SPACESCAPES/PAYLOADS FOR THE ARTS

By Joe Davis

ADMINISTRATIVE AND TECHNICAL ASPECTS OF THE NEW WAVE RUBY FALLS GET AWAY SPECIAL PROJECT ARE REVIEWED IN PERSPECTIVE

Introduction:

The first efforts to involve NASA and space shuttle in projects for the arts were, by and large, disastrous. Artists had a hard time understanding their role in contending with technical benefit requirements of the program and, further, they typically expected money to flow in the wrong direction, thus compounding the problem. One of the few (if not the only) NASA offices actually accustomed to paying independent, or free-lance artists was the Office of the Graphics Coordinator at NASA Headquarters, which is where many artists with would-be shuttle projects eventually ended up, and were of course subsequently dismissed. NASA has not been historically inclined to recognize the arts from the standpoint of practical benefit, save perhaps in the context of the usefulness of the graphic arts to document programs and procedures for books, charts, brochures, and other materials either for print or broadcast. Unfortunately, it seemed as if the inherent utility of the arts might remain submerged in the fabric of such a narrow application. To NASA, space was strictly business; the place for serious and justifiable (in Congress) research. Meanwhile, to the artist, space was the place for works of enormous power and scale; a stage for the struggle with gravity which has always stood between the sculpture and the sculptor; even between the fresco and the floor, and now, between the artists and the artist's vision. It wasn't the Graphics Coordinator's job to hire on artists with projects for the space shuttle; and in the transition from landscapes to spacescapes, artists weren't presenting themselves as potential customers, submitting earnest money, or otherwise substantially contributing to positions in which they could be treated according to the same policy and regulation as other commercial users.

NEW WAVE RUBY FALLS:

As the need for a negotiable commercial relationship had become more apparent, earnest money was submitted in July,'78 for a 5 ft.^{3}/200 lbs. GAS payload that would eventually become NEW WAVE RUBY FALLS. Accompanying correspondence described the payload as a "unique science/art juxtaposition that will satisfy technical, and 'human benefit' criteria which NASA requires for small, self-contained payloads".

While it has become technically possible to create works of art on an enormous scale, art itself is becoming as societal as it is monumental. Where prospective works of art could involve large sums of money, thousands upon thousands of work-hours, and support systems that include agencies of the government, artists are finding - in some cases, for the first time - that they are being asked to resolve the practical issues of that participation.

By December, 1978, NASA was still uncertain, and an offer was made to refund the earnest money untill a decision was reached to "...permit this class of payload to fly,..." Again, by return mail, the issue of technical benefit was addressed, and this time, with some direct reference to the principals of free enterprise:

"...Still, remembering that NASA has its deepest roots in the American free enterprise system in general, and in uncounted hosts of fiercely competitive support contractors, janitors, clerks, and artists in particular, it is surprising that NASA has not decided to grant a fair and equal opportunity to any and all of the above who could develop a meaningful, ethical payload, and pay the same price as other STS customers...

...When we consider the relative benefits of typical shuttle payloads, even if we choose to ignore the history of underdeveloped peoples whose lives have been destroyed or severely exploited as a part of the planetary cost of technical advancement, at least we can agree that the history of human suffering, and the depletion of natural resources has had little or nothing to do with art. Indeed, if the priorities for allotting shuttle payload space allow for projects that contribute to the improvement of the human condition and the quality of life, then the arts represent a very humane and universal practicality...

...Even if the existing priorities relate exclusively to technical research and development, it should be remembered that many of the technical advances vital to our way of life are, in fact, directly attributable to development in the arts. A few among these

are the invention and development of practical photography(including the basic camera and photographic plates); lost wax casting, lithography, silk-screen printing, pigments chemistry... all of which technology as we know it could do little without... The point is that technological development is not, and has not traditionally been the private domain of science and industry...

...I do not expect or desire a refund unless there actually is a decision to specifically prohibit art, even in payloads that comply with prescribed technical criteria..."

- letter to STS Operations(1/8/79)

Some ten months later, NASA decided to accept the earnest money based on compliance with the policy for scientific research and development. In a letter dated Oct. 23, 1980, the payload was finally assigned an official payload number(266A) in the earnest money queue. The NASA/customer relationship was thereby legitimized, and lines were drawn on the matter of what could fly, and what could not. NASA would neither qualify or disqualify a project simply because it contained or pertained to a work of art, though clearly if the artistic and scientific aspects of such a payload could be at all separated, then NASA would fly the science and not the art. Here integration of sensibilities was as important as integration of hardware; and the commitment to develop and administer to this integration was no doubt an equal challenge to both worlds.

