The Hewlett-Packard Corporation contracted with the Museum as a Sponsor Corporation in August, 1968, after a fairly prolonged exchange of correspondence between the Museum and David Packard. Hewlett-Packard had declined to join as Patron Sponsor, and we might not have persisted so long in soliciting their cooperation except that we had toured their Palo Alto facility with Mr. Packard in July and felt strongly that their technological potential for an artist, especially in the area of lasers, was exceptionally important. By joining the program in the Sponsor capacity, Hewlett-Packard ultimately provided valuable resources and went to considerable effort and expense in assisting the artist matched with them—their commitment finally equalled that of most Patron Sponsor corporations.

After Hewlett-Packard had signed a Sponsor Corporation contract, nearly a year passed before they received an artist, though the assignment, when made, was accomplished easily.

In March, 1969, Hal Glicksman received a letter from Washington, D.C. artist Rockne Krebs:

> Walter Hopps suggested that I contact you if I was interested in participating in the L.A. County Museum's 'Art and Technology' show. I am.
>
> Perhaps Walter mentioned my light structures to you. I would be particularly interested in producing one in collaboration with a corporation which makes lasers. I have been plugging away at these things since the spring of 1967 when I panhandled a laser and set one of the structures up in my apartment. Since then there have been three one-man shows—a fourth coming up at the Corcoran in May [this was later rescheduled for November]. I have yet to scratch the surface in terms of the possibilities. The inevitable inhibiting factors for me are technical assistance and the equipment necessary to realize the work. Needless to say, your project sounds attractive to me.
>
> I now have eight lights of my own. All but one were purchased from Spectra-Physics, a firm based in Mountain View, California. Their local rep has been reasonably cooperative about lending me equipment when he has it available. I understand that Spectra-Physics is one of the few companies left whose primary product is lasers. I mention this because Spectra-Physics might be limited in how much they could afford to subsidize this kind of project as compared to a large corporation for which lasers would be a subsidiary product. I am just speculating, however. Laser applications apparently have not kept up with what was envisioned initially.
>
> If you are interested, I will prepare a detailed proposal for a piece.

We were indeed interested, and on April 11, Rockne sent us a carefully drawn up proposal. It described two works, one to be set up outdoors and shown at night, the other an indoor piece. He called them *Night Passage* and *Day Passage.* In May, we brought Krebs to California for three days to tour corporations. He visited Hewlett-Packard, and signed an artist contract. It was immediately evident that Hewlett-Packard would be well equipped to work with Krebs, and following Krebs' tour, we sent his proposal to Dan Lansdon, Administrative Head of Hewlett-Packard's laboratory, with a letter urging that a collaboration be initiated. On June 6, Lansdon phoned to say that Hewlett-Packard was prepared to work with Krebs: it was agreed that Krebs would begin residence in mid-July. A year later, Rockne wrote about his feelings at that time, just after he had first toured the corporation:

> Initially, from the point of view of realizing a laser piece, I had some misgivings about a collaboration with Hewlett-Packard. They made lasers, but I had no idea if they were the type suited for my work. The security lid was on the project they had going with lasers and they refused to discuss it with me.
>
> I did feel that there were some interesting people there but in terms of Hewlett-Packard's products, I did not immediately see any possibilities for the kind of work that was on my mind when I went to Palo Alto . . . .
>
> To be completely honest about it, at the time I wanted very much to make a piece. This is not the cool, think-tank theme that might be popular to peddle, but several years of ideation and attempts to visualize pieces that were beyond my resources to realize, both technically and financially, had preceded my initial visit.
>
> Maurice Tuchman and Hal Glicksman stressed the importance of the unknown possibilities that this sort of collaboration might point to: Quote MT: 'You may not even want to make a laser piece.'
>
> Okay. I was skeptical, but I told MT, HG, JL and BA that I would be glad to go to Hewlett-Packard and spend time in the labs and see what happened.
>
> Who knows what was on the group mind at the Hewlett-Packard labs? There was an unknown. Titillating.

Krebs was at this time more enthusiastic about doing an outdoor piece (some version of *Night Passage*), than the indoor *Day Passage* and in June sent us an RCA price schedule on laser equipment with hand-written notes on how he might use their argon laser, Model LD 2100, for such a project. He wrote,

> The LD 2100 has an internal cavity prism assembly which permits the selection of a minimum of six individual frequencies—colors.
>
> It should be possible to devise a way to run through its color range continuously which is from green-yellow to blue. Now try to imagine a huge exterior light structure of three of these on different cycles and one stable red 50 mw helium neon zapping between the buildings and finally shooting off over Wilshire into the L.A. atmosphere. [1]
>
> Flowers would grow in the cement out front of the L.A. County Museum the three or four hours a night that it was turned on.
>
> In fact—let this be my proposal to Hewlett-Packard. I recall that they have one argon laser some place. They would begin by making an automatic wavelength selector device that runs on a continuous cycle for their argon laser. (Although I would be interested in how it's done, it is not necessary that I know. Then if I'm allowed out there I could have that to begin experimenting with when I arrive in July. If it does what I think it will, we could then see about renting or borrowing the one or two more lasers necessary to realize the piece.) I would like to be able to control the cycle rate—slow or fast, and to be able to stop it on a specific color if I wanted . . . .

