Way of the Jitterbug

Norman T. White

Abstract Norman White retraces a long, convoluted mental journey which started with a childhood love for fishing. College courses in Biology, exposure to the work of jazz pianist Lenny Tristano, a by-chance job wiring up a telephone switchboard, travel in the Middle East, and attendance at early club gigs by Pink Floyd all conspired to set him on the path of artistic experimentation using electronics. After an initial period of building "light machines", he turned to creating interactive physical devices that have "lives of their own", wherein programmed instructions and cycles process and respond to sensory data gathered from chaotic environments, thus giving them surprising and unpredictable behaviors.

Jitterbug

My fascination with robotics may well have originated with a childhood love for fishing. Mostly I liked to fish for bass, as it gave me the opportunity to fish with "plugs", crude imitations of creatures that fish eat. These are usually made of painted wood, metal, rubber, and plastic, and bristle with treble (three-pronged) hooks. Of course, fish are unlikely to be impressed by garish paint jobs; what really fools them is how the lure *behaves.* Pulled through the water with jerks and twitches, plugs take on a life-like action, like injured minnows or swimming frogs. It's up to a fisherman to turn, by skillful manipulation of rod and line, an unseemly conglomeration of chrome and plastic into something subtly alive. Years later, this same disjuncture of appearance and function infused my robots, obviously artificial and awkward contraptions attempting to mimic the subtle behavior of living organisms.

N.T. White (✉)
Ryerson University, 268 George St. East, Durham, ON, Canada
e-mail: normill@normill.ca

D. Herath et al. (eds.), *Robots and Art*, Cognitive Science and Technology,
DOI 10.1007/978-981-10-0321-9_11

Euglena

My love for fishing led me to pursue Biology. Although I got straight A's in high school, college was a different matter; I was mediocre at most of my subjects. Nevertheless, there were certain studies that I loved, specifically the labs. In my Organic Chemistry labs, I learned how minor modifications to carbon-based molecules could cause what once smelled like fresh cut grass to smell like dirty socks! And I became so attached to my fruit fly mutants that I nurtured them for weeks after the Genetics course had finished. Most of all I loved the biology labs, and I feel extremely privileged as an artist to have been exposed to the lives of invertebrates, algae, fungi, mosses, slime molds, and single-celled animals.

One genus stands out above all the others: *Euglena*. Now I'm a big fan of achieving a lot with a little, and I'll bet there are not many organisms on this earth that can compete with this microscopic, single-celled animal when it comes to Economy of Means. Here's a run-down of its principal features: (1) For locomotion it has a "flagellum", a whip-like structure that propels its torpedo-shaped body through the water. (2) It makes its own food by using green structures called "chloroplasts" to convert carbon dioxide, water, and sunlight to sugar using photosynthesis. (3) It is able to home in on sunlight thanks to a little red "stigma", or eye-spot. (4) As osmosis is perpetually causing water to penetrate its cell wall, it employs a "contractile vacuole" or bailing structure to pump the water back out. (5) And of course it has its genetic blueprints stored in a "nucleus", so that it can reproduce itself asexually by dividing from time to time. In other words, it has all the equipment it needs to prosper, given modest access to carbon dioxide, sunlight, and water… even moderately polluted water! Can there be a better muse for robot-building than this? I don't think so.

Lenny

By the time I graduated from college, I realized I'd make a poor biologist. Fortunately, as part of my liberal arts education, I had taken courses in Studio Art from T. Lux Feininger.[1] Unlike most of my other subjects, art came easy. As graduation approached, I asked Feininger whether I had a reasonable chance to succeed as an artist. With his positive encouragement, I moved to New York City in the Fall of 1959, and rented a dingy little apartment on the Lower West Side. I worked first as a Claims Examiner for an insurance company, and in 1961, as a Lab Technician at the Rockefeller Institute for Medical Research. By night I'd hang out with artists, writers, and poets in the Cedar Street Bar, just North of Greenwich Park, or sling paint at canvases in the reckless style that was all the rage those days. It was a good time to be living in New York; the East Coast

[1]Son of painter Lyonel Feininger and brother of photographer Andreas Feininger.