At this time NASA was still formulating key elements of the GAS program. The GAS Final Rule, GAS cannister dimensions and structural characteristics, facilities for an opening end, optical window, and the contingency for deploying GAS payloads were all among the issues yet to be resolved. It follows that the nature of these uncertainties would figure significantly in forthcoming proposals. Accordingly a variety of technical applications were assessed so that the project could cope with anticipated variables in final determinations about payload 266A, and GAS payloads in general. Such diverse areas as space inflation technology(inflatables), foam-metals techniques, vacuum welding, laser-interferometric and holographic-interferometric gravitational wave detection, Earth-resource imaging and reconnaissance techniques, crystal growth and semiconductors ... were analyzed with respect to feasible interfacing of artistic and scientific objectives.

Although there was no requirement to do so, copies of drawings and abstracts from the aforementioned explorations were forwarded to STS Operations and presented at GAS-user symposiums, etc., over a period of several years. Payload 266A was thereby pursued in terms of alternatives so that options were switchable in the face of administrative and/or technical dead-ends; and it was also intended that at this

point a rejection or disqualification of the payload would be discouraged on the basis of a single possibility.

GAS payloads can, and in fact already are used to create small amounts of new and unique materials with implications that are as artistic as they are scientific; having ultimately as much to do with the arts as paint and marble do now. Foamed metals could be used for instance, to create very lightweight and tenuous, yet extremely strong bases for massive, weighty objects...foamed gold or platinum would have as many scientific uses as uses in lapidary and sculpture; likewise for payloads devoted to the manufacture of ultrapure semiconductors(saphires, garnets) and ruby rods for lasers. The final disposition of such payload products may present some problems for the artist-user however, as NASA has rejected payloads it feels would take unfair advantage of public resources by producing non-technical financial 'killings' on the open market. NASA has thus rejected proposals for payloads that would fly stamps, coins or medallions, prints, and even crematorial ashes, on the basis of preventing what is obviously considered unethical entrepreneurial activity at the expense of the federal government. An artist 'cashing-in' on a relatively miniscule investment, or one who plans to do so, might similarly provoke the ire of the space administration in such a way as to inspire regulation that could effect the entire community of the arts. What portion of such a payload would be used for art; and what part for research? How would products thereof find a fair price and a fair market?

Due to the complexity of these issues; and because of artistic motivation to involve the site itself, as well as the mere characteristics of the site, concepts for payload 266A moved more toward schemes for shuttle-based environmental art. In an early proposal made by the user in connection with Dr. Leon Goldman(Director of the Laser Laboratory at the University of Cincinnati Medical Center),the GAS container would be used, possibly with a sub-cannister, to discharge 5 ft.^{3} of crushed glass, shreaded aluminum foil, and UV-activated phosphors. The idea was to use ground-based lasers targeted on the discharged materials to create spectacular displays of light and color visible to large numbers of observers on the ground for both artistic and scientific purposes. Observations of atmospheric absorption, refraction and beam divergence could be made for a variety of lasers operating at different places on the visible, and ultra-violet parts of the electromagnetic spectrum. Also, drift and diffusion of the discharged particulate could be observed and measured. Again, there were certain problems.

Although NASA had not unconditionally decided to prohibit deploying GAS payloads on the long term, they had decided that there would be no deploying GAS experiments on the short term. Machinery to facilitae deploying experiments was at this time still in the process of design and testing, and users were warned of additional high costs which would probably become associated with deploying payloads.

Because of potential interference with other payloads, and with ground-, and shuttle- based astronomy, NASA was reluctant to encourage the GAS-related deployment of any particulate or solid materials whatsoever.

In any case it was evident that the GAS cannister of maximum weight and volume could not contain a materials-intensive environmentally scaled experiment, artwork or not. Indeed, a GAS cannister could only contain part or portion of continuous physical objects much larger than at best, a few score meters(as in the case of inflatables). Consequently GAS experiment/environmental artworks conceived of as works with light represent an adaption to the confusing relationships of scale seen in the utilization of a 5 ft.^{3} space in a high speed global trajectory. Light has long since been common ground to the interests of art and science; is weightless; not restricted by physical connection to any particular space or area; will not outgas or physically contaminate other experiments; and is not adversely affected by vacuum, temperature extremes, vibration, G-force variations, or any other known characteristic of the near-shuttle region.