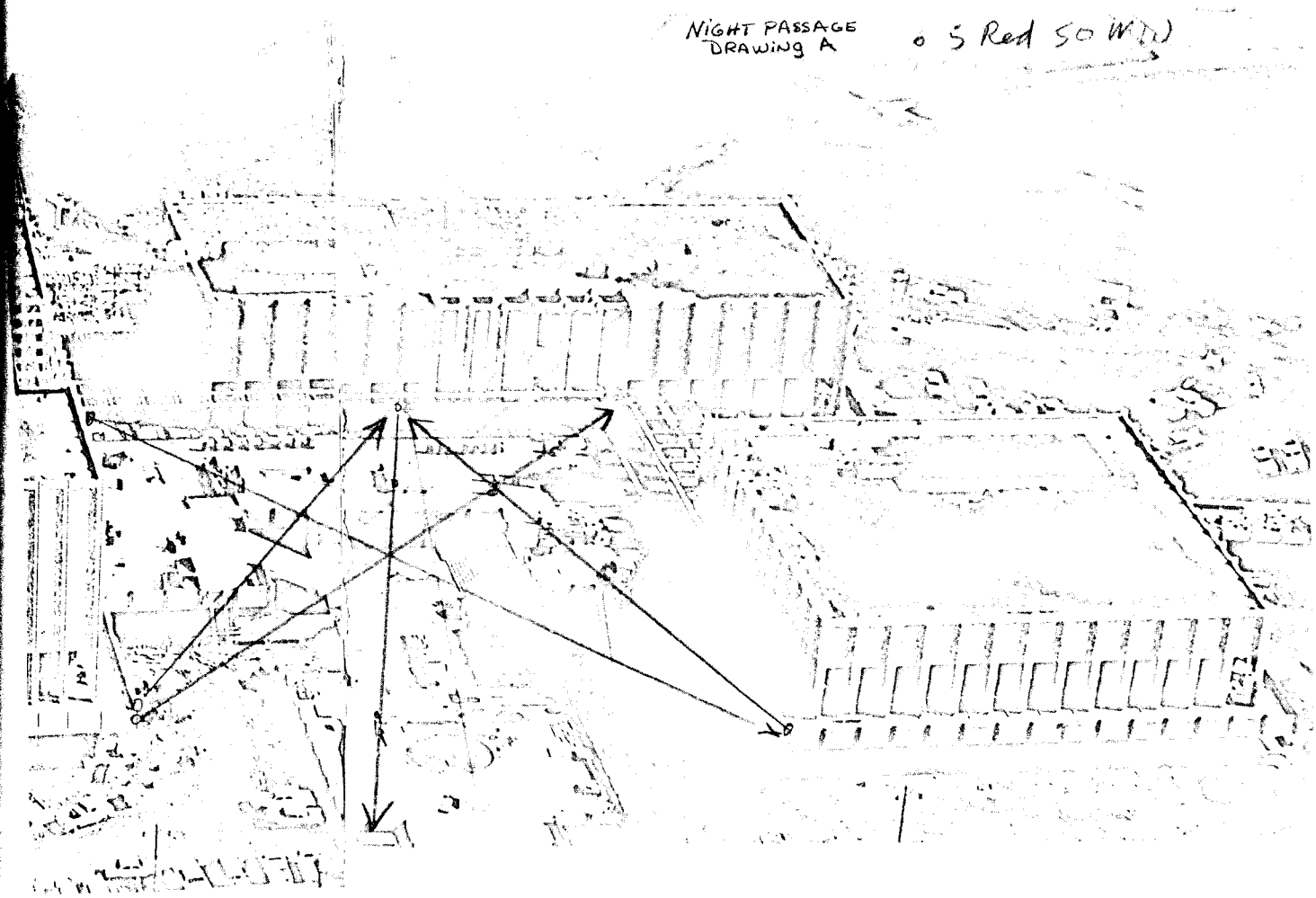
By the time Krebs arrived in Palo Alto in July, and the collaboration was underway, it had become fairly certain that some of the A & T projects would go to Expo 70, and we encouraged Krebs and Hewlett-Packard to execute a laser environment that could be displayed in the New Arts area. Thus, the idea of creating an outdoor work was relegated to secondary priority. Krebs and Hewlett-Packard's physicist Laurence Hubby did run some night tests during his stay at Hewlett-Packard involving a laser beam directed into the atmosphere and hand-manipulated mechanically to change color. This peripheral experimentation was actually of key importance to the artist in many respects. He afterward wrote,

> I have a reasonably good science-fiction background. When I arrived at the Hewlett-Packard labs I could turn a laser 'on' and 'off.' I felt that the technology involved was best left to the technicians. Still do with this qualification: I want to know all the capabilities and limitations of the tool. What we were doing wasn't merely collaborating on the execution of a piece for Expo. I was able, with the assistance of Hubby and others, to research in a much broader sense, possibilities for work that had nothing to do with any particular piece. For example: Larry Hubby and I would go back to the labs in the evening (on his time off). We would set up and run the tests for outdoor pieces. With Larry's assistance I was able to determine the power of laser required to do an outdoor piece, and the size of optical telescope necessary to refocus the laser light to get minimal divergence in relation to distance. In other words, what my scale limitations were. I learned that there was a definite relationship between the particle size, the frequency of the light (color), and how well it scattered under normal atmospheric conditions—appeared visible along the path of the beam. I learned that the blues and greens would be scattered better by the incidental matter present in the atmosphere than the longer wavelengths of red.

