TECHNICAL NOTES
by Norman McLaren (1933-1984)

Throughout his career, McLaren fielded many inquiries about his films and techniques, so he got into the habit of writing up technical notes for much of his work.

All the technical notes, written and revised by Norman McLaren between 1933 and 1984, have been assembled in a booklet.

Some of those texts were published in a slightly modified version in *Norman McLaren: On the Creative Process*, Don McWilliams (ed.). Montréal: National Film Board of Canada, 1991, 106 p.

Table of Contents

Technical Notes on *Alouette* (1944)

From the sing-along series *Let's All Sing Together No.1* (Black and white)

The music was recorded first. As is normal practice, the soundtrack was measured for musical beats, bars, phrases and sentences, as were the words of the lyrics.

These measurements, in terms of frames, were written down in 'dope-sheet' form, to be used as a guide while shooting the picture.

The visuals were animated with simple white paper cut-outs, moved a single-frame at a time, on a black ground.

Norman McLaren (1944, revised in 1984)

Technical Notes on *Ballet Adagio* (1972)

It was decided to make this slow-motion film with two hopes in mind: one, that it would reveal for ballet students some of the body "mechanics" of a difficult classical pas-de-deux Adagio; two, that the slow motion would enhance the beauty of the dance for the ordinary viewer.

The whole film was shot at 96 frames-a-second, to give motion four times slower than normal. For it to be a 35 mm, one reeler, a pas-de-deux of about 2 ½ minutes had to be chosen from the repertory of the two dancers.[1]

On the first day of shooting they performed five different pas-de-deux. I chose one that included some very swift actions. It was part of a ballet called "Spring Water" choreographed by Russian A. Messerer to music by Rachmaninoff.

We filmed with two cameras, one for longer shots, the other for closer. The dancers performed to a tape recording of the Rachmaninoff music. When completely edited the 2 ½ minute adagio had become a ten minute performance.

The next step was to find new music, that was much slower than the music the dancers originally performed to, and of just the right tempo and length for our 96 frames-a-second version. The human mood conveyed by our slow motion had become quiet different from the mood of the original normal-speed ballet; the music we were looking for had also, therefore, to be in sympathy with this new mood.

After trying disc recordings of various pieces of likely music, we considered having especially composed music, but finally decided to search more diligently among existing recordings. We were rewarded by finding Albinoni's *Adagio* which was of right tempo and mood, and almost of the exact duration. By repeating a certain passage of it, we were able to extend it to the same length as the visual.

Norman McLaren (1972-1973)

[1] Canadian dancers, David and Anne-Marie Holmes, based in London, UK.

Technical Notes on *Begone Dull Care* (1949)

The Soundtrack

The music, although recorded before the visuals were made, was the result of a close collaboration between Oscar Peterson (with double bass percussion) and myself. Four days were needed to evolve the musical structure and details.

There was much give-and-take between us, in the sense that Peterson often did things on the piano that for me gave rise to new visual ideas; on the other hand, I had already certain visual ideas which dictated that he do certain things in the music. From his abundant improvisation I was able to select from and arrange ideas that would inspire us when I and Evelyn Lambart came to make the picture. The shaping of the music evolved almost bar by bar, and certainly phrase by phrase.

Preparation for the Visuals

The music was measured, note by note, phrase by phrase, etc. The measurements, transferred to a “dope-sheet” which charted the music on paper. The measurements were numbered, and these numbers were marked on the 35 mm celluloid, between the sprocket holes and along the edge of the film.

Making the Visuals

The movie is in three parts; the first and third were almost all painted on clear 35 mm celluloid leader; the second, (very slow part) was engraved on 35 mm black emulsion coated film.

The First and Third Parts

The clear celluloid was stretched out and pinned down to a very long narrow plank of wood (over 12 ft. or 4 meters long)

In a various ways, almost too many to list, we applied all kinds of transparent coloured dyes, and scratched or engraved on them.

One basic way was to apply a different colour to each side of the film, for the following reason. A flat wash of yellow on one side and blue on the other side gave us an overall green ground; engraving on the yellow side produced a blue pattern, on the blue side a yellow pattern.

We applied the dyes with big and little brushes, with stipple brushes, with sprayers, with finely crumpled paper, and with cloths of various textures. We pressed dry textured fabrics into washes of still wet dye. Netting, mesh and fine lace were stretched out tightly in various ways against the celluloid, to act as stencils when dye was sprayed on the film. Different types of dust were sprinkled on wet dye, which formed circles as it recoiled from each dust speck. We found a black opaque paint which, as it dried, created a crackle pattern. And so on.

Generally, in the first and third parts the frame-line was disregarded; we tended to treat the visuals in metrical lengths of textured patterns corresponding to the paragraphs and sentences of the music. However, sudden musical accents or short phrases were later emphasized by additional painting or engraving, in which case the actual frames of the film were taken into account.

In certain solo percussion sections we engraved on black film, individual frames with clearly defined images being synchronized with musical beats.

In the still other sections, painting with a full brush of wet dye was applied as the films moved through the gate of a moviola, the brush being moved to and fro, up and down, or pressed in and out, from its base to its tip, in rhythm to the music, which was run interlocked in the sound-gate of the moviola.

The Second Part

For the second, very slow section of the film, only black leader was used. While running in a moviola interlocked with the soundtrack, it was engraved on by a sharp-pointed knife. If the knife touched the film very lightly, the intermittent motion of the film in the moviola gate, made the knife bounce, so that little clear dots were created on each frame; if pressed harder the knife made larger dots with a faint tail; if pressed really hard, it made a more or less vertical line.

Thus, the knife-point was made to slide and move on the surface of the film; my hand pressed, guided and, as it were, made it “dance” to the rhythm of the music.

The total painted and engraved film was used as a master positive, from which was made a colour negative. Initial release prints were then struck from this negative.

Norman McLaren (1949)

Technical Notes on *Blinkity Blank* (1955)

Visuals

An animated film made without the use of a camera, by engraving directly on black emulsion-coated film with a penknife, sewing needle and razor blade, the engraving being coloured with transparent dyes, and a sable-hair brush.

Animating directly on opaque black film poses the problem of how to position and register accurately the engraved image from one frame to the next. To bypass this problem *Blinkity Blank* intentionally set out to investigate the possibilities of intermittent animation and spasmodic imagery.

This meant that the film was not made in the usual way, one frame of picture following inexorably after the next, each second of time crying out for its pound of visual flesh – its full quota of 24 frames; instead, on the blackness and blankness of the outstretched strip of celluloid on my table top, I would engrave a frame here and a frame there, leaving many frames untouched and blank – sprinkling carefully – in relation to each other, to the spaces between, to the music, and to the idea that emerged as I engraved.

On the majority of the frames there is nothing at all. When such a movie is projected at normal speed, the image on a solitary frame is received by the eye for a 48^{th} of a second, but, due to after-image and the persistence of vision, the image lingers considerably longer than this on the retina, and in the brain itself in may persist for several seconds until interrupted by the appearance of a new image.

To make play with these factors was one of the technical interests of producing *Blinkity Blank.* Sometimes, for greater emphasis, I would engrave two adjacent frames, or a frame-cluster, (that is, a group of 3, 4 or more frames); sometimes a frame-cluster would have related and continuous image within it and would thus solidify some actions and movements; at other times the frame-cluster would consist only of a swarm of disconnected, discontinuous images, calculated to build up an overall visual "impression". Here and there, to provide much needed relief from the staccato action of single-frame images and frame-clusters, I introduced longer sections of contiguous frames with a flow of motion in the traditional manner.

During the process of making the film, tests and experiments revealed a number of definite laws relating to persistence of vision, after-image effects and intermittent imagery as they affect both the retina and the mind, especially when organized in sequences and with continuity.

Perhaps the film can be likened to a sketch, which uses a kind of impression of action and time, much like a draughtsman when he suggests a scene by leaving most of the page blank and only here and there draws a stroke, a line, or a blob of tone – often

to indicate quite a complex subject; this is in contrast to the usual animated film, in which all the frames of celluloid carry images, and which could be likened to a surface of paper which a draughtsman has completely covered with a fully rendered drawing.

Soundtrack

Since it was decided to record the music first, and having in mind that I would be sprinkling the images only here and there on what was for most of the time empty black film, music composer Maurice Blackburn took this into consideration in scoring the music, by allowing many silences between notes, phrases, short chords and tone clusters. He also approached the scoring in an experimental way, which he has described in the following notes.

Norman McLaren (1955)

Notes on the Music of *Blinkity Blank* by Maurice Blackburn (1955)

The group of instruments used for the recording of *Blinkity Blank* consisted of a flute, an oboe, a clarinet, a bassoon, and a cello. The music was written without key signature on a three-line stave (instead of the usual five lines); the spaces between the three lines were not used, therefore there were only three possible note positions to indicate pitch. If a note appeared on the top line, it indicated that the instrument played in its high register; a note on the middle line – in its middle register; and a note on the bottom line – in its low register. The limits of the three registers were set before-hand for each instrument. Inside that register, the musician was completely free to choose whatever note he wished.

The notes, however, indicated the precise time value and rhythmic pattern, time signatures and bars being used in the usual manner. It was therefore possible to conduct the orchestra and give some coherence to the group of instruments.

Signs for the control of dynamics and signs for instrumental colour were used in the conventional manner.

The best results of this “semi-free improvisation” were achieved by taking the orchestra practically by surprise and recording without rehearsals, thus ensuring as complete a divergence of inspiration in each musician as possible, a complete freshness of improvisation and a complete disregard for all consciously agreed key signatures.

Occasional percussive rhythms were added by engraving directly on a separate 35 mm optical track, which was fed into the final mix.

Maurice Blackburn (1955)

Technical Notes on *Canon* (1964)

The Visuals

There are three sections in *Canon.*

First Section

A chess-board with moving cubes. Here the technique was that of single-frame animation of the cubes, to a carefully plotted path of movement prepared beforehand. Each cube follows the same path as the one ahead of it, thus creating the visual equivalent of a canon.

Second Section

Tiny men, sliding, swinging and jumping along a preplanned path. The original shooting in black and white consisted of only one man, a white paper cut-out on a black card.

In the optical printer, we repeated the single man up to four times, staggering the entry of each of his images by several seconds; at the same time we coloured each man with a different coloured filter. Thus we made the little man, when there were several of him, behave according to the laws of a musical canon.

Third section

This more elaborate live-action canon, performed by animator Grant Munro, involved fairly complex optical printer work.

A single man enters screen-left, performs a number of actions as he passes across the screen and exits screen-right. His actions had to be so designed, that when the same man with the same actions again enters screen-left 189 frames (about 8 seconds) later, the actions of both would interlock and relate each other.

In the original shooting he performed to a strict metronome beat, and on certain beats his gestures had to be precisely positioned. Although we used several methods to get him in just right place at the right time, we made many takes in the original shooting to ensure correct positioning.

We struck two prints from every take, and ran each pair staggered by 189 frames bi-pack in a moviola. With two strips of film going through the moviola together, the

image was very dark, but it instantly revealed any undesirable overlapping of images. By this means we found a take that interlocked perfectly.

Once having solved the staggered superimposition of the first two men satisfactorily, it was possible optically to print a long chain of men, all interlocking, four being on the screen at any one time. So, every man in the chain was derived from the best man in original shooting.

When we introduced a female, we had to make a new additional shot. Since the female was actually the male dressed-up, she was able to follow the path of the man fairly closely, so it didn't need too many takes of her for us to get one that fitted with the man.

During the latter part of this sequence, the single original shot of the man is used in a few other ways by the optical camera. The action is reversed, the image turned upside down and the motion, by skip-framing, speeded up by 2, 4 and 8 times. All of which corresponds musically to retrograde, inverted and diminished canons.

Soundtrack

In the opening section with the cubes, the soundtrack was shot first, by the card method of animated sound. (1)

In the second and third sections, the soundtrack was made after the visuals. The music for piano was especially composed to fit the action of the film, and to be a precise example of the kind of canon that was being illustrated on the screen. The actions of the cut-out men and the live man had been performed to a steady beat, to make the composer's job of synchronization easier.

Norman McLaren (1964, revised in 1973)

(1) See the paper « Notes on Animated Sound by the Card Method »

Technical Notes for *C'est l'Aviron* (1944)

In the following series *Chants Populaires, No.5* (Black and white)

This folksong was recorded and its rhythmic beats, phrases and verses measured in terms of frames, prior to shooting the picture.

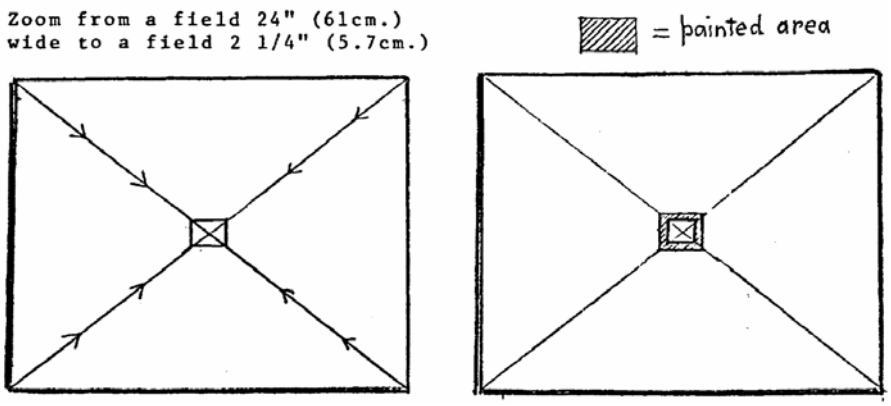
The main conception of the visuals depended on "zooming".

An essential part of a standard animation camera stand is its zoom column, which permits the camera to approach toward and recede from the table top on which drawings to be photographed are placed.

The special feature of *C'est l'Aviron* is that it makes use of approaching, overlapping zooms continuously throughout the film, to give the effect of swiftly traveling down a river with landscape on either side, reflections in the water and mists here and there.

About one hundred and fifty 24" x 18" (61 cm x 46 cm) black cards were prepared, each with only one plane of landscape painted on it with white and grey tempera paint.

The camera zoomed from its largest field 24" x 18" (61 cm x 46 cm) down to a close field of about 2 ¼" x 1 ¾ "(5.7 cm x 4 cm).

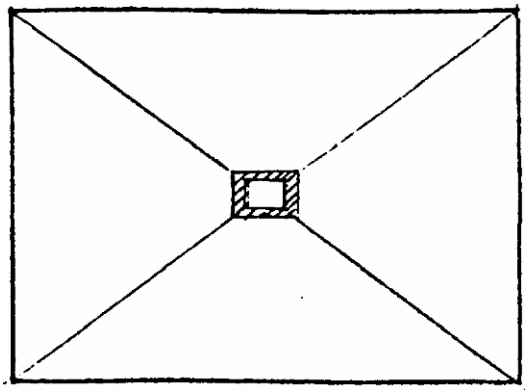


The painting on any one card was restricted to an area of about one or two inches (2.5 to 5 cm) around the smallest field (but never inside), and represented only one plane of the landscape. Trees, rocks, cliffs, or mists, etc. were painted there, as close as possible to the smallest field, which remained black. The rest of the card was also left black.

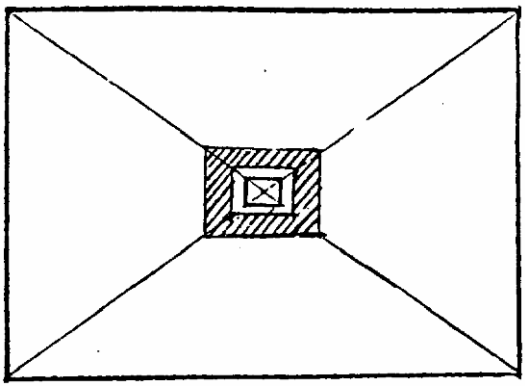
With the camera zooming from largest to smallest field in 100 frames or 4 seconds, and with the first 2 seconds consisting of a fade-in, we had the effect of one plane of landscape appearing out of darkness, while approaching, and eventually coming so close that it passed out of the edges of the frame. As soon as the smallest field was completely black, we made a very quick 8-frame fade-out, just in case the black card was picking up some slight exposure.

DIAGRAM OF ONE ZOOM

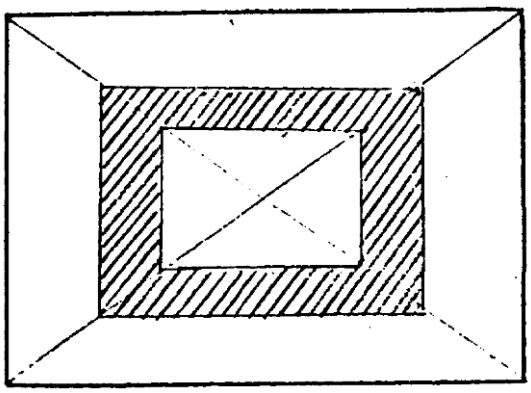
TOTAL CAMERA FIELD Painted area of black card



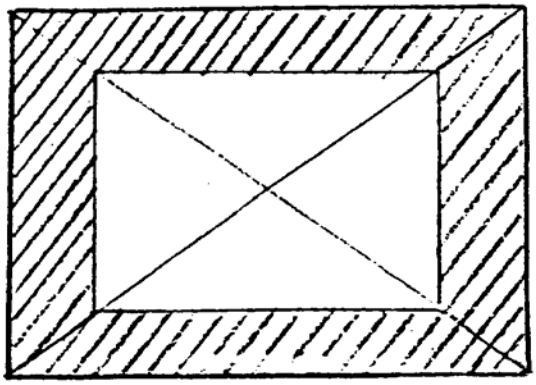
Area & position of one plane of painted landscape at start of a 100 frames zoom: (camera counter at zero)



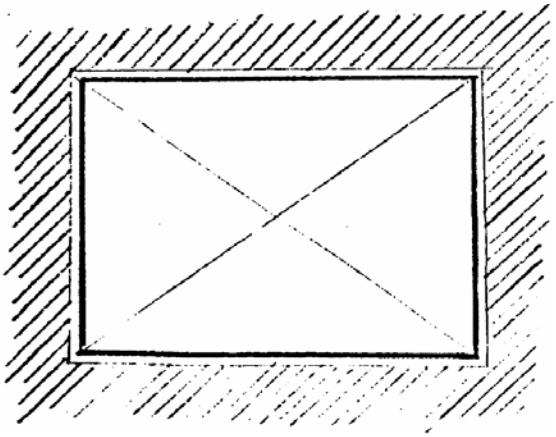
Approximate area & position of landscape - one second later: (camera counter at 25 frames)



Approximate area & position after about two seconds: (counter at 50 frames)



Approximate area & position of landscape after about three seconds: (counter at 75 frames)



Position of landscape after four seconds: (counter at 100 frames)

The shooting procedure was identical for all cards, except that each card started zooming 25 frames later than the previous card.

This created a continuous and constant series of staggered superimpositions in which, at any one moment, each landscape-card was at a different distance from the camera.

The final result gave an impression of traveling through multi-planed depth.

By studying the shooting dope-sheet on the next page, it will be seen that a maximum of four planes appear at any given moment. The first or nearest place passes out of the edges of the field when the fifth or most distant plane starts to fade in, which is when the fourth plane is halfway faded in, and the third plane has just fully faded in.

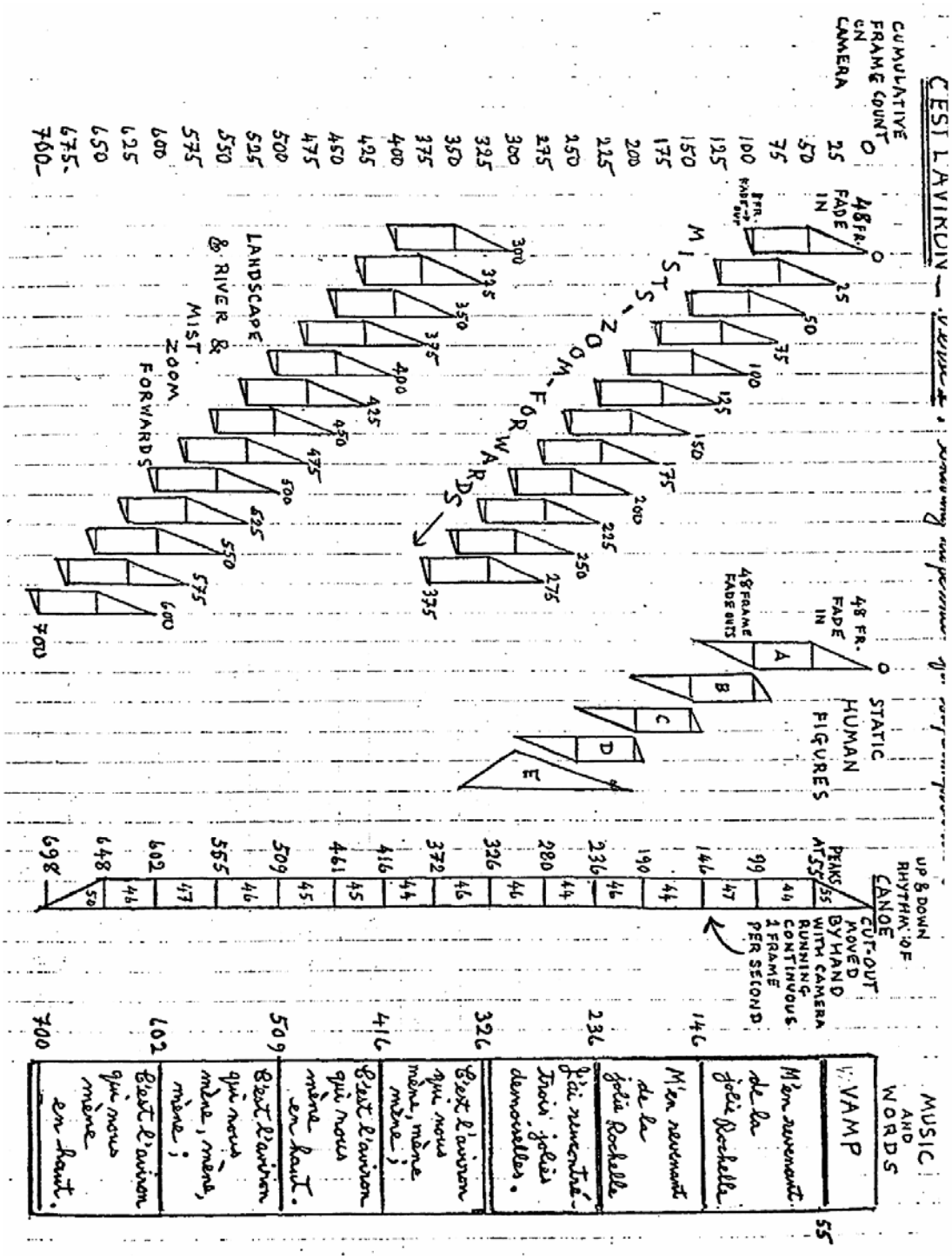
Because the details of landscape appeared on a black ground (or out of darkness), four planes were all that was necessary to suggest a continuous land- and riverscape.