Abstract Expressionist movement may have been winding down, but there was a vibrant jazz scene in progress. On many evenings I'd take in live performances by Charlie Mingus, Ornette Coleman, Thelonius Monk, or Horace Silver. However, the music that had the greatest impact was that of the blind pianist, Lenny Tristano. In particular, one of his recorded pieces, "Turkish Mambo", paved the way for my understanding of the interplay of order and chaos. In this work, Tristano overlaid multiple out-of-phase tracks of his piano riffs. The result was extremely complex syncopation, rich with musical surprise.

Hunter's Point

The Fall of 1961 found me arriving in San Francisco with $5 in my pocket. I wasn't too worried about surviving; I was sure I'd soon get a job washing dishes or mopping floors in some restaurant. I was wrong on that account… those jobs required union membership! Luckily it was the time of dented-can supermarkets and day-old bread shops, so one could live very cheaply. I rented a hotel room in North Beach for fifty cents a night, and got temp jobs through a municipal employment center. A chance conversation with the hotel desk clerk informed me that a local shipyard was looking for electricians. I applied, took a test, waited a few months for security clearance, and eventually signed on as a Helper Electrician at the Hunter's Point Naval Shipyard.

It was an amazing place to work, surrounded by World War II vintage moth-balled battleships and destroyers. Here, civilian "yard-birds" like myself converted ships bristling with heavy gunnery to those carrying only a few missile-launchers each. Steel superstructures were stripped away and replaced with aluminum ones, making the ships faster and harder to hit by enemy fire. And of course all this new missile technology required masses of electronic support, including hundreds of cables connecting all the various radar, launchers, target tracking systems, and the bridge.

For the first few months I worked on a "cable gang", pulling metal mesh-sheathed cable that reduced my work gloves to shreds within a week. Eventually I was given the task of wiring up a telephone switchboard, interconnecting the hundred or so dial-up ship's telephones. It was a job that changed my life.

At the time I still considered myself to be the kind of artist that paints images on rectangular objects, and indeed I continued to struggle along in this *modus operandi* on evenings and weekends. Trouble was, although I still loved the materials of painting, the smell of ageing linseed oil and turpentine, the ritual of stretching and priming coarse linen canvas, I was lacking original subject matter, or more centrally the reason why I should paint at all. A comment by Theodoros Stamos, from whom I had taken an evening Art Students League class while living in New York City, kept haunting me: "Nice painting, but why BOTHER?" It felt as though urgency was disappearing from my artwork, that it was becoming gratuitous.

Fig. 1 Heddon Jitterbug, drawn by the artist

Fig. 2 Eucalyptus Trees in Golden Gate Park (Chinese ink on paper)

There was one exception: a small Chinese ink-on-paper painting I did from life while hanging out in Golden Gate Park. It was a painting of eucalyptus trees, though not so much of the trees as the shadows that obscured the outlines of their trunks and branches. As much science as art, it was a spontaneous enquiry into how our brains extract meaning from a confusing mix of object and field. The same preoccupation would resurface with even more passion when I tried to incorporate image recognition into robots 10 years later (Figs. 1 and 2).

Campbell

At the shipyard, I worked under the supervision of a charmingly sly and cocky Jamaica-born journeyman named Joe Campbell. By flaunting the technical jargon that permeates electronics, he had thoroughly convinced everyone that he was a master of his craft. However when it came time for Joe to explain to me the complex wiring blueprints of the telephone switchboard that I was about to wire up, I noticed major contradictions between what he and the blueprints were telling me.

I nodded appreciatively at his explanation and, after he'd left, started to connect wires according to the blueprint. When, weeks later, it came time to test the system, Joe threw the main power switch to ON, and lo, it functioned perfectly! Joe, probably more surprised than anyone, immediately started strutting around, shouting "Campbell, you're a fucking genius!"

Meanwhile, I was being mesmerized by what was happening within the guts of the switchboard. Whenever someone dialled a telephone number, electromechanical switches called "relays" would writhe and chatter like something alive, creating series of staccato clicks as they sought the desired connection (note, these were the days when telephone systems still used moving parts; it'd be another few years before relays would be replaced by silent, non-moving switches called transistors).