Throughout Krebs' initial residence at Hewlett-Packard, from July 21 through August, and in the later stages of the project, Dan Lansdon served as his principal contact. Lansdon was extraordinarily helpful in directing the artist to the right personnel for advice and assistance in the various technical aspects of the project; according to Krebs, "Lansdon had the authority, and used it: he knew what people to see and how to approach them." Krebs not only worked with a great number of technicians at Hewlett-Packard, but made several connections with laser experts outside their laboratory. The Palo Alto area is probably the world center of laser research, and on five or six occasions, Krebs was led by Hewlett-Packard people to seek information from experts at such nearby organizations as Spectra-Physics, Coherent Radiation Laboratories and Stanford Research Laboratories. He presented a slide lecture to personnel at Spectra-Physics which was received with considerable enthusiasm. Indeed the first two or three weeks of Krebs' stay in Palo Alto were devoted primarily to a process of gathering and exchanging information and simply conversing informally with various laser researchers. Krebs said later that when he arrived at Hewlett-Packard with his project in mind, he "didn't know if the piece was *possible;* I suspected it was, but it was much more complicated than I had envisioned. Technically, it's more complicated than any work I've done."

Rockne also commented that he was intensely affected intellectually by his experience in Palo Alto: "My mind was stimulated," he said, "in a way it never had been before, and probably never would be, particularly by art."

Krebs was extremely gratified to find that he could easily obtain direct and precise answers to questions he had hitherto not been able to resolve. For example, he consulted with a Stanford Research Institute physicist, Dr. Arthur Vassiliadus, on the issue of the precise threshold levels of eye damage by laser light, and got exact quantitative information from him, based on recent studies, that probably was not available at that time anywhere else in the world.



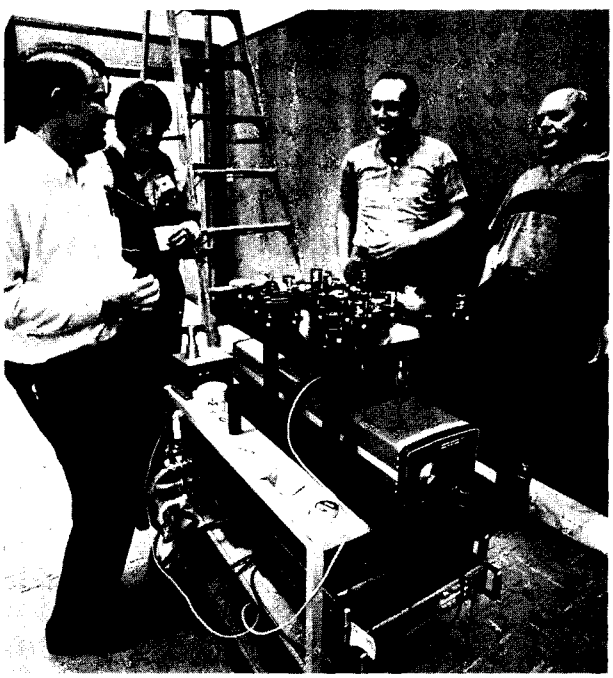
1

One incident occurred, not directly related to his work on the main project, which may have especially significant ramifications for Krebs. He was asked to present a lecture with slides to a group of Hewlett-Packard employees. The talk elicited similar interest to that expressed by the Spectra-Physics audience, and one man, a scientist named Egon Loebner, approached Krebs at the end of the presentation to invite him to lunch. Loebner is an authority on patent procedure (he was teaching a course in invention at Stanford), and he felt that something Rockne had demonstrated might in principle be a patentable technique. He saw in some of Rockne's laser light configurations a potentially utilitarian function as a device showing particular ways of architecturally delineating space, or "light as structure." Loebner and Krebs sought the advice of a patent lawyer whom Loebner knew, and as a result a patent search is presently underway for what is being termed "architectural photon structures." According to Krebs' description of the projected uses for this phonomenon, it would be employed literally as an architectural element. For example, temporary walls, false ceilings and room dividers might be created with laser light. Such structures could be constructed indoors or outdoors; one advantage, for instance, might apply in a landscape situation, in which one wished to mark out a space without physically disrupting the terrain or flora. Although this potential function for his laser environments had not occurred to Krebs, he quickly saw its rationale, as envisioned by Loebner. Krebs had used light in this way repeatedly, but was not particularly aware that it might constitute a patentable invention, or even that he may indeed have been doing it for the first time.

