Arthur D. Little, Inc. ACORN PARK · CAMBRIDGE, MA 02140 · (617) 864-5770 · TELEX 921436

May 16, 1978

Prof. Arthur F. Scott
Department of Chemistry
Reed College
Portland, Oregon 97202

Dear Professor Scott:

Your letter of May 11 inquiring about our recent lead balloon endeavor has been forwarded to me for response. This "curious project", as you aptly described it, is not easy to summarize briefly so let me give you a broad general picture and if you have subsequent questions regarding specific details I would be happy to elaborate further.

As you know, Arthur D. Little, Inc. is a large and venerable international consulting organization with its fingers in many pies. Fifty some years ago our founder, whose name we bear, was looking for some way to demonstrate the firm's ability to cope with unusual problems in imaginative ways and struck upon the idea of making a silk purse from a sow's ear. This was in the earliest days of synthetic fibers and his approach and ultimate success are recounted in the enclosed booklet. The original silk purse presently resides in Washington, D.C. at the Smithsonian Institution. Over the years the company has gotten much mileage from this ingenious effort.

About a year and a half ago I was doodling at my desk when the phrase "goes over like a lead balloon" crossed my mind and for no apparent reason I quickly began to calculate the feasibility of such a device. The calculations, of course, are trivial; it's simply a matter of making the balloon as large as possible for great lift and as thin as possible for minimum weight. If you assume the availability of one mil lead foil as an article of commerce (I wasn't sure of this at that time), and let helium be the lifting gas, it can readily be shown that a sphere six feet in diameter will go up rather than down with lift to spare. I sent a memo with these calculations to the company's public relations department and a note to the effect that the silk purse was getting a bit threadbare with use and perhaps it was time for a fresh effort. The

PR department picked up on this concept and asked me to explore it further. Incidentally, although I approached the PR department for support in the effort, my main reason for wanting to do such a thing was simply that it appeared that it would be a hell of a lot of fun and a really neat project for a group of people to work on. The PR benefits I thought of principally as spin-offs.*

The challenge in making such a device of course is in the construction itself as the lead foil is very fragile and the unsupported structure prior to flight is highly vulnerable to rips, tears, snags, etc. It seemed that a great number of man-hours would probably be entailed in manufacturing such a device and at a consulting firm, as elsewhere, man-hours are both scarce and expensive. For that reason, it seemed the best way of getting the project done would be to organize it as a form of competition within the company with the public relations department paying for the materials of construction, but with the interested staff members donating time. A special committee of balloon judges was organized, consisting of some eight individuals within or associated with the company including the Chairman of the Board, the stock room clerk, a secretary, a biologist, an author of a play entitled "The Lead Balloon", the daughter of the public relations director, and others of unfettered mind to ensure that it would be conducted thoroughly but with no more seriousness than necessary in order to guarantee some measure of success. A public announcement in the corporate newspaper and elsewhere outlined specifications which we, the committee, would require of a balloon in order to be judged successful and proposals for construction were solicited. Probably our most stringent specification was that lead be the principal membrane material containing the lifting gas as we wished to preclude such shortcuts as vapor depositing lead on a plastic film. We received six responses from within the company and three tongue in cheek ones from without. All responses had two things in common. Firstly, they included clever insight into design fabrication and actual flight of the devices, and secondly, they contained most outrageous puns, double entendres and peculiar forms of humor. This of course, encouraged the committee that it was on the right track.

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* Incidentally, during some experimental work about 25 years ago to investigate the forces acting on superconductors in magnetic fields ADL staff members successfully levitated a hollow lead sphere, 1 cm in diameter. See the Journal of Applied Physics, <u>24</u>, No.1, pp.19-24, (1953) for a description of this somewhat constrained flight of a miniature lead balloon.

From the submitted proposals, we selected three which appeared worthy of further support. These three proposals involved completely different methods of construction and it seemed that by supporting these three we could improve our chances of at least one successful balloon. The announcement of the finalists was made in the first public address by our company's new Chairman of the Board, at which time he impressed the employees immensely by his ability to indulge in bad puns with the best of them (he justified the expense of the project by stating that "there is no such thing as a free launch").

The spherical team proposed to build a roughly 9' diameter lead sphere made of traditional lozenge shaped gores of 1 mil lead foil. However, to reduce the materials handling problem, they proposed using an inflated latex weather balloon as the mandril upon which to assemble the gores and then, at launch time, to simultaneously deflate the latex balloon while filling the space between it and the foil balloon with helium, ultimately withdrawing the latex balloon from the bottom of the lead balloon just prior to launch. They also proposed to minimize ripping by using an open netting of gauze, not unlike a cheesecloth, which would be attached to the lead panels by a heat sensitive adhesive. (Such material is available in dressmaker shops.) The gores were cut and fastened to their netting backing by ironing, using the tables in the research and development library as work platforms. The set of gores was then carefully transported to one of the company's large boiler rooms for final assembly.