Further non-zooming, static superimpositions were added by mixing-in and –out human figures, horse, fountain, house, etc., all painted on a black ground.

A final superimposition was required for the prow of the canoe, which was a painted cardboard cut-out, hand-held above a black ground. With the camera running continuously at very slow speed, the cut-out was moved constantly up and down every 45 frames, that being the rhythmic beat of the music.

Norman McLaren (1944, revised in 1983)

TYPICAL SHOOTING DOPE-SHEET FOR A VERSE OF *C'EST L'AVIRON*



Technical Notes on *A Chairy Tale* (1957)

Visuals

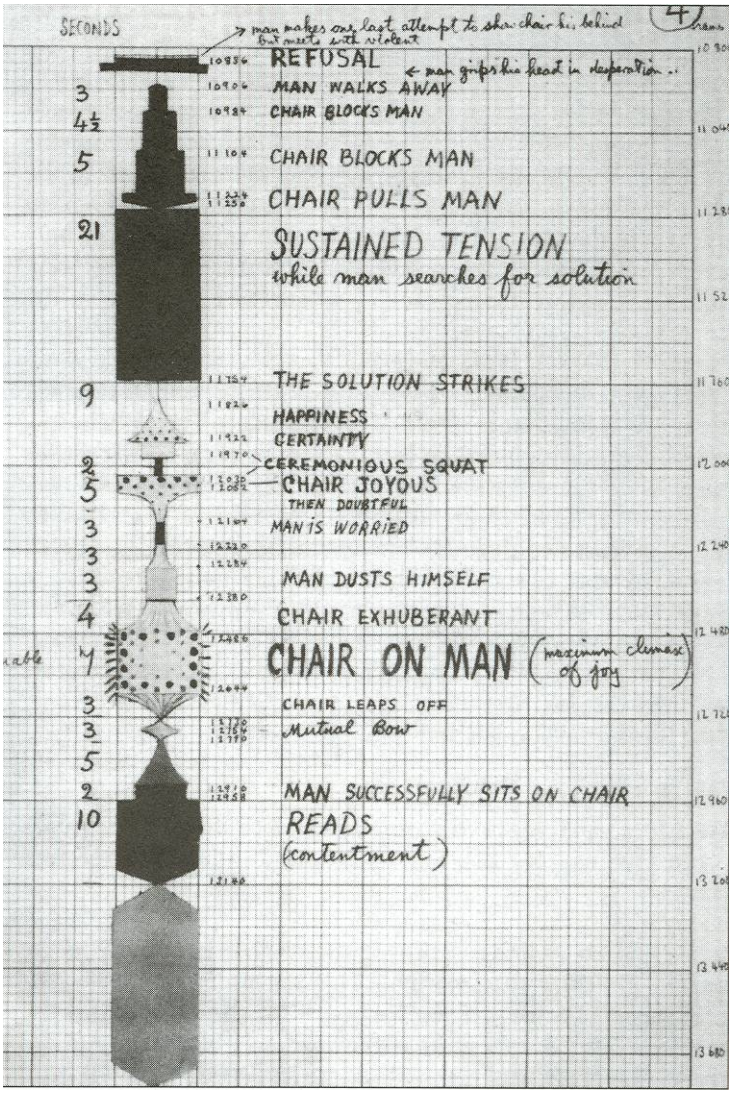
Our method for making the chair move was that of traditional string-puppet technique, except that instead of having the strings run vertically upwards, we had them attached to the chair and run horizontally to off-screen right and off-screen left, where they were manipulated by two animators. For only a very few scenes did we use vertical threads. The strings were fine black nylon fishing tackle, which was invisible to the camera.

While rehearsing, we discovered that it was very important just where the strings were attached to the chair. Tying them low on the legs, or high on the legs, or low or high on the chair's back, or to combinations of these parts, made possible very different types of chair motion. If we wished the chair to rotate, at least two threads were wound around the chair's four legs in advance of shooting; during the shot these threads were pulled (off-screen) in opposite directions. For the most complicated motions, such as the chair leaping off the floor and flying through the air, we had to have four manipulators and add threads running vertically to pulleys on the ceiling, then horizontally to left and right off-screen.

Use of Sub-normal Camera Speeds

We had a variable speed motor attached to the camera, which could give us 16-, 12-, 8-, 4-, 2- and 1- frames per second (fps).

It was much easier to control the chair's behaviour if we moved it slower than normal. This led us often to shoot at half-speed (12 fps). If we wished both the chair's and the man's action to appear as if they were behaving at normal speed, the chair was manipulated at half-speed, and the man performed at 1/2-speed. Or, if the chair's action was really tricky to manoeuvre, we would run the camera at 6 fps, and have the chair and man move at 1/4 –speed. As long as the action and camera speeds were slowed down by the same amount, the final projection looked normal.



Part of visual outline of *A Chairy Tale,* prepared by McLaren for Ravi Shankar.

In cases where the chair moved with supernatural speed and the man with normal speed, our formula might be: camera 8-fps, chair normal speed, and man 1/3-normal speed. (The idea of variable ratios between camera speed and performance speed is dealt with in more detail in the technical notes on *Neighbours*).

When the man was dashing back and forth across the screen in search of the chair, he was running as fast as he could and the camera was turning at 2 fps, producing a blurred effect.

During the shooting there was considerable improvisation, for instance, when the man was chasing the chair in circles, we tied threads from his knees to the chair-legs, and had him run backward, pulling the chair after him, while making gestures as if to catch the chair. This, when the action was reversed in the optical printer, gave a convincing effect of him racing after the chair.

Soundtrack

The picture was completely edited before we considered what to do about the sound.

At this moment, by great good fortune, the distinguished composer-performer sitarist Ravi Shanker, who was then living in New-York, had come to Montreal for a TV recital. I invited him and his tabla-player, Chatur Lal, to view the silent film. He expressed a keen interest in composing the music.

We went about it in this way. In advance, I prepared a chart of the whole film on square-off graph-paper, where each square represented one second of time. The duration of sequences, episodes, actions and gestures was indicated precisely on this chart, by the use of colours, diagrammatic marks, names and numbers.

I then spent an afternoon screening the film many times for Shankar and his percussionist. Between every screening we would identify each sequence on the chart. After about a dozen screenings, they were both thoroughly acquainted with the film and the chart as it related to the film. They required three weeks to evolve the music based on the chart.

For the recording session the film was split into about ten loops, and the music performed as each loop was projected. About 20 seconds of silence was included in the loop, just enough for decisions to be made for improving the substance and manner of the performance.

When the music was felt to be right, we did not stop the projector, but continued running, and made several takes immediately; for Shankar it was important that they be recorded while at the peak of their “warming-up” rehearsals.

We also recorded ‘wild’ a few special effects on the sitar, and many percussive and semi-musical sounds on the table. These were later selected from an edited into the re-recording tracks for the final sound mix.

Norman McLaren (1957, revised in 1984)

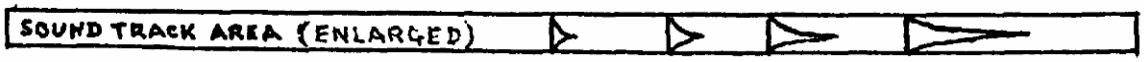
Technical Notes for the Sound on *Dots* and *Loops* (1940)

The percussive, semi-musical sounds were made by painting and drawing with black India ink on clear 35 mm film.

The sounds were placed in the soundtrack area adjacent to the picture; in this case, on the same piece of film on which the visual images were drawn. For synchronization during projection, the track was positioned 20 frames ahead of picture it was intended to synchronize with.

The soundtrack was later transferred to normal variable area format for release.

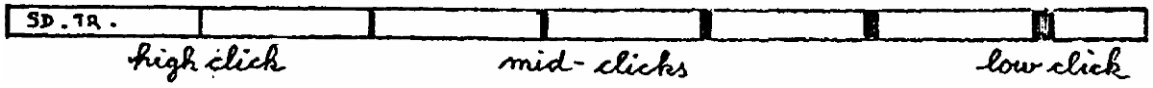
Almost all the sounds were in form of 'notes' having an abrupt beginning or sudden attack, and a tapering-off or decay, where possible, with an exponential shape or envelope:



Each note was made up of a number of strokes of the pen or brush

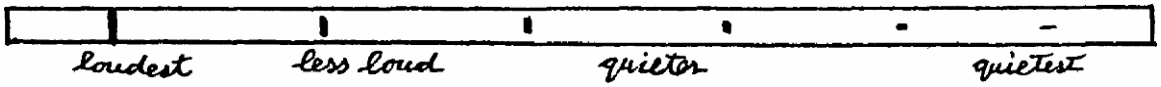
Clicks without Precise Pitch

Just one stroke across the track made a clicking sound:

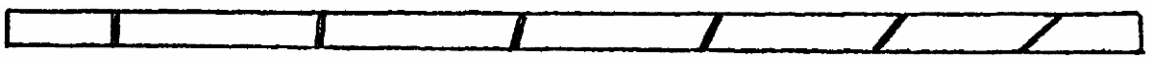


Volume of Click

The loudness of a click depended on how much the strokes stretched across the soundtrack. For example:



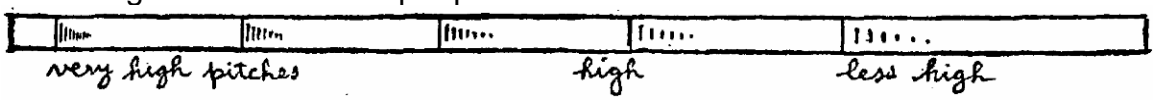
Volume could also be controlled by the slope of the stroke:



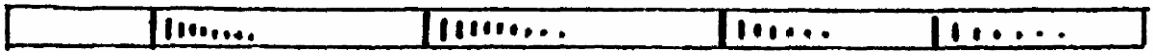
Sounds with Pitch

At least six strokes, if evenly spaced, were enough to make a sound with a definite pitch; the closer together the strokes were the higher the pitch, the further apart, the lower the pitch.

For high sounds a crow-quill pen was used:



For notes in the middle-pitch range, an ordinary broad pen was used:



For deep notes narrow and broad brushes were used:

The Precise Pitch of Notes

To control the precise pitch of note by direct drawing on the film, the spacing of the lines has to be very even for any given note. Low pitches were easier to make than high pitches, since the distance between strokes was much greater. Making notes in octaves was easy, as it required simply doubling the number of strokes in a given distance. For example, six stokes opposite one picture frame would produce a pitch 6 x 24 = 144 strokes or vibrations a second; 12 strokes per frame, a note 12 x 24 = 288 vibrations a second or an octave higher.

The musical interval of a fifth was also easy to make as it depended (not as the octave, on a ratio of 1:2) but on a ratio of 2:3. This meant drawing 9 strokes per frame to get a note 9 x 24 = 216 vibrations a second. Similarly, a musical fourth above the basic tone of 144 vibrations a second.

The sound of *Dots* and *Loops* relied mainly on octave notes and musical fourths and fifths in various octaves. But for other notes on diatonic scale other numbers of strokes per frame had to be calculated.[*]

After making the sound for *Dots* and *Loops* I switched to engraving on black emulsion-coated film for all hand-made sound. The reason was that clear film got scratched and dirty very easily while working on it, and this resulted in undesirable noise. There is no such problem when engraving on black. The same rules about size, spacing and shapes of strokes apply.

Norman McLaren (1940)

[*] For another description of direct-made sound see the paper “Handmade Soundtrack for Beginners”.

Technical Notes on Earliest Films (1933-1939)

Hand Painted Abstraction (1933)

Silent footage, not a structured film, designed to be accompanied by discs of any fast jazz or popular music. Painted on salvaged 35 mm film with a very limited range of semi-transparent dyes, shoe-polish and India ink, and with total disregard for the frame-line or for synchronization with the music.

The very rapid fluctuations of patterns and the very fast music created an acceptable random synchronization, which often looked very intentional.

No prints were ever made. The original was projected so often that is disintegrated.

Seven Till Five (1933)

A straight-forward 'documentary' shot with the simplest kind of 16 mm camera. Much use was made of short shots and close-ups. The theme was a day in the life of an Art School.

Camera Makes Whoopee (1935)

A kind of impressionistic documentary on the preparations for and the final annual Christmas Ball at the Art School. A silent film to be accompanied by the music of various phonograph discs.

Shot with a 16 mm Cine-Kodak Special camera, mainly with live action, an attempt was made to exploit almost every technical possibility of the camera, such as fades, mixes, multiple exposures, split-screen, the single-frame animation of drawings and objects, etc. Cross-combinations of these effects were tried. All effects were done in the original shooting; no optical camera was used.

Polychrome Phantasy (1935)

For backgrounds, crystal formations were shot through a low-power microscope, and made to change their colour by using polarized light. The lower part of the picture area was shaded-off with a soft-edge mask so that live dancers could be superimposed by a second pass in the Cine-Kodak Special camera.

The dancing was done to the disc accompaniment of a Johann Strauss Waltz.

***Five Untitled Shorts* (1935)**

Silent straight-forward colour shooting of live action for publicity commercials, for a chain butcher shop windows with rear projection.

***Colour Cocktail* (1935)**

A silent abstract short, mainly using the play of coloured lights on the curved shapes of paper sculptures rotating slowly on a turntable. Multiple exposures, mixes and fades were made in the camera.

***Hell Unlimited* (1936)**

A black-and-white silent film with an anti-war message, which used a combination of live actors, puppets, diagrams, maps and newspapers headlines.

***Book Bargain* (1937)**

A straight-forward documentary shot in 35 mm black-and-white, with commentary which records chronologically the mechanical procedures involved in making London's telephone directory. Starting with huge rolls of paper and tanks of black ink, it follows in detail the assembly-line process to the completed bound volume.

***News for the Navy* (1937-38)**

A straight-forward commentated documentary, which shows how a letter from home reaches a sailor on duty in foreign waters.

***Mony a Pickle* (1937-38)**

A savings publicity short made by several directors. In my 2-minute section, shot in live-action, a couple sit in their kitchen-living room discussing the changes they would make if they had £1000. Furniture and other household objects animate, mix-in, mix-out, pop-on and pop-off, to create the room of their dreams.

***Love on the Wing* (1938)**

Continually metamorphosing linear images and symbols were drawn with an ordinary pen and India ink on clear 35 mm film stock. A positive and a negative (black-line-on-clear) was made to protect the original.

Painted colour multiplane traveling backgrounds were shot on Dufay-colour (now obsolete) negative.

The black-line-on-clear negative when printed bi-pack with the Dufay colour negative gave a clean-line image on positive colour background. This acted as the master positive from which a colour dupe-negative and all release prints were made. All 35 mm printing materials were lost, and existing prints were made from a well-used 16 mm print. Hence, the traveling backgrounds, which were fairly essential to the animation have almost disappeared.

The Obedient Flame **(1939)**

The first half of this film was made by a standard animation studio's cell technique, from a detailed diagrammatic didactic story-board supplied by me, and designed to be accompanied by commentary. The second half of the film is in straight-forward live-action shootings. Its message is the promotion of natural gas rather than electricity for cooking.

Norman McLaren (1933-1939, revised in 1984)

Technical Notes on *Fiddle-de-dee* (1947)

Fiddle-de-dee was made by painting directly on a clear 35 mm motion picture film.

The film was laid out and tacked down in long lengths on a table top covered with white paper.

The soundtrack had been recorded beforehand, and the beats, phrases and sentences of the music had been measured. These measurements were transferred to the film, as small numbers in the sprocket-hole area of the film.

The painting was done, not a frame at a time, but in stretches corresponding to phrases and sentences of the music.

The textures were got by using brush strokes, stippling, scratching with razor blades and sand-papers of different roughness, painting on both sides of the film, and further scratching.

A certain “effect” was usually maintained for the duration of at least a musical phrase.

Later, framed images were added, often just for one frame at a time, and usually to coincide with the first beat of a musical phrase.

The finished painted original was considered a master positive, from which a negative and subsequent release prints were made.

Norman McLaren (1947, revised in 1983)

Technical Notes on *Keep Your Mouth Shut* (1944)

Black and white

This film was made for use as a wartime anti-gossiping campaign short.

The visuals consist of a stretch of black leader, followed by a real skull with glass eyeballs animated frame by frame, followed by an actuality wartime shot. This pattern is repeated with different content several times.

During the black leader we overhear people gossiping about the whereabouts of their husbands, sons or relatives in the armed forces. This is followed by a close-up of the skull talking – thanking the gossipers for the information.
The skull talks by single frame animation of the jaws, head posture, and movement of the eyeballs, synchronized to pre-recorded speech. The eyeballs momentarily become swastikas by means of short mixes or jump cuts. Immediately after the skull has spoken the film cuts to a wartime actuality disaster, then back to black leader again.

Norman McLaren (1944, revised in 1984)

Technical Notes on *Là-Haut sur ces Montagnes* (1945)

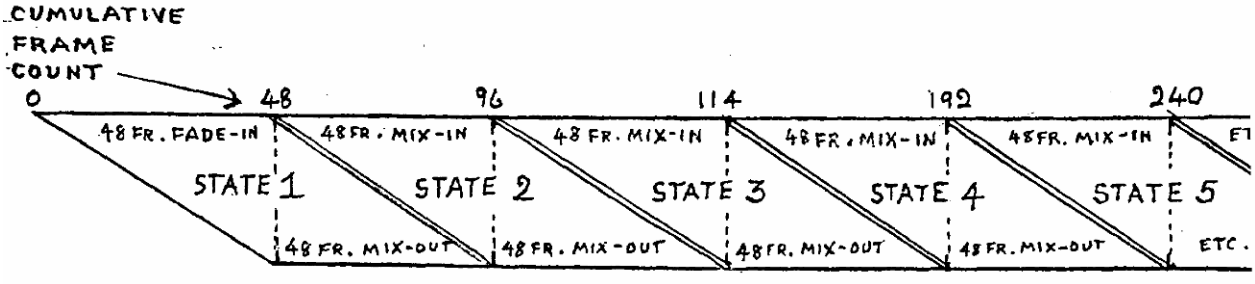
In the folksong series *Chants populaires, No. 6* (Black and white)

The music and lyrics were recorded first.

The visuals were mainly made by a continuous chain of abutting mixes or dissolves. A pastel drawing about 24” x 18” (61 cm x 46 cm) was placed on the animation table. The drawing, a landscape rendered in smooth, soft-edge light-and-shade, was slightly changed between each mix; the tonalities of different areas were lightened or darkened; new forms made to appear, old ones to disappear; details were emphasized and then obliterated.

Each mix was two seconds (48 frames) long, and as soon as one mix was finished the next one began.

A simple diagram shows the process more clearly.



At the very end of the film the mixes were stopped and the two little trees were made to grow by single-frame additions of pastel on a static background. For the butterflies, a set of replaceable flat cut-outs (with different wing positions) were laid on top of the card and shot frame by frame.

Norman McLaren (1945)

Technical Notes on *Lines-Horizontal* (1961-62)

The Visuals

Foreward

Upon completion of *Lines-Vertical,* we become curious about the possibility of a version of the film in which all the lines were horizontal, and their movement vertical.

By viewing our vertical-line film with our heads cocked horizontally, we were able to see that there was something more to the effect than a mere 90 degree change in the angle of the lines. In fact, with horizontal lines, our minds read into their rising and falling motion the existence of gravity. Since the lines did not decelerate as they rose up, nor accelerate as they fell down, they seemed to float. This seemed sufficient reason to have our entire vertical-lines film turned on its side by 90 degrees.

To have this unusual operation done we had to send our engraved original (clear-lines-on-black) to a special optical company in New York. The first generation of our new horizontal version was in negative form, black-lines-on-clear. Screening a work print from this confirmed our feelings that, if it had an entirely different colour treatment from *Lines-Vertical,* and a new musical score, it could be released as a separate (but related) film.