In executing the piece for Expo, Krebs worked perhaps most closely with Hewlett-Packard physicist Laurence Hubby [2], who designed and put together the optical apparatus, and with optics engineer Bruce Ruff. Of the system designed by Hubby, Krebs was to say later, "The apparatus that controls the argon beam is a work of art in itself. It has been absolutely beautifully designed." [3] (A technical description of the optical system developed for Krebs was written for us by John Lazier, and is included as an appendix on p. 176.) Besides the intricate optical system, which incorporated hundreds of parts, the work basically comprised a series of small mirrors to direct the light beams, two helium neon lasers, special mounts for the helium neon lasers, the large argon laser, the fog-producing machine needed to increase the visibility of the beams, and two eight and one-half by fourteen foot plate glass mirrors which were made in Japan. The Japanese company that provided the mirrors stated that they may be the largest true mirrors ever made. Rockne wrote, elaborating on the system,

> These *small* mirrors were no small design problem. First, they needed to be adjustable through three axes—x, y, and z, with as much adjustment as possible. The latter was necessary to give me flexibility when redirecting the light beam. Second, they had to be stable, so that once a position was determined the mount itself would not slip and cause misalignment. Third, the mount had to be attached to a wall of similar plane. Fourth, I wanted all this to happen in as discreet a piece of apparatus as possible: a small three inch diameter mirror mount that would protrude little from the wall. (My feeling about these pieces is that the *work of art* is not the apparatus. Rather, it is a score or arrangement [or whatever] determined in relationship to a specific enclosure. Allowing for the obvious contradiction of the necessity for some kind of apparatus [mirror mount] to redirect the light it is important to me that they be as inconspicuous as possible.)

This kind of mirror mount (or Maurice's term 'beam joint') is not stock optical equipment. Dan Lansdon and I spent an amazing number of hours discussing the requirements and attempting to find some kind of existing mount that could be altered—none existed! Although several of Hewlett-Packard's mechanical engineers worked on it at various times, it was Lansdon who resolved and perfected a mirror mount which satisfied my requirements, with the beautiful plus of being relatively inexpensive to produce—about $30 per mount. If I continue to work with lasers, as seems likely at this time, try to imagine how long it would have taken, how much it would have cost, how difficult it would have been for me to locate people capable of and willing to bother designing this one little item. With the prototype which I now have I can have them made myself.



2

The main aspect of the project accomplished in terms of realizing the piece for Expo during Krebs' initial stay at Hewlett-Packard was the designing of the programmed optical system; this is of course in some ways the crux of what the work is about, but it still remained to actually obtain the large argon laser (a problem which caused difficulties until the last moment) and physically set up the entire structure for final experimentation and perfection. This process had to take place in the installation area at Expo. Fortunately, there was considerable flexibility in the final disposition of the components within a prescribed space.

HG wrote this memo to the staff on August 28, 1969:

> Rockne Krebs has left Palo Alto for Washington, D.C. He will return mid October. [This was eventually postponed.] Hewlett has approved $10,000 worth of mirrors and other devices for the infinity reflector system and other uses which Krebs gets to keep. The Argon laser has *not* been approved. Jelco (Japan Electronics Co.) makes a suitable laser that could be rented in Japan. Lansdon is investigating this and other possibilities.

In September, Krebs met in New York with members of the Expo Exhibition Design Team and us. At that time a tentative location for the work was selected. It seemed then that the major problems were the hazard created by

3

the artificial fog (this actually posed no difficulties) and the rental or purchase of the argon laser. Krebs needed a corridor-like space or spaces with low ambient light; these requirements were easily met, and it was provisionally decided to distribute the bouncing light beams in several sections located at various points in the area, mounted high overhead. Krebs made several drawings showing alternative plans for distributing passages of laser light through the New Arts area. [4]

After this meeting, some radical revisions in the New Arts area were effected.

Krebs wrote to Dan Lansdon on October 15,

> . . . I mentioned when I called last week that the architect of the U.S. Pavilion in Osaka, Ivan Chermayeff, indicated there were going to be some changes in the New Arts Exhibit area. I have just received a revised plan for the area. The space is now divided into rooms rather than having it in one big area. My new space is roughly forty feet by twenty feet. This changes the enclosure to the extent that my piece will have to be reworked. I am concerned now that in a more confined area the intensity of the Argon's green and blue beams will wipe out the lower power He Ne red.
>
> The altered space should not change the apparatus we collaborated on this summer except for reducing the number of small mirror mounts required. I think I said twenty versus thirty mounts last week when we talked. Reduce that to fifteen total (or fourteen in addition to the prototype I have), and hold up making the mount for the He Ne lasers . . . .

Hewlett-Packard and the Museum attempted to procure the argon laser as a donation from its manufacturer. Finally, it was purchased by Hewlett-Packard from Coherent Radiation Laboratories, and two helium neon gas lasers, model 251, were lent by University Laboratories.

