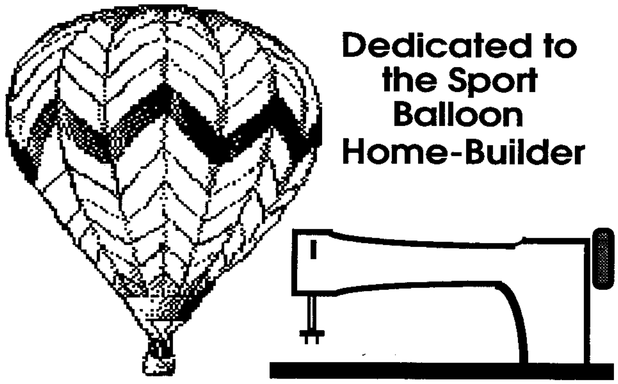
Volume 2, Number 2 (Issue #8) **$2.00**



Dedicated to the Sport Balloon Home-Builder

Published every two months-$12 per year

THE BALLOON BUILDERS' JOURNAL

September-October 1994

In This Issue

Up and Coming

In part 2 of his article, Adrian Brookes will follow up on the Tracy Barnes philosophy of envelope construction. Construction details will be presented for the builder. Look for more from the Vermont Experimental Balloon Meet.

Notices To Readers

Status on Renewals

Our register currently displays 127 subscribers including 17 who have not renewed their subscriptions. All of these 'non-renewers' began their subscriptions with the first issue. I can't continue to carry them and have removed them from the mailing rolls. We continue to receive new subscriptions, averaging about 11 per month.

Current revenues, into the second fiscal year stand at $1,197.43, with 110 current subscribers. As subscriptions expire, I provide two issues of notice. Revenues permitting, I will continue the practice of including a stamped, self addressed envelope with each renewal notice.

Submitting Articles for Publication

We invite readers to submit articles for publication. No fancy format is required. Your editor will work with any format from a few rough ideas sketched on a yellow pad to camera ready copy or computer files. We will continue to award subscriptions for articles of interest.

Estimating Envelope Lift Force with Graphic Tools

By Bob LeDoux,

2895 Brandi Lane, Jefferson, OR 97352 CompuServe: 73474,76

This computer spreadsheet and graph combination is a basic design tool for the builder or experimenter

For the builder, a most useful tool is a spreadsheet and chart combination which relates balloon performance to different atmospheric conditions. *Figure 1* shows how one version of a chart could be constructed. Each graph line displays the envelope lifting power as a function of internal envelope temperature. The different graph lines represent performance curves; that is, they represent performance at different ambient temperatures and flying altitudes.

Such a tool allows the designer to test conceptual ideas, determining their reasonability and eliminating impractical concepts early in the design process. For the student of aerodynamic design, this tool provides a powerful learning tool, allowing "what if" games to be played to see how design changes impact overall aircraft performance. For the pilot, such a tool provides a better understanding of how changes in altitude and atmospheric conditions impact balloon performance.

Introduction

Our version of the graph, in *figure 1*, is actually driven by the spreadsheet in *figure 2*. (page 6). To make the chart work, the user enters a value for the envelope volume in cell C3 of the spreadsheet. This volume, which also appears in the graph title, applies to all the performance or graph lines which appear on the chart. Each column of data on the spreadsheet, from column C through column G creates a different graph line. For each graph line, an altitude and temperature at altitude is entered in row 5 and row 6 respectively. For example, one graph line displays lift data for an ambient temperature of 40°F. at an altitude of 300 feet MSL (cells C5 and C6 respectively.) These values create the graph line that happens to appear at the top of the chart.