Colouring

The colouring was added with filters by two passes in the optical printer. In the first pass, a black-line-on-clear-ground print was used to colour the background. In the second pass, a clear-line-on-black-ground print was used with filters to colour the lines. Where we wished the lines to be black, no second pass or exposure was required.

To go from one colour to another, (be it on the background or lines), mixes of varying lengths were used.

Soundtrack

A score was planned and performed by the well-known American folk musician, Pete Seeger, using a number of instruments and multiple recordings.

Norman McLaren (1962)

Notes on the Music of *Lines-Horizontal* by Peter Seeger (1961-1962)

For the music of *Lines-Horizontal,* I played two different wooden flutes, a five-string banjo, a mandolin, a six- and twelve-string guitar, drums, maracas, autoharp and sound effects.

Since I am an “ear musician”, and read and write notes but poorly, I improvised my way through. I rigged up our barn as a recording studio with acoustic tile in one room and synchronous-speed movie projector in another room. The movie was projected through a heavy glass window onto the screen of the recording room.

I looked at the film dozens of times, with my banjo in hand and whistling and humming to myself. Then I decided roughly what I wanted to do. I divided the film into four pieces and worked on each separately. I spliced each section of film head to tail making a loop which repeated itself on the screen without rethreading.

For the first sequence of the film I recorded the theme melody after improvising and rehearsing with the alto Chalil (Israeli bamboo flute) for about an hour. Then the flute melody was played back to me from the first track of the tape recorder. As I listened through the earphones I improvised a guitar accompaniment for the flute. The guitar was recorded on track two of the tape recorder. Now the two tracks – flute and guitar – were played back to me together and I added a banjo track.

The second section of the film was now projected while I played for it, adding new instruments to the arrangement already recorded. For this sequence I omitted the flute but added the mandolin and a shimmering thunder effect, made by shaking a long strip of copper flashing left over from the year I repaired my roof.

For the third sequence of film I used drums, rattles and a guitar bass drone as a basic background for the counterpoint of two tenor recorders, plus banjo and then 12-string guitar. In the fourth sequence of film I returned to the original instrumentation.

A few weeks later, at the National film board in Montreal, all nine separate instrument tracks were mixed together into one.

If my music is good, credit should be shared three ways: between the visual inspiration of the film, the technical staff and the instrumentalist.

Peter Seeger (1961-1962)

Technical Notes on *Lines-Vertical* (1960)

Lines-Vertical was made by etching straight lines on 35 mm black leader. That is, by running the tip of a knife, sharpened like a tiny chisel, along a straight edge, the black emulsion was lifted off the film and a white line resulted. As we wanted the lines to be as smooth as possible, it was necessary to have a particularly good straight-edge, and a method of stretching the film out perfectly straight and holding it there while drawing the line. We were working with approximately six foot lengths of film and therefore needed a six-foot rule, true through its entire length.

A number of pieces of stock brass and steel supplied by our Engineering Department were tried, in the hope that one would be true enough, but all had waves in them which showed up as undulations in the line when projected. A special stainless steel draughtsman's rule was finally ordered from England, and this helped give us the desired smoothness.

The line needed to be clean as well as firm and straight. To support the film a steel plate about seven feet long by eight inches wide by a quarter inch thick was used. This hard base made it easier to get the line clean. A piece of tape was placed along one side of it and one edge of the tape was cut straight with the ruler; this gave us a guide edge as straight as the original ruler. Each section of film was taped securely by its edge to this guide-edge before the engraving began.

Three knives were kept sharpened to a different thickness at all times, so as to be able to produce lines of varying thickness at will. The finest knife gave the most trouble as it was constantly breaking, thus making itself wider, or cutting the film. Such things as the hardness of the emulsion, the amount of pressure put on the knife, and the exact angle at which the knife was held all affected the thickness.

Emulsion is a solution of silver nitrate in gelatine; when exposed to light the silver nitrate turns black, and fixing makes the black permanent and tough enough to withstand ordinary handling without scratching. The emulsion on old film which had been exposed to dry air for some times gets very hard and brittle and it was almost impossible to get a clean line out of it. No matter how carefully the knife was handled, the line came out ragged and weak with patches in it. There are quite a number of these places in the film, they were kept because it was almost impossible to duplicate the 'shot'. We learned to keep only a small stock of film on hand and to take it out of a sealed can only what we wanted to use immediately.

The formations used in the film were drawn on squared paper first. A lot of experimental drawing was done to find out which were the most effective and what form the film should take.

In order to make these formations intercuttable, several standard gauges or line positions were adopted to which the lines always returned at the end of each sequence. The simplest one had five equally spaced points. The next one divided the spaces

between these points evenly, giving nine points; the next one had seventeen, and that seemed to be about the limit.

By making the slow-moving lines thin, and the fast-moving thick we were able to create an impression of perspective.

Colouring

From our etched clear-line-on-black original we struck a negative (black-lines-on-clear), and from that a print (clear-lines-on-black).

With a first pass in the optical printer, the negative was used with colour-filters to print the hues of the background onto colour-stock. In a second pass, the print (clear-lines-on-black) was used without filters to burn in out white lines.

Soundtrack

When our visuals were completed, we asked NFB staff composer Maurice Blackburn to create the music. This he did, partly by composing and partly by improvising, using a pentatonic scale. Having worked out a few motifs related to the film in advance, he then improvised freely on these themes while viewing the film section by section, sequence by sequence.

Evelyn Lambart & Norman McLaren (1960)

Technical Notes on *A Little Phantasy* (1946)

Known more fully as *A Little Phantasy on a 19th Century Painting,* this film, based on a very famous painting "Isle of the Dead" by the German-Swiss artist Arnold Boecklin was made as a sequence for inclusion in a full length wartime documentary on Germanic culture; it was intended to depict one aspect of late 19th century German Romanticism in the Arts. With the end of the war, the documentary was never completed, and this sequence was released on its own.

To begin with, Boecklin's painting was exactly reproduced in pastels on a card about 24 x 18" (61 x 46 cm) and the film's technique was almost identical to that used in *Là Haut sur ces Montagnes,* except that the card was attached to a wall with the camera mounted on a tripod, shooting horizontally; the advantage of this was that as pastel was rubbed away, it automatically fell to the floor and did not have to be blown off a horizontal card and into the air, where part of it would settle on the drawing again.

By the mix-chain method described in the notes for *Là Haut sur ces Montagnes*, the light and shade of the pastel drawing was made to metamorphose, but done more boldly. Not only the chiaroscuro but the depicted shapes themselves changed their forms more rapidly; parts of the subject matter disappeared into blackness, while other parts were lightened to reveal new forms.

From time to time, chain-mix metamorphosis stopped and by means of frame by frame addition and subtraction of pastel, new imagery grew, moved and disintegrated.

In the end, the "painting" returns to its original form.

The musical soundtrack was arranged from existing musical library material by Louis Applebaum, after the visuals were completed.

Norman McLaren (1946, revised in 1983)

Technical Notes on *Le Merle* (1958)

Le Merle (*The Blackbird*) is based on a well-known old French-Canadian folksong. It is a cumulative nonsense song about a bird which, with each verse, loses a different part of its body…but no sooner is a part lost than it re-appears three-fold and, as the song progresses, the lost parts accumulate.

The soundtrack was recorded first.

Technique for Visuals

Single frame animation of stiff white paper cut-outs on a black horizontal surface, photographed on a black-and-white stock. The image of the bird was extremely simplified and stylized; the various parts of its body were made with small round-ended rectangular bits of paper, occasionally jointed together, but more often left un-jointed and kept free from each other to allow for greater flexibility in animating.

The colour backgrounds which consist of holds, pans, and zooms on pastel drawings were shot separately on Eastman colour negative. By bipacking a high contrast black-on-clear negative of the animation with the colour negative of the background we got colour master positive which as the first stage in release printing.

Norman McLaren (1958)

Technical Notes on *Mosaic* (1965)

Visuals

By engraving straight lines on black leader with a knife, we had made the film *Lines-Vertical.* By optically turning this image 90 degrees, we had made the film *Lines-Horizontal.*

By running a clear-on-black copy of both vertical and horizontal in contact with each other, in an optical printer, we got the basis for the film *Mosaic,* namely a new negative, the print from which had a black background with clear dots wherever the lines intersected.

For colour our intention was to have the dots, wherever they crossed each other, briefly flicker in different colours, on a background which slowly changed its overall colour.

To plan the colour scheme for the flickers, we used a very thin, transparent coloured celluloid, with adhesive on one side, which we stuck onto our work print, a different colour on each frame, for the duration of the flicker. This gave us dot-colour only, on a black background.

To plan the effect of adding coloured backgrounds, we used two interlocked projectors; the first took our coloured dot work print; the second took a corresponding 'negative' (black-dots-on-clear ground). In front of the lens of the second projector we held by hand pieces of coloured celluloid, which we would change at will. In this way we decided what the colour scheme for the backgrounds would be.

To make the final new colour negative of the film, we had to have two passes in the optical camera. For the first, we used a high contrast clear-dot-on-black-ground print, and colour filters corresponding to the hues of our flick-dot work print. For the second pass a black-dot-on-clear-ground print was used, with filters matching the colours of our hand-held celluloids. Slow mixes were made from one background colour filter to another.

Soundtrack

Apart from the human whistle at the beginning and end of the film, the rhythmic soundtrack of *Mosaic* was made by direct engraving on 35 mm black emulsion-coated leader. The black emulsion was scratched off with a knife or needle to leave occasional small clear marks; such scratch-marks, when run on the optical soundhead of a moviola or projector, produced percussive sounds.

Variations in the size and shape of the scratched marks affected the pitch, volume and quality. In this way a variety of clicking, thumping, thudding, and rasping sounds were produced.[1]

This is the same method as used in the percussive soundtrack of *Rythmetic*; however in *Mosaic,* since there were long intervals of silence between the percussive sounds, during the final mix we added a very great deal of echo and reverberation, often increasing the dynamic of the reverb which follow the clicks.

Norman McLaren (1965)

[1] For more details on engraved soundtracks see “Technical Notes on Handmade Sound”.

Technical Notes on *Narcissus* (1983)

In the first two parts of the film, where Narcissus encounters first the girl and then the boy, no special optical effects were used. The original shooting was done mainly in slow motion, with the camera running at 48 frames per second; some shots were also taken at 24 fps, and 36 fps.

In the final editing these speeds were freely intercut, depending upon the nature of the dancing.

In the third part of the film, Narcissus encounters himself, first as a reflection in a pool, then as a live person, who has come out of the pool to confront himself.

Since we could not find identical twin dancers, Narcissus had to perform two roles in succession – his real self (N1) and his reflected other self (N2).

In order to combine his two performances within any given shot, we had to use an optical printer; this would have been necessary anyway, since we intended to employ a number of special optical effects.

As is the normal procedure in optical work, interpositives were made; these were loaded on the projector heads of the optical printer, and the special effect were created while shooting onto an optical negative

Here is a description and explanation of the various effects and techniques, as they appear chronologically in the film.

The Initial Full-figure Self Encounter Sequence

Only in this one particular shot was a large mirror used. To have Narcissus 1 move out of step with his mirrored reflection Narcissus 2, we made two passes in the optical printer; in the first, we masked off N2 and shot N1's action normally; in the second pass we masked off N1, and by skip-framing, freeze-framing or double-framing, we advanced, retarded and resynchronized N2's action relative to N1's.

From here on, no mirror was used (except for one brief close-up shot towards the very end of the film). We filmed the dancer performing each role in succession, and later combined them in the same frame by reshooting with two passes on the optical printer. This became our standard procedure.

The Disappearing Sequence

When N2 becomes mischievous, evading N1 by repeatedly disappearing and reappearing, we simply mixed-out to blank background on the N2 pass for the disappearances, and mixed-in again.

To heighten N2's evanescence, we made him flicker by the use of blank frames, beginning with him1-frame on screen and 1-frame off screen. Other flicker patterns followed: 1-frame on screen and 2-frames off, 2 on and 4 off, and finally a random flicker with a constant 3-frames on and anything from 4 to 15-frames off.

The Dance-together Sequence

When N2 stops being mischievous and presents himself to N1, N1 starts a joyful dance. N2 perform the same dance but with jump cutting. This involved taking an approximate 11-foot section of N2's dance, cutting it into eleven pieces, each about 16 frames long, numbering the pieces in chronological order, and reassembling them in this manner: 1,3,2,4,6,5,8,7,9,11,10. This procedure may appear arbitrary, but it was arrived at after experimenting with different-sized lengths and different ways of back-tracking.

At the end of this sequence, while both figures are kneeling, N2 vanishes (by a mix-out to empty background). He reappears, entering N1's image from behind (a mix-in of reverse action to the point where both images exactly overlap).

The Criss-cross Sequence

This starts with a very distant Narcissus on screen-right, running into centre-screen with a large leap. At the peak of the leap he splits into two figures and both descend from the leap in symmetrical synchronization, (two exactly super-imposed passes to the peak, at which point one of the passes was flipped left to right).

Later in the shot, at the peak of another centre-screen leap, a pair of frozen images remain static in the air and mix-out, while the two remaining images continue their action. This required four optical printer passes, two of which were flipped. The inner two (one flipped and one unflipped) were freeze-framed and mixed-out.

Four passes were again used at the climax of the shot, when four figures dance in a symmetrical interlacing manner.

This starts with two figures, each at extreme right and left of screen; each figure splits into two; one of each remains frozen at screen right and left, the other pair moves onward to centre-screen. After 60 frames the frozen pair also start moving forwards

through the same path of action, but, because of the 60- frames freeze they were delayed by about 2 ½ seconds. In other words, their relationship to the first pair was similar to a two-part musical canon. To complete the canon, the pair which did not freeze at the start, froze for 60 frames at the end of their motion, thus letting the delayed pair catch up and unite the first pair.

The Upside-down Sequence

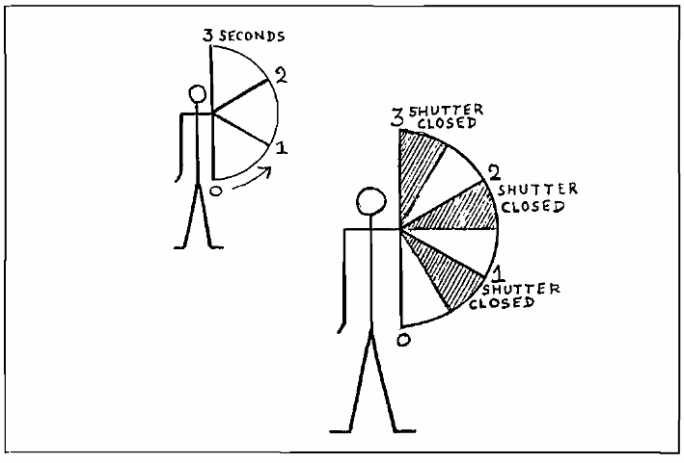
In the original shooting only one upright figure was filmed. For the figure in the sky the image was turned upside-down and flipped left to right to get diagonal symmetry. Two passes were therefore necessary in the optical printer. Two put the action of the two figures in and out of step with each other, we again used freeze-framing, skip-framing and double-framing.

The Blur Sequence

For this we had to turn to a complex technique which required considerable preliminary experimentation.

In the original shooting the dancer performed at normal speed while the camera mechanism ran 24 times slower than normal (shutter open ½ second, shutter closed ½ second). When the dancer move swiftly a large area of blur was recorded on a single frame, when moving at a moderate speed a smaller area of blur resulted, and when not moving at all there was a sharp image with no blur. In other words, the faster the motion the greater the area of the blur.

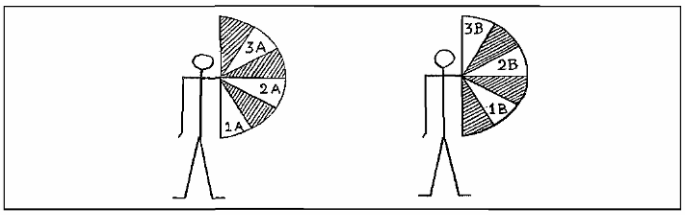
With the camera adapted for this speed of 1 frame per second, only ½ a second of the action is recorded on each frame; during the other ½ second the rotating shutter of the camera is closed to allow the film to be moved on to the next frame.



Thus, if the dancer raised his arm in three seconds, only the first, third and fifth ½ second segments of the blur would be seen on three successive frames of film; the action during the second, fourth and sixth segments would not be recorded.

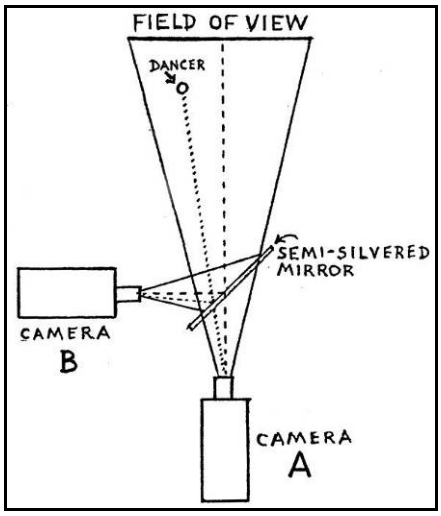
To record the action of the second, fourth and sixth ½-second segments, another camera (B) was required, interlocked (either mechanically or electronically) with the first camera (A).

The shutter of camera B was put 180 degrees out of phase with the shutter on the A camera; in other words, one camera's shutter was open precisely when the other camera's shutter was closed. Thus, we were able to record all segments of the 3-second blurred action,



on three successive frames of Camera "A", and on three successive frames frames of Camera "B".

Theoretically, the two cameras should have been in exactly the same position in relation to the dancer, but of course this was impossible. The problem was solved by having camera B placed at right angles to camera A, with a semi-silvered beam-splitting mirror set at 45 between each camera.



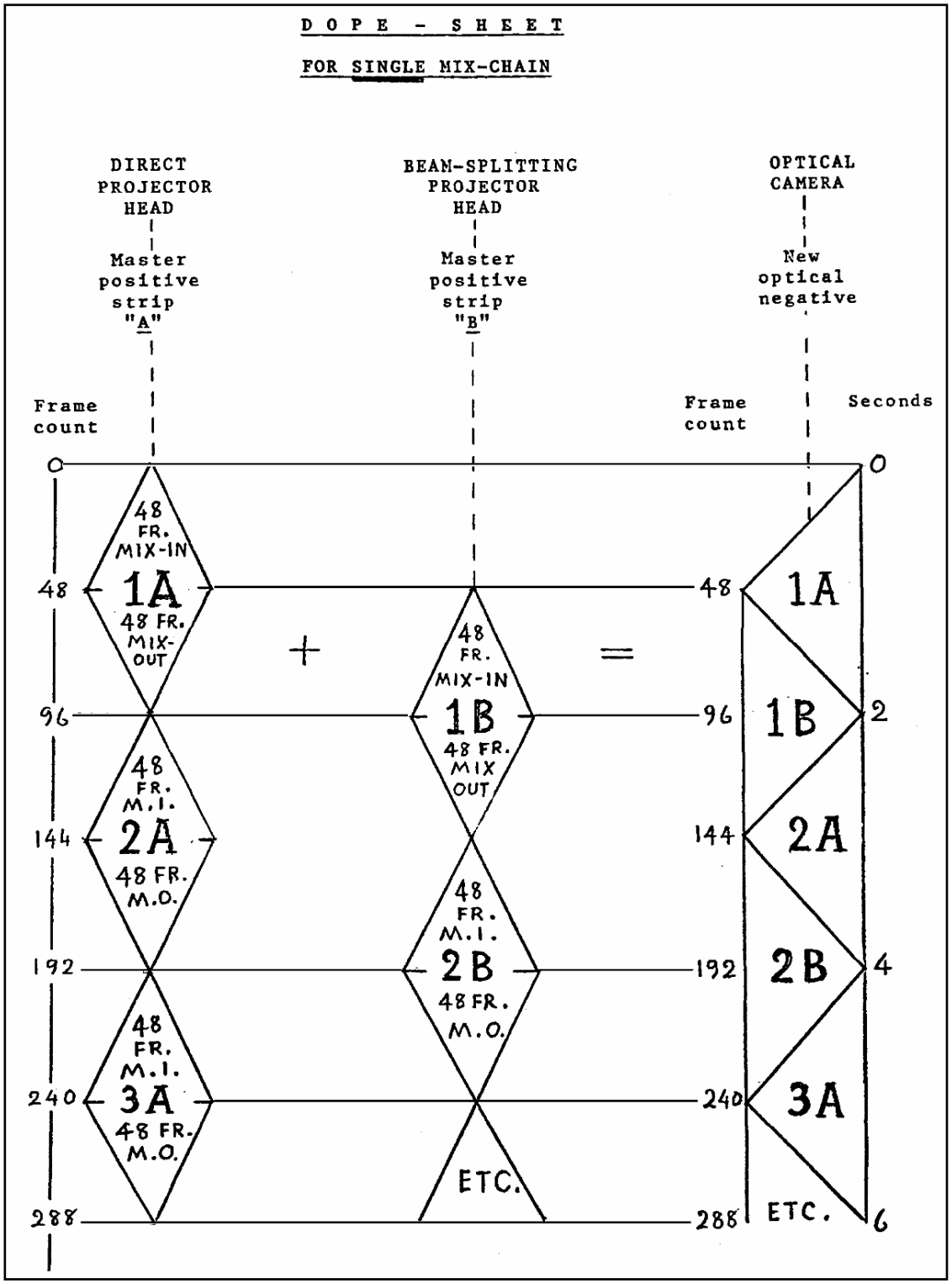
Great care had to be taken to line-up the cameras so that the dancer appeared in precisely the same position on the view-finders of both cameras.

