

INSTITUTE OF CURRENT WORLD AFFAIRS

DRP-14

4284 Hemlock Road  
Branchport, NY 14418  
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It Works!

Peter Martin  
INSTITUTE OF CURRENT WORLD AFFAIRS  
4 West Wheelock Street  
Hanover, NH. 03755

Dear Peter,

It gives me great pleasure to report that the Automated Web for Canopy Exploration (AWCE) has been installed at finca Rara Avis near Braulio Carillo, one of Costa Rica's finest national parks (see DRP # 7). I announce this with enormous relief; the project's birth has taken much too long.

The project was initially proposed to the Rolex Awards for Enterprise in early 1982, and in 1984 I was awarded a first prize of \$23,000 to develop AWCE. I then thought it would be simple to raise additional funds to develop a complete system that would give access to ten or more acres of forest. Over the next two years, however, I approached a number of institutions that were unwilling or unable to support AWCE. Through the tropical grape vine, I heard that certain senior scientists, some of them in very influential positions, did not want to see AWCE completed, even though this type of vehicle is absolutely essential if tropical rain forest ecosystems are to be adequately investigated.

As the years passed, almost no additional funds were found, so I resolved to build AWCE with the funds made available by Montres Rolex S.A. and the Institute of Current World Affairs.

Before leaving for Costa Rica, the timing for AWCE's construction had gained crucial importance. Intrepid, a documentary film-production company, had to have a reliable schedule for hiring a film crew, and the New York Times needed an exact date for dispatching reporter Erik Eckholm and photographer Gary Braasch. Once the travel plans for these people were set, they could not be changed. (The documentary appeared on National Geographic Explorer on April 24, and the article was the cover story of the New York Times Sunday Magazine on January 17th.)

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Donald Perry is an Institute Fellow who has developed an effective vehicle for conducting research in jungle treetops. Photographs were taken by Norman Milks.

Eight people, including myself and Norman Milks, a photographer I personally hired, had made travel plans based on the arrival of the equipment in Costa Rica on or before November 11th. So when John Williams postponed the shipment a few days before our departure date, I began to feel a little edgy.

I left for Costa Rica on November 9th, sensing that the project was plagued by the disease that had caused so many previous delays. A part of me had joined those who, after having read my reports, have come to think of me as an opinionated bag of wind. I, too, began to fear that AWCE might never be constructed.

Much was at stake. If I did not deliver the finished project within my stated time frame, both the New York Times and the film company would have some serious difficulties covering the project.

In a letter and by telephone the Costa Rican Ministry of Science and Technology had hinted that there would be no difficulty in getting the equipment through customs. This alleviated my concern about the late shipment since I had allowed a few extra days for complications.

In San Jose on the night of November 9th, Amos Bien, the President of Rara Avis and my old friend from graduate research years in the lowland forests of Costa Rica, told me it would take at least eight days to get the equipment (fifteen-hundred pounds of cables, motors, and miscellaneous gear) out of customs. I told him that would be too long.

The next day the legal secretary of Dr. Zeledon, the minister of Science and Technology, informed me that although it normally took several weeks to get items through customs, I was one of the fortunate ones whose equipment could clear customs in a mere eight days. I did not believe these projections -- I could not believe them -- nevertheless, I called Intrepid and suggested they come a few days later if that was at all possible. The firm voice on the other end of the line was uncompromising, and left no doubt that this was a preposterous suggestion.

And so began a period of frustration that only worsened as new obstacles, such as another postponement in delivery of AWCE and the need for yet another governmental paper, further delayed the project. For some reason it had not occurred to me that my ambitious plans for publicizing AWCE could become a ruinous trap. As tension mounted, I began to berate myself for having proposed the idea to Rolex, the Institute, the Heinz Foundation, and everyone else. I saw visions of the people who had obstructed funds for AWCE with satisfied smirks on their faces. Science society may have stalled the construction of AWCE, but I alone had placed my career in jeopardy.

When the film crew arrived on Saturday, November 14th, the equipment still had not left L.A. We spent Sunday in San Jose. On Monday, November 16th, we left for Horquetas, a farming settlement near Rara Avis. Amos remained in San Jose to await the equipment's arrival.