Light in the context of environmental art is nothing new, neither for that matter is the overlapping technical interest. For decades, and in some cases for centuries, artists have employed mirrors, lasers, projectors, searchlights, pyrotechnics, etc., to create large-scale public works. The interdisciplinary works of Rockne Krebs, of Washington, D.C., and John David Mooney, of Chicago, Ill. are contemporary examples. The late Alexander Calder, artist of 'mobiles' and 'stabiles' fame(who also painted Braniff jetliners) had collaborated with Dr. Goldman at Cincinatti to determine the feasibility of placing mobiles in space which would interact with lasers based either on-orbit, or on the ground. This was some time before the start of the GAS program, and Calder died unfortunately before he had time to work out other possibilities. Still other artists, mesmerized with shimmering auroras produced in many years of rocket-borne investigation of the ionosphere and the earth's magnetic field, have proposed the creation of auroras for artistic purposes by the pyrotechnic/chemical release, and other methods heretofore employed by scientists associated with auroral experiments in rocketry. Regrettably, the cost of such a project, owing to the need for an expendable launch vehicle and support systems, can easily range into figures unaffordable by any individual artist, even if the artist in question happened to be an extremely wealthy one, and even if associated government agencies had offered their cooperation, which they had not. The fact remained that technology necessary for the production of artificial auroras would be prerequisite if large -scale atmospheric lightforms were ever to become a medium for envronmental art. In the context of GAS payload 266A, given both the widespread scientific and technical interest, and the breakthrough economics of the GAS program, an auroral payload concept began to take form.

One possibility would have been to propose the deployment of Barium triple-carbonates, and other materials used in conjunction with pyrotechnic/chemical release without the pyrotechnics in subcontainers designed to quickly disintegrate on reentry; allowing for the ionization of materials solely by atmospheric heating. It is fair to assume a more favorable response from the space administration to payload concepts not pertaining to the use of plastic explosives, thermite, or other pyrotechnic materials, especially in view of the sensitive and tenuous issue of deployment of anything at all. And, although the user(s) has described an option for the use of one or two such subcannisters in the NEW WAVE RUBY FALLS payload accommodations requirements, launch agreement negotiations, etc., the inclusion of such subcannisters have been proposed only optionally, as the user pursues a higher order of compromise on the matter of deployment.

Natural auroras have been associated with surges of electrons in the ionosphere which, in turn, have been associated with solar activity. Mimicking this natural process, scientists have used electron guns as surrogates for solar and magnetospheric activity to introduce beams of electrons into the environment under controlled conditions. An electron gun consists of a cathode(-), which consists of, or is coated with an electron emitting substance, and anodes(+), which focus and/or collimate the electrons, and determine the voltage(energy) of the electron beam. The amperage or current density is work function of the cathode which is usually heated to the specific temperature at which desired emission takes place. Electron guns have been used for a variety of purposes with and without chemical release materials in sounding rocket, as well as deep space missions, and two have flown in large, non-GAS shuttle experiments to date. Although the two guns involved in experiments carried out on board shuttle(OSS-1's Fast Pulsed Electron Gun on STS-3; and the SEPAC experiment on STS-11) were not necessarily intended to produce emissions visible to observers on the ground, the problem of determining the characteristics of an electron gun intended to produce visible auroras is an eminently solvable one; and the road to that solution has benefited greatly by the fruits of earlier investigations. It was with this project in mind that NASA signed a standard launch services agreement to fly GAS payload 266A, NEW WAVE RUBY FALLS; the first launch agreement signed for a payload containing, or pertaining to a work of art, and the first private sector payload launch agreement for a GAS payload intended to at least partially deploy. That signing occurred May 4, 1982 nearly four years after the original submission of earnest money. On June 8, 1982, the user reserved two additional payloads under the auspices of the Center for Advanced Visual Studies(payload identification numbers 439 and 440 in the earnest money queue) for future payload projects.

One of the first determinations made of the 'RUBY FALLS experiment parameters derived from published observations of natural auroras.