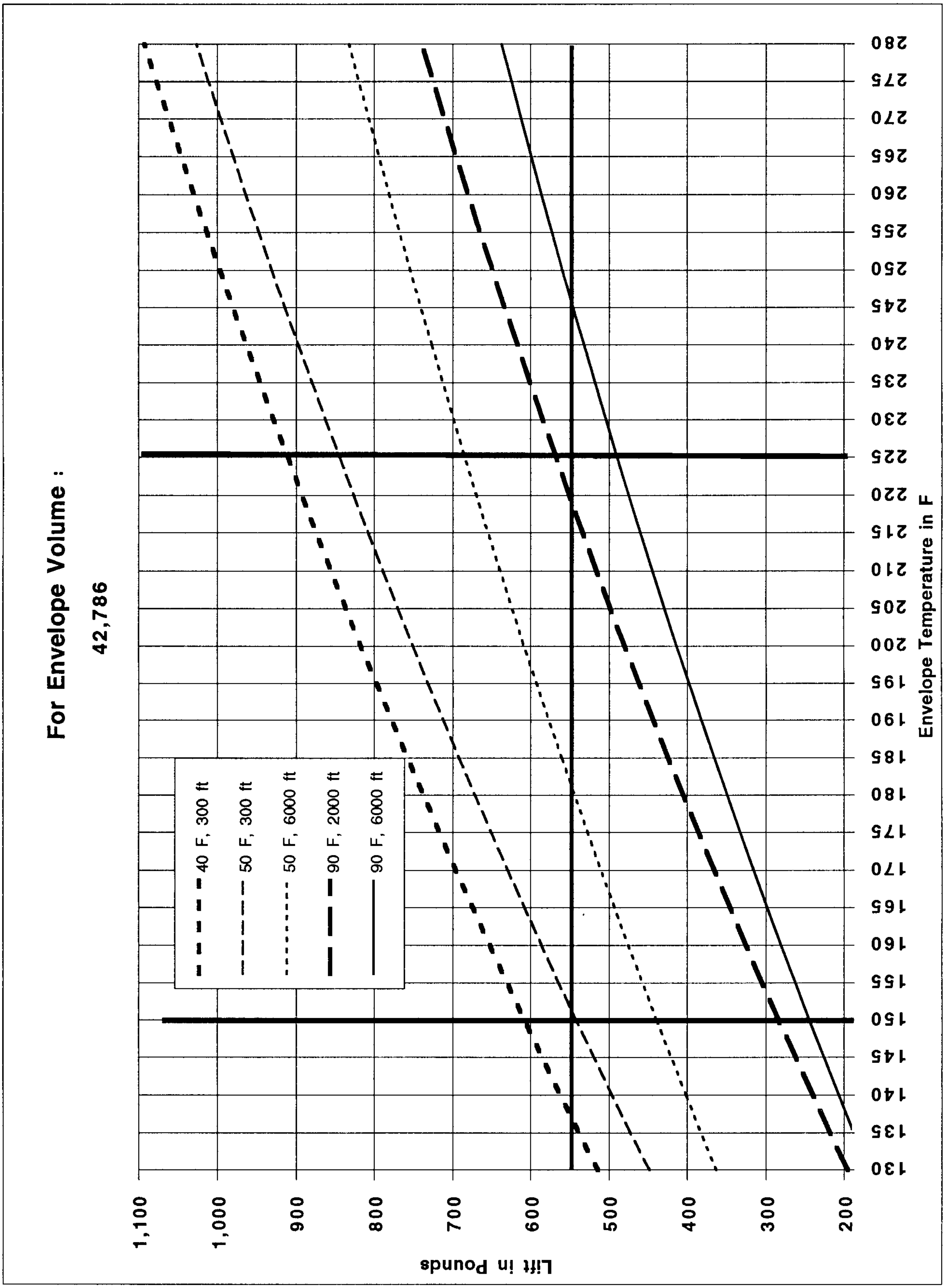
While the skilled computer user could create a number of different graph formats, I have chosen to display the graph that has proven most useful in my design work. In this format the horizontal or 'X' axis displays the internal envelope temperature, while the vertical or 'Y' axis displays the envelope lift in pounds.

As most of our readers are from the United States, we have chosen to use the American measurement system rather than the SI-international metric system. Thus lift force is in pounds, volume is in cubic feet, altitude is in feet, MSL, and temperature is in degrees Fahrenheit. For calculation purposes the Fahrenheit temperature is translated into the absolute, Rankine scale. The reader with a basic understanding of physics and algebra should have no trouble translating the graph into the metric system.

For the reader, new to spreadsheet analysis, a better understanding of the basics can be realized by reviewing Issue 1 of *The Balloon Builders Journal.* Most of that issue was dedicated to a gore pattern spreadsheet. As part of that discussion we covered some elements of spreadsheet techniques and terminology.

The graphing tool is based on the traditional lift formula which is derived from Archimedes principle, as well as the Boyles and Charles gas laws. Practically speaking, the builder is interested in defining balloon performance, as measured in terms of its lift capability. Lift in pounds is determined by the envelope volume, the internal envelope temperature, the ambient temperature, and the air pressure. The air pressure is in turn a function of altitude.