We were taken by tractor up the mountain to El Plastico on Tuesday morning. El Plastico is a remodeled farmhouse that can house twenty visitors in five upstairs bedrooms. Downstairs, there are three showers, two toilets and an outhouse.



Four-wheel drive tractor stuck in mud.  
El Plastico is in background.

There is also a kitchen, storage room, the cook's bedroom, and a large room with a dirt floor that is used for dining and research. As Amos likes to point out, El Plastico is rustic. It is where some members of the Institute will stay, if the Institute convenes a meeting at Rara Avis.

That afternoon I went for a hike with three workers from Rara Avis: Trino, Juan, and my friend Carlos Gomez, who is a Costa Rican biologist. We were looking for a site for AWCE.

As we walked I reprimanded myself for not bringing the small rockets that John Williams had packed with the rest of the equipment. These would be used to string rope over the trees. I had manually strung line over the jungle roof in 1979, which left me never caring to repeat the experience. At that time I had connected a system of ropes between and above treetops that allowed me to study nearly an acre of forest (see Scientific American, November 1984). The crossbow I used was not powerful enough to shoot a monofilament line between the support trees, so it was necessary to shoot from the top of each tree toward gaps in the canopy. The lines were tied together at the ground and

replaced with successively larger line until finally a rope was threaded between the trees. When the rope was raised, it became caught under limbs, and it took two weeks of difficult work to raise all the ropes into positions above the trees.

With an optical range-finder I found that the span between AWCE's support trees would be between 600 and 900 feet, which was two-to-three times longer than the longest span of my rope system. Even though I had a newer and more powerful crossbow, I knew it could not shoot an arrow with an attached line that far. To avoid the time-consuming work of earlier years, I would use rockets: small, hobby-shop varieties that can fly to an altitude of 2,000 feet. With these, a single line could be shot between the two support trees of the system, thereby avoiding a considerable amount of difficult and dangerous work.

For four hours and into the dark we crawled up and down the mud and rock slopes of Rara Avis, fighting tangles of tropical vegetation and always keeping an eye out for poisonous snakes. (When Trino found a fer-de-lance a week later, I discovered how pointless it was for me to look for snakes. Coiled up on the trail, it looked no different than a large, decomposing leaf. Even when Trino pointed directly at it, I couldn't see it.) We were investigating the canyon area I had spied from an airplane in July. We found three possible sites for assembling AWCE, but on the hike back to El Plastico, I began to think that those sites were much too far from the road. We arrived at El Plastico exhausted, and I resolved to find a site closer to road access.

The next day we explored the vicinity where the road met the canyon. At this point the canyon is shallow and the terrain is fairly level, having merely gentle rises. The river flowed through a shallow gorge that was narrow enough for Amos to have a bridge constructed with the trunks of some large trees. On the other side was a clear area that had once been owned by Trino, but his home there had long since decomposed. This is the site where Amos is building his hotel. When I arrived, the foundation was in place and stacks of wood were drying.

There are two workers' compounds at the hotel site. These are little more than shanties that protect against rain. Since the climate is generally agreeable and the elevation is too high to promote mosquitoes, even a shanty is a fairly comfortable place to live. When we arrived, many of the workers were on vacation, which left some rooms vacant.

The road to the hotel was made of tree limbs embedded in mire. In many places the logs disappeared into stretches of mud swamp of unknown depth. Walking in ankle-deep mud was routine, with an occasional slip into knee-deep mud. Living at El Plastico and working near the waterfall required a disagreeable two-hour, round-trip commute each day through what can only be described as a mud hell.

Trino and I searched the area for a possible site and immediately a tall tree that stood near the gorge caught my eye. The forest had been recently cut, leaving the tree exposed. Yet time was already beginning to heal these wounds and thirty-foot-tall trees, known as second growth, veiled the tree's lower half. We made our way to the tree to inspect the condition of its

trunk. Near the ground, the girth of the trunk was about three-and-a-half feet and this size was maintained to above sixty feet. The tree seemed in good health and it was close to the road.