Though I had yet to make a connection between art and what the relays were doing, I recognized right away that what was going on, this crude simulacrum of life, was beautiful!

Reorientation

In the year and a half I worked at Hunter's point, I managed to save up about $2000. The money was targeted for extended travel abroad. I'd been reading a lot about the Middle East in books by Lawrence Durrell (Alexandria Quartet), Henry Miller (Colossus of Maroussi), and Nikos Kazantzakis (Zorba the Greek), and that unique Mediterranean light they spoke about pulled at me like a irresistible magnet. Cheap trans-Atlantic air fares were not yet available, so I forked out $108 for a New York-to-Tangiers sea crossing. In early 1964, with a fresh copy of "Europe on $5 a Day" in my backpack, I boarded a Jugolinea freighter that was to take 6 weeks to make frequent stops along the U.S.'s Eastern seaboard, and then diesel its way slowly across the Atlantic.

I spent the next 18 months hitch-hiking though Spain, France, Italy, Yugoslavia, Greece, Turkey, Syria, Lebanon, Iraq, Iran, West Pakistan, Nepal, and India. These were eye-opening months. The Islamic decoration and architecture that I encountered in Spain, Turkey, Iran, and the Arab countries resonated with me on many levels. At times exotically floral, at times geometrically stripped-to-the-bone, here were Mathematics and Biology wedded inextricably. Moreover, the passion of the artwork was expressed in terms of calculation and precision, a far cry from the Dionysian recklessness that the Abstract Expressionists had promoted as the only sane way to make art.

Wireways

Sitting in a cafe in Calcutta, I noticed that a rotating ceiling fan reflected in my spoon resembled a miniature turn-style. I took this as a sign that it was time to start heading back west. Three months later, after lingering one more month in

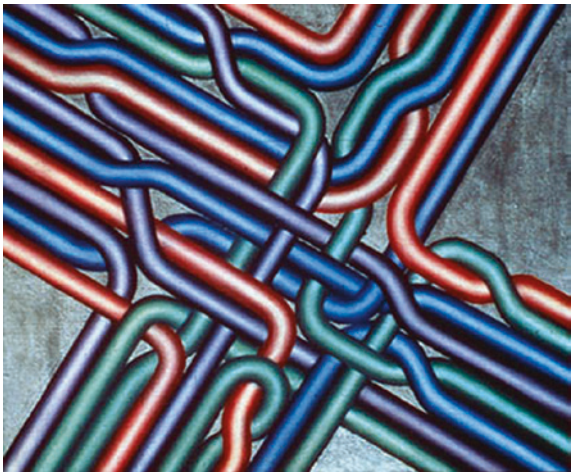

Fig. 3 Wireway Four (oils on canvas)

Greece, I hitch-hiked to London. There I discovered that many English artists too had turned their back on the recklessness of Abstract Expressionism, and that masking tape had teamed up with paint as Op Art and related calculation-based art became the new norm. After a couple of months of temp jobs, I got hired as a caretaker for a block of Flats in Hampstead that allowed me the freedom to add my own take to that art practice (Fig. 3).

One morning in a dream I received a clear vision spawned by memories of Hunter's Point. Running along the ceilings of ships' passageways are structures called "wireways". Masses of cables run along these wireways, crossing over each other from time to time like roadways in a complex highway system. In my vision, I saw cable-like structures doing much the same thing in a way that depended upon quasi-Islamic calculation. Feeling I'd finally come up with imagery that I could call my own, I embarked on a series of Wireway paintings, each one consisting of a different logical enquiry. The cables pictured always had 45° or 90° bends, and would always be the same diameter. These bends occurred at constant intervals, and would sometimes be duplicated exactly by adjacent bends. But, like the Lenny Tristano jazz tracks, the bends were often out-of-phase, giving the impression of a random scramble. On careful analysis, however, a viewer could discern that a rigorous logic was in force.

U.F.O.