The reader can consult a number of different books and magazine articles to find the standard lift formula. We have taken our material from Aerostar's *Technically Speaking*, published in September/October 1991. It is titled "On Balloons and Buoyancy, A discussion of the Science of Lift." This document may still be available from Aerostar. The cover price is $1.00. We also developed the exponential equation to translate altitude into standard atmospheric pressure from the *CRC 1976 Handbook of Chemistry and Physics, 73rd Edition, 1992-93,* page 14-12.



For Envelope Volume :
42,786
40 F, 300 ft
50 F, 300 ft
50 F, 6000 ft
90 F, 2000 ft
90 F, 6000 ft
Lift in Pounds
1,100
1,000
900
800
700
600
500
400
300
200
Envelope Temperature in F
130
135
140
145
150
155
160
165
170
175
180
185
190
195
200
205
210
215
220
225
230
235
240
245
250
255
260
265
270
275
280

Figure 1

Using the Graph: One Approach to the Design Process

I recently designed and I am currently building a new envelope to fly over my single place basket. The Lift Chart in *Figure 1* was generated as part of that process. I will use it as an example of how this graphic tool can be put to work.

Each time I build a balloon, I start with a 'mission statement'. This is nothing more than a clear statement of what I want the balloon to do. My newest balloon had the following mission statement: 'Permit solo flight for a minimum of 3 hours; allow up to 30 gallons of fuel to be carried; operate over the normal range of ambient temperatures and altitudes normally encountered.'

While your mission statement is likely to be different the analysis techniques using the graphics spreadsheet should be similar.

The mission statement defines a set of flight extremes. At one extreme is winter-like conditions. Here in the Pacific Northwest, this represents about 40° at ground level. My ground level is 300 feet MSL. At the other extreme is a hot summer afternoon at altitude. I chose a 90° day at 6,000 feet MSL. (As we will see in a moment this was too high for my design purposes and I chose to accept a 2,000 foot altitude.) Looking at the graph, these two extremes are displayed as the top and bottom data lines, respectively. The graph also displays three other lines which are more representative of normal flying conditions.

For design purposes I also found it useful to set other limits. I chose a maximum equilibrium temperature of 225° for the envelope. This means the fully loaded balloon should be lifting free of the ground at no more than this temperature. I chose to display this limit as a vertical line on the graph. In my Microsoft Excel graph this vertical line is an arrow, without an arrowhead, manually added to the chart. (Note that the spreadsheet details presented later do not include instructions for adding this and other accent lines in the graph)

I also prefer not to operate much below 150°. This is my personal standard. It reflects the minimum temperature at which I want to encounter wind shears or thermals. This standard also ensures reasonable descent rates with a 'cool' envelope. Note that descent rate is also a function of envelope volume and load. Your standard may be different. I have also displayed this limit as a vertical line on the graph.

To perform the 'what-if' testing, I began by making a rough estimate of the required envelope volume for my balloon system. I then estimated the gross weight of the balloon including an envelope of that volume. This estimate was made by itemizing all the balloon components along with fuel load and passenger weights on a separate spreadsheet.

This estimated gross weight, 550 pounds, was also placed on the graph as a horizontal line. The graph lines generated with these parameters were then examined. I then modified the volume until a reasonable compromise in performance was reached. If large changes are made to envelope volume, it may be necessary to alter the gross weight due to change in envelope weight.

The final result of this process is the graph in *figure 1*. As the graph shows, my envelope just barely meets my operational limits. On a chilly morning the operating temperature at takeoff would be more like 140°, not the lower limit of 150° I'd like to see.

On the very hot, 90° day I could not operate a 550 pound balloon at a 6,000 foot altitude. My equilibrium temperature would be about 250°F. (This is shown as the bottom line on the chart.) At 2,000 feet on this hot day, the operating temperature is just barely within the 225°F limit. Under hot conditions I might be forced to remove one of the fuel tanks and fly at about 475 pounds gross weight. But since these very hot temperatures are extremely rare in my Northern climate, I was willing to compromise on this end of the scale. If you live in the Southern United States, your decision might be different. Under these circumstances a larger envelope might also be appropriate.