Cutting and dodging through the underbrush, we made our way to the edge of the canyon -- a sheer, volcanic-rock cliff that was matted with trees and vines. It was impossible to see the far ridge through the tangle, so Trino opened a window with his machete, revealing the forest that blanketed the ravine. Rising from the forest, about 200 meters away, stood several trees that were likely candidates.

To save time and to avoid mud, I decided to live at the hotel site with Norman Milks (my photographer); Trino, Little Trino, Gabriel (workers); and Juan (the cook) for much of my stay at



"Restaurante de Juan" at the Rara Avis hotel site.

Rara Avis. The film crew and Carlos lived at El Plastico, which had not only showers and toilets, but also a refrigerator stocked with cold beer. Occasionally, thirst drove Norm and I down to El Plastico for an overnight stay.

The hotel site had reasonably comfortable foam beds and one other saving grace: a picturesque kitchen/dining room that was practically part of the forest. We dubbed it "Restaurante de Juan." Juan was a rich character straight out of "The Treasure of the Sierra Madre," a film where Humphrey Bogart plays a swindler who catches gold fever and then is beheaded. Juan, in his independence, reminded me of the Mexican outlaw who responded to the questioning of his authority by Bogart with (if I recall correctly), "Badges? I Don't need no stinking badges." Juan was tough and proud of his strength. But alongside Norm, who had a thick, graying beard and weighed two-hundred-and-fifty pounds, Juan looked like a half pint. Juan named Norm "Oso", which means "bear" in Spanish. The name stuck.

One evening Oso and I witnessed a display of Juan's temperament in a tavern in Horquetas. A drunk approached our table, hoping to join the conversation. This greatly irritated Juan who glowered at the man and told him in Spanish, "You had some reason for coming into this bar. Why don't you continue doing it?" With that, Juan put his hand on the drunk's shoulder and directed him toward the bar. Oso described Juan's temperament as pugnacious. Juan was all of that and more.

One night at the Restaurante De Juan we all began exchanging essential phrases in our respective languages. "Beautiful woman" and "give me one more kiss" were the most frequently requested English words. Little Trino was especially alert: he was twenty years old and almost always thinking about women. Inspired by the lesson, he strummed his guitar as he wailed a heartrending Latin serenade. Torrid lyrics of love lost and love won rang through the air. Occasionally, the group was moved to accompany him; even the forest animals seemed to participate with their own lyrics of love.

It was after one of these language/music sessions that Juan asked me to arm wrestle. Being a sport, I said yes, and when he put his arm on the table I asked him in English how to proceed. While he tried to figure out what I meant, I pushed down on his arm, obtaining a comfortable advantage. Juan fought mightily and for a long time, but my initial advantage gave me what I needed to win. Afterwards, as we rubbed our sore elbows, Juan complained about my starting before he was ready. I used the opportunity to teach him another English word -- cheater.

After a couple of days at Rara Avis, the equipment still had not arrived. Now it was time to face the grueling task I had been dreading for so long: stringing the line with my crossbow. This was when I decided to empty the bag of equipment I had brought with me from San Jose. It had been in storage there for two years. This bag contained all the tools for stringing cable over the canopy, such as arrows, fishing line, and a climbing harness. I dumped the contents onto the dirt floor at El Plastico only to discover that the arrows were missing!

Arrows could be purchased in San Jose, but that meant waiting at least a full day, and those arrows might not be strong enough to use with my crossbow. Oso, who had been keeping a close eye on the progress of the project, began to doubt my competence at leadership. Already the equipment hadn't arrived,