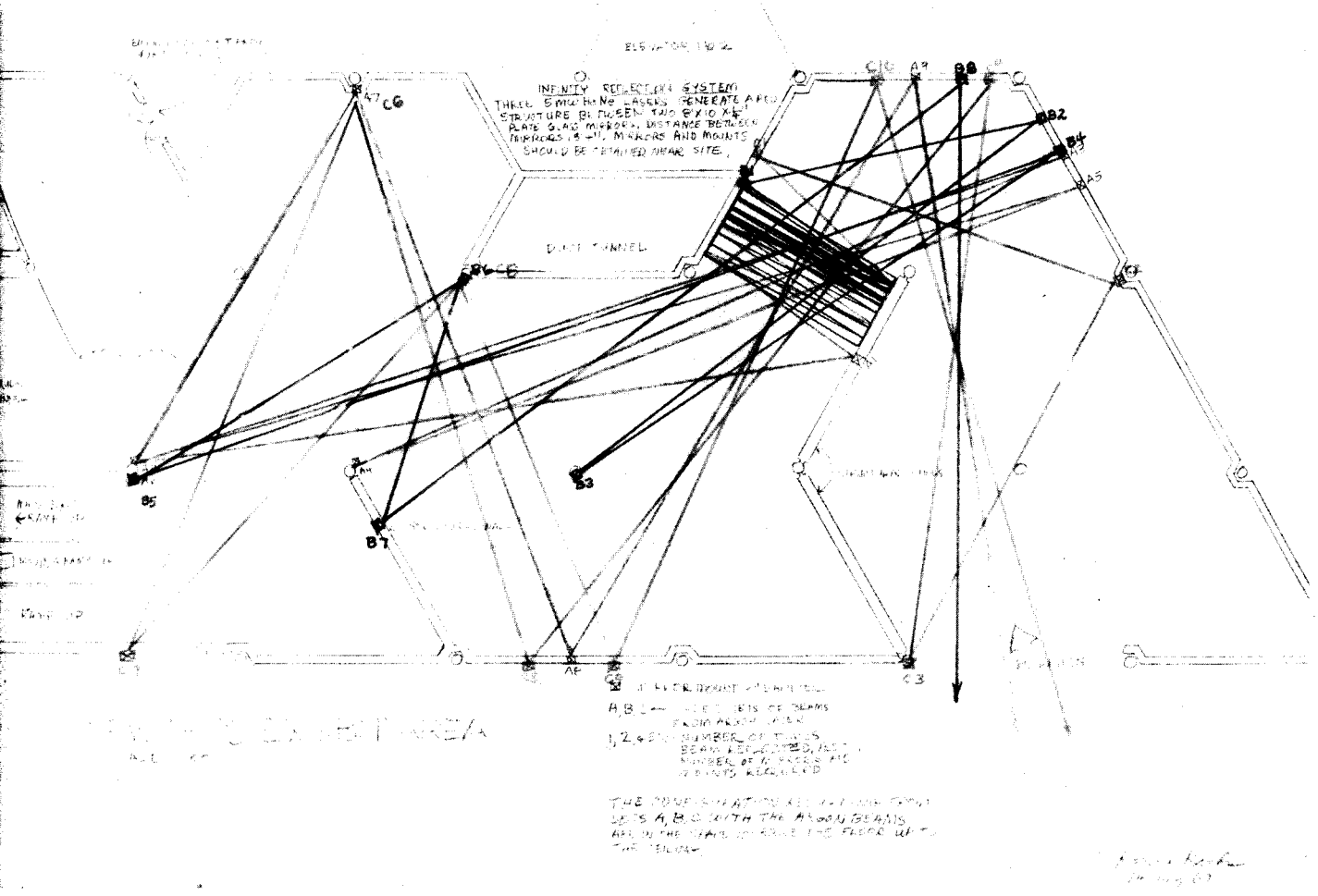
Once it was determined that the large parallel mirrors would be made in Japan, and the sources of the three lasers and the fog juice was resolved, the question of actually installing the work at Expo was at issue. There was no doubt that Krebs would have to supervise the installation himself, but before his arrival considerable preparation was expected.

Krebs wrote to David Sutton, November 28, 1969,

> Regarding your suggestion in your November 18 letter that the Japanese contractor purchase and install the mirrors—I have three enclosures which should give you the information he would need. I like the idea of having the floor to ceiling wall of mirrors as you suggested over the phone, and I think it could be done. It would make for a better looking installation than what is called for in my enclosures. My reasons for not suggesting this possibility initially were the additional expense of the mirrors and the difficulties encountered in aligning the mirrors in a co-planar relationship. It would be necessary to install the plywood paneling in such a way that you could insure the two walls used with the mirrors be co-planar before any attempt is made to install the mirrors. Then, in installing the mirrors, I would recommend covering the entire surface of the plywood with an even coating of 'mirror mastik.' This could certainly be done before I arrive in Osaka. (Note: the mirrors to be used are simply standard one-fourth inch thick plate glass. They come in a stock size of eight feet by ten feet in the U.S.) Once I am there and install the lasers and other apparatus, it would be necessary to drill three holes in one mirror. However, I do not think this will pose a problem.

