"
          STRING = "&FILD='&COND'"
      ENDIF
      IF UFILD="TIMEUNIT".OR.UFILD="SIZEUNIT".OR.UFILD="NAMESOUND";
        .OR.UFILD="NAMEODOR".OR.UFILD="OTHER".OR.UFILD="COLOR";
        .OR.UFILD="MOVEMENT".OR.LEFT(UFILD,4)="TEXT"
           STRING = "'&COND'$&FILD"
      ENDIF
      IF UFILD#"REPORTNO".AND.UFILD#"DECAY".AND.UFILD#"DIMENSION";
       LEFT(UFILD,4)#"TEXT".AND.UFILD#"TIMEUNIT".AND.UFILD#"SIZEUNIT";
       .AND.UFILD#"NAMESOUND".AND.UFILD#"NAMEODOR".AND.UFILD#;
       "OTHER".AND.UFILD#"COLOR".AND.UFILD#"MOVEMENT"
            STRING = "&FILD=&COND"
        ENDIF
        AVERAGE (&FLD/1) TO AVG FOR &STRING
        ACCEPT "SEND OUTPUT TO PRINTER? (Y/N) " TO PRNT
        IF UPPER(PRNT)="Y"
            SET PRINT ON
        ENDIF
        ?
        ? "AVERAGE OF &FLD FOR &STRING = "
        ?  AVG
        ?
    ENDIF
    IF UPPER(YN) # "Y"
```

```
    AVERAGE (&FLD/1) TO AVG
    ACCEPT "SEND OUTPUT TO PRINTER? (Y/N) " TO PRNT
    IF UPPER(PRNT)="Y"
        SET PRINT ON
    ENDIF
    ?
    ? "AVERAGE OF &FLD = "
    ?  AVG
    ?
ENDIF
SET PRINT OFF
?
? "Press any key"
? CHR(7)
WAIT ' '

CASE CHOICE = 2
    CLEAR
    CNT = 0
    X = 0
    ACCEPT "GIVE COUNTS FOR WHAT FIELD? " TO FLD
    @ 10,10 SAY "COUNT &FLD TO WHAT VALUE? ";
        GET HIGH PICTURE "999"
    READ
    ACCEPT "SEND OUTPUT TO PRINTER? (Y/N) " TO PRNT
    IF UPPER(PRNT)="Y"
        SET PRINT ON
    ENDIF
    ? "&FLD VALUE " + "  NUMBER OF RECORDS"
    DO WHILE X<=HIGH
        COUNT FOR &FLD=X TO CNT
        ? STR(X) + "   " + STR(CNT)
        X = X+1
    ENDDO
    SET PRINT OFF
    ?
    ?  "Press any key"
    ?  CHR(7)
    WAIT ' '
ENDCASE

ENDDO

SET PRINT OFF
GO TOP
RETURN TO MASTER
```