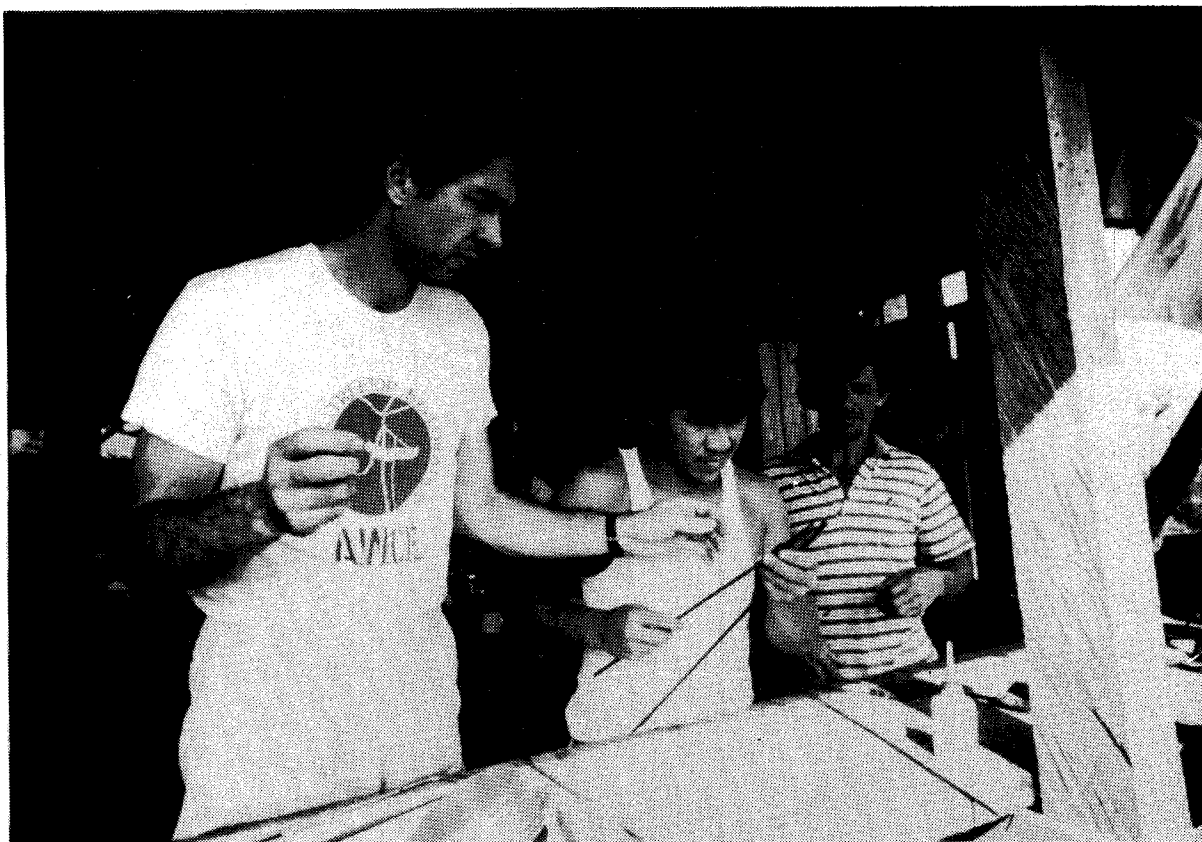
A language session at Restaurante de Juan. From left to right: Little Trino, Juan, Trino and me.

and now we didn't even have the minimal tools to string the cable.

"Lets make some arrows," I declared confidently.

Oso saw this as a desperate move to save face -- an absurd hope -- and his feelings were undoubtedly shared by the film crew. He later told me that it was this point in time when he began to grasp the full scope of the adventure.

Trino knew where to find wood to make arrow shafts. The shafts had to be stronger than ordinary arrows to withstand the force of the crossbow, which had a one-hundred-and-fifty pound pull. The wood was actually sections of a dead palm trunk. The palm is related to bamboo and is composed of two parts: a woody lattice surrounding dense, ebony veins of a crystalline substance. These veins carry nutrients between the palm's crown and roots. The ebony strands also give strength to the palm trunk, which must support a head of leaves approximately seventy feet above ground on a thin trunk. According to Trino, pre-Columbian Indians used the same material to make arrows.



### Making arrows at El Plastico

In the evening, Trino and Juan demonstrated their skill with machetes by carving fine shafts out of thick splinters of palm trunk. They used their machetes as a carpenter would use a hand plane. It took thirty minutes to shave a single shaft, and four were made.