Krebs returned to Hewlett-Packard for a week in January, 1970, to finish the work begun the previous summer—the lasers had still to be tested in operation with the small mirrors, and the optical system completed. During this period he worked intensely with Laurence Hubby, and again Lansdon assisted him significantly. Because Krebs was to accomplish the installation himself, without the assistance of the Hewlett-Packard scientists who had developed the work, he had to be taught to assemble and operate the optical system. Krebs wrote,

> John Lazier, the Hewlett-Packard electronic technician who designed the electronic shuttering system and the program which could control the rate of change and configuration and color change, had worked out a number of variable program possibilities. He and I discussed these at length, he trying to visualize what the various program possibilities might look like. I decided for the most apparently random program. The limitations were: three positions, 'A,' 'B,' and 'C' which could result in three separate light configurations and two basic colors. I wanted the rates, color, and position changes independent of one another. We were told the average viewer would spend roughly three minutes in the space, so the possibility of the piece completing its cycle—running through all three positions and the final 30-second rapid stage—had to be worked out with this three-minute time factor in mind. The more we discussed it, the more I began to see how important the rate of color change and the rate of re-positioning would be to the final piece. And without actually experiencing it in the space I was reluctant to settle for a basic program which I could not alter. John Lazier was sympathetic and spent considerable extra time designing into the system a control mechanism which would allow me to alter the rate of the cycle to fit


INFINITY REFLECTION SYSTEM
THREE SIMULTANEOUS LASERS GENERATE A PLANE
STRUCTURE BETWEEN TWO 6'X10' X 1/4"
PLATE GLASS MIRRORS, DISTANCE BETWEEN
MIRRORS 18 - 11, MARKERS AND MOUNTS
SHOULD BE DETAILED NEAR SITE.
DUCT TUNNEL
B5
B7
B3
B2
B4
B5
AF
C3

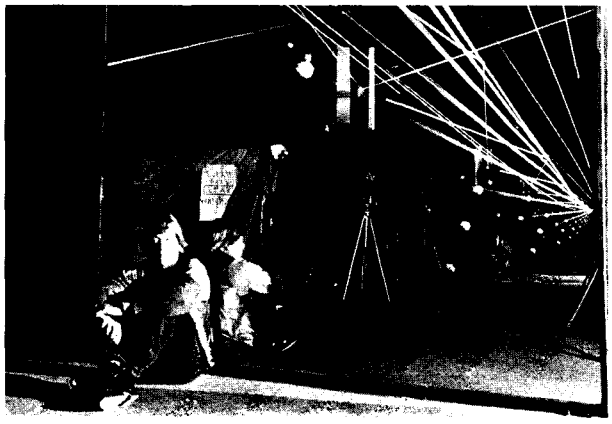
the situation. Also, to facilitate making the piece, a switch was put in so I could leave it on at any designed point in the cycle.

The last night I was in Palo Alto, Lansdon, Hubby, and I were up into the wee hours setting the argon laser and its optical system up to test it. We actually mounted several small mirror mounts and put up a test configuration. Everything worked beautifully except the collimating telescopes. I felt that visually the beam's intensity was too weak because of the beam diameter. I asked Larry Hubby to redesign the telescope and reduce the beam diameter to one-half inch, which he did.

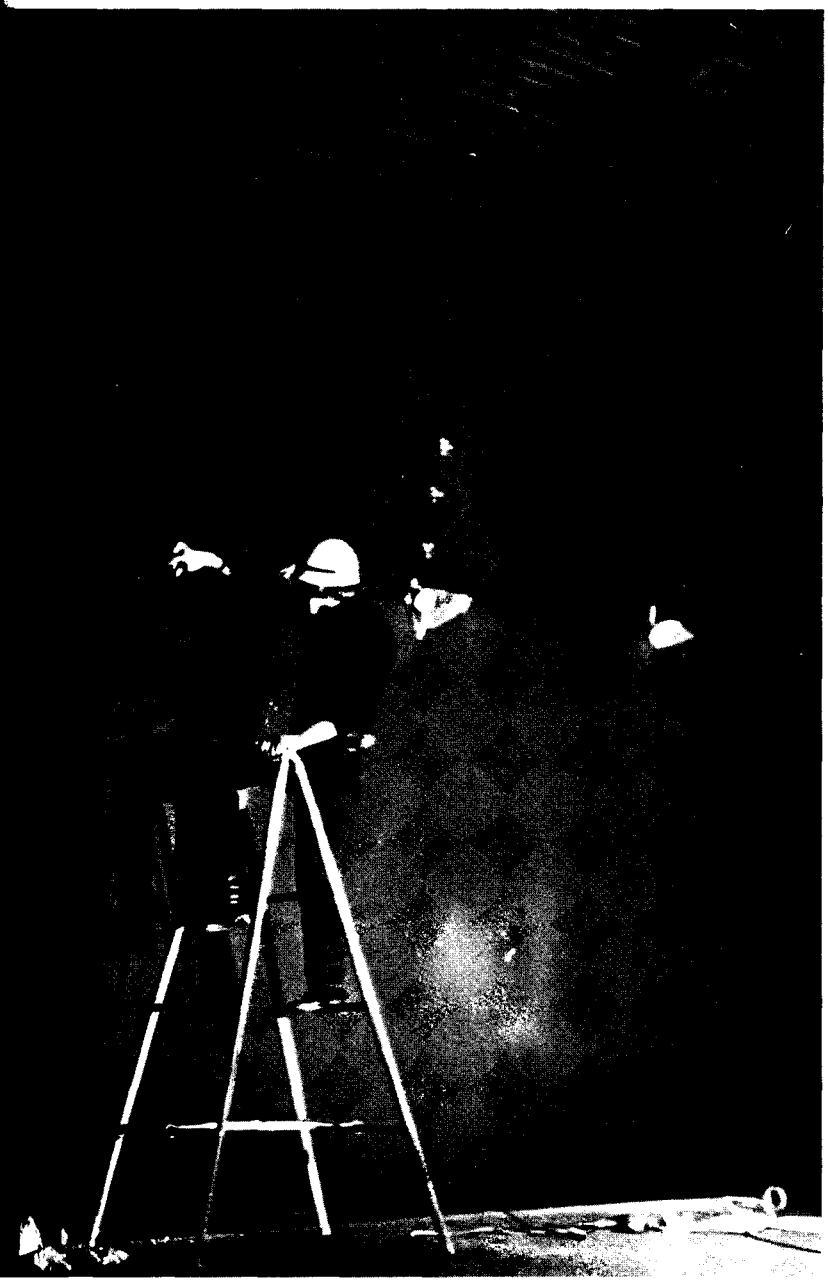
On January 24, Krebs arrived in Osaka to begin the six week job of installation. The space in the New Arts area allotted for the work measured twenty-three feet by forty-six feet; it was a parallelogram-shaped room. Beside it there was a separate, walled off utility room within which the laser apparatus was to be mounted; the large mirrors were placed face to face in the center of the room. [5] Krebs accomplished nearly all of the immensely complicated installation himself. He moved into a schedule whereby he would work at night, alone; it was easier for him to function undisturbed by the workmen in adjacent areas.