These performance lines are estimates. The performance is based on theoretical calculations, and may vary with actual results. The envelope temperature displayed on the 'X' axis is assumed to be at an average value. In real life, an envelope has dramatic variations in temperature. The air temperature near the envelope fabric surface can be many degrees below average, while the core of the balloon, near the burner, can be far above the average temperature.

Also be aware that during a flight fuel is consumed which changes the aircraft weight and may significantly impact performance. In particular, designers constructing for high altitude flights may need to employ more sophisticated analyses to estimate performance at altitude.

Spreadsheet Construction

As already noted, the original spreadsheet was created using Microsoft Excel. I've attempted to use standard spreadsheet conventions so the formulae can be readily translated to other products like Quatro Pro or Lotus 1-2-3. Readers with a bit of spreadsheet experience should have little trouble creating the actual spreadsheet shown in *Figure 2*, regardless of software package used.

Creating the graph, in *Figure 1*, may require a bit more effort. Each software manufacturer has its own conventions for creating graphs from a spreadsheet. Thus, it is difficult to lay out a single set of instructions for every reader. We have attempted to explain the basic graph elements in a common terminology. By referencing your spreadsheet user manuals the graph should not be that difficult to create.

Let's begin with the spreadsheet. Our discussion will concentrate on columns A, B and C because only these three columns are required to generate a simple single line graph. By copying column C into other columns, like, D, E, F and G, additional graph lines are created.

Column A rows 10 through 40 (A10:A40) is a computational column. It translates the envelope temperature in column B from Fahrenheit to Rankine degrees by adding 459 to the Fahrenheit value. For example the 130° Fahrenheit temperature in cell B10 becomes 589° Rankine in cell A10.

Column B, cell range B10.B40 is the 'X' axis of the graph. This column displays the internal envelope temperature in degrees Fahrenheit. I chose to start at 130° and increment in 5° segments to 280°. Feel free to change this range, the spreadsheet will compute correctly for other reasonable temperature ranges.

Column C is the first column of actual lift data. Each cell in column C shows the lifting force in pounds for the internal envelope temperature shown in column B. Column C is the first of what can be a series of columns, each of which creates a graph line. For each graph line, the ambient temperature will be the value entered in row 5 and the altitude will be the value in row 6. In our example in column C, the legend shows the scenario as '40°F, 300 Ft., for an ambient temperate of 40°F at an altitude of 300 feet MSL.

The data is rows 42, 43 and 44 are calculated values to simplify the data entry. For our example in column C, cell C42 is the ambient temperature in cell C5 converted to Rankine degrees by adding 459°. In cell C43 the altitude of 300 feet has been converted to a standard atmospheric pressure of 2093 pounds per square foot or 14.53 pounds per square inch. Cell C44 is a calculation constant which simplifies the calculation in the overall spreadsheet.

The values and formulae in column C create the heavy dotted line, the top line on the graph. By copying the range C5 through C 44 into column D, a new line is created when the user enters new values in cells D5 and D6. In our example, the D column has a new ambient temperature of 50°F, which generates the second line down from the top of the graph.

In like manner your spreadsheet *copy* routine can be used to add any reasonable number of lines to the chart.

The one value not yet mentioned is in cell C3. This is the volume of the envelope in cubic feet. This volume applies to all lines in the chart. When this value is changed, all the chart lines will change.

There are two unusual formulae in the spreadsheet. In cell C9, the temperature in C5 and the altitude in C6 are converted to an alphanumeric string that can be displayed in the graph legend. Cell C43 has an exponential function which translates altitude into atmospheric pressure. This formula must be entered carefully for the program to work. The caret (^) symbol denotes a power function. It is found on most keyboards as a 'shift-6' on the top row of number keys.

This is the second computer tool printed in *The Balloon Builders Journal.* In our first issue we presented a spreadsheet to create gore pattern layouts. Since then, I have received a number of phone calls seeking assistance with the spreadsheet. Without exception the spreadsheet was working correctly, but readers were not able to use the software. For example, several readers called to say the numbers didn't change when new values were entered. Their spreadsheet software was set to 'manual re-calculation' and they were not striking the proper 'recalc' key. Read your manuals, avoid frustration.

Purchasing the Spreadsheet Files

We have added this spreadsheet and graph file to our diskette offer. For $5 we will provide a diskette with *The Gore Pattern Spreadsheet* from our Issue 1 along with this Lift Force Graph. Readers who have already purchased the diskette may receive this update by returning your old diskette, or a replacement diskette along with $2 to cover mailer and postage. *You must have a spreadsheet program on your computer to run this software.* Files are provided in Microsoft Excel spreadsheet format and in Lotus 1-2-3 WK1 format. Most other spreadsheet packages, such as Quatro Pro, are capable of reading one of these formats. Any reader who finds the software unacceptable may return it for a full refund or credit.