At that time (mid 1960s) there used to be an basement dance venue on London's Tottenham Court Road that could hold up to about two hundred people. I can't remember what it was called, but I do remember, most of the week, it featured ballroom dancing. On Saturday nights, however, it metamorphosed into a psychedelic

club called the "U.F.O." Lighting techies erected scaffolding, and on those scaffolds they mounted slide projectors. The "slides" themselves were thin sheets of glass between which were sandwiched mixtures of water and oil containing aniline dyes. Projected onto the wall behind the stage, the dyes created organic patterns so intense in colour as to be almost painful to look at. The techies then animated the projections by directing blowtorch flames onto the slides, causing the patterns to squirm, swell, and explode in an unpredictable manner. On the adjoining dance floor, strobe lights made from burnt-out car headlights created a now familiar fracturing of time. The stage itself was usually occupied by one of two newly-formed bands. One was The Soft Machine; the other, Pink Floyd. Burned into my mind's eye is the memory of musicians playing with their backs to the audience, using the projected patterns as sheet music.

Out in the lobby, little black boxes were for sale. These were approximately cubic, about 6 in. on a side. On the top of each box were nine miniature neon bulbs[2] that flashed in a seemingly random order. There was no switch, no way to turn the lights on or off, so the box was like a little creature that had a life of its own. You could stick it into a bottom drawer, but you knew that down there, covered in sweaters, it would still be flashing in its own secret way. These little boxes pushed me over the edge. They seemed to pull together all the elements that had fascinated me up till then: the artificial life of fishing lures, *Euglena*, Lenny Tristano's tapes, telephone relays, Islamic geometry… Suddenly I could hear electrons whispering urgently in my ear, "Follow!"

Radio London

Even with the encouragement of electrons, I still considered myself to be a painter. I would guiltily turn my back on whatever canvas I was working on in order to indulge my new obsession with electronics. My radio was often tuned to the pirate station called "Radio London", and one afternoon a calm, self-secure voice came on that caused me to put down my soldering iron. What it was saying made no sense at all, while at the same time making extreme sense. In some coded, poetic way it reinforced what the electrons were whispering, that my new obsession was not an indulgence at all, but something that desperately required the attention of artists. I waited excitedly for the speaker to finish so that I could find out his name. It was Marshall McLuhan.

[2]These were the only bulbs available at the time that had long life-expectancies. They required a hazardous 90 V to illuminate. Low voltage light-emitting diodes (LED's) would not appear on the market until about 5 years later.

Proops

A "U.F.O." Black Box cost more than I could afford on a caretaker salary,[3] so I set about building one. At the time I knew next to nothing about electronics, except for a few basic principles I had picked up from my high-school and college physics courses. This was mostly theory, with almost all my practical knowledge coming from the shipyard job. Theoretically, I understood the relationship between electronic "pressure" (volts), "flow" (amps), and "resistance" (ohms), and, practically speaking, I understood the importance of wire colour-coding so that one could more easily trace what was connected to what. But I had yet to learn how to read the stripes on resistors, or know what a capacitor or a diode did.

A few doors down from the "U.F.O." was an electronic surplus shop called "Proops". In the window of this shop were laid out an array of circuits and parts, like candy store sweets. Among them were neon bulbs exactly like the ones on the Black Boxes. One of these bulbs was made to flash by a small exposed circuit consisting of four or five parts, none of which I could identify for sure. Face pressed against the glass, I made a crude sketch of the circuit, which I brought inside hoping to get advice on how to build the circuit myself. Unfortunately the sales people were either too busy or didn't know themselves. Nevertheless, I purchased a few neon bulbs, and on succeeding paydays returned to Proops to buy more.

I then set about building a small table-top artwork called "The Blue-Green Machine".[4] It's purpose was to generate, on an 8×8 rectilinear grid, two simple overlapping light patterns, traversing the grid at slightly different speeds and opposing vectors, so as to create a confused result. I wanted to see whether the eye could disassemble this complexity into the two underlying patterns using Gestalt perception. This was exactly the same perception phenomenon I had pursued in my Wireway paintings, now brought into a kinetic dimension.