The work is difficult to describe, but in assessing the artist's intentions for it, and the important issue of its special nature as a collaborative project, some attempt at description is necessary.

Two kinds of laser light were used. The argon laser produced most of the light, and because its powerful light green and blue beams could be controlled by the optical system (in conjunction with the small "beam joint" mirrors, to disperse the beams) [6, 7], to flash on and off, or change color, it was used to generate the



5



6

complicated configurations of continually changing light structures. The red beams emanating from the smaller helium neon lasers formed a *static* configuration seen reflected "to infinity" in the two parallel mirrors.

The argon beams were structured in three basic sections. Originating at each end of the room, and traversing it length-wise, were "fans" of light. At one end, "joints" of light originating from a single beam (sections of beams reflected between small mirrors) traversed the area in a parallelogram which hung horizontally, at a distance of seven and one-half to eight feet above the floor. At the other end, a beam was positioned vertically, up the wall, from eight to twelve feet above floor level. This beam would then fan out in a vertical line and twist into a horizontal configuration. Then this entire system would be reversed, and the same thing would occur at the opposite end of the room. The configurations of light were programmed to run through a repetitive cycle; they would pop back and forth, or seem to swing; just as the spectator began to apprehend the pattern from one point of view, it would suddenly begin to enter a "dialogue" phase, popping back and forth across the space. The cycle was determined at seven minutes, based on the anticipated rate of traffic flow through Krebs' room.

7

The third argon beam was positioned vertically in the center of the space, running down the center of the mirrors. This generated a kind of "wall," but worked into the sweep of the beam activity originating from each end of the room. The center beam worked in various combinations with the peripheral argon structures. Reflected in the infinity reflection system it moved in and out and changed shape in relation to the "armature" of the red (helium neon), static beam network.

The apparent depth perceived as one stood between the parallel mirrors was calculated by Krebs to be about ten times that of the actual distance between them (about) eighteen feet). Thus as one walked through the area, he entered a passageway between the mirrors which was

actually *narrower* than the rest of the room, but seemed to open out suddenly into a great expanse.

When this description of the work had been written, it was shown to Krebs in the hope that he could add to, or clarify it. Krebs felt that it was not totally accurate, and submitted three drawings which he hoped would make the structure more easily visualizable to us. [8]

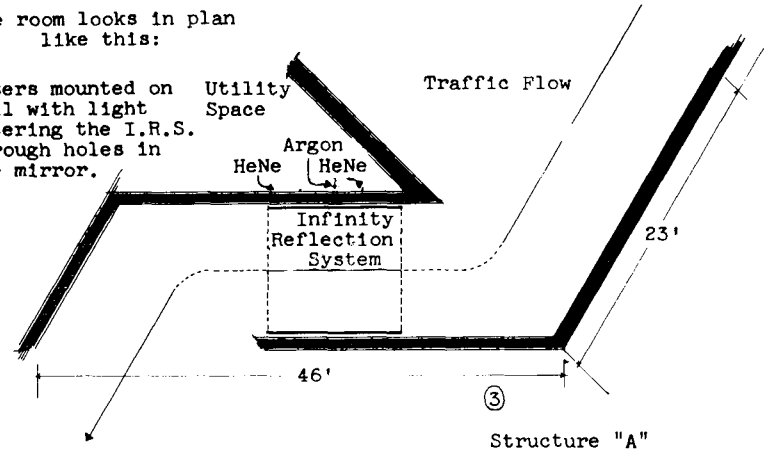
In relation to Krebs' past work with lasers, this piece represents a significant departure chiefly by virtue of the programming system, which he could not have developed without the assistance of specialists. The artist had for some time wanted to find a way to weaken the psychological persistence with which laser beams are perceived as apparently *real matter.* He felt that by making the beams temporarily disappear, and then reappear, or by repositioning the light from one source into a series of varying configurations, he might succeed in achieving a sense of the light in its true character—as simply light. The ability of laser light to suggest spatial delineation, and to convey both the transiency and relativeness of this process, is realized, Krebs found, only when clues are given to counter the strongly illusionistic felt presence of a laser beam projected uninterruptedly. The clues were provided by the programming system. Discussing his intentions for the Expo piece, Krebs wrote,