	A	B	C	D	E	F	G
1	ENVELOPE LIFTING CAPACITY SPREADSHEET						
2							
3	Volume in Cubic Feet		42,786				
4							
5	Ambient Temp in Degrees		40	50	50	90	90
6	Flight Altitude Feet MSL		300	300	6,000	300	2,000
7							
8	Envelope	Envelope					
9	Temp Rankine	Temp F.	40 F, 300 ft	50 F, 300 ft	50 F, 6000 ft	90 F, 300 ft	90 F, 2000 ft
10	589	130	514	448	363	208	195
11	594	135	538	472	382	232	218
12	599	140	562	496	402	255	240
13	604	145	585	519	420	278	262
14	609	150	608	542	439	301	283
15	614	155	630	564	457	324	304
16	619	160	652	586	475	346	325
17	624	165	674	608	493	368	346
18	629	170	695	629	510	389	366
19	634	175	716	650	527	410	385
20	639	180	737	671	544	431	405
21	644	185	758	691	560	451	424
22	649	190	778	712	577	471	443
23	654	195	797	731	593	491	462
24	659	200	817	751	608	510	480
25	664	205	836	770	624	530	498
26	669	210	855	789	639	549	516
27	674	215	874	808	654	567	533
28	679	220	892	826	669	586	550
29	684	225	910	844	684	604	567
30	689	230	928	862	698	621	584
31	694	235	945	879	712	639	601
32	699	240	963	897	726	656	617
33	704	245	980	914	740	673	633
34	709	250	997	931	754	690	649
35	714	255	1,013	947	767	707	664
36	719	260	1,030	963	781	723	680
37	724	265	1,046	980	794	739	695
38	729	270	1,062	995	807	755	710
39	734	275	1,077	1,011	819	771	725
40	739	280	1,093	1,027	832	786	739
41							
42	Rankine Temp at Altitude		499	509	509	549	549
43	Pressure in PSF for Altitude		2,093	2,093	1,696	2,093	1,968
44	Calculation Constant		1,679,013	1,679,013	1,360,383	1,679,013	1,578,256

Figure 2: The Spreadsheet that Creates the Graph

Instructions for Building the Lift Force Graph and Spreadsheet

CELLS	ACTION	EXPLANATION
Open a new worksheet. Select cell range A1:G44	Set Column Width to 11 Set Alignment to "RIGHT" Set Number Format to 0,000 Set Font to Helvetica, Size 10	Set the default values for the spreadsheet. Each cell is set to 11 characters width, all cells align on the right edge, numbers are formatted with no decimal places and font is Helvetica size 10 in plain style. Exceptions to defaults are made later as necessary. If you are using an older spreadsheet like Lotus version 1a, you won't be able to select a font or its size. In that case you may need a column width wider than 11 spaces to avoid run-on titles.
A1 A3 A5 A6 A42 A43 A44	Type in: ENVELOPE LIFTING CAPACITY SPREADSHEET Type in: Volume in Cubic feet Type in: Ambient Temp in Degrees F Type in: Flight Altitude in Feet MSL Type in: Rankine Temp at Altitude Type in: Pressure in PSF for Altitude Type in: Calculation Constant	Type in the titles. After titles are entered, set the Format Alignment for each of these cells to "LEFT." If titles run into column C set your column width to a higher number than the 11 spaces set above.
In cells A8 through B9	Enter column titles as shown on the spreadsheet	After the titles are entered, set the Format Alignment for each of these cells to "CENTER."
C3	Enter the number: 42786.	This is the volume of the envelope desired in cubic feet. The initial number is for testing purposes. The number is formatted to remove the values after the decimal point.
C5	Enter the number: 40	This is the test ambient temperature in degrees F.
C6	Enter the number 300	This is the test altitude of 300 feet MSL.
B10:B40	In cell B10 enter the number 130. In cell B11 enter =B10+5. Then copy cell B11 to the range B12:B40.	This generates the envelope temperature range of 130°F through 280°F., by entering the first number and then incrementing by 5 degree increments.
A10:A40	In A10 enter =B10+459. Then copy cell A10 to the range A11: A40.	Column A converts the temperature found in column b from Fahrenheit degrees to the absolute temperature base Rankine.
C9	Enter the following formula: =C5 &" F, "&C6 &" Ft" Note: Enter the spaces as shown in the formula above	This formula translates the temperature in cell C5 and the flight altitude in cell C6 into a character string that can be read as the chart legend. If you are using a spreadsheet other than Excel, your formula could be different. When properly entered this cell should show the following 40F, 300 Ft
C42	Enter Formula: =C5+459	This formula translates the ambient temperature in cell C5 to the Rankine scale by adding 459.
C43	Enter the formula: =2116*((288.15/(288.15-0.00198*C6)))^-5.25587	This formula converts the altitude in cell C6 from feet to pressure per square foot using a standard physics formula. Enter this formula carefully. Note the caret (^) denotes this is an exponential formula.
C44	Enter the formula: =C3*C43/53.34	This formula generates a calculation constant based on the envelope volume in C3.
C10	At cell C10 enter the formula: =((1/C$42)-(1/$A10))*C$44 Copy that formula from cell C10 to cells C11:C40.	This formula generates the actual lifting force in pounds for the given envelope temperature in column B. Absolute references ($) to cell C42, A10 and C44 are necessary for the formula copy which is performed. Check cells C10 through C44 for correct values against the sample spreadsheet