Assuming the shot of the dancer, performing at normal speed, lasted 1 minute and 40 seconds (100 seconds), his actions would be recorded as a series of blurs on 100 frames in camera A, and on 100 frames in camera B.

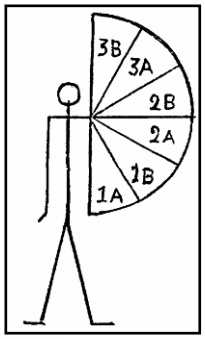
If projected at normal 24 fps speed, these 100-frame strips would each have appeared as about four seconds of frantic motion. Our purpose, however, was not to consider them as ordinary movie material, but rather as a series of consecutive still pictures, to be converted back into a movie by a chain of continuous mixes done on the optical printer.

Master positives were made from the original negatives of the two strips. Master A was loaded on the direct projector head of an optical camera, and master B on the beam-splitting head. (Should the optical printer have only one head, A and B could have been shot in two successive passes).

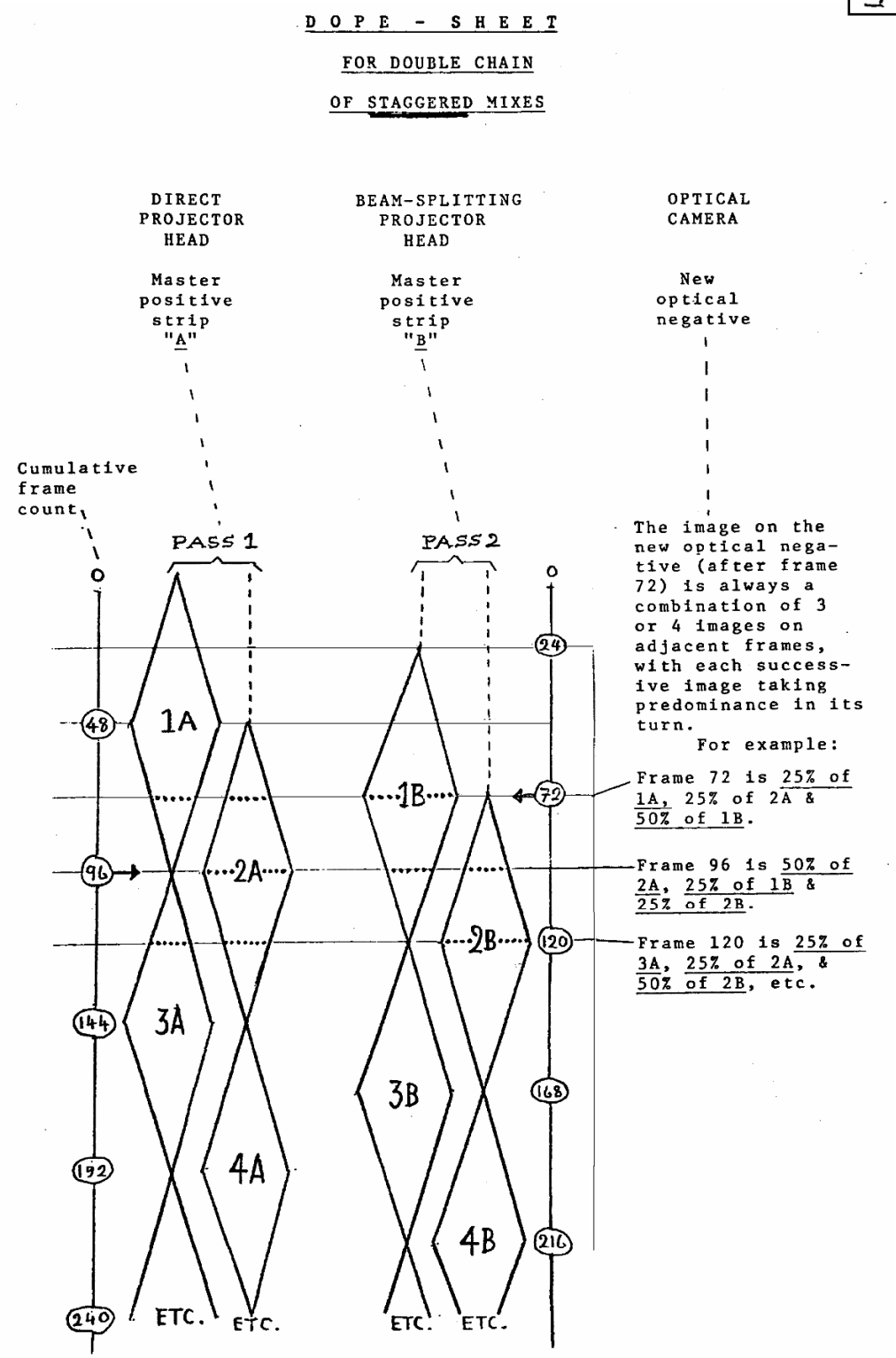
If we were to make a simple chain of 48-frame (2-second) mixes onto a new optical negative, a dope-sheet such as follows would be needed, each frame being frozen during its mix-in and mix-out.



The result would consist of blur 1A mixing out as blur 1B is mixing-in; and blur 1B mixing-out as 2A is mixing-in, etc. This would be seen more as a series of static adjacent blurs than as a blur that flows forward.



To help create more of a sense of flow an overlapping of the blurs was required. This was done by a double chain of staggered mixes. For this we used the following type of dope-sheet:



The Reverse-split-image Sequence

This is the last extended sequence of the film; in it the single forward-moving Narcissus repeatedly splits into two figures, one continuing forwards, the other reversing on its previous path of action while fading out.

Only one master positive with a single figure was used. The first pass consisted of the forward-going figure uninterrupted from beginning to the end of the shot.

The second pass superimposed the same image on itself until the split, at which point the master positive in the projector head of the optical printer was run in reverse and mixed out, while the dupe negative in the camera continued forward.

The Final Kiss Close-up

This was shot with a mirror placed as close as possible in front of a brick wall. At a certain moment in the shooting, the camera was stopped, the dancer held his position rigidly, the mirror was swiftly withdrawn to reveal the brick wall, at which point the camera started shooting again, and the dancer continued his action.

Later, in the optical printer, a slow mix was made from the mirror shooting to the brick wall shooting.

Norman McLaren (1983, revised in 1984)

Notes on the Music of *Narcissus* by Maurice Blackburn (1984)

The score of *Narcissus* was written in the traditional way of music for film. That is, it was composed after the visuals were edited; the key points of its general structure were known in advance.

It was decided after discussion with Norman McLaren, that the music style most suited to the spirit and unfolding of the action be romantic, with solo instruments. As to the choice of instruments, Norman would have liked to use the panpipes as the main link throughout the film, but in view of practical difficulties, we finally opted for the transverse flute, with the addition of harp and piano, and for a harmonic background, a group of seven strings.

The melody for solo voices was composed and recorded several months in advance of the final recording. It was built into the final mixing tracks with the addition of some harp and held strings.

The synthetic or “animated” sound was way of being a discreet homage to the inventiveness of McLaren, who photographed it himself, following my score.

My overall conception of the music was to give a kind of subconscious interpretation to the story on the screen, and to attract the attention of the ear as little as possible; in my opinion, this admirable film was made first and foremost through the eyes.

Maurice Blackburn (1984)

Technical Notes on *New York Lightboard* (1961)

In 1961, the Canadian Government Travel Bureau rented the huge open-air light-bulb screen in Time Square, New York for “Come to Canada” tourist publicity.

The Bureau asked the NFB to produce a 9-minutes silent 16 mm film for this screen.

The screen consisted of over a thousand high-wattage light-bulbs; 27 horizontal rows of 38 bulbs formed a large luminous rectangle. Behind the screen, on the wall of a large room, were 27 rows of 38 photo-electric cells, each linked to one of the bulbs. A 16 mm silent projector projected animated images in black and white (no greys) onto the photo-electric cells. The film had to be joined in a large loop, for continuous projection. A solitary projectionist guarded and maintained this primitive set-up.

Since the photo-electric cells were spread out with spaces between them, the animation had to be done with very broad lines or broad areas. Thin line imaginary, when it fell between the photo-electric cells, would not activate the light bulbs.

Four animators each did a sequence namely Ron Tunis, Kaj Pindal, René Jodoin and myself. Some of us worked directly on 35 mm clear film with a very broad-nibbed pen and India ink, (This was later reduced to 16 mm). Others worked flip-book style, on small sheets of thin paper, having a field-size of about 4” x 3” (10 x 7.5 cm), using a very broad felt marker pen; during shooting these were registered, not by punch-holes, but by their corners.

New York Lightboard Record (1961)

This film is a straightforward silent documentary record of the reactions of New Yorkers in Time Square while watching the light-board film we had made for the large out-door illuminated screen.

Norman McLaren (1961)

Technical Notes on *Opening Speech* (1960)

All shots where there is lip-synch speech, were made with normal camera and sound recording equipment. In such shots the movement of the misbehaving microphone was controlled either by off-screen human hands, in the case of close shots, or, in long shots, by black nylon fishing tackle (invisible to the camera) attached to the microphone and manipulated off-screen.

In shots where there is no lip-synch speech, and especially later on in the film, we used a camera with a variable speed motor. This allowed us to shoot many scenes at 12- or 8-frames-a-second, for more precise control of the microphone's action; I would slow down my own performance correspondingly, except at moment when I wished to react to the microphone's behaviour in a super-fast way.

We also made use of single-frame-at-a-time shooting, as for instance where I am chasing the step-ladder around the microphone.

Our choice of single-frame or slower-than-normal-speed shooting, with or without black nylon threads, depended upon what was easiest for the desired result.

Norman McLaren (1960, revised in 1984)

Technical Notes on the Multiple Image Technique of *Pas de Deux* (1967)*

In the original shooting of *Pas de Deux* no attempt was made to get a multiple image. The dancers, dressed in white, were filmed against a completely black background and black floor. The shooting speed was mainly at 48 frames per second, to give a slight slow motion effect. (Normal speed is 24 frames per second.)

The multiplication of the image was done at a later stage in an optical printer. In the projector of the optical printer we used a high contrast positive made from the original negative; in the camera of the optical printer we used black-and-white dupe negative.

To create the multiple image, we exposed this high contrast positive many times successively on to our new optical negative. The same shot was exposed on itself, but each time delayed or staggered by a few frames. Thus, when the dancers were completely at rest, these successive out-of-step exposures would all be on top of each other, creating the effect of <u>one</u> normal image; but when the dancers started to move, each exposure would start moving a little later then the preceding one, thus creating the effect of multiplicity.

The maximum number of exposure was eleven. The amount of stagger varied from shot to shot, and also within a single shot. A 2-frame stagger created a tightly packed chain of images; a 20-frame stagger made a very widely spaced chain; an average of a 3-, 4- or 5-frame stagger gave images that were overlapped, but distinct enough to be separately identified.

Two methods were used to collapse the image-chain into a single image. In the first, we would, in the original shooting, have the dancers come to a natural stop and pause. In the second, at a suitable moment in the action, we would optically freeze a frame of the first exposure long enough to let all the other exposures in turn catch up to and freeze on the same frame. When the last exposure was caught up, we would have a single, unified static image. Then, by having all the exposures proceed in step with each other, the figure would continue the action as a single unified image.

If, by the second method, we wished this single image to spread out once again into many images, we would have to optically freeze all exposures except one, allowing it to proceed, then allow each of the other exposures in their turn to proceed, with, say, a 5-frame delay between each.

In addition to having black backgrounds, preliminary tests proved that it was essential to have back lighting on the dancers. Normal front lighting lead to visual clutter

* Titled « Duo » for 35 mm Theatrical release in the USA

when the images multiplied. Delineation of the dancers by as thin a line of light as possible, gave maximum readability, when the multiplied figures were in motion.

Norman McLaren (1967)

Notes on the Music of *Pas de Deux* by Maurice Blackburn (1967)

On seeing the silent cutting copy of *Pas de Deux*, the musical piece that came immediately to my mind was “Song of the river Olt” played on the panpipes by Constantin Dobre, with a very quiet murmuring orchestral backing, on a disc of Rumanian folk music.

It was an extremely lyrical piece and the panpipes gave to it and undeniable human breath. In my opinion, it captured the very essence of the film. In the space of a few hours of listening to the disc, I was able to envisage how to develop the piece. Explaining my ideas to Norman, he agreed and gave me carte blanche.

The music on the disc was not more than three minutes long while the film required a thirteen minute soundtrack.

But the solution to this problem of length and that of the structure already seemed to me sufficiently clear. I had only to follow the film’s narrative development, starting with the girls’ introspective self-withdrawal and follow the action through the final ecstasy.

I, therefore, began by making several copies of the piece on magnetic tape, and with these, I separated all the musical elements: the initial orchestral murmuring, the panpipe motifs, phrases, sentences and also the entire melody.

Then I rebuilt a soundtrack which began with only the quiet murmuring accompaniment of the orchestra which continued without interruption to the end of the soundtrack. On top of this background, at critical moments in the visuals, I added short fragments of the panpipe, a few notes, a motif, then phrases, sentences and finally, in the last minutes of the film, the entire melody.

I had already recorded a great variety of harp arpeggios in different pitch registers, colourations and tonality related to the murmuring, so that they would integrate with the background of the melody. These I made into many separate tracks.

Finally, our marvellous sound mixer, Ron Alexander, with great subtlety manipulated the dynamics and colour-shadings of the various tracks to form a constantly shimmering background and support for the panpipes.

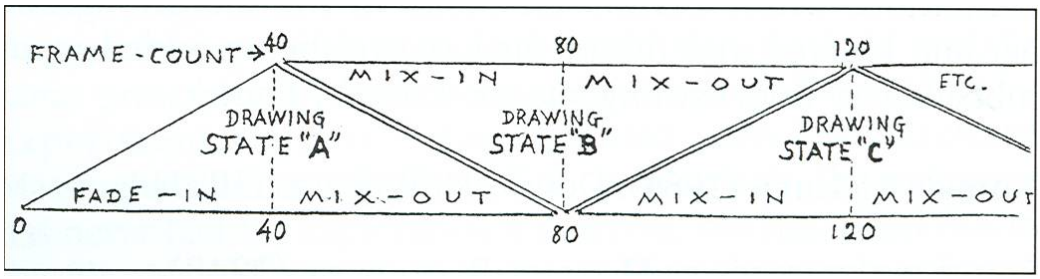
Maurice Blackburn (1967)

Technical Notes on *A Phantasy* (1948)

The Visuals

The film is in three parts. The first and third part used the same technique, namely: a single colour-pastel drawing which was slowly metamorphosed by an almost continuous chain of 48 frame mixes; the drawing being slightly changed between each mix.*

A simple example may show this process more clearly.



The initial drawing (STATE "A") is faded-in from frame zero to 40, and mixed-out from 40 to 80. The film, without being exposed, is then wound back to 40.

The drawing, by adding or removing pastel, is changed to STATE "B", which is then mixed-in from 40 to 80, and mixed-out from 80 to 120. Once again the film, without being exposed, is wound back 120 to 80.

Again the drawing is changed to STATE "C", which is mixed-in from 80 to 120, and out from 120 to 160, etc.

As a result of this technique, the drawing is put into a continuous state of flux or metamorphosis.

Different areas of the drawing are made to metamorphose at various speeds. While some areas remained static between states, others changed slowly, moderately or rapidly.

Generally, the area of primary interest in the drawing had the swiftest change. Further, sometimes only a minute detail would change during one mix, while at other times the whole drawing might do so.

In my opinion, the metamorphosis of a drawing (or painting) by the chain-of-mixes technique is especially effective when the drawing is in soft-edged and blurred chiaroscuro, or is rendered in pointillism and broken texturing, or even in fine or loose cross-hatching. Chain-of-mixes are much less suited to clear-cut linear imagery of hard-edged areas.

Donald McWilliams (1991)

* For a fuller description of "Mix-chains" see "Technical Notes on *La Poulette Grise*".

Furthermore, there was considerable additive and subtractive animation, where certain elements in the imagery grew, became blurred and diminished (pastel being added-to or rubbed-away from existing images, frame by frame).

Also, at times thin flat cut-outs bearing pastel drawing closely related to the basic imagery were animated frame by frame on top of the drawing.

In the second part of the film[**], there is no metamorphosis. Flat circular cut-outs, painted to look like spheres, were animated single-frame on a black background. With a second pass in the camera, panning pastel backgrounds were superimposed.

Norman McLaren (1948, revised in 1984)

Notes on the Music of *A Phantasy* by Maurice Blackburn (1948)

The music was planned after the visuals were completed.

The score for saxophone an animated sound[*] was written as an ordinary score, the animated sound being considered as an instrument of the ensemble. The only difference being that in their length and placing synthetic notes were thought of in units of 1/24 of a second, or in other words, framefuls of films.

A “click-track” was made from the shot synthetic sound in order to synchronize the other instruments too. The other instruments were three saxophones (soprano, alto and tenor). They were each recorded in turn by the same instrumentalist to this click-track, which therefore permitted complete and individual control of each track in the final mixing of all 4 tracks.

Maurice Blackburn (1948)

[**] This second part was again used in 1969 as the second part of the film *Spheres.*
[*] See “Technical Notes on Animated Sound by the Card Method”

Technical Notes on *Pinscreen* (1973) by Guy Glover

This production is a straight-forward demonstration-film made primarily for in-house use by National Film Board animators who would wish to work with the pin-screen. In it, Alexander Alexeieff and his wife Claire Parker explain in great detail the maintenance and use of the pinscreen to a group of NFB animators.

Near the beginning of the film there is a sequence with a greatly enlarged model showing the unique principle of the Alexeieff-Parker invention – the screen, the pin-holes, the pins-holes, the pins and the lighting.

In 1972 the NFB contracted with the Alexeieffs to construct an improved model of the pin-screen, the original form of which the Alexeieffs had conceived and built in 1933.

A couple of later pin-screens were built and are in the Alexeieffs' personal possession in Paris. The 1972 model is the only one as yet owned by anyone other than the Alexeieffs' themselves, and is unique in that it incorporated technical features not included in earlier models. These features are in the process of being patented. The NFB film (shot just after the pin-screen had been assembled and installed at the NFB in Montreal) is purposely vague about these structural details and shows only the overall principles involved, and how to operate and maintain the device which requires careful handling.

Until the patentable aspects of the pin-screen are finally covered by patents, the device is not likely to be manufactured commercially and then, probably, it will be in precious small numbers. At the moment, anyway, pin-screens could be seen (let alone worked with) only in Paris and Montreal, so the device is scarcely of any present utility to the general run of animation artists.

Our film would nevertheless, I suspect, interest film-people and film enthusiasts who are familiar with or who are in a position to screen any of the Alexeieffs' own films made on the pin-screen; namely, *Night on Bare Mountain* (music, Moussorgsky) made in 1934, *The Nose* (1963), and *Pictures at an Exhibition* (music, Moussorgsky) 1972. These are considered in animation circles to be of great and unusual interest both from the technical and aesthetic points of view. Most standard histories of animation give some reference to the Alexeieffs.

> (An historical note is that the Board contracted with the Alexeieffs in 1944 when they were living in New York, to produce on the pin-screen one of the *Chants Populaires – En Passant.* This was included in *Chants Populaires No.5* along with McLaren's *C'est l'Aviron. En Passant* is unfortunately no longer distributed because of poor sound quality)

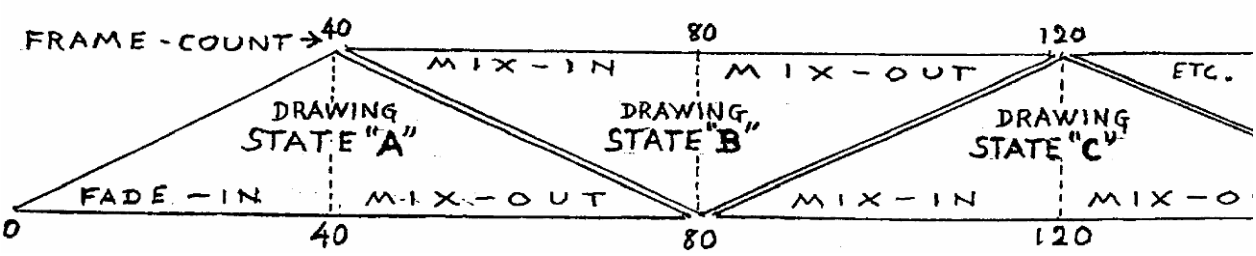
Guy Glover (1973)

Technical Notes on *La Poulette Grise* (1947)

The music was recorded first, and the lyrics of the folksong served as a basis for the visuals.

The visuals were shot in 16 mm by a continuous chain of abutting 40-frames camera mixes or dissolves, with the camera trained on a single colour-pastel drawing, which was modified between each mix.

A simple diagram may show this process more clearly.



The initial drawing (STATE “A”) was faded-in from frame zero to 40, and mixed-out from 40 to 80. The film, without being exposed, was wound back to 40.

The drawing, by adding or removing pastel, was changed to STATE “B”, which was then mixed-in from 40 to 80, and mixed-out from 80 to 120. Once again the film, without being exposed, was wound back from 120 to 80.