The technology I employed was inspired by wind-up music boxes. A single motor turned two cardboard drums at different speeds via different sizes of Mecanno gears. The drums were covered first in copper foil and then with adhesive plastic from which squares had been cut away. The resulting bare patterns allowed copper brushes to make electrical contact with the drums, thereby powering the neon bulbs in the desired sequences.

Resources

One of the perks of the caretaker job was access to the consumer electronics that the tenants were throwing out. I'd carefully disassemble and de-solder whatever transistor radios, tape-recorders, etc. I found in their rubbish bins, thereby

[3]Five Pounds Stirling, or about 14 U.S. Dollars a week.

[4]The title came from its shell of blue and green Plexiglas, scrounged by friends from Hornsey Art College bins.

accumulating an assortment of usable components. I found this tapping into a source of free parts tremendously satisfying. Like the burnt-out headlights that the Pink Floyd techies had turned into strobes, these materials were not only saved from land-fills, but resurrected for potentially creative uses, all at no cost! Trouble was, I had yet to learn how to substitute recycled parts for the ones specified by the D.I.Y. articles in hobby electronics magazines. While attempting to build a simple electronic organ, rather than dulcet tones I got shocks, sparks, and smoke! Nevertheless, there was no going back to painting; it was as though a huge bird has sunk its talons into my shoulders and carried me off into new giddy heights of wonder.

Around that time (1966), a Canadian friend sent me a newspaper clipping describing the work of Toronto-based artist, Michael Hayden. The article described a number of Hayden's large-scale electronic installations. What blew me away was that not only was there another artist working with electronics, but that he was getting his materials donated to him by various local electronics and plastics companies. While I was putting aside shillings to buy another motor or neon bulb, this Canadian guy was getting all his stuff free! A couple of months later, I was on a Holland-American liner bound for Canada.

Shift Register

The western Atlantic crossing took 5 days, way faster than the eastern crossing 2 years earlier. During those 5 days I spent most of my waking hours working on a circuit design problem. Using the only electric switching components I knew about, relays, I was trying to figure out how to pass binary (either on or off) signals along a chain of devices in an orderly manner… like a bucket brigade.[5]

I stopped off at my parents' home in Massachusetts still lacking a solution. When I told them what I was trying to do, they suggested I have a chat with an electronic engineer who lived down the street. And so it transpired that Charles Grandmaison, an electrical engineer who worked for a company called Sprague Electronics, sat down with me one evening over a pad of yellow paper. Right off the bat Charlie told me that I shouldn't be using relays at all; that it would be far easier to use integrated circuits (I.C.'s). I didn't have a clue what an integrated circuit was, but Charlie patiently sketched out the basics of what they were and how they worked. He told me moreover that a chip called a "shift register" did precisely what I wanted. A few weeks later, he sent over a box containing several hundred I.C.'s that looked like little metal octopuses, each with eight copper legs extending downward from a tiny inverted tin-can body.

[5]These days, you see this phenomenon in scrolling message signs.

On arriving in Canada, I landed a part-time job as a graphic artist for Erindale College, a satellite branch of the University of Toronto. On my days off, I returned to the shift register project, this time using the Sprague parts, and after a bit of frustration managed to get a chain of these working. Now it came time to put these to work in an art context.

E.A.T.

In the Fall if 1967, I heard about an exhibition[6] that was being organized by Billy Kluver, a friend of Marcel Duchamp, that was to take place in the Brooklyn Museum, New York City. It was sponsored by an organization called "Experiments in Art and Technology", or "E.A.T." for short. The idea behind the show, and indeed E.A.T. itself, was to bring together the creative minds of artists and engineers. The former would come up with concepts, and the latter, implementations. Since I could put down Charlie Grandmaison's name as my engineer, we indeed fit the paradigm, and here was a chance to show off my shift registers in action. As Charlie and I live hundreds of miles apart, both concept and implementation became my responsibility. Not that I regretted having to fill both shoes. I knew that if I gave an engineer a particular concept to implement, and if s/he were competent and the task do-able, I would get exactly what I asked for, nothing more, nothing less. But if I implemented the concept myself, I would probably make mistakes, and those mistakes might lead me to discoveries that would alter and enhance my original concept.