> The light beam would fill the room with one configuration and then another—versus 'to flash on and off' . . . . you just have the sense of something that's in one place and then it's in another. As you noticed, the beams of laser light have visually a tangible presence. But I am not dealing with material in the same manner the sculptor has in the past. Conventionally a sculpture is a configuration of mass that one sees because it is illuminated by some light source. I reversed this proposition. I put incidental matter into the atmosphere (or use what is already present) and project light through it. The path the light beams take as they pass through incidental matter in the atmosphere is the sculpture. It is a piece of sculpture that one could physically move through.
>
> But, it is light (I think Newton called it 'a unique form of matter') and it has unique capabilities. In the configuration that resulted from positions 'A' or 'C' there was never any sense of the structure as a kinetic thing—of the light moving from one point to another. Rather it was simply there in a space that had previously either been empty or occupied by a different structure.
>
> So these are some things that I am able to do with my medium that I could not do with another. There are other possibilities. This piece was not an attempt to demonstrate all the unique properties of light in general or laser light in particular. It was an attempt to realize a particular work of art which did of course use some of these properties.
>
> The visual presence of the laser light can be sufficiently convincing that one forgets with his eyes and ultimately with his mind the reality of what he sees. The idea of reconfiguration is then a self-conscious attempt to tickle both his mind and eyes.

Rockne plans to expand the basis for the Expo piece somewhat in doing a work for the Museum exhibition; there will probably be a greater profusion of light beams from the argon lasers, and possibly the addition of one or two helium neon lasers. We are planning as well to arrange for the artist to set up an outdoor work, using one or more powerful argon lasers, shooting beams out over the city of Los Angeles from the Museum.

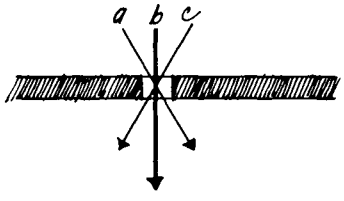
Jane Livingston

The room looks in plan like this:



① Lasers mounted on wall with light entering the I.R.S. through holes in the mirror.

② Blow-up of Argon section of the above plan view.

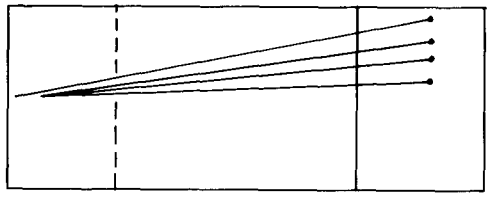


Mirror with 1" diameter hole for the three separate beams of Argon laser light to enter the space, The hole is 10' above floor and centered.

A, B, C are the green and blue light beams which produce the three separate configuration - A, B, and C. Actually the beams would enter the space either one at a time or in the combinations of "A" and "B" or "B" and "C".

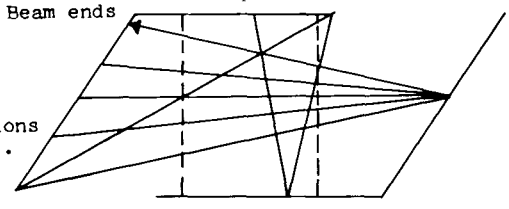
③ Structure "A"

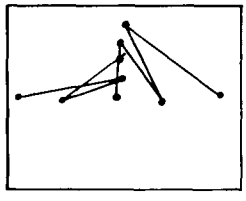
Side View



Top View

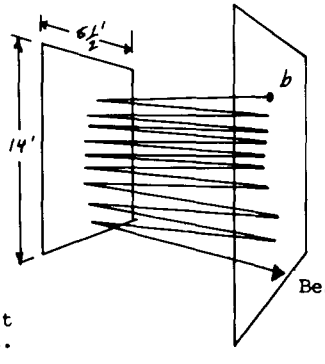
Beam ends





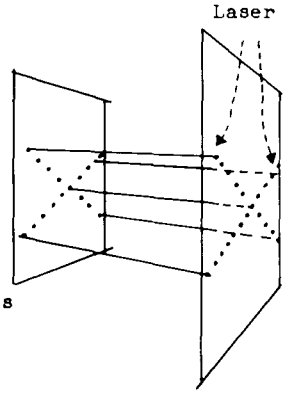
End View

④ Structure "B"



In "B" the light walks down the two mirrors of the I.R.S. which run vertically from floor to ceiling.

Beam ends



⑤ Structure "C" is similiar enough to "A" that it should suffice to think of "C" as "A" reversed.

⑥ 2 HeNe red-projected through two holes in mirror 9' above floor - from the configuration shown as the light beams walk down mirrors diagonally.