Again the drawing was changed to STATE “C”, which was mixed-in from 80 to 120, and out from 120 to 160, etc. etc.

As a result of this technique, the drawing was put into a continuous state of flux or metamorphosis.

Different areas of the drawing were made to metamorphose at various speeds. While some areas remained static between states, other changed slowly, moderately or rapidly.

Generally, the area of primary interest in the drawing had the swiftest change. Further, sometimes only a minute detail would change during one mix, while at other times the whole drawing might do so.

From time to time the card used for drawing on, due to the application of so much pastel, and to so much rubbing-off and changing of the pastel became slippery and would not hold further pastel. As such a time approached, I would simplify the imagery to such an extent that it was easy to copy it on a fresh card. It did not have to be an absolutely precise copy, since the metamorphosis called for a slight change anyway, and I contrived to make card-changes at the pauses between the verses of the song.

Final Observations on Mix-Chain Metamorphosis

In my opinion, the metamorphosis of a drawing (or painting) by the mix-chain technique is especially effective when the drawing is in soft-edged and blurred chiaroscuro, or is rendered in pointillism and broken texturing, or even in fine or loose cross-hatching. Mix-chains are much less suited to clear-cut linear imagery or hard-edged areas.

Although to date, I have used either 40 frame or 48 frame mixes; chains may be made of much longer or much shorter mixes. Chains in which the mixes are 3, 4 or 5 frames long produce their own distinctive effect.[1]

Norman McLaren (1947, revised in 1984)

[1] For details on making long chains of very short mixes see paper on “Very Short Mix-Chain Technique”.

Technical Notes on *Rythmetic* (1956)

The Visuals

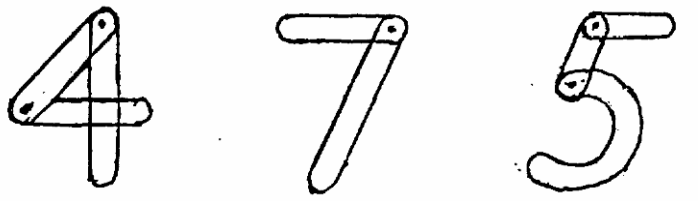
The numerals (about 1 ½ or 4 cm high) were cut out of stiff white paper, and animated on a large black card on the animation table-top.

For precise positioning of the numerals we drew lines and marks on the card using a dark red pencil, well sharpened to give a very fine line. Because of the fineness of the line and the darkness of the red on the black, the camera did not pick up the lines, but they were clearly visible to the animators who were relying on them for proper line-up, and moving of the numerals.

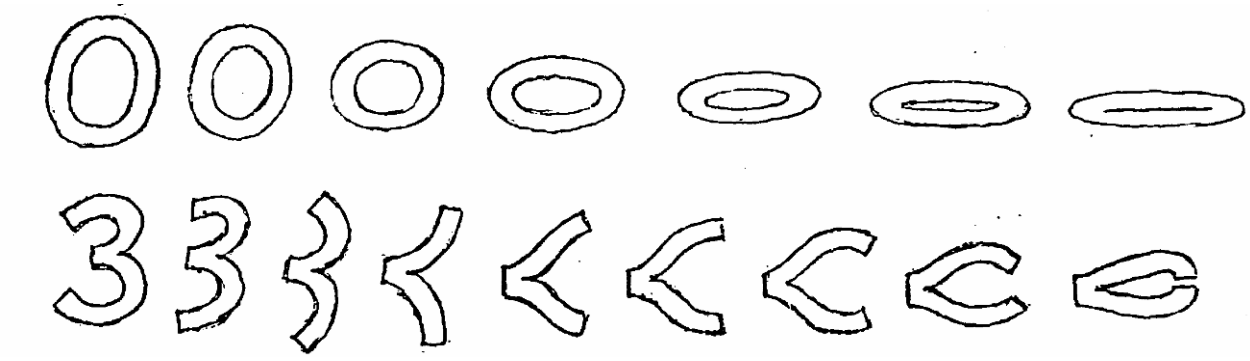
Such dark red marks, in the shape of small ticks, permitted preplotting of the calibrations of much of the animation.

The basic cut-outs of the numerals were rigid, in other words, we could not animate their internal form, only slide them around the field.

To get internal flexibility we used two methods. With numerals 4, 7 and 5 we jointed their elements where the dots occur:



With numerals such as zero and 3, we made a series of replaceable cut-outs:



In addition, the numerals appear and disappear with very short 10-frame fade-ins and fade-outs. These fades were not done with the camera; instead, for each numeral, we made a series of ten replaceable cut-outs, in progressively darkening shades of grey, from white to black. This method of fading involved less labour than using the camera for the great number of fades that we had to do.

From the black-on-clear negative, a high contrast master positive and a dupe negative were made; these were used with colour filters in the optical printer in two successive passes to colour the numerals and the background.

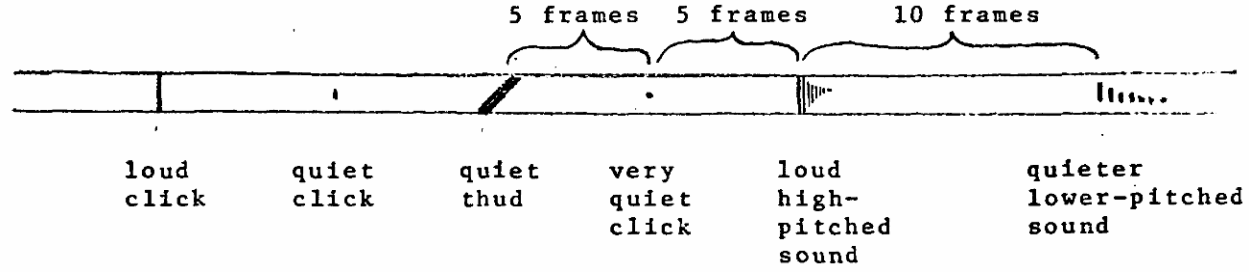
The Soundtrack

The soundtrack was made after the picture was completed. The popping-on of the numerals and arithmetical signs and their actions had all been shot in units of 5, 10, 15, 20, 30, 40 or 60 frames. This provided a steady, recurring rhythmic structure for the 'music'.

This 'music' was made by engraving small marks on the soundtrack area of black emulsion-coated 35 mm film, with a knife, razor blade and stylus or needle. Broad knife-strokes gave deeper pitches, very thin needle-scratches gave high pitches. Strokes going fully across the soundtrack were loud; strokes going only partially across the track were quieter. The degree of quietness could also be controlled by how diagonal a stroke was. Strokes at right-angles to the track had maximum volumes; the more sloping a stroke was to the track the less volume it gave. [1]

Many of the peeps clicks, clacks, clucks and thuds consisted of only a single scratched stroke on every fifth or tenth or twentieth frame. Percussive sounds that had a more definite pitch consisted of several scratched lines closely grouped together.

Examples of scratching on soundtrack (enlarged):



This directly engraved original track served as a master to rerecord from. During the rerecording slight amounts of reverb were added here and there. Because of the rerecording, the appearance of the track on release prints is that of standard variable area.

Norman McLaren (1956, revised in 1984)

[1] For further details see "Technical Notes on Handmade Soundtrack".

Technical Notes on *Serenal* (1959)

The music was selected first (from the NFB's music library). After being transferred to 16 mm magnetic film, it was run on a moviola, so that the rhythm, beats and phrasing could be measured.

The visuals were scratched or engraved on 16 mm black leader. Much of the snow-flakelike imagery was made by a hand-held electric-drill, with various styluses and knife-blades inserted in its rapidly vibrating point. Such engraving disregarded the frame-line, and was done in large sweeps along the length of the film in synch with musical phrases. Further animation was done frame by frame with an exacto knife and stylus.

The imagery was then coloured with acetate dyes, applied frequently to both sides of the film, and further engraved to give combinations of the colour on either side on a ground of them both together.

Technical Notes on *Mail Early for Christmas* (1959)

This film was made in an almost similar way as *Serenal.*

Norman McLaren (1959)

Technical Notes on *Short & Suite* (1959)

The picture was made to accompany some music composed by Eldon Rothburn, which I found in the NFB sound library.

The visuals were made in two stages. Images were etched on black 35 mm, and hand coloured with transparent dyes.

From this a high-contrast black-on-clear master was made.

For the final colour negative, the etched-coloured original and the black-on-clear master were used in succession in the optical printer. The coloured original printed only the coloured images; then the black-on-clear master with the addition of colour-filters controlled the colour of the background. The optical printer was also used to offset some of the images.

Norman McLaren (1959)

Technical Notes on *Spheres* (1969)*

Foreword

In 1948, René Jodoin and I set ourselves the exercise and goal of making an abstract film which would use only sphere-like circles whose animation would be restricted to constant motion.

Accelerations and decelerations were so much a part of the motion and interest of abstract as well as figurative animated films that we wished to discipline ourselves with the challenge of constancy. The greatest risk we could run would be that of mounting monotony. We would attempt to compensate for this by gradually increasing the number of spheres, and the paths they followed; but here again we limited ourselves to straight-line, horizontal, vertical, diagonal and circular paths movement.

Technique

The "spheres" were moveable cut-outs; each was a thin flat metal disc painted to look like a sphere. Theses discs were animated frame by frame on a block card, upon which their paths and motion had been pre-calibrated faintly in dark red pencil, which was invisible to the camera.

The film was in three parts. In part one, we restricted the motion to a flat surface, and then superimposed (by a second pass in the camera) a constantly changing coloured background, made by a continuous chain of mixes.

In the second part, the motion is also almost entirely on a flat surface, but by superimposing panning background, the spheres appear to drift or float in the sky.

In the third part, we superimposed multi-plane zooming backgrounds (in much the same way as in *C'est l'Aviron*), so that the spheres appear to be traveling through depth and space.

Furthermore, we made the 'spheres' themselves appear to approach and recede. To do so, we prepared in advance a series of 40 different-sized discs graded from about ¼" to 4" (6 mm to 102 mm) in diameter, all painted like spheres. While shooting, if we wished a 'sphere' to recede, we replaced it with a smaller sphere and on successive frames, kept replacing it with the next smallest in the series. To make a 'sphere' approach, we reversed the procedure.

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* Visuals shot in 1948. Music added & film released in 1969

Afterword

On completion of the picture, we considered the film as a whole (though perhaps calming to the nerves) to be visually too monotonous for release. We tried accompanying it with many sorts of existing disc music, but none seemed to fit, none seemed even to hint at an appropriate kind of soundtrack, and I didn't have the effrontery to ask a composer to write a special score, for I considered he would find the picture too uninspiring.

About every five years I would screen and asses the picture, but always decided to put it back on the shelf.

However, about twenty years later, 1968, its visuals seemed definitely more tolerable (perhaps because of my exposure to the 'minimal' and geometric 'op' art movements of the 1960's).

It was at this same time that I had recently purchased a recording of J.S. Bach's 96 Preludes and Fugues, as played by pianist Glenn Gould. One day while listening to them, it suddenly occurred to me that the constant, steady and flowing motion of some of the slower fugues and faster preludes might be just the right kind of accompaniment for the 'spheres'.

Playing selected cuts from the disc with each of the parts of the film, confirmed that many of the fugues and preludes not only fitted but greatly enhanced the visuals, elevating them to a plane that might justify releasing a marriage of them both as a film; of course, I was in no doubt as to which was the superior partner in this alliance.

After considerable searching, I fortunately found that Fugue 22, Prelude 20 and Fugue 14, apart from being right in tempo and mood, were also of the same duration as the three visual parts of the film; in only one case did a repeated musical phrase have to be omitted.

Gould, who was shown a picture-plus-music cutting copy, approved of the marriage, and preferred that we use his performance on disc, rather than make a new recording specially for the film, because he could not guarantee the precise durations if he recorded anew.

Norman McLaren (1969, revised in 1984)

Technical Notes on *Synchromy* (1971)

Around 1950, Evelyn Lambart and I worked out a method of shooting soundtrack optically on film, without using a microphone or regular sound system, but with the use of an animation camera. We called it “animated sound”, because it was shot frame by frame, onto the soundtrack area at the edge of the picture.*

For pitch control we used a set of 72 cards, each having stripes or striations, and each representing a semi-tone in a chromatic scale of six octaves. The more stripes the higher the note, the less stripes the deeper the note.

Our first set of the cards (with which the music for *Neighbours* was made) had soft-edge undulating stripes, corresponding roughly sine-wave sound. A later set of cards had simple hard-edge black-and-white stripes, corresponding acoustically to square-wave sound. It is with the square-wave cards that I shot the music for *Synchromy.*

The volume was controlled by varying the width of the soundtrack. A moveable shutter, controlled this width. If the shutter was almost closed, the extremely narrow band of striations would give a pianissimo note. If the shutter was wide open, the broad band of stripes would give fortissimo. All intermediate degrees of volume were possible by regulating the position of the shutter, which was calibrated in decibels.

In *Synchromy* the music was composed first, and filmed by the above method. It started with a single musical part, later to be joined by another, and finally by a third (mid pitch, treble and bass).

These three parts were shot on separate strips of film, which were rerecorded and finally mixed in the normal manner onto magnetic tape and thence to standard optical track for release prints.

The Visuals

To create the visuals the three-striated card soundtracks were kept separate and in their striated form. By means of an optical printer they were moved over into the picture area of the film.

Since the shape of the soundtrack opposite a single frame of film is a long, narrow column, and since the visual frame is rectangular, it was possible to fit as many as eleven columns for soundtracks, side by side in the picture area.

* See “Technical Notes on Animated Sound by the Card Method” available from the NFB.

At the very outset of the film, where there is just one musical part, only the central column carries the striations; but somewhat later the same striations are moved into one or more of the other columns.

What is on the screen, be it in one or several columns, is strictly the striated images of the original sound shot with cards. Thus, there is exact parallelism between sound and image. When the second and third musical parts enter they are clearly visible as such.

While optically shifting the soundtrack into the picture area, we added colour by filtering a black-and-white master positive, and its dupe-negative. We opticalled one column at a time (the rest being masked off).

In column with no striations, or with just white striations on a coloured ground only one pass was needed.

Where there were coloured striations on coloured ground, two passes were needed, one using a clear-on-black master positive, the other using its matching black-on-clear dupe negative.

Towards the end of the film, where all eleven columns were active, if we wished both ground, and striations to be coloured, 22 passes were required.

Variety was given to the visuals by frequently changing the track positions from one column to another. In general the colouring was changed at the beginning and end of musical sentences or phrases for variety's sake; although no "colour-sound-theory" was relied upon, pianissimo passages were usually in mutes hues, and fortissimo passages in highly saturated contrasting hues.

Apart from planning and executing the music, the only creative aspect of the film was the "choreographing" of the striations in the columns and deciding on the sequence and combination of the colours.

Norman McLaren (1971, revised in 1984)

Technical Notes on *Stars and Stripes* (1939), *Boogie Doodle* (1940), *Dots* (1940), *Loops* (1940), *Mail Early for Christmas* (1941), *V for Victory* (1941), *Hen Hop* (1942)

The Visuals

The visuals of the above films were drawn directly on clear 35 mm film with pen and India ink. This produced a black-line image original (first generation). From this was made a clear-line-image-on-black print (second generation), and then from this a black-line-image-on-clear print (third generation).

The second and third generation prints were used to make colour prints on a now defunct 2-colour black & white separation process (Warner Colour System). This process used two dyes, red and blue; two passes were needed to make the final colour print.

Printing the second generation print (clear image on black ground) with the red dye produced a red linear image on a clear ground. Then, with a second pass, using the third generation print (black-image-on-clear) printing for the blue dye produced a blue background with an unexposed linear image.

The final result was a red linear image on a blue ground.

If the red and blue dyes overlapped the result was black; if they underlapped the result was clear. By slightly horizontally off-setting the printing of the 2nd & 3rd generations with each other, the red-line image developed a black edge on one side and a clear edge on the other side. This off-setting method was used in several of the above films.

In *Mail Early for Christmas* panning and zooming backgrounds, shot originally in black and white, were superimposed on the linear images.

The Soundtrack & Synchronization

The soundtracks of the above films (with the exception of *Dots* & *Loops*) were recorded prior to the visuals. For synchronization in all such cases, the soundtrack was then threaded on the sound head of a moviola with blank leader on the picture head. With both running interlocked (often at slower than normal speed), the musical beats, phrases and sentences, were tapped out on the blank leader with grease pencil. The leader was then run through a frame-counter and the distances in terms of frames between grease pencil marks measured as an accumulating total, from which the number of frames between each beat could be derived.

These measurements were written down on a “dope-sheet” which provided all information necessary for synchronization (where needed) of the visuals with the sound. This is, of course, one of the usual standard practices for synchronizing animation to pre-recorded soundtrack.

The soundtrack for *Dots* & *Loops* was drawn and painted directly on 35 mm film. See separate Technical Notes for this.*

Norman McLaren (1985)

Technical Notes on *Five for Four* (1942), *Dollar Dance* (1943), *Hoppity Pop* (1946)

Visuals

The visuals of these three films were made in the same way as the seven films grouped under *Stars and Stripes*, except that a 3-colour black-and-white separation process, rather similar to Technicolor, was used (VITA-COLOR, now defunct). Its dyes were yellow, magenta and cyan.

Three parallel originals were prepared as the separations; in the case of *Hoppity Pop,* with different images on each separation. For *Five for Four* one of the separation carried photographed black and white panning backgrounds.

Soundtrack

In all three films the music came before making the visuals. *Five for Four* used boogie-woogie piano lifted from a disc. *Dollar Dance* had a special score written by L. Applebaum with lyrics by N. McLaren and Guy Glover. The old-fashioned calliope track for *Hoppity Pop* was found in the NFB music library.

Norman McLaren (1985)

* Footnote : Handmade Soundtrack

Technical Notes on the Card method of Optical Animated Sound (1952)

As developed at the NFB of Canada by Evelyn Lambart and Norman McLaren (1952) and as used in

Film Title	**Music Composer**
Neighbours	Norman McLaren
Two Bagatelles	Norman McLaren
Now is the Time	Norman McLaren
Korean Alphabet	Norman McLaren
Synchromy	Norman McLaren
Canon (partial)	Eldon Rathburn
Opus 3	Pierre Hébert
Around Perception (partial)	Pierre Hébert
Phantasy (partial)	Maurice Blackburn

The synthetic music of the above films was made without the use of traditional instruments, microphone or sound recording apparatus by a non-magnetic optical method.

Early Optical Sound Systems

Before the advent of magnetic sound recording for music, voice and sound effects, two different optical systems were in general use.

Variable Area
(In its simplest form)
Waves in black and clear.

Variable density
(see footnote)
Waves in shades of grey

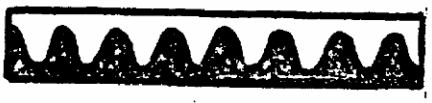
Both activated the projector's exciter-lamp similarly so as to produce identical sounds.

The Pitch

In both sytems, pitch was controlled by the frequency of waves per second; thefewer the waves, the lower the pitch; the more, the higher the pitch.

Variable Area

LOWER PITCH



HIGHER PITCH

Variable density

The Volume

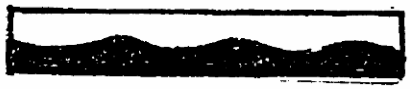
Variable-area volume was controlled by the size or amplitude of the waves

Variable-density volume was controlled by the amount of contrast between the light and darks of the waves

HIGHER PITCH

Big waves

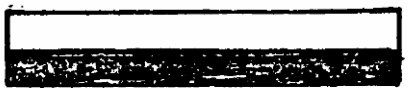
Waves ranging thru grey tones from black to clear.



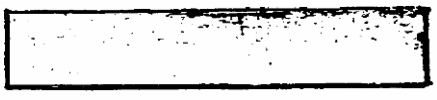
LOW VOLUME

Shallow waves

Low contrast in close tone of grey



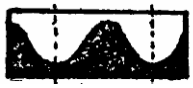
SILENCE

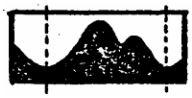


No waves

Uniform tone of grey

The Tone Quality

The tone-quality (colour or timbre) of a note depends on the particular shape of the wave. Above we used an approximate sine-wave  which gave the soft pure tone of a tuning fork.

Adding one harmonic to the wave  gives a slightly less soft tone, such as can be made on a violin played softly.

Adding many harmonics  gives a strident tone such as that of a brass instrument.

In fact, there are countless wave-forms, each having its own distinctive tone-quality.

A wave may even be square  having in theory an infinite number of harmonics, and sounding extremely strident.

Early Attempts in Synthetic Optical Sound

In the late 1920's and early '30's, early experimenters tried photographing graphic patterns on the soundtrack area of the film to produce music. Most of their work was done in Europe and the USSR, mainly using variable area. Being interested in creating new tone-colours, they used repeated shapes such as circles, triangles, squares, ovals, etc., rather than conventional sound-wave forms.

The best-known example of a completed film using such graphic sound is *Toenende Handschrift* (*Tonal Handwriting)* made in Switzerland by Rudolph Phenniger in 1931. The first part of this short film is a documentary showing his method of shooting variable-area cards frame by frame; the latter part was a cartoon with music made in this way. His card-pattern resembled conventional sound waves; the style of music was also conventional, but distinctive by the use of extremely rapid arpeggios and runs.

I saw this film in the '30's, and kept it in mind for further exploration as a valid and useful way of making truly animated sound, and particularly to accompany animated films.