Still, I did need *some* kind of instruction, and during this period, my teachers were the people who wrote articles for the hobbyist electronics magazines of the day.[7] It was as though the physical junk available from surplus electronic stores was mirrored by informational junk sold at the corner variety shop! Instructions on building a windshield wiper control could be more broadly applied to the speed control of any direct-current motor, while a project involving maintaining an optimum water temperature in a fish tank could be useful as an insight into sensors generally.

The artwork into which I put the 300 shift register I.C.'s was called "First Tighten Up on the Drums", a tip of the hat to Archie Bell and the Drells, as well as to my belief that rhythm was humankind's first means of expressing the *logical* division of time. It used 109 neon bulbs arranged in a hexagonal matrix, on which I hoped to generate kinetic patterns similar to the dancing lights seen on the bottom of swimming pools. Instead I got patterns more like the sometimes stretching, sometimes compressing shapes of clouds, or rain water running down a window.

---

[6] "Some More Beginnings".

[7] E.g., Don Lancaster (*Radio Electronics Magazine*), and later Steve Ciarcia (*Byte Magazine*) and Forest Mims III (*Engineer's Notebook*).

Ménage

Over the next 8 years (’68 to ’76) I designed and built a number of “machines” that manifested various nuances of logical interactions in light and sound. However, one of my artworks during that period took a small side step into more physical expression. It was inspired by an article in a 1950 *Scientific American* magazine documenting robotic projects by W. Gray Walter, an English neurologist. Dr. Walter had built wheeled artificial “tortoises” out of surplus parts, each incorporating the simplest possible control element: a single radio vacuum tube. In fact, his basic intention underlying the project was to demonstrate that complex and unpredictable behavior could derive from extremely simple control principles. Guided by emitted and sensed light, his robots would chase each other around and pull back from collisions, as well as autonomously find their way to recharging stations when their batteries were running low. If one singled out robots that approach *Euglena*’s economy of means, Walter’s “tortoises” would undoubtedly be high on the list (Fig. 4).

Fig. 4 Ménage

My 1974 response to Walter's work had no pretense of originality. "Ménage" consisted of five robots, four of which travelled slowly back and forth under separate ceiling-mounted tracks. A fifth robot sat on the floor, unable to move except to sense, track, and record the activity overhead. Each ceiling robot had a horizontally rotating antenna on the ends of which were attached light sensors, and a single incandescent light bulb mounted on the middle of the antenna. With this configuration, a robot could haphazardly locate the light emitted by one of its fellow robots. When this happened, its antenna would cease its searching behavior, and instead home in on the light source. This would increase the chances that it and the target robot would "lock into" each others' gaze. The drive motors that moved the robots along the tracks would ultimately break up any such semblance of machine rapport, a feature which prevented the installation from entering a steady state from which it could not extricate itself.

Meddle

My sound and light machine series culminated in two works called "Splish Splash One" and "Splish Splash Two", the first, a table-top prototype; the second, a 40 ft × 8 ft mural, built in 1976 for the Vancouver offices of the Canadian Broadcasting Corporation.[8] Again, the names were derived from a pop song, this one by Bobby Darin. The concept itself was triggered by a Pink Floyd album cover ("Meddle"), and was yet another expression of my old fascination with the way simple and similar, yet out-of-phase, events interact to create patterns of chaotic complexity. Hence, both of these machines portray raindrops falling on the otherwise still surface of a pond.

F.O.L.L.