In the process of documenting auroral observation, international brightness coefficients were established to standardize references to intensity of brightness. International brightness coeffecients are incremented in terms of Rayleighs, a standard of brightness which is in turn translatable into photons per sq. centimeter per second(i.e., 1 Rayliegh = 10^6 photons $^-cm^2$ $^-sec.$ at 5577 angstroms, a green emission line in oxygen). Further, the brightness intensity of minimally visible auroras(so called 'diffuse' auroras) has been established as having an international brightness coefficient(IBC) of 1, or 1 kilorayleigh. Thus the brightness of minimum auroral visibility can be expressed in terms of oxygen emissions as 10^9 photons $^-cm^2$ ^-sec for auroras which normally occur at an altitude of about 100 km. 'RUBY FALLS' parameter for minimum visibility was thereby established, as well as an ideal target altitude of 100 km, in the electrically active auroral zone.

The next step was to determine what output levels of current and energy were required so that the 'RUBY FALLS electron gun could produce the prescribed auroral brightness, and penetrate to the preferred altitude. Fortunately, these values were also calculable in terms of extensive earlier investigations.

In the process of ionization and recombination, atoms of gas emit photons with a frequency or 'color' that directly corresponds to the amount of energy consumed by the atoms at the start of the process. When an atom of gas absorbs energy from its environment, an electron can move to a higher energy level. Once in the higher level, the electron tends to return quickly to the original energy level. In this downward transtition a photon with an energy nearly equal to that of the energy absorbed in the upward transition is released. A photon is released when an electron moves from one of the allowed energy levels in an atom to a lower level. Such electron series transitions are predictable according to the species and density of gasses involved, and the amount of incoming energy. Visible(Balmer Series) emissions in atmospheric gasses at 100 km(auroral zone) would correspond to an output of 1.6 amps at 6 kv for the RUBY FALLS electron gun according to the conclusions of the 'RUBY FALLS research group. In order to allow for a significant margin of error, a 10 amp/10 kv gun is proposed which correspond to atmospheric emissions with an international brightness coefficient of three(IBC-III), or three times minimum observable emission.

Based on a 28 volt/40 amp-hour power supply, the 'RUBY FALLS electron beam will be pulsed at 1 millisec/1 sec. during discharge sequences over night sky through one to several consecutive orbits. Again, given a 50% margin of error, approximately 3000 individual millisecond pulses should be possible according to current estimates; including 225 watts of cathode heating power. 3000 IBC-III rated emissions are therefore anticipated.

The process of acquiring specific payload hardware and support services for the NEW WAVE RUBY FALLS project has matched technical chal-

lenges with significant economic ones. Due to thoroughly interdisciplinary project characteristics, NEW WAVE RUBY FALLS has not been fundable by foundations or endowments designed to support either the community of the arts, or the sciences. In the larger view, the lack of, or dwindling scale of traditional support for the arts and sciences reflects the society-wide economic condition of course, and the special nature of the 'RUBY FALLS project merely amplifies that effect. Still the economic principal of such a situation is that a shortage of currency accompanies a surplus of goods and services. With respect to this surplus, coincident interests were established with corporate and government sources of 'RUBY FALLS-required hardware and services in order to form the basis for practical relationships with product development and market research groups in industry, as well as with research communities associated with government agencies and academic institutions. Likewise, emphasis has been placed on utilization of existing services and available, off-the-shelf hardware(when at all possible) in order to foster containment of time and costs in the development and testing phases of the project. The attention of the press has also figured significantly in developing relationships with project support by disseminating information which has helped to instigate those relationships in the first place, and by representing public-relations/advertising benefits to companies participating in a project with extensive media visibility. Companies currently cooperating in the NEW WAVE RUBY FALLS project include EG&G CORPORATION, Electronic Components Div., Salem Mass; KILOVAC CORPORATION, Santa Barbara, Calif.; TRI-CON INC., Cambridge, Mass; G-TEK INC., Waveland, Miss; STRUCTURAL COMPOSITES INDUSTRIES, Pomona, Calif.;...(partial listing). Additionally considerable testing support, as well as extensive reference and consulting has been provided by the Space Physics section of the Air Force Geophysics Laboratory at Hanscom AFB in Bedford, Mass.

It has not been the user's intention in compiling this account to imply that all of the problems associated with the NEW WAVE RUBY FALLS project have been solved, for certainly they have not. On the other hand, some of the issues approached - and resolved - with regard to reconciling the antagonistic sensibilities of the cultural and technical worlds have never been resolved before. One of the benefits of the project is that technology has been represented with a certain integrity as an interdisciplinary resource. 'RUBY FALLS will help to express the fact that, especially in America, technology is both accessible and adaptive; and by expanding what is generally held possible for an artist to do, it is about the right to make a difference.