Animated Sound at the National Film Board of Canada

In the mid-1940's, Evelyn Lambart and I began experimenting with optical graphic sound, and gradually developed it into a simple and practical method for creating music. It has been used in the films listed at the start of these notes.

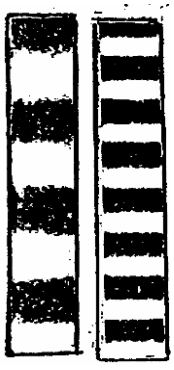
35 mm animation camera with a full-aperture gate, which included the soundtrack area, on the left on the picture, was used.

Graphic patterns on cards were shot frame by frame onto this soundtrack, no use being made of the picture area (except perhaps to identify the pitch of the card being shot).

Since the sound was shot one frame at a time it would be truly correct to call it "Animated Sound".

At first we tested a wide variety of methods, such as using repeated geometric or arbitrary variable-area shapes, and controlling the volume by a range of neutral density filters over the camera lens.

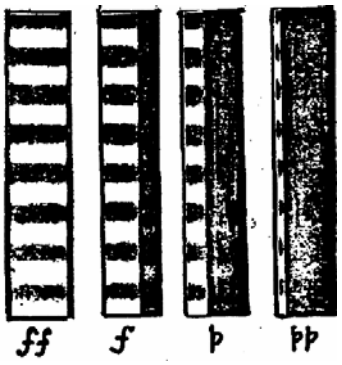
In the end, we found the best and simplest method to be a combination of the variable-density and variable-area system; variable density to control the pitch, variable-area to control the volume.



Each pitch-card had stripes or striations running across the full-width of the soundtrack area, similar to the full-volume variable-density waves.

For volume control we narrowed down the width of the track by a black mask or shutter placed above the card

.



The Cards

We prepared a series of pitch cards, one for each semitone of the equal-tempered chromatic scale, covering five octaves, from two octaves below “middle-A” to three octave above. Our “middle-A” was planned to give standard international concert pitch of 440 cycles-per-second, thus permitting us, if we so desired, to rerecord our animated music together with traditional instruments.

The cards were about 4” x 20” (10cmx51cm) and the actual area photographed by the camera was a column of about 1 3/16”x13” (3 cm x 33 cm).

Each card had a small label indicating its pitch in staff notation. The cards were assembled in a box, five rows of twelve, one row for each octave. The box stood close to our animation table, convenient for the desired pitch-card to be selected and placed on the table top in such a position that it would be photographed precisely on the sound-track area of the film when the single-frame button was pressed.

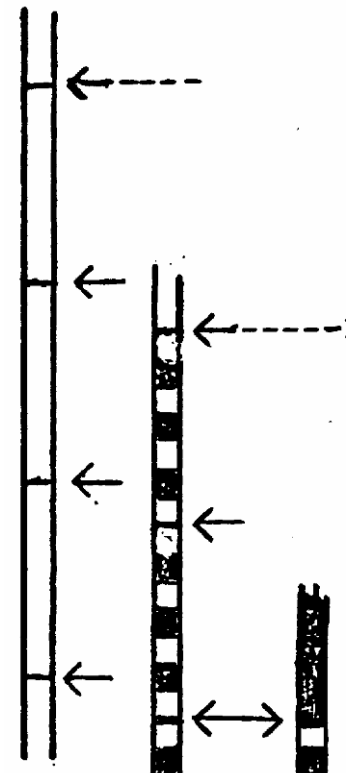
When the exposed negative was developed and printed on a continuous printer, the print, if run on any optical sound system, (projector, moviola or steenbeck) would be heard as music; transferred to magnetic it would serve as a work print.

An interesting feature of it was that each note was completely dry or without reverb, so that if run in reverse, the music did not have the backward-sounding quality typical of instrumental music run in reverse.

At a later date, we made a set of cards with hard-edge black & white stripes, covering a semi-tone range of six octaves (three below and three above “middle A”). These square-waves created a much more strident tone-quality than the sine-wave cards. (The sine-wave cards were used throughout most of *Neighbours*, while the square-wave cards were used entirely in *Synchromy.*

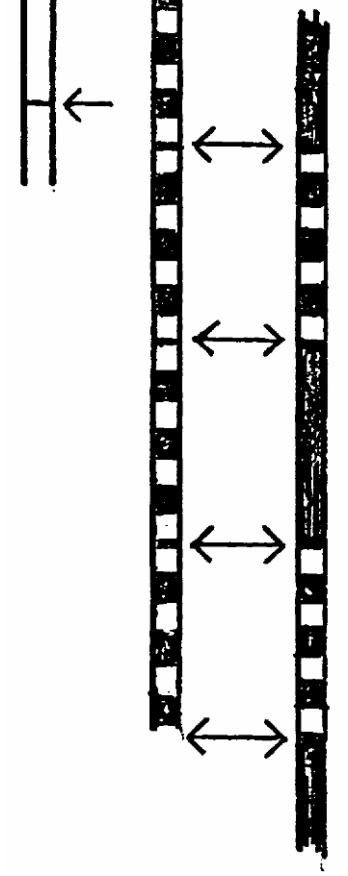
The square-waves, being rich in harmonics, had the advantage that, during re-recording, much frequency-filtering could be used to change their tone-quality.

The Sound-Track Area & The Frame-Line



Frame-line – Opposite one frame of the picture, the soundtrack area would normally be a simple rectangular column, with the frame-line separating each frame.

Frame-line – If the same pitch-card were shot on every successive frame, during play-back, in addition to the sustained pitch of the card, the frame-line would create a 24-cycle-per-second "purring" sound, faint but audible enough to be undesirable.

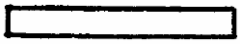


←Frame-line – If, however, the same pitch-card were shot on every other frame, with one black unexposed frame between each note, no 24-cycle "purr" would occur. The pitch would be heard as the same note repeated 12 times a second, which is very rapid, and about the limit of rapidity that the player of a traditional instrument can repeat a note.

This tends to classify the card-method as a non-sustaining instrument (such as guitar or balalaika). But not entirely so, because, if a different pitch-card is filmed on every adjacent frame, no frame-line "purr" can be heard, so that complex arpeggios, thrills, and runs of 24-notes-a-second can be produced with rapidity well beyond performance on a traditional instrument.

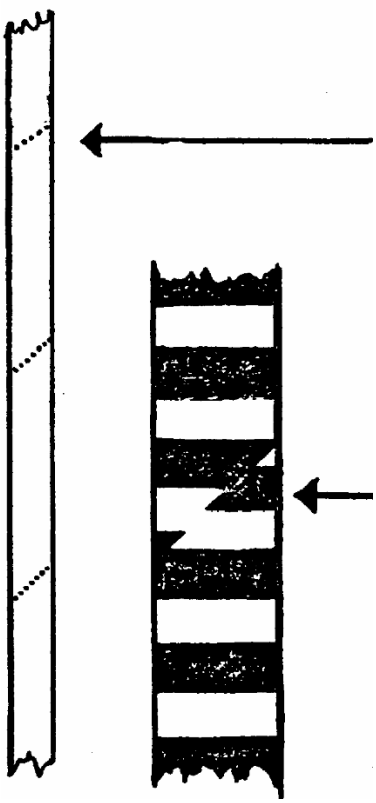
For most music it was not necessary to shoot a note on every frame. For a very rapid passage of eight notes per second, two black frames were left between each exposed frame; for six notes per second, three black frames between each note; for four notes per second, five black frames; for three notes per second, seven black; for two notes a second, eleven black; for one note per second, twenty three, and so on. It should be kept in mind that the resonance of a one-frame note could be greatly lengthened by adding reverb during rerecording.

The Envelope of a One-frame Note

The simplest shape or envelope of a one-frame card-note is an elongated rectangle  ; the closest equivalent in traditional sound is an extremely brief organ note played in a completely sound-dampened environment: sudden attack, very short sustention, abrupt stop. A short piano note has a very brief attack, almost no sustention and a logarithmic-type of decay, short or long depending on the use of the foot-pedal and the force with which the note is a struck. A tap on a wood block has usually a sudden attack, no sustention and a very brief decay. A violin, like the human voice, is capable of almost any kind of attack, sustention and decay.

Our unreverbed one-frame notes had a sudden attack, a 1/24th of a second sustention and an abrupt decay.

Sustained Tones and Notes Longer than 1-Frame

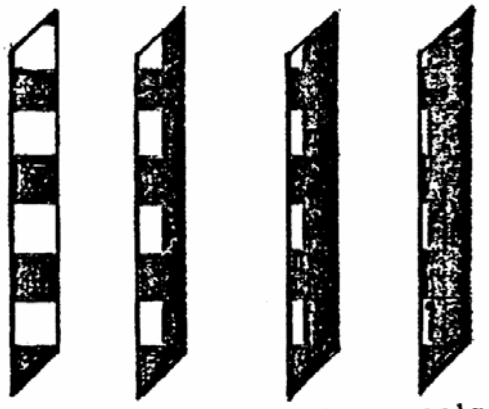


In the hope of getting “purries” sustained tones, we had the camera’s frame-line on the soundtrack side shaved away completely, at a diagonal slant. However, we found that if many adjacent frames were shot with the same pitch, this did not result in a completely pure sustained tone.

The reason for this was that the number of stripes or striations for most pitches did not fit precisely into the length of a frame, which caused a bad link-up between one frame and the next; and since these bad link-ups occurred 24 times a second, they still created a 24-cycle “purr”, but a much quieter “purr” than that made by our non-diagonal unshaved-away frame-line. So much quieter that the same pitch could be used in two; three and even four adjacent frames, without the “purr” being heard. With more than four, the “purr” became slightly perceptible.

To get completely purrless sustained notes of any lengths, we eventually had our cards notched in such a way that they could be shifted slightly forwards or backwards, between the shooting of each frame, so that the stripes would properly link on to each other. We did this only for the bottom three octaves; it became impractical for the top three, as the necessary shifts became too small to be manageable.

FIGURE I



Volume-control & Basic Envelope Shapes

As mentioned above, we controlled the volume by narrowing down the width of the soundtrack by means of a black shutter or mask placed above the card.

Originally, we used only one such mask, but later we found that by using two masks, one on either side of the rectangle, each able to pivot at either end and move sideways, we were able to have two other 1-frame envelope shapes, making a total of three basis envelopes for a single frame.

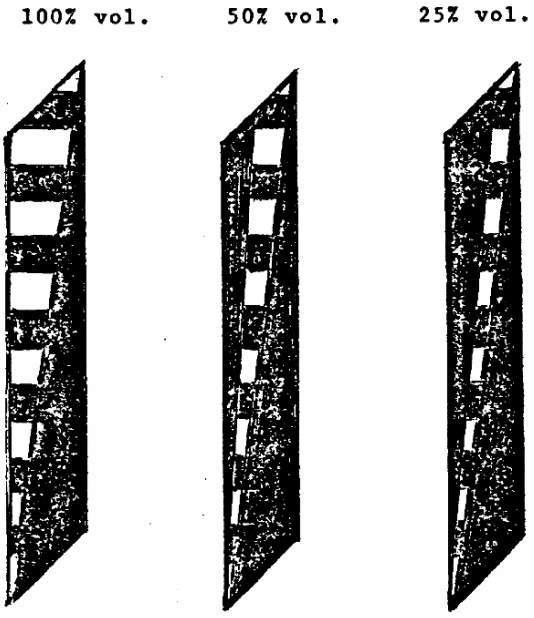
FIGURE 2

The “instrumental” difference between these one-frame envelopes was perceptible, even it slight.

The sloped rectangle (1) sounded rather like a very brief dry organ note; the slow decay triangle (2) like a very dry staccato piano note; the gradual attack triangle (3) like the start of a wind instrument with a sudden cut-off.

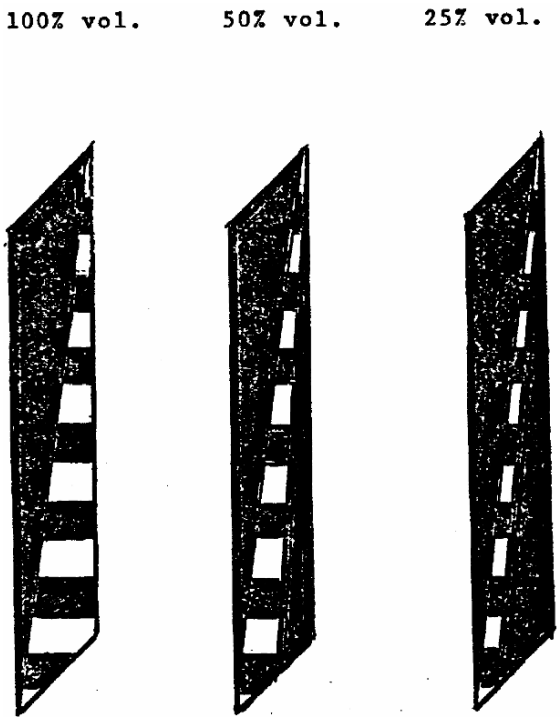
To control the volume of envelope “1”, we used only the right-hand mask, as illustrated in figure 1.

Figure 3
Quick-attack, slow-decay



With envelope “2” the right-hand mask was anchored in a fixed position, while the left-hand mask was used pivot-fashion to control the volume.

Figure 4
Slow-attack, quick-decay



With envelope “3” the left-hand mask was anchored in a fixed position, while the right-hand mask was used to control the volume.

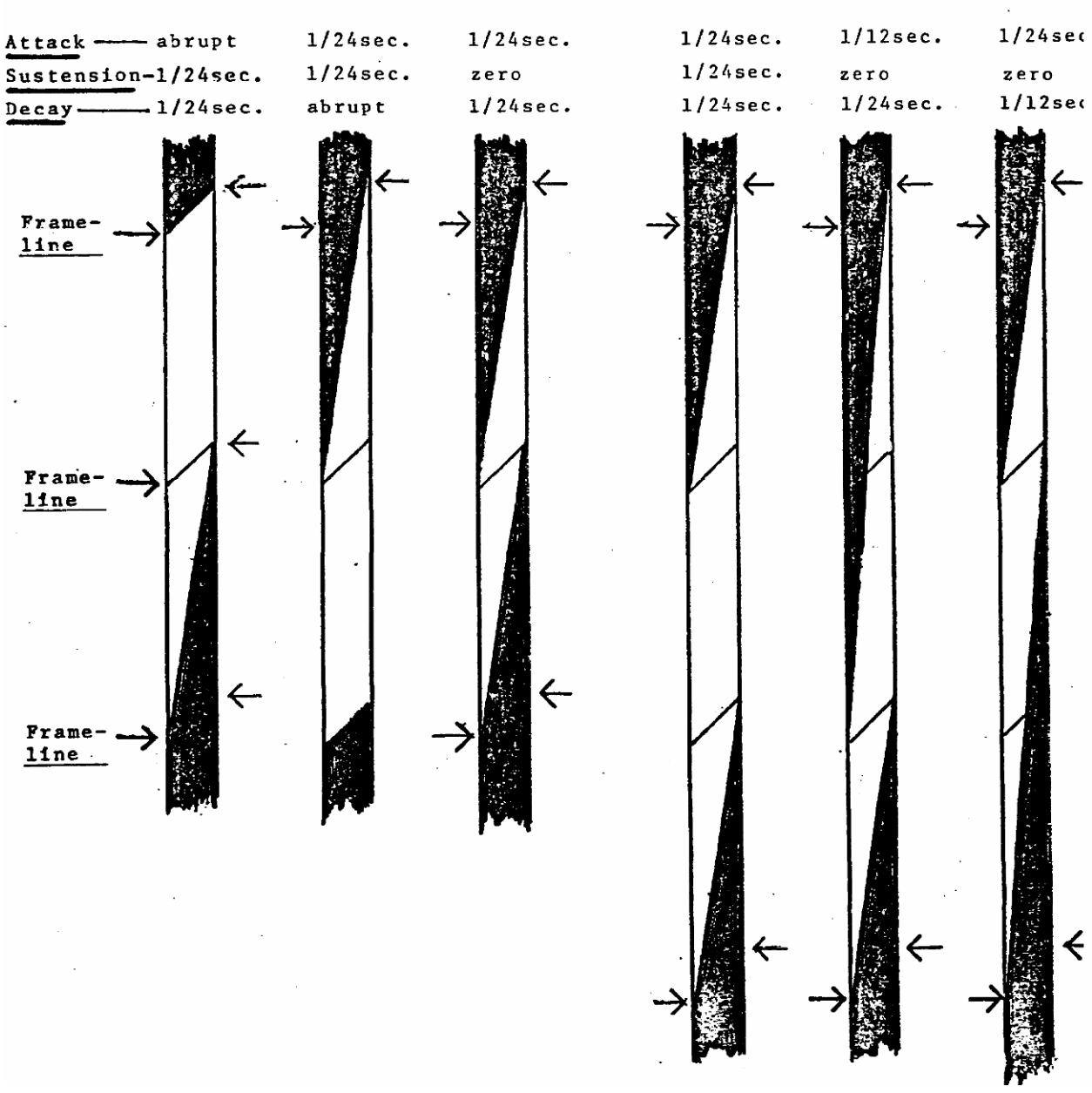
The movement of the masks was made by levered handles, which bore a thin hair-line, above a fine-line scale marked off in 25 degrees of equal volumes; as intermediate positions could be used, a range of over 100 degrees of volume was possible.

Notes Longer than 1-frame, with Various Envelopes

Since the “purr” from imperfect link-up of the striations could not be heard on less than four adjacent frames of the same pitch, and since the two volume-masks could be move sideways as well as pivoted at all four corners, various 2-, 3-, and 4-frames envelopes for a single note were possible. Most gave a perceptibly different “instrumental” character to the note, apart from extending its duration.

Some 2-frame envelopes

Some 3-frame envelopes



Note: White represents enveloped sound. Black indicates masked-off area.

General Remarks

Re-recording

For harmony, counterpoint, and music with more than one part, we shot each musical part separately and lined them up in parallel for rerecording in a final-mix. This allowed for flexibility in the acoustic and dynamic treatment of each part.

The Musical Score for Shooting with the Card System

This took many forms, but in all cases the composer, apart from keeping a cumulative frame count and indicating the number of black frames between each note, had to determine the precise volume or dynamic level of every note. In traditional music scoring this is not done. The standard pp, p, mf, f and ff, etc. indicate relative and approximate volume, and are never applied to every single note in a score, and their final determining is left to the interpreting artist; but in creating animating music the precise dynamics of every note was the job of the composer, who was usually the performer.

Since the advent of electronically synthesized music, it has, of course, now become common practice for composer-performers to determine precisely the volume, the envelope and all other factors of each note in his score.

The one important aspect of this optical animated card method is that the sound or music has to be thought of in terms of twenty-fourths of a second which is a great convenience for the animator, if he is at all concerned with exact synchronization of the picture and sound.

Norman McLaren (1952, revised in 1984)

P.S. Since the introduction of magnetic tape, electronic and other methods of synthesizing sound and music, the reader may conclude that this optical card method has been overtaken by vastly more sophisticated and flexible methods. This is true, except that the card method should not be considered obsolete, but rather as just one more specific musical instrument with its own limitations and particular characteristics. The above technical description may have made it seem complex, but in actual fact, it is an easy gadget to operate, its use can be learned in a very short time, and its possibilities have far from been fully exploited.

Norman McLaren (1985)

Handmade Soundtrack for Beginners (1969)

Making soundtrack directly on film (35 mm or 16 mm) without the use of a camera or recording apparatus and as used in the films *Rythmetic* & *Mosaic*.

There are at least two possible methods: 1) drawing with pen or brush and ink on clear film; 2) engraving or scratching black, or opaque coloured leader with knife, needle or stylus.

The clear film method, although I used It for *Dots* and *Loops*, is not recommended, as the clear ground, while working on it, readily picks up dirt and dust, and this makes undesirable noise.

The black film has not this disadvantage and can be handled fairly carelessly as far as dirt is concerned. 35 mm or 16 mm film where the soundtrack is black and the picture-area clear, or in a different density from black is preferable, as it shows the exact width of the track.

It is a better to scratch on fairly recently developed film, when the emulsion can be removed with ease. Avoid old film, especially if it has lain around inaan unsealed can in a hot dry room, for the emulsion becomes hard and is difficult to scratch off.

No attempt should be made in any way to imitate the appearance of a standard optical soundtrack, be it variable density or variable area. The result will most likely be a confused jumble of noise.

A good approach to discovering the possibilities is to take a strip of black film, or film with a black soundtrack area, two or three feet long. Make a single scratch on it, join the film into a loop and run it on a moviola or projector. The scratch will give a click with a certain quality. The splice in the loop may also make a click. This may be eliminated by covering it with a small piece of opaque adhesive tape. Or, it may be incorporated into the rhythm. For this description, I am assuming it is eliminated. Next, take the loop off the projector and make another type of scratch with a different size and shape, at least 4, 6 or 8 frames away from the first scratch, run the loop again, and you should hear two clicks, each with a different quality; one may have a hard sound and the other a soft sound, or one may be loud and the other quiet. Identify which is which.

If the two clicks sound the same (even if made by different types of scratches, which is possible), add still another type of scratch to the loop and run it again.

By adding various types of scratches one by one, and by identifying them as you go, you will learn what kind of scratch gives what kind of sound.