After completing Splish Splash Two in 1976, I lost interest in building light machines. Momentous events happened to me that year that sent me off in another direction. The most life-changing was the birth of my daughter, Laura. The day following her birth, I celebrated by purchasing my first single-board microprocessor-based system, a "Motorola D-1 Evaluation Kit". By today's standards, the spec's of the D-1 are almost laughable. It required a dumb terminal for human interaction, and an audio cassette interface for downtime program storage. With less than 256 bytes of on-board memory, it had to be programmed in hand-assembled machine code. Though acutely aware of its limitations, I was enchanted with its potential to emulate the adaptive nature of living systems. Rather than hard-wired elements

[8]As of this writing, more than 38 years later, "Splish Splash Two" is still 100 % operational.

controlling an artificial organism's behavior, non-physical instructions could now take on that job. They could even be modified by the organism itself![9]

I immediately plunged into learning how to program the D-1. Its miniscule memory may have made it useless for screen graphics, but it was perfectly adequate for controlling devices that interacted with the physical world. With proper interfaces, I could use it to control the speed and turning direction of motors, create tone sequences, or read a variety of sensors. In other words, it was fine for simple robotics. When an invitation came from the National Gallery of Canada to participate in a four-person[10] show called "Another Dimension", I felt I had to submit something incorporating the D-1 Kit… something robotic.

The work I built for the National Gallery show I called "Facing Out Laying Low", or "F.O.L.L." for short. Onboard was the D-1 Kit, with its memory augmented to a staggering 8K. Conceptually it was an offshoot of Ménage's floor-situated robot. The bases of both machines were essentially stationary, and both had optical scanners that could rotate 360°. However, whereas the earlier robot simply recorded the kinetic light patterns of its environment by scribbling on a circular piece of paper, F.O.L.L. constantly scanned its surroundings looking for novel activity… most likely, the coming and going of humans. When it located such activity, its scanner would tend to linger in that quadrant, although from time to time it would glance "over its shoulder" to ensure it wasn't missing anything (Fig. 5).

I used a large portion of F.O.L.L.'s memory to create an internal map of where it was most likely to find activity. Conceptually peaking, it was like a square of stretched rubber sheeting that could be distorted by poking here and there. When a particular point was poked, adjacent points would also be distorted, proportional to their distance from the point of contact. With no further poking, the rubber sheeting would slowly return to its original flat state. In this way F.O.L.L. was able to "forget" about activity that ceased to be ongoing. The robot also used variable thresholds to decide whether a stimulus was strong enough, or unforeseen enough, to warrant a response. Therefore it would turn away from persistent stimulation coming from a certain sector.

Emotion

In 1978, I started teaching electronics and computer programming at the Ontario College of Art.[11] It's Chair was Richard Hill, a disciple of Marshal McLuhan. The story went that Hill had met Roy Ascot, then president of the College, at a 1970s

[9]Self-modifying code is very much frowned upon by professional programmers, as too easily it goes out of control.

[10]With Ian Carr-Harris, Murray Favro, and Michael Snow.

[11]As it was called at the time. In 1996 its name was changed to the "Ontario College of Art and Design", and in 2010, to "OCAD University" in moves that reveal an increasingly conservative, industry-minded mentality.

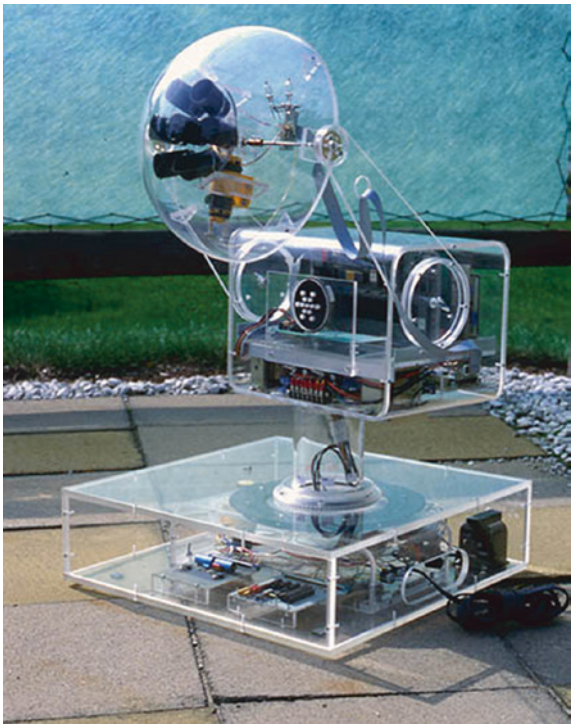

Fig. 5 Facing Out Laying Low

cocktail party, and had convinced him to create a new department called "Photo-Electric Arts". The title derived from Hill's prophetic belief that the telephone, television, and digital computer were about to fuse into a single technological phenomenon, and that this would have huge consequences for human culture. Although small, poorly funded, and often ridiculed by the rest of the College, the Photo-Electric Arts Department attracted students with a wide range of talents. Sensing the liberating truth of Richard Hill's prophesies, they bonded into a tight, committed cadre.