The triangular "feathers" were cut from sheets of metal taken from a can. The base of the shaft was split and the metal was positioned within the slit so that a metal feather projected from both sides of the arrow. The feathers were held in place by wire taken from a piece of galvanized-steel cable. The wire was wrapped around the shaft just in front of and behind the feathers. The arrows did not need points, which would only make them more likely to stick into a tree, but they did need weight to ensure that they would return to the ground once they had flown over the treetops. For this, a piece of heavy wire was taped to the shaft.

On Wednesday, Trino, Oso, and I went to the second support tree, tree #2, along a muddy forest trail. The ground to the right of the trail sloped down, sometimes vertically, to the river and was covered with dense forest. We came to a grove of



trees that were about one-hundred-and-twenty feet tall. From the ground it was impossible to see the first support tree that stood near the road and waterfall, or even the river below. Trino assured me that this was the grove we had seen the previous day.

I decided to climb a hundred-and-thirty foot tree near the trail to survey the forest and to determine which tree would be best for supporting the cable. I unpacked the crossbow and arrows and prepared to shoot a line. Naturally there was a certain amount of suspense concerning whether the arrows would work. If not, even a trip to San Jose wouldn't guarantee that stores would have the special variety of arrows used by my crossbow.

I aimed and pulled the trigger of the crossbow. The arrow flew straight and fast; the twenty-pound test, monofilament fishing line whirled from the hand-held spool. It flew high above the tree and gained momentum on the way down until it hit ground. The first shot was perfect and Trino's eyes beamed with satisfaction. All of us marveled that hand-made could be as good as machine-made.

Next, I used the line to pull a strong, 150-pound-test, braided nylon cord over the high limb, which in turn was used to pull the climbing rope in place. Trino often climbed trees bare-handed so he watched intently as I put on my climbing harness. The harness was then connected to an ascender that I placed on the rope. I put my feet in stirrups that were tied to another ascender. This ascender was attached to the rope below the first. Ascenders were used to climb the rope in an inchworm fashion.

This was the first time I had climbed in a year. Safety concerns overwhelmed me. Had I tied the rope properly? Was my equipment in good condition? Was the tree strong? Each foot in height magnified the importance of each question. I reached my destination of one-hundred-and-ten feet wondering, as I often have, if this would be my last climb. This was a real concern; a few years earlier England's foremost canopy researcher, Andrew Field, fell to his death during a climb in Venezuela.

The height gave me an excellent view of the future research area. It was beautiful beyond description. In the distance, below my cliff-edge view point, was a double waterfall. The higher falls dropped fifty feet, followed by a ninety-foot cataract that plunged into a large, black lagoon, creating billows of mist. A tall, strangling fig tree overhung the lagoon and its branches were dressed in mats of mossy epiphytes that had been nurtured by the moisture. A Morpho butterfly flew near the falls, diving in flight only to rise again for another dive. The flashing of its brilliant blue wings beckoned me to join its dance in the rainbow's mist.

The fig tree and black lagoon sat in the middle of an amphitheater of about five acres of low forest. This would be the far end of the cable system. At the close end, where I was hanging, was another amphitheater of high forest mixed with trees of virola, annonaceae, figs, vochysia, and many more. Both amphitheatres allowed observation of about fifteen acres of forest, although only the forest below the cable would be directly accessible from the vehicle.



Climbing tree #2 to shoot a line

That day, David Haugland of Intrepid had gone to San Jose with Carlos to help Amos. The wisdom of the moment was that both Haugland and I were lunatics if we thought the equipment would be out of customs within a day, or for that matter, within a week. Haugland was the best person for this job. He was experienced at dealing with government officials, and he would be paying the crew's expenses if there were any delays.

As I looked toward tree #1 across the forest roof, a distance of about seven-hundred feet, I again lamented



Fig tree in the mists of the black lagoon.

about not having rockets. Before leaving for San Jose, Haugland had urged me to begin stringing the web with our home-made arrows. The span needed three shots.