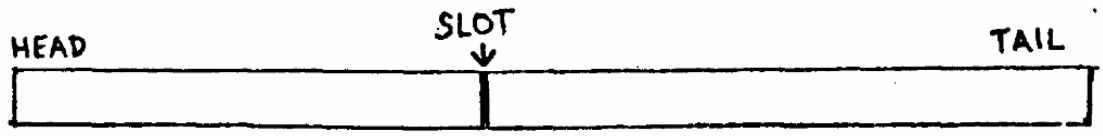
Varying the distance between scratches will help to identify them, and also it will lead you to discover the rhythmic possibilities of distributing the scratches in various ways on the loop.

In fact, once you have found, say, three or even two different types of click, especially if they are of different loudness, you should plan a new loop in which your concern and interest is to make an interesting rhythm.

Having experimented with loops you may drop the loop method and attempt a continuous soundtrack.

It should be kept in mind that the soundtrack is scanned by a thin slot of light,

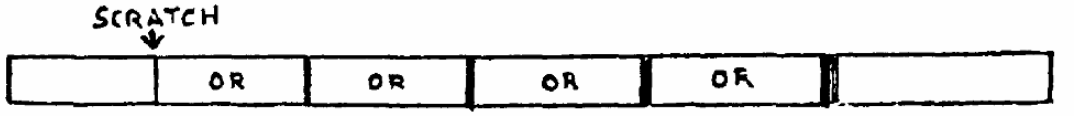
Example #1



and that the sound is caused by the fluctuation of the light.

If the light is made to fluctuate suddenly and fully by a scratch covering the complete width of the soundtrack like this:

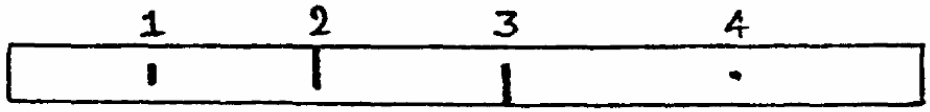
Example #2



the volume will be loud.

If the light slot is made to fluctuate only partially, the sound will be quieter:

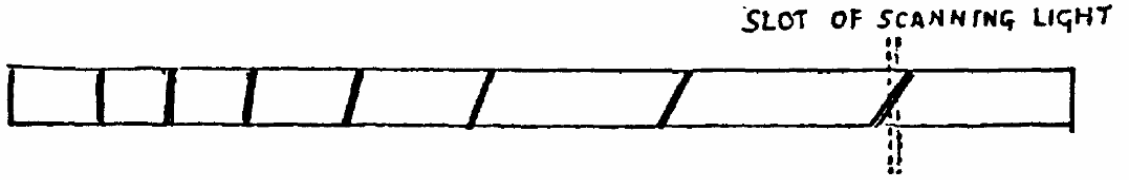
Example #3



No. 1 is quieter than 2, or 3; and 4 is quieter still. Nos. 2 and 3 should be equally loud; if you think in terms of the slot scanning the track, you will readily realize that the different positions of 2 or 3 are not important; the amount and duration of light fluctuation is the same in both cases. No. 4 is quietest of all.

One can experiment with the effect of a stroke made at different angles to the length of the soundtrack:

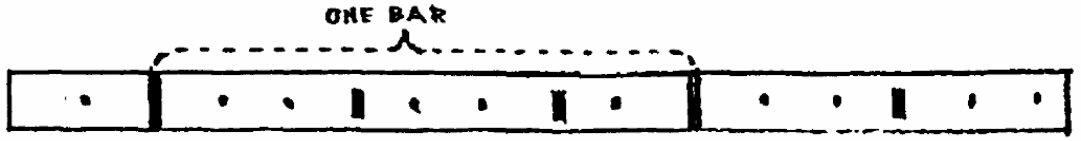
Example #4



Think in terms of what is happening to the slot of light scanning the track, and it will be obvious the more slanted the stroke, the weaker will be the volume.

The manipulation of clicks with differing volumes is very important in the creating of interesting rhythmic effects.

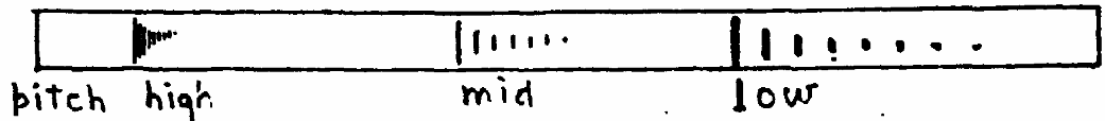
Example #5



Example #5 uses three different types of scratch, equally spaced 6 frames apart, and arranged in a rhythm of eight beats to the bar, grouped 3 + 3 + 2, a rumba rhythm. Differences in the volume of the three types of scratch play an important part in the total rhythmic effects

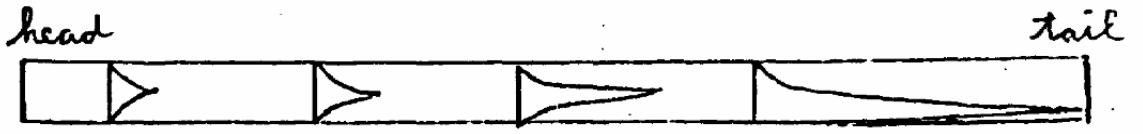
Example #6 uses small groups of scratches called envelopes, which have different pitch depending on how closely or widely the strokes of each group are spaced:

Example #6

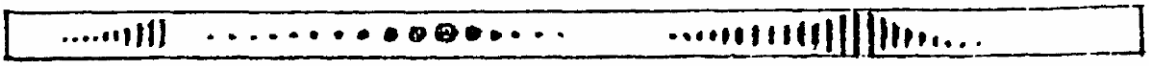


Make the scratches as neat and regularly spaced as possible, to get a definite pitch, otherwise they will result in noise.

Example #7



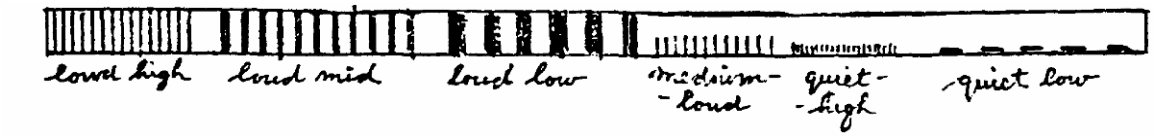
A tone “envelope” shaped as above will produce a rather natural percussive sound; sudden attack and rapid decay. You may wish to try out other types of envelopes.



In your first experiments, keep your notes separated by at least four frames; twenty-four frames apart is in a good distance if you wish to identify each note.

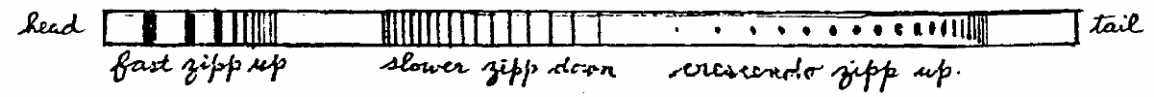
Sustained Sounds

Continuous sounds may be made like this:



Example #8

Fast zipping or ripping effects can be made this way:



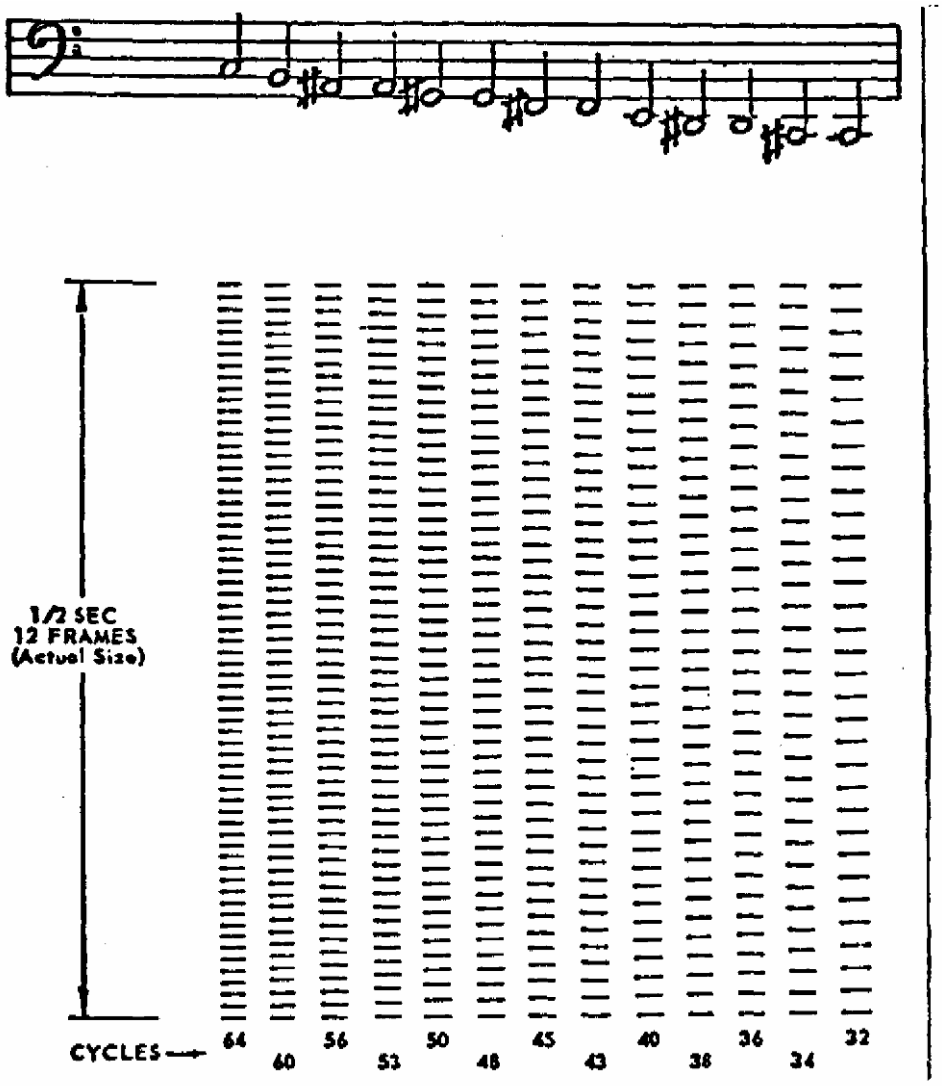
Reverberation or Echo

All direct engraved effects will have a completely “dry” quality. Be re-recording them with reverberation or echo, they will sound very differently and more “natural”.

The soundtracks of *Rythmetic* and *Mosaic* were made mainly with single-stroke scratched; however, they sound quite different because in the former film only a slight amount of reverb was added, while in the latter, a very great deal was added, and the volume boosted up after the click.

If you are particularly interested in pitched-notes, and are using 16 mm, the diagram on the next page* indicates the spacing of strokes needed to produce the semi-tones within an octave of a chromatic scale:

* Reproduced by courtesy of Kodak Ltd., from their article “Movies and Slides without a Camera”.



Norman McLaren (1969, revised in 1984)

Some Notes on Animated Sound as Developed at the NFB by the Card Method (1952)

As used in the films:

Neighbours	Canon
Now is the Time	Korean Alphabet
Two Bagatelles	Opus 3
Twirligig	Around Perception
Phantasy	Synchromy

To create the music and sound effects of the above mentioned films [1] no traditional musical instruments or noisemaking devices were used, nor were any microphones or sound recording apparatus. In their place was a small library of several dozen cards each painted with a drawing representing sound waves.

These drawings were photographed with the same kind of motion picture camera as is normally used in the shooting of animated cartoons. In fact, they were shot in precisely the same way as the drawings of a cartoon; (that is, one drawing is placed in front of the camera and one frame of film is taken, then the first drawing is removed, replaced with another drawing and the second frame of film taken, the drawing is changed again and the third frame taken, and so on).

The only difference from normal cartoon picture shooting is that the drawings are not of scenes from the visible world around us but are of sound waves, and they are not done on cards of a screen-shaped proportion but on long narrow cards. These cards are photographed not on the area of the film occupied by the picture, but to the left of it, on the narrow vertical strip normally reserved for the soundtrack.

When the film is developed and printed, and run on a sound projector the photographed images of these black and white drawings are heard as either noise, sound effects or music.

Terminology

It is therefore logical to call the kind of sound produced in this way “animated sound”, for it is made by the same method as animated pictures, and from a creative and artistic point of view it shares many of the peculiarities and

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[1] *Neighbours, Now is the Time* and *Two Bagatelles.* Music composed and photographed by Norman McLaren (with the exception of old fashioned calliope section in *Two Bagatelles*)
Twirligig and *Phantasy.* Music composed and photographed by Maurice Blackburn, the latter being written for a combination of animated sound and saxophones.

possibilities of animated visuals. It could also be called “drawn” or “graphic” sound; in the past it has frequently been called “synthetic” sound, which is correct, but since “synthetic” sound also includes sound made by new electronic and electrical instruments which do not necessarily involve the use of motion picture film, this is a more general term. “Animated” is by far the most precise term for the type of sound discussed in this.

There are a great many possible ways of making animated sound, some of which have been tried out as long ago as 1931. [(2)] These notes and remarks deal only with the particular method we have been developing during the last few years at the National Film Board of Canada.

The Drawings Used for Sound Waves

What are the drawings of sound waves like, and how are they arrived at?

There are many different ways of producing them. For instance, it would have been possible to make them by recording (i.e. photographing) “live” musical sounds onto film soundtrack, then tracing the resulting patterns from the track. However, to do this would be as pointless and creatively stultifying as to make animated cartoons by photographing live actors and tracing their outlines. Instead, in the films under discussion, a non-naturalistic approach was taken, with no particular attempt to imitate natural sounds or by traditional musical instruments. New kinds of sound waves were made by using simple and easily-drawn shapes.

The drawings consist of a basic figure or simple shape, that is repeated over and over to form a patterned band. The figure may be no more than a white line running at right angles to the lengthwise direction of the soundtrack on a dark ground or a single gradation of tone from light to dark, but, by virtue of its identical repetition, it builds up into a series of sound waves having a definite tone colour.

Pitch

Each card in our library of drawings carries one such band of repeated patterns, on an area approximately one inch wide and twelve inches long. We have one card for each semi-tone of the chromatic scale, covering six octaves, from three octaves below Middle A to three octaves above Middle A. For our lowest note the pattern is repeated between four and five times, and for our highest note it is repeated about one hundred and fifty times.

[(2)] See the paper “A Brief Summary of the Early History of Animated Sound on Film”, N. McLaren, August 1952 National film Board of Canada.

The basic principle behind the number of times that the pattern must be repeated is this: Middle A has 440 vibrations per second, that is to say, to produce Middle A on film the chosen pattern must be repeated 440 times per second, or in terms of one frame, 440 divided by 24 (for a projector running at 24 frames per second), this equals 18.33. So the card for Middle A has the pattern on it repeated 18.33 times.

To raise any given pitch by one octave the number of vibrations per second must be doubled, so the card for an octave above Middle A has the pattern repeated 36.66 times (twice 18.33). For an octave above this again 73.33 (twice 36.66). For the octave below Middle A 9.165 (half of 18.33)

The subdivisions of the octave are a more complicated matter. Good articles on this subject exist in many musical encyclopaedias and in the Encyclopaedia Britannica. It is too lengthy to discuss here.

Our pitch cards were labelled with the standard musical notation and arranged systematically in a small box to form a kind of keyboard.

When the music was being shot, the box was placed beside the camera so that the composer (who would also operate the camera), desiring a particular pitch, would select from the box the required card and place it in front of the camera.

For occasional passages with a very deep pitch, the music was shot an octave higher and twice as fast as finally desired, and in the process of rerecording slowed down by half, and thus dropped one octave in pitch.

The Mosaic Nature of the Music

Because of the fact that a picture camera takes film intermittently by the frameful (rather than running continuously as in the ordinary sound recording equipment) the soundtrack has a mosaic nature; in other words it builds up out of small units each 1/24th of a second long.

If the duration of a note is desired longer, several successive frames of the same card are shot, thus building up a sustained effect, or by a very rapid repetition of the same note, as in a mandolin or xylophone; for a very short note, just one frame or at most two frames suffice.

For rests and pauses a black card is photographed.

Dynamics

Before exposing the film, however, the composer has to determine the precise volume or dynamic level of that note. This is one of the important new factors in animated music, for in the past dynamic markings have never been written in traditional music scoring with any degree of precision.

The standard pp, p, mf, f, and ff etc., indicate relative and approximate amounts of volume, and are never applied to every single note in a score, and their final determining is left to the interpreting artist; but in creating animated music the precise dynamics of every note in the score is the job of the composer; in other words the composer must also be the interpretive artist.

To this end, 24 degrees of dynamic level were used (representing a decibel scale) and opposite each note in the score the number representing the desired dynamic level of that note was written.

For instance, 0, 1 and 2, represent three differing degrees of ppp; 9, 10, and 11, three shades of mp; 12, 13, and 14, three degrees of mf; 21, 22, and 23, three degrees pf fff. and 24 represents a ffff.

Subdivisions of these 24 degrees were constantly being used (particularly in crescendos and diminuendos) but were seldom written into score. In local or rapid crescendos and diminuendos only the starting and finishing dynamics marks were written and the type of crescendos and diminuendos (such as “arithmetical” or “geometric”) were indicated by a small sketch.

The volume was controlled by covering up the one inch wide drawing until only ½” of ¼” or other fraction of its width was visible (variable area control); the calibration was in decibels.

Tone-contouring

Not only did the composer have the last and precise word on dynamics but he was also forced to specify the exact tone-contour of each note; that is, what sort of attack, sustention and decay each tone was to have.

This is important because even more than the basic tone quality of the note, the contouring of the note affects the “instrumental” effect. In traditional musical sounds for instance, a piano note has a very rapid attack, no period of sustention, but a long period of decay; its contour is like a mountain peak with one very steep side, and one gently sloping side. A typical organ note has an abrupt attach, a prolonged sustention and a rapid decay; a contour rather like a plateau with a precipice at one side and a steep slope at the other. A tap on a wood block has a sudden attach, no sustention and a very rapid decay. Wind instruments are capable of much less abrupt forms of attach than percussion

instruments. A violin, like the human voice, is capable of almost any kind of attack, sustention and decay.

And so the composer, by giving a particular contour to each note, affected what would traditionally be called its instrumental quality. In practice this was done by placing black masks of varying shapes in front of the selected pitch card bearing the drawing of the sound waves; in this way we obtained about six kinds of tone-contour, some not possible by traditional instruments.

In *Neighbours* there was very considerable use of variable tone-contouring, while in the other films only one percussive-type contour (wedge shaped) predominated.

Tone Quality

In the soundtrack of *Neighbours* the range and variety of sound effects and tone qualities was considerably enlarged by using several supplementary sets of drawings, some of which had rising and falling pitches for portemento and glissando effects. Some drawings, though very simple to the eye and to prepare, had a very complex sound wave structure, rich in harmonics, thus giving very strident and harsh sound qualities.

Harmony

For several simultaneous musical parts either in harmony or counterpoint, three different methods were used. Either different drawings were superimposed on each other by several separate exposures, or the soundtrack was divided lengthwise into several parallel strips and the different drawings shot along side of each other in each strip. Alternatively each musical part was shot on a separate film and the various parts mixed together during recording.

Acoustic Quality

Animated sound produced by this method is normally completely “dry” or without resonance or echo. To achieve more resonance and add acoustic quality two methods were used. The first, mainly for specific notes and localized or momentary effects, was done by shooting the same note in a rapid series of diminishing volumes (that is, the same drawing in smaller and smaller sizes); this simulates the natural effect of the sound waves bouncing back and forth from the walls of an instrument, room, hall or cavern. The degree to which any particular note in the score can be placed in such an acoustical environment is controlled during shooting by the number and nature of diminishing replicas or the original drawing of that note. The second method was to add reverb and echo during a re-recording process by the usual electronic means.

Norman McLaren (1952, revised in 1961)

Some Notes on Stop-Motion Live-Actor Technique (1952)

As used in the visuals of *Neighbours* (1952) and *Two Bagatelles* (1952)

This technique (sometimes referred to as “pixilation”) consist of applying the principles normally used in the photographing of animated and cartoon movies to the shooting of actors; that is, instead of placing drawings, cartoons or puppets in front of the animation camera, we place real human beings.

The technique is not new. Its origins go back to the early French movies of the Mélies epoch, when the camera was stopped in the middle of shots to produce trick effects, and the same principle has since been used occasionally in films by experimentalists like Hans Richter, Len Lye, Richard Massingham and many others. But on the whole, the technique has never had the exploration it deserves, nor has it had this in the film *Neighbours* or *Two Bagatelles,* where only a few possibilities have been applied, and rather crudely at that. Nonetheless, as a result of working with this approach I have jotted down the following observations.

In essence, any technique of animation consists of stopping the camera between the taking of each frame of film, instead of letting it run on relentlessly at normal speed (that is, 24 frames a second). Once it is assumed that the actor being photographed by a movie camera can stop between any or every 24^{th} of a second, a new range of human behaviour becomes possible. The laws of appearance and disappearance can be circumvented as can the laws of the momentum, inertia, centrifugal force and gravity, but what is perhaps even more important, the tempo of acting can be infinitely modulated from slowest speed to the fastest. Apart from the apparently spectacular feats of virtuosity that this makes the actor capable of, it is possible to use the technique in a concealed way behind what appears to be normal acting. Or, if used in a less concealed way it can permit to the actor a caricature type of movement. In much the same way as a pictorial caricature can make comment on character and situation by distorting the static form of a drawing, so live-action-animation can create a caricature by tampering with the tempo of human action, by creating hyper-natural exaggerations and distortions of the normal behaviour, by manipulating the acceleration and deceleration of any given human movement. This type of caricature is, of course, often found in animated cartoons, but cannot be found in live-action films until an animation technique is applied to them.