CELLS	ACTION	EXPLANATION
Columns C through G	Copy the range C5:C44 into columns, D, E, F and G	Column C creates one line on the graph. Each additional column creates an additional line. If column C is copied to all the columns (D, E, F, G), then a 5 line graph will be created.
D5 through G6	Enter the values for ambient temperature and altitude as shown on the sample spreadsheet. Check the computed lift values in C10 through G40. Confirm the values are the same as the spreadsheet.	This is a test of the spreadsheet for accuracy. If numbers are different confirm that the volume is C3 and the numbers in rows 5 and 6 match examples in the spreadsheet. Also confirm that the absolute ($) references in the formulae are properly entered.
CREATING THE GRAPH	Create the chart using the following: The 'X' range is B10:B40 The first data range is C10:C40 The second data range is D10:D40 The third data range is E10:E40 The fourth data range is F10:F40 The fifth data range is G10:G40 The legend for each data range is in row 9. So for the first data range the legend is cell C9, the second data range legend is D9, the third data range legend is E9, and so on.	Your chart is created using the routines appropriate for your specific software. The notes to the left are general in nature and specific to Lotus 1-2-3 version 1a or 2. For Excel users, a simple approach can be followed. Highlight the range B9:G40 and use the Chart Wizard. The Wizard will ask a series of questions. Your data appears in columns, the first column is your 'X' axis and the first row is your data legend. Our graph is a line chart style but you might want to try other chart styles.
Graph Title Option 1	Enter the graph title: 'For Envelope Volume: on your graph. Then display cell C3 of the spreadsheet under or beside the title.	This displays the envelope volume that applies to all the graph lines on the graph. Your spreadsheet may have special instructions for displaying spreadsheet values on a graph. In Excel, simply 'click' on the graph, enter an equal sign (=) and then click on the spreadsheet cell and press the enter key. The spreadsheet volume will appear on the graph. Then use your mouse to move the value to the desired location.
Graph Title Option 2 (not shown on spreadsheet)	In A46 enter the following formula: =A3 & C3 Go to the graph and name cell A46 as the Title of the graph.	The ampersand (&) combines two cells together as an alphanumeric string. This string appears in cell C46 which is then referenced in the graph as its title. In most spreadsheets, the comma in the envelope volume will be removed so the volume 42,786 will appear as 42786. If there is no space between the title and the volume number on the graph, edit cell A3 on the spreadsheet and add a space or two to the end its name.