Directly in front of my tree-top position were four-hundred feet of continuous forest canopy. The arrow would fall into thick forest on a steep slope, and finding it would be difficult. I elected to shoot about twenty degrees to the left of the span, hoping the arrow would reach the river where it would be visible from a long distance. The drawback was that the line would be off-center, causing the cable to catch on limbs when it was ready to be lifted into place. I was not too concerned because it would be corrected when the rockets arrived.

I loaded an arrow and shot. It flew straight and far, disappearing behind a tree crown. The people below jubilantly watched the arrow's perfect performance.

I yelled to Trino, questioning whether he might be able to find the arrow and he disappeared into the greenery. In the meantime, I remained in the tree tugging the line. Wherever the arrow was, it would be easier to see if it was hopping up and

down. It was about three o'clock. An hour passed, and then another half-hour. Trino still had not found the arrow and I grew weary of tugging the line. The day ended on a low note, with Oso and I hiking back to El Plastico in the dark.

Trino arrived at El Plastico a half-hour later with an unsuccessful look on his face. Had the sky been blue, the whitish, monofilament fishing line would have led directly to the arrow, but the line was invisible in the afternoon overcast. The arrow's brown color melded into the dark browns and greens of the forest.

That evening we decided to decorate the remaining arrows with something colorful. Our search through the storage areas of El Plastico had come up empty, but one item resting on a shelf in the dining room caught everyone's attention. My hard hat was resplendent with orange day-glow tape.

In 1977 I had bought the hat secondhand from a war-surplus store in downtown Los Angeles. The store had gotten it from the water department where hats, for safety reasons, were brightly decorated. It had an advertising decal I liked that said "Water - Power", which of course is the elemental force, along with light, that invigorates a rain forest.

Biologists are expected to merge with their surroundings so as not to disturb wildlife, but I decided to see if the hat's dazzling color would attract wildlife, such as treetop hummingbirds. This would have made it simpler for me to make a list of species. Experience demonstrated, however, that the only animals that took note of my hat were a few biologists. They were aggravated by this unacceptable field dress.

The next day I shot a decorated arrow in the same direction as the first. This time Trino had blue sky for a background, and he took a walkie-talkie on the hunt. After about forty minutes he called saying he had found both arrows about thirty feet apart. They were in the forest on a steep slope above the river.

The day was spent shooting another line to the lagoon and replacing the first segment of line with heavy cord. Stringing line is slow and frustrating due to numerous obstacles. Besides taking a long time to find an arrow, the cord that is towed across the tree tops behind the line often becomes caught in vegetation. A half-hour or more might be spent trying to pull the cord, which is much larger in diameter than the line, through obstacles. This happened ten times on a single span. With each successively larger rope, more people were needed to pull. It was great exercise, but after a few days our hands were worn, sore, and slightly infected.

By Friday, I still hoped for rockets, even though a cord was nearly strung between the trees. Neither Carlos nor David had returned from San Jose. Each passing day elevated tensions; there were no more buffer days, and that meant installation and operation would have to move quickly and without errors.

Saturday was heavy with anticipation as we waited for the equipment. If Carlos and David did not return, it meant they had been unable to get the equipment out of customs, or worse, it hadn't arrived.

One of the most discouraging problems for a film crew, other than not having a project to film, is continuous rain. On

Saturday morning it rained heavily for many hours, dumping six inches on the hills above Rara Avis. I am used to working in rain, but this was a deluge. Trino and I returned from the forest to take refuge at the "Restaurante de Juan" until the rain subsided. While sipping hot, aromatic coffee and slowly drying out, I noticed that Trino, my right-hand man throughout the project, had become interested in something outside.

Thunder was echoing throughout the region. This did not seem particularly noteworthy, yet Trino acted as though it was a highly provocative event. Spanish spilled out of his mouth as he talked excitedly with the others. I managed to pick out a few words. Quickly, I grabbed my socks, wrung them out, laced up my sopping wet tennis shoes, and ran to the river following the others. The thunderous booming I had been hearing was not thunder. Huge boulders, some the size of Volkswagon bugs, were being washed down river.