Before my working at O.C.A., I described my art practice as a pursuit of the aesthetics of logic, accompanied by an interest in the origins of chaos and the mechanics of perception. Teaching, however, inspired me to pursue a different kind of logic, one expressed in emotional terms. Turning away from computer science's longstanding interest in Artificial *Intelligence*, I started focusing on the undervalued role that emotion plays in **directing** our intelligence. Could a machine which is fundamentally a product of the intellect also model emotions? If so, how does one even begin to build a conceptual emotional framework? Are there primary emotions, like primary colours, from which all other emotions evolve?

With these questions in mind, I constructed a robotic installation that would form a test bed for experimenting with Artificial *Emotion*. I called it "The Helpless Robot" because it contained no motors, no way of moving any part of itself. This

Fig. 6 The Helpless Robot

was partly to get around the fact that motors are usually the first thing to go in a kinetic artwork. Mostly it was because the concept simply didn't require them. Inspired by an early Candid Camera TV skit involving a very perverse "Talking Mailbox", its only output device consisted of a speaker by which it could voice its thoughts to passers-by. Input-wise, it had sensors that informed it whether there are humans in the vicinity, and a rotation sensor that indicated whether and how it was being turned, as well as where it was pointed at any given instant (Fig. 6).

Superficially I designed the robot so that it looked nothing like a human. The disconnect between appearance and behavior was deliberate; it was important to me that its obvious mechanical nature contradict any life-like dimensions of its behavior.

The robot rotated on a large industrial "lazy susan", and did so only by enlisting the help of human beings. It had a verbal repertoire of 512 phrases, from which it selected one based upon the settings of sixteen 3-state[12] software "discriminators"

[12]The three possible states are "Yes", "No", and "Irrelevant".

that were constantly being recalculated by the main program. The discriminators answered such questions as “Is there a human present?” and if so, “Have they arrived recently”, or “Am I being turned?” and if so, “In the right direction?” Also influencing the the next utterance was a 4-state “politeness” variable, which decremented with human cooperation and incremented when the robot was ignored. The only random aspect of the Helpless Robot’s program was the selection of its next target position. What made the work unpredictable derived entirely from the jostling between its internal program and the uncertain behavior of humans.

It is this uncertain response of humans which is often the experiment’s downfall. Most people take perverse pleasure in simply spinning the robot this way and that, ignoring its pleading for cooperation. As a result, most tormentors hear only a tiny fraction of its verbal repertoire: “Stop, please”, “SLOW DOWN!”, “Go the other way”, etc. A notable exception occurred when it was installed for a month in the cavernous lobby of the Municipal Offices of the City of Ottawa.[13] The security guards there, grateful for an outlet from boredom, went to great lengths to listen to and alternatively fulfil and thwart its requests, thereby navigating its full interactive labyrinth.

Enough

Looking back on the evolution of ideas that brought me to the building of robots, I detect several evolving threads. Among these are:

(1) a love of organic form and process. There is no wiser muse than Nature.
(2) a deep respect for an Economy of Means. Achieving goals with a minimal expenditure of resources is an aesthetic act in itself.
(3) a celebration of emergent phenomena, whereby one sets up the starting conditions of an open-ended situation, hoping to be surprised at what ensues.
(4) “bottom-up” practice, first becoming intimate with materials and processes, and then letting their properties lead to concepts.
(5) “knowing enough”… in both its meanings: knowing enough to get a job done, and knowing what *is* enough.

[13]The installation, curated by Dr. Caroline Langill, occurred in 1994 under the broader exhibition cycle titled *Invading the Imagination*, which was generated out of the SAW Gallery, Ottawa, Ontario.