Formula for Lift

$$L = \frac{VP}{53.34}\left(\frac{1}{\mathrm{Ta}} - \frac{1}{\mathrm{Te}}\right)$$

Where:
L = Lift in pounds
V = Envelope volume in cubic feet
P= Atmospheric pressure in pounds per square foot
Ta = Ambient temperature in degrees Rankine
Te = Envelope temperature in degrees Rankine
53.34 = Ideal gas constant
Rankine degrees = Fahrenheit degrees + 459

Altitude to Pressure Formula

$$P = 2116\left(\frac{288.15}{288.15-.00198A}\right)^{-5.25587}$$

Where:
P= Atmospheric pressure in pounds per square foot
A = Altitude in feet above mean sea level (MSL)

Letters to the Editor and Other Tidbits

A Burner that's Anything but Homebuilt

Bill Basset of Woodinville, WA. built this burner while a technical college student. It appears to have many of the best features of the Adams and Balloon Works T3-017 burners. The vaporization coils are made from Inconel™ with a wall thickness of .020 inches. This material was purchased at a local metal supply shop for about $2 per foot.

It was constructed using basic metal working tools. Three individual coils make up the vaporization assembly. A simple bending jig was used to make the individual bends in each coil. By choosing a triangular rather than a rectangular coil, fewer bends had to be performed. Bill reports that bending a circular coil requires a form and special tooling. It may be beyond the realm of the amateur builder.

In building this burner a bit of welding and some lathe turning were required. The burner shell was constructed using standard sheet metal bending and shearing tools.

The burner operates above a chair type balloon carriage constructed from a reclining automobile seat. Bill has offered to write us an article on building his burner. Look for it in an upcoming issue.

Tidbits

While preparing this issue I was monitoring the progress of the **Peregrine Flight Project.** This project involved a successful trans-Atlantic flight by Tim Cole and Steve Fossett. Dennis Brown and Bruce Comstock performed technical backup. Alan Noble was flight director. John Kugler provided public information, which I received on CompuServe. Following this event on the 'information highway' was a real experience.

On August 2nd. we first heard about the project. On August 8th. we received word the flight was on hold, and golf was the popular pastime. A low pressure system off the coast was running the jet stream in a circular pattern. On August 10th. John reported that meteorologist, Bob Rice, expected the weather pattern to continue for another 5 to 7 days. On August 17th they reported that all systems were ready to fuel and they were waiting for a drop-off in a strong wind shear at 200 feet AGL. Then things began to happen. *Italic* text is the actual communiqué as taken off the computer:

PEREGRINE IS IN THE AIR!! We were informed 10:15 PM Central time that the balloon is in flight! They had tried the night before but did not inflate due to high ground winds. Zonal weather pattern is good with rather fast winds-50-60 kts. Estimated *crossing time is 36 hours. Excellent weather pattern for a fast crossing. Maybe Moscow in a 4-5 days!!*

John Kugler 08-18-94

Peregrine has crossed the UK and headed out to the North Sea flying at 13,600 MSL, 30 knots, track 086 degrees. ...Lithuania is the next target for landing. Flight could possibly to do Sweden, Norway, Denmark. They are expecting landing at dawn if the swing to the North continues.

3 of 7 propane tanks have been used. This balloon has a lot more flying capability left. If weather holds who know how long they can go. I suspect that it is more of a pilot endurance test now. Alan Nobel indicates that all are in good spirits.

Kugler 08-20-94

We received the following as a flight summary:

To: balloon@lut.ac.uk
Date: Sun, 21 Aug 1994 09:10:25
Subject: Atlantic balloon flight
From: ALAN NOBLE <anoble@balloons.win-uk.net>

Steve Fossett and Tim Cole from Colorado, USA, have completed a flight from St. John's, Newfoundland, to Grande, North East of Hamburg, in Germany. The flight, in a Cameron Roziere balloon of only 77,000 cubic feet capacity, covered 2,400 miles and took three days and two hours. They landed at 0520Z on 21 August, 1994, having averaged around 35 knots and achieved a maximum altitude of 19,200 feet. The Roziere balloon is a heated helium balloon with an enormous ability to cover distances. It is somewhere in the region of 35 times more efficient than a simple gas balloon. At the end of the flight the crew still had three of their 80 litre propane cylinders left untouched. They only landed because they didn't want the problems of negotiating their way into and later back out off the former Eastern bloc countries. The balloon was equipped with HF and VHF radios, transponder with mode C, weather fax receiver and Inmarsat data communications which was connected to a GPS able to provide automatic position reports back to the Control Centre at Cameron Balloons in Bristol. I was Flight Director and if anybody would like further information please e-mail your questions.

Regards: ALAN NOBLE

Other Tidbits

John Kugler is running for BFA board member from the gas division. You can read his candidate's statement in the August 1994 issue of the BFA *Skylines*.

Kathy Kugler received her gas balloon rating, June 23, 1994.