Swollen with run-off, the river had become a raging torrent. Our greatest concern was whether the bridge that Amos had built, connecting the hotel site with the road to El Plastico, would survive the storm. The bridge was made of three sturdy trunks that spanned the gorge. Water from the mountains rushed down the steep gorge in violent cascades that were coming increasingly closer to the bottom of the bridge. The banks supporting the bridge were not washing away, yet the bridge itself was imperiled. At any moment a tree upstream could lose its footing, wash down river, and be dashed against the bridge with considerable force.

But it was the thunder that left the small group of on-lookers awe-struck. Juan pointed at some white, moving froth -- a huge, rock, billiard ball -- as it bounced and ricocheted off the bottom, shaking the banks all the way to the brink of the falls. There, it took the plunge, sounding a hellish roar as it struck rock bottom six stories below. Over and over again this bowling alley of the gods resounded with the fierce reports of these gargantuan boulders.

Entranced by the spectacle, Juan and I scurried to the precipice of the waterfall so that we might witness the plunge of the boulders. The cliff edge was overgrown with tree ferns, small trees, and vines. He cut a passage through this where we could lean out over the cliff, holding onto a small tree trunk. We watched for some time, becoming more and more impressed and respectful of the river's force.

When we walked to the cliff edge, I noticed with some suspicion that the ground under our feet sagged like a mattress. The land was wet and heavy with rain. It is not uncommon for mats of tropical life that cling to steep slopes to absorb too much water. These mats lose their grip and become avalanches of life and loose soil. Huge, bald spots in steep terrain mark such events. Noticing my concern, Juan jumped up and down shaking our viewing platform. Instantly we thought the same thought-- this was not the place to watch car-sized rocks hurtling over the falls. We retreated to the safety of Restaurante De Juan to wait out the storm.

By late morning, the rain slowed to a drizzle and Trino and I continued stringing line. Around noon, Oso, who had spent the



Enjoying the waterfall from AWCE

night at El Plastico, tramped into our work area with the incredible news that not only had the equipment arrived, it was on the way to El Plastico.

Amos, driving his Toyota land-cruiser, arrived at the waterfall tree that afternoon. This was a phenomenal achievement as the rain had turned the road into a thick bed of mud. Carlos and Little Trino were with him, and in the back sat the six-hundred-and-fifty pound spool of stainless-steel cable. We

dumped the spool onto the wood cords and rolled it down to the position adjacent to the road where it would be unwound. Amos, in an eager moment, backed the Toyota's front left wheel off the road. In an effort to regain all fours on the road, he gradually slipped further away, and eventually the Toyota laid on its belly across the shoulder. The car had become quite stuck. No problem, the tractor was coming with the equipment.

Or it would have come, had it not become helplessly bogged down in mud just on the outskirts of El Plastico. Like an African beast at the end of a drought, it had spent the better part of the day in two different wallows. The path was scarred by ugly tractor ruts that were two feet wide and two feet deep. Finally, it was disengaged from its trailer and taken up to the falls to rescue the Toyota. Once the Toyota had been pulled free we all returned to El Plastico, I wanted to check the equipment, and a cold beer was in order. The Toyota immediately lost a drive shaft and had to be towed back down the mountain to Horquetas.

El Plastico buzzed with excitement that night as each group exchanged stories about the hurdles they had overcome. Those who had been in San Jose: David, Carlos and Amos, told a continuous nightmare about every stage of the equipment's journey from the U.S. to Horquetas. The equipment narrowly avoided missing its Pan American connection in Miami. A call from David solved this problem with only minutes to spare. But when the equipment arrived in San Jose on Thursday afternoon, it was left in storage instead of being taken to customs. A heart-to-heart talk with a fork-lift operator from LACSA airlines, along with a little monetary incentive, got the equipment into customs so it would be there first thing Friday morning.

Meanwhile, Amos bounced between the offices of several ministers, all of whom were very effective at sending him to different departments for new papers. These perplexities continued the next day when Carlos, David, and Amos combined efforts to get the equipment. They finally achieved this goal only minutes before customs closed that evening.

Throughout the evening Carlos interrupted these stories murmuring, "It was a miracle. It was a miracle."

(to be continued)

Sincerely,



Received in Hanover 5/6/88