The second team, the cube team, decided to avoid the problem of support prior to the launch by building a cubic balloon in a "folded flat" manner. This balloon was constructed of plainer sections which would unfold upon inflation much the way the bottom of a brown shopping bag unfolds to yield a 9' x 9' x 9' cube, but bulging, like a pillow. Thus this balloon, until launch time, was a two dimensional device laid up on a large plywood bed. Seams at which the cube would unfold were reinforced with tape, but again the principal expanse of the balloon was 1 mil lead foil.

A third approach was termed the barrel or cement mixer because of its shape. The structure was 14' long and 9' in diameter at its widest. It was built around an open lattice constructed of custom milled 1/4" x 1/4" light cedar strips, all joints glued and tied with nylon thread. 1 mil lead foil was then glued over this cedar support structure to yield a rigid but light-weight lead zeppelin.

Incidentally, the lead foil was purchased from Revere Metals in Brooklyn, New York. It measured out to be 8/10 of a mil thick and roughly 20 inches wide. It was remarkably free of pinholes; during unrolling from its original spool, it was passed over a light source in a darkened room so that any pinhole could be spotted and marked with a magic marker for later repair by dab of glue. Conventional glue, (Pliobond Cement), served as the principal adhesive for most of the teams. It worked very well, giving a very strong bond. Helium was used as the lifting gas in all cases despite the expense as we felt that hydrogen would be too risky with a crowd of spectators. (It was suggested that, however, hydrogen would at least be flamboyant.) The balloonists spent impressive amounts of time working on their projects during the evenings, during weekends, and as the deadline for launch approached, occasionally even charging vacation time so that they could work through the day on their projects.

Our original launch date of Friday the 13th of May had to be cancelled due to extremely high winds and the launch was rescheduled for Monday, May 16th. On hand for the launch were reporters and photographers from all of the local newspapers, plus the New York Times, the Wall Street Journal, the Associated Press, and live coverage by the local NBC television station. Again, on the 16th it was somewhat windier than we had hoped we would have considered prudent but the teams were eager to go anyway. Our plan was to fly the balloons only sufficiently to judge their capabilities but to retrieve them for a more public later flight as part of a larger Cambridge festival. All were to be tethered on Monday and the test flights would be from a large paved area in front of the shipping room (near the dumpster). The cement mixer entry had in fact been completed there and was stored hoisted overhead in a large high bay area. The cube could be transported from its construction site early as it was, as mentioned, folded flat. The sphere was to be filled with helium and the inner fugitive mandril balloon removed in its boiler room and the vehicle transported by hand around to the launch site.

What actually happened was a bit unstructured and unplanned and probably better than anything we could have choreographed. Gas filling activities commenced in the middle of the afternoon and by roughly 5 o'clock both the cement mixer and the sphere had "gone light" in their respective hangers. The cube was brought out on its plywood base and connected to four helium cylinders, one at each corner, and filling commenced. At that point the cement mixer team could restrain itself no longer and wheeled its entry out of doors. (I should note that it was constructed on a large wooden wagon which had a horizontal iron pipe running full length inside the balloon and out the other end. At each end of the cement mixer was an opening with a fabric closure with drawstring sort of like a pair of pajama bottoms so that when the balloon was drawn off the pipe these sphincters would be tightened to retain the gas.) 20 lb. test steam-tarred cod line was used as the tether for the cement mixer. However, as this balloon was being withdrawn from its support rod and sphincters tightened it broke free from the grasp of its handlers and started up. For a few moments it remained on its tether but then a gust of wind brought it down toward the ground leaving slack in the line and then took it up again rather rapidly giving the line a snap and breaking it. It rose incredible rapidly overhead amidst cries and cheers and general pandamonium. We don't know what its rate of ascent was but calculations suggest that the balloon had a weight of 20 lbs. a lift of 30 lbs. or a net lift of 10. In any case, it really soared skyward and was reported some time later by the pilot of a commercial aircraft to be at 4,000 feed heading out to sea.

This episode of course, stirred the adrenelin of the other balloonists. The cube was partially inflated when it developed internal adhesions due to some of the Pliobond Cement not being fully dry when later panels were added. During the unfolding process, some rips developed in the bottom of the structure. Emergency patching techniques were employed and the balloon was fully inflated and allowed to rise some 20 feet overhead. However, the wind rapidly began to shred the foil where the tears had been earlier initiated so the structure had to be rapidly brought back to earth.