Mike Emich has put up for sale his little solo balloon system, the one featured in our last issue. Mike reports that the light weight system has some shortcomings in competition. In particular, the terminal descent rate is too slow. Mike is now flying an Aerostar 65,000 cubic foot envelope over an Aurora basket in competition. His homebuilt system is listed under the classified section in this issue.

Regarding competition: **Bill Arras** notes some serious competition pilots are expressing concern about flying the very light weight fabric envelopes. In competition, equipment abuse, in particular, overheating of envelopes, is part of the game. Some competitors have been known to heat balloons nearly to the melting point. The heavy weight fabric has a reputation of taking it while still maintaining aircraft integrity. The light weight fabric is still an unknown.

Mike Glasgow's new balloon was featured in the June Experimental Aircraft Association (EAA) newsletter, *The Experimenter*, under their "What Readers Are Building" segment. The EAA made space for a fairly extensive discussion of the balloon. As continues to be the case, balloons tend to be relegated to this black and white publication, while the less colorful airplanes are featured in the EAA full color publication *Sport Aviation*.

The August 1994 magazine, *Balloon Life* features a nice four page article on the **May Vermont Experimental Balloon Rally,** written by Ruth Ludwig. Ruth also wrote a similar article which appears in the September *Ballooning Journal.* In that same issue, Brian Boland, in his 'Experimental Aeronaut' column , discusses his latest version of a lightweight hot air blimp We saw this blimp in Vermont and are impressed with its potential.

Some commercial interests are opposed to the experimental coverage in ***Ballooning Journal****. We ask readers to encourage the BFA to continue this coverage. Let your director know or write the BFA at P.O. Box 400, Indianola, IA 50125.*

Jess Blen is writing a newsletter called **The Airship Homebuilder.** The three issues published so far show considerable research. You can reach Jess at Rt 2, Box 53-4, Elba, AL, 36323.

Australian **Steve Griffin** recently completed a solo Roziere balloon flight across his home land. He spent a total of 56 hours in the air and has claimed a couple of world records. His feat should appear in U.S. magazines in the near future.

Letters

Dear Bob,

Here is a picture of the just completed Kennedy-Lehmann 90K super light balloon on tether in a 20 mph breeze. The envelope is Soarcoat, six colors, 18 gores, with three point pick-up for a three cornered basket. The bottom 16.5 feet [of the envelope] is 1.9 ounce waterproof rip stop nylon. The throat is 12 feet in diameter with 3/32 inch stainless steel cable rigging. I intentionally increased the drop to close up the 50° angle at the basket attachment to put a bit of tension on the throat. This seems to keep it open on tether and inflation. The parachute top is 23.5 feet in diameter in a 20 foot hole. I have flown this size parachute for many years and feel it is safe and helps out in our 20 to 40 mph landings we sometimes have in this part of the country.

Kennedy-Lehmann 90,000 Cubic Foot Balloon

Seven strand paracord is used for shroud and centering lines. The centering attachments are 10 feet [down] inside the opening. Velcro™ tack tabs are just off the vertical load tapes, sewn to the outside the envelope and sewn to one side of the chute load webbing. When cleared, there is no contract of the velcro to either the chute or the envelope.

The whole system, including the cardboard patterns were built on a steel bench, 5 feet by 15 feet, thus the cutting was done with an Exacto™ knife in the up direction around the weighted pattern. Sewing was done with a double needle sewing machine with 3/8 inch spacing. The 270 panels and the top went together nicely thanks to your help with the dimensions. I used an .875 seam allowance.

The scoop is 7 ounce Nomex and the storage bag is 36 inches in diameter and 36 inches tall--plenty of room to fit all of it in. The envelope and rigging weights 135 pounds. The bottom 1.9 ounce material and the load tape doubled the weight of the envelope, but 135 pounds still isn't too shabby.

It was difficult to determine the inside versus outside of the Soarcoat fabric. Since we were building a complicated patterns and wanted the same light reflection over all, I decided to use white thread on the needles and black thread on the bobbins. There is no question of in or out that way.

The fabric is translucent and the colors appear to change when viewed looking towards the sunlight.

The feds are hopefully going to give us the blessing next week and we will se how ell it flies. On tether with three fairly heavy people and 30 gallons of propane on an 80° day, we didn't hit 180° envelope temperature.

Yours truly, gentle breezes,

Ken Kennedy.
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