During this time the sphere had been readied for launch and was carried out from its boiler room accompanied by tanks of helium wheeled alongside, giving it continuous gas transfusions as it was a rather leaky structure. In any case, partly by accident but one suspects not entirely, the sphere lurched out of its handlers' hands, sort of gently rolled up a tree, (a rather unusual sight) and wandered sedately off toward the north gaining only modest elevation. It disappeared from view and was subsequently retrieved about a mile away.

Thus ended the balloon flights. The cube and the sphere were too severely damaged to ever fly again, and the cement mixer as mentioned was last seen heading toward Portugal. The balloonists, the committee and other hangers on repared to the Chairman's house to drink a great deal of beer and congratulate themselves. We were not too sure of what we had accomplished but we all felt that we had done something very good.

I think for those of us involved the project really turned into something of an adventure. The participants donated incredible amounts of time to it. By calculation the cement mixer could have been replicated by the original team in about 350 man-hours of work. This suggests that maybe 500 went into the origianl. The other teams put in comparable amounts of time, enthusiasm which indicated that it meant much more to the participants than simply the subsequent exposure in the press. Incidentally, this has been considerable. The project and launch were described in newspapers all over the country and several abroad. Writeups have appeared in a variety of journals and the cement mixer balloon which was declared the unanimous winner by the judges is featured on the cover of the Arthur D. Little, Inc. annual report for 1977 (copy enclosed).

I enclose also some other xerox's and photos, etc. for your information. If you have any further questions do not hesitate to contact me. I'm sure you can tell we are all very pleased with this project and would be willing to talk your ear off, but not now for today is the first anniversary of the Great Lead Balloon Launch and the balloonists and committee are meeting at my house for an anniversary party.

Very truly yours,

Jim Birkett

James D. Birkett

/ms
Enclosures

ENTER THE GREAT LEAD BALLOON CONTEST!

In 1921 Arthur Dehon destroyed that old adage concerning silk purses and sows' ears. Now you, ADL's successors, can dispel that old chestnut about lead balloons and ideas that don't fly.

Rules:

Submit your brief proposal for the construction of a flight-worthy lead balloon, according to specifications supplied below. Proposals should be submitted to Lead Balloon Contest, Box 2006, 25 Acorn Park and should include cost estimates for materials to be used. Winning entrants must construct balloon on their own time; reasonable cost of materials to be funded by ADL.

Specifications:

1. Diameter a minimum of 18″ (hopefully larger)
2. Buoyancy sufficient to rise overhead, high enough to satisfy a juvenile balloon addict
3. Durability, stability and gas-tightness (gas of your choice) so as to remain aloft for a convincing length of time
4. Design concept having lead as the principal construction material and serving as the impermeable skin of the balloon

Deadlines:

- Proposals for construction due by March 30
- Decision announced on winner(s) by April 4
- Balloon constructed for test flight demonstration on May 13
- Public flight and celebration (more about this later) on May 21

Example:

Preliminary calculations have shown that such a balloon is feasible:

- A spherical balloon six feet in diameter has a volume of 3.2×10^3 liters and a surface area of 105×10^3 cm^2
- Hydrogen gives a lift of about 1 g/liters or 3.8 Kg for the total volume (assuming STP, etc.)
- A lead skin .5 mil (0.0013 cm) thick would weigh about 1.5 Kg.

Questions regarding performance criteria, scheduling and interpretation of contest rules should be directed to any of the committee members, c/o Box 2006, 25 Acorn Park.

Distinguished Committee Members:

Dr. James D. Birkett, Chairman
Robert L. Barclay
Gordon R. Conrad
Beverly L. Gowen
Dr. Cecil J. Kelly
Dr. Nelson R. Lipshutz
Robert K. Mueller
Kim Triner (Juvenile Balloon Addict)


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THE WALL STREET JOURNAL,
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ADL Scientists Deflate Myth of 'Lead Balloon'

By a WALL STREET JOURNAL *Staff Reporter*

CAMBRIDGE, Mass.—An "ingrained distaste for shibboleths about what can't be done" is a byword at Arthur D. Little Inc. Thus the "Great Lead Balloon Contest" held one recent Monday in the firm's parking lot.

Three teams had designed and built in their spare time three ballooons made of lead foil, which they inflated with helium to the cheers of onlookers.

A 10-foot cube tore its lead fabric and barely rose from the ground. A "traditional" sphere rose, slipped its mooring, and sailed across a highway into neighboring Arlington.

The winner, a 14-foot long, sausage-shaped affair, broke its tether in a westerly gust of wind and last was sighted by a private plane "heading for Spain," according to James Birkett, the ADL chemist who organized the contest.

Arthur D. Little, Inc.

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