It is also possible to devise many new ways for a human being to locomote. Apart from new types of walking and running, a person may get from one place to another by sliding, (while sitting, standing, balancing on one foot, or any other way) and appearing and disappearing, and a host of other ways.

At the outset of shooting *Neighbours* our conception was to get all the action by taking a single frame at a time throughout each shot (having the actors move in small amount, between frames), but after some experimenting it became apparent that the single frame approach was best only for certain types of shots.

To meet all our requirements, we decided to use a whole gamut of shooting speeds, from one frame every five minutes to one frame every 1/16th of a second, depending on the nature of the shot, so we would select the most desirable shooting speed. Within one shot we might often vary the shooting speed if different part of the action demanded it.

The tempo of the actor's movement was also considered a variable factor, ranging from very slight changes of static positions through very slow movement, up to normal speed.

The tempo of the actor's behaviour and the tempo of the camera's shooting was therefore adjusted to any desired ratio, depending on the final desired effect, and the speed at which it would be easiest for the actor to achieve his point. For instance, if the actors moved half as slow as normal and the camera shot half as slow as normal (twelve frames per second), the final screen speed would appear normal but, in the process of shooting, a tempo-control factor of two has entered in and the actor, by performing at speeds between half-normal and normal had available a range of final screen speeds ranging from normal to twice normal. The concept of a tempo-control factor proved to be a useful one.

Many of the shots in *Neighbours* that appear in fairly normal tempo were shot with camera and actors both moving slowly, sometimes as much as four, six, eight, ten and twelve times slower than normal. In the shot with speeded up human action the camera often took pictures at eight times slower than normal, while the actors moved about four of three or two times slower than normal.

Another advantage of achieving a final normal speed affect by using a tempo-control factor while shooting was this: to tie in with steady musical beats and phrases of the as-yet-unmade soundtrack, we often wished the actions to be of precise metrical lengths, so while shooting at slow speed we would count out the number of each frames as it went by in the camera, thus the actors could arrange to be as such and such a spot on the 60th frame, to have their arms raised at the 80th frame, and their hands touch on the 90th frame, to start rotating on the 100th frame and to decelerate to a standstill over a period of sixty frames, etc. For purposes of integrating human action with music (in a rather ballet-like way) this method is of considerable value, especially so if the music has already been recorded, and the lengths of beats and phrases permanently fixed.

Effect of tempo

Since both camera tempo and acting tempo are considered as flexible, in order to obtain, for instance, the effect of a man walking, starting at one mile an hour and gradually and almost imperceptibly speeding up until he reaches twenty miles an hour, either the may be run at a constant slow speed and the man allowed to accelerate from extremely slow to normal speed, or alternatively the man may walk at a constant speed, and the camera be allowed to decelerate. In either case the overall effect of tempo will be the same, but in the bodily or muscular behaviour and centre of balance of the figure there will be differences.

We did not use or explore this field of subtle differences, but we did compare the convenience of either varying the actor's or the camera's speed. In many but not all cases it was found better to keep the camera speed constant and let the actor do all the modulating of the movement himself; at times both methods were used, especially if during a take the actors were tending to move either too slowly or too fast, we would compensate by pushing the single frame button slightly more or slightly less frequently.

Obviously a normal effect (a 1:1 ratio of camera and acting speeds) can be achieved at any overall tempo, such as, for instance as the camera running at half normal speed and the actors performing at half normal speed; alternatively, the camera running ten times slower than normal and the actors performing ten times slower as well, etc.

However, apparently normal effects achieved by such means do not appear normal when certain effects of gravity, inertia, centrifugal and centripetal force are involved, for instance if a girl who wears a long full skirt twirls around rapidly, and this is photographed normally, the skirt will fly out in all directions (the more rapidly she rotates the more the skirt will fly out), but if the camera is made to shoot twelve times slower than normal and the girl to rotate twelve times slower than normal, on the final screening the girl will still twirl at the original fast speed but her skirt will not fly out. The audience will interpret this either as a lack of centrifugal force or more likely as the skirt's being made of lead or some excessively heavy substance. The degree to which the skirt will fly out (or its apparent weight) can thus be controlled by the changes in the overall tempo of the 1:1 ratio between shooting speed and acting speed. Many gradual or sudden modifications in the behaviour caused by momentum, gravity and other physical forces are possible by this technique.

The creative potentialities of this stop-motion live-action technique are quite considerable for a new genre of filmic ballet and mime.

Norman McLaren (1952)

Further Notes on *Neighbours*

We used a single camera that could run at 24, 16, 12, 8, 6 & 4 frames a second, and also take single frames.

We used two animator artists as the actors; this was important, as when it came to shooting single-frame sections (and also other speeds slower than normal) they knew exactly how to move themselves, for instead of making a series of drawings they made a series of postures.

At the outset of shooting, in single-frame sections we made the actors move a small amount, then hold each new position while we clicked each frame; but we soon found a better method; a certain action being decided upon, the actors chose the best rate for clicking the camera; the cameraman then clicked at that speed (usually about ½, 1 or 2 seconds), counting aloud the number of each frame (1,2,3,4, etc.); the actors then moved very slowly and continuously, synchronizing their tempo, acceleration and decelerations to the frame-count. For instance, we decide to shoot them walking nine paces, the first pace to take 30 frames, then next 25, then 20, then 15, 10, 8, 6, 4, 2. It is possible they will do this steep acceleration correctly on the first take, because both their action and the camera are going so slowly. When the cameraman gets to the first 30th frame, he starts calling from 1 again and goes to 25, etc., to make it easier for them. Again, in another shot, if both actors were to converge from a distance on the flower at the same instant, and one was moving too slowly, we could always shout out to him to speed up a little.

Not too much of *Neighbours* was shot single-frame. Some shots or parts of shots had to be, such as the deck-chairs sliding on the grass and opening up, all the scenes where actors slide, whether on their backs or on their feet, the flower and the fence moving, and the man flying in the air (which was done by having him jump as high as he could, and clicking one frame at high-point of the jump; he kept jumping continuously, and moving side-ways each time, and we kept clicking the camera. Only when he got exhausted after 20 or 30 jumps did he shout out to stop the camera; with his feet position marked, he then lay down on the grass, and rested up for the next series of jumps).

Occasionally, very much time was required to change the positions of things between the taking of single frames, such as in the animating of all the fence posts around the graves at the end of the film. With 3 or 4 of us working on it, it might take 3, 4 or 5 minutes. Changing the fence's position between the two houses, 2 or 3 minutes. Changing the position of a baby on the ground, less than half a minute. Changing position of an actor sliding on his back on the lawn (he did it himself) took five seconds.

Much of the fighting was shot continuously at 8 frames a second. Where great rapidity and violence were needed, it was shot either at 4 fps or rapid single-frame, so that no actual physical violence was involved.

Near the opening of the film, the scene where the men walk back to investigate the flower was shot at 12 frames a second. Since they also slowed down their action by about half, the tempo looks almost normal, but in their performance they were thus able to incorporate slightly eccentric nuances in their gait.

Since there was no scenario, but only a skeletal idea of the theme and its rough development in my head, the detailed action was improvised from day to day as we shot. It was all filmed in natural sequence. At the start of each day, our team of four (2 actors, cameraman and myself)[*] discussed for about an hour how we should make the action progress for that day. Then before beginning each shot we would decide at what camera speed it would be best to take it; sometimes we would break a shot down and shoot different parts of it at different speeds. It might, for instance, start with some action at 12 fps, then require 4 fps, then a patch of single frame work, with longish pauses between each frame for careful re-positioning of the props (and therefore also the actors), and then the shot might finish with a stretch of single frame, clicking a frame every half second, every second, or every two seconds.

No optical work was used. The fade-in at the beginning of the film was done in the camera; and the fade-out at the end was made by God. When we first filmed our last shot we began at 3:30 p.m. and were most annoyed that before we could finish the action the sun had set, and it was dark. But in the rushes, the natural sun-fade-out looked good in itself, so we retook the shot, carefully planning to start at 1:45 p.m., so that the sunset would coincide with our last bit of action.

As is obvious, the whole film was shot out of doors in the one location. If doing another such film, I would shoot it indoors with artificial light.[**] For single frame work, the summer climate of eastern Canada fluctuates too much from day to day. Many days we had to stop shooting because of grey skies; but what was worst was that on a sunny day, when we were shooting , a slowly passing cloud might block out the sun in the middle of a single-frame shot, just when the actor was balancing on one leg and holding a difficult position.

Norman McLaren (1973)

[*] Actor-animators : Grant Munro and J.P. Ladouceur; Cameraman: Wolf Koenig

Stereographic Animation (1951)*

The Synthesis of Stereoscopic Depth from Flat Drawings and Art Work. An outline of the Production Techniques used in *Now is the Time* and *Around is Around*

1. Introduction

A year ago, the festival of Britain asked the National Film Board of Canada to contribute two shorts for a program of stereoscopic and stereophonic films being shown at the Telecinema in London, with the specific request that the films be of a cartoon or animated nature to set off the natural or "live" stereo films being made by the British themselves.

To our knowledge, no stereoscopic cartoon-type animated film had been made before. In 1939, Loucks and Norling made most successful use of stereoscopic animation in the sense that solid objects were photographed using a stereo camera and stop motion; and we were familiar with the results of this work presented by Mr. J.A. Norling to the S.M.P.E. in 1939 and 1941.

Our problem, however, was somewhat different, for we were concerned with the making of a stereoscopic film from drawings or art work which in themselves were flat – the problem of synthesizing three-dimensional space from two-dimensional subject matter.

Since the subject matter to be photographed is flat, no special stereoscopic camera is needed, but simply the regular type of animation and optical set-up, the film for each eye being shot in succession.

Many possible technical approaches suggested themselves – the most obvious being that of adapting the standard cartoon technique – by preparing two sets of drawings, a left and right eye version of each cell, with all the necessary parallaxes drawn into each cell.

This technique, however, was discarded, due to limitations of time, staff and budget, in favour of several simpler methods which this paper will describe in detail.

Before doing so, it might be useful to review in simple language the principles behind the animator's approach to creating depth.

* N.B. This paper was given as an explanation following the actual screening of these two films.

2. Control of Depth by the Animator

Principle of convergence, screen, film, and cell-parallax

In essence, this is done by controlling the amount of toe-in or toe-out of the spectator's eye-balls.

In a normal flat cinema when a spectator looks at the screen, the lines of sight from his left (L) and right (R) eyes are toed-in so as to meet each other at a point (lr) on the surface of the screen, as in diagram No.1:

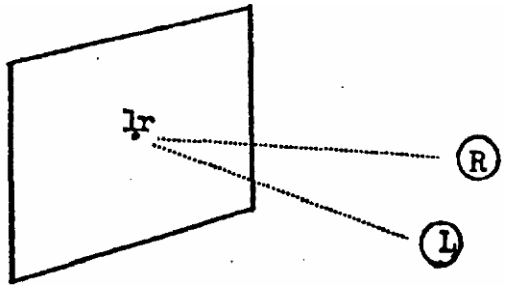

Diagram No.1

Throughout the viewing of a normal flat film, the spectator's eye-ball toe-in remains fixed. In viewing a stereoscopic film, however, this toe-in varies.

If our spectator, instead of looking at the screen, were to let his eyes drift and look away beyond the screen, staring at infinity, the lines of sight from his eyes (L and R) would become parallel, as in diagram No. 2, and these lines would pass through the screen at two separate points (1 and r).

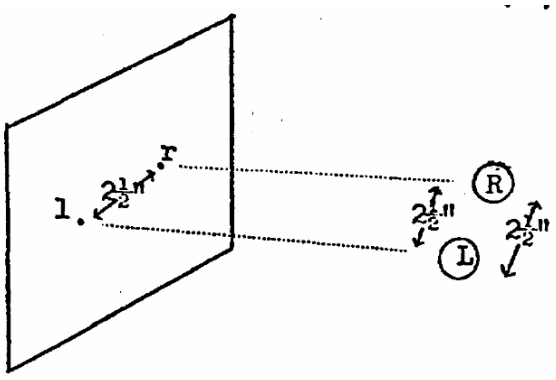

Diagram No.2

Since the distance between the average spectator's left and right eyes is 2 ½ inches, and since his lines of sight are parallel, the distance between the two points on the screen (1 and r) will be 2 ½ inches. No matter at what distance from the screen the spectator is sitting, this will always be so.

Now if our spectator were to look at an object located exactly half way between himself and the screen, his lines of sight would cross each other at a point (1r) half way between himself and the screen, as in diagram No.3, and the lines of sight, if projected beyond this point, would fall on the screen at two points, 1 and r.

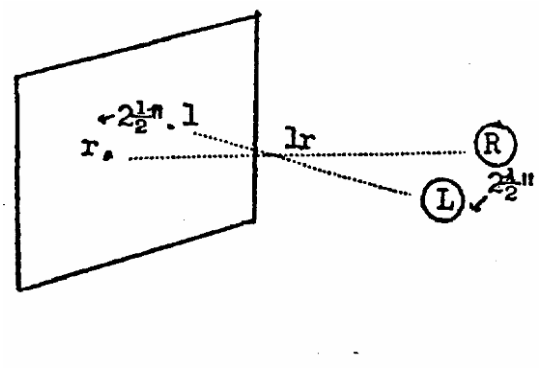

Diagram No.3

Again, by simple geometry, we can see that the distance between 1 and r is 2 ½ inches, and that no matter what distance the spectator is from the screen, this will always be so; it is important to note that 1 and r are now switches, so that 1 is to the east and r to the west.

For the stereoscopic animator, these are three basic diagrams on which to anchor all calculations of parallaxes. In designing a stereoscopic scene from flat drawings, the artist, if he wishes, let's say a dot to appear on the surface of the screen, he must have the left and right eye versions of the dot coincide precisely. For the dot to appear at infinity, there must be a 2 ½ inch separation between the left and right eye images on the final screen, the left eye image being on the left hand side of the screen and the right eye image on the right.

For the dot to appear midway between the spectator and the screen, there must be again 2 ½ inches separation between the two images, but this time the left eye image is on the right hand side of the screen, and the right eye image on the left.

If the images are separated by progressively less than 2 ½ inches, the dot will be located progressively nearer to the screen than half way, or nearer to the screen than infinity.

Separation of more than 2 ½ inches for back-of-screen images has generally to be avoided as it places the object 'beyond infinity', a condition which, due to the spectators' having to wall-eye, is almost as awkward to perceive as conceive. Separations of much more than 2 ½ inches to bring the image closer to the spectator than midway can be used, but sparingly, in order to avoid eye strain for a certain percentage of the spectators.

The animation artist therefore is not troubled by the major limitations which afflict the regular cameraman in stereoscopy. The stereoscopic world created by him is so calculated that no part of it will exceed the tolerable limits of parallax when projected on the screen, that is, so long as he knows the maximum size of screen on which his film is to appear. Knowing this size of screen, the amounts of parallax on the surface can be mathematically translated into amounts of parallax on the surface of the 35 mm film, and that, in turn, can be converted into amounts of parallax on the surface of the cell, cards or other art work.

The size of screen for which these Canadian films were designed was fifteen feet wide, this being the requirements for the Telecinema in London, England, where two interlock 35 mm projectors were lined up with their optical axes converging at the surface of the screen.

A paper entitled "The Determination of Stereoscopic Parallaxes in Animation" by Mr R.J. Spottiswoode, Technical Director of the Festival of Britain's stereoscopic program, was used as a basis for calculating all parallaxes.

I will now give a detailed account of the various production techniques used in the two films entitled *Now is the Time* and *Around is Around.*

3. Techniques used in *Now is the Time*

Parallax by Moveable Cut-outs in the Art Work

The opening scene of *Now is the Time* is progressively built up of twelve planes of clouds, each flat in themselves, starting from the most distant and working forwards.

The most distant plane was to be located at stereoscopic infinity. The nearest plane was located approximately half way between the spectator and the screen.

The material prepared for shooting consisted of one basic black card 10" by 14". Clouds, varying in size from ¼" to 3" wide, were painted with white paint on small bits of black card. These were then stuck to the black card with double-sized tape in a series of horizontal rows varying in size from the smallest row in the center of the card to the largest at the bottom. The card was then placed under a standard animation camera and photographed on high contrast stock in such a way that the various row of clouds were revealed in turn by a series of cross fades. This shooting was for the right eye viewpoint; the card was then kept in the same position under the camera, but the lateral position of all the clouds on the card was changed. The cloud cut-outs were moved in varying amount either to the east or to the west to allow for the desired amount of parallax. Only one plane of clouds was left untouched, the one located on the surface of the screen. The parallactic shift was mathematically calculated for only the farthest and

nearest planes, the rest being adjusted by eye – a relatively simple matter. The card with clouds was then shot again, following the same footage dope-sheet as before, to obtain the left-eye footage.

The sequence of appearing suns which follows the cloud sequence was done in the same way as the clouds.

Parallax by Lens-shift in the Optical Camera

The little dancing man and the animation that grows out of it was done by a different method. With an ordinary writing pen and India ink, the action was drawn frame by frame directly on clear 35 mm machine leader (the usual animation stages of pencil sketches, inking, shooting and developing being short-circuited in the process of making the original negative).

The drawing was done from a mid-interocular viewpoint, that is, it was designed on the assumption that it would be representing a viewpoint midway between the final left and right eye viewpoints. The animated image itself was designed to remain at all times within a plane parallel to the cinema screen.

From this original hand-drawn negative, an optical print was made and loaded into the projector of a standard optical printer. A left and right eye optical negative was produced in turn, the transverse action of the camera lens being used to create the required parallaxes. The amounts of parallaxes for the nearest and farthest planes were calculated mathematically. These amounts, split in half for each eye, were marked on the indicator controlling the transverse action of the lens on the optical camera, as movements to the left or right of zero position. The zero position itself represented the plane located on the cinema screen. A dope sheet indicating the amounts of parallax required at key points in the animation was prepared. The dope sheet for the right eye being the same as for the left except that, in shooting, the direction of transverse movement was reversed. The optical print was projected continuously at a speed of 160 frames per minute, during which the artist by glancing at the dope sheet and watching the animation, turned the transverse control and created variable parallax in sympathy with the size perspective of the flat drawing.

In cases where the parallax changed rapidly and in a varied fashion, the shooting was stopped periodically, or the process run slowly to secure greater control.

Combining Material for Release Printing

The left and right eye negatives from the optical camera bearing the animated images, and the left and right eye negatives from the animation camera bearing the static backgrounds were then used as material for building up six

parallel picture separation negatives (a yellow, cyan and magenta record for the left eye, and a yellow, cyan and magenta record for the right eye), for release colour printing in English Technicolor.

Stereophonic Animated Soundtrack

Strictly speaking, the music of the film *Now is the Time* should be classed as animation. This synthetic sound was produced by photographing patterns of black and white sound wave forms on to the soundtrack area of 35 mm film, using standard animation equipment and techniques.

The stereophonic system used in the Telecinema at the Festival of Britain employed four channels. To make the animated sound stereophonic, four identical prints were lined up parallel in a four-way, each representing one of the channels. Various notes were then blooped out of certain of the tracks, depending on which channel or channels the sound was desired to come from. This was possible because the animated sound was built out of small units each separated by small sections of unmodulated track.

4. Techniques Used in the Film *Around is Around*

Parallax by Double Punch-Holes on Art Work

The opening build-up of eight planes of stars was produced as follows:

The stereoscopic location of the eight planes was decided upon, and from this in turn was calculated the amounts of screen parallax, the amounts of parallax on the surface of 35 mm film, and the amounts of parallax for art work with a field 12 inches wide.

Eight standard animation cells (10” by 14”) were then punched with two sets of registration perforations; the distance between the two sets of punch holes varied for each cell and depended on the amount of parallax required for the plane represented by each cell.

The plane representing the surface of the screen had only one set of punch holes, there being an absence of parallax for that particular plane.

The art work (stars in this case, and representing no depth in themselves) was then painted on the eight cells. In order to prevent the final stereo scene from being asymmetrical, during the painting, the cells, when placed on top of each other, were registered for a mid-interocular viewpoint, that is, the midway points between the two sets of punch-holes were registered with each other.

In shooting, a standard animation camera and stand with registration pins and glass platen were used. The eight cells were not separated physically in space, but pressed close together under the glass platen. They were registered by the set of punch-holes for the right eye and shot once, then registered by the other set of punch-holes and shot a second time, for the left eye.

All static background material for the film *Around is Around* was shot in this fashion.

Parallax by Frame-stagger on the Negative

The horizontal panning background of clouds and stars were cases in which the speed of travel of the various planes was so calculated that the dynamic parallaxes of a monocular panning shot gave rise automatically, when two identical prints were staggered by a certain number of frames, to the required binocular parallaxes for a stereo pair.

The monocular cloud and star panning shots were made by multiple exposures, the various planes, each with a different travel speed, being superimposed in the animation camera.

Assuming a one-frame stagger, the travel speeds for various planes were calculated. For example, for the infinity plane: the amount of parallax needed on the surface of the 35 mm film to locate a plane at infinity is known, therefore, the corresponding amount of parallax needed on art work of a given field width can be calculated. This amount is the same as the amount of travel per frame required to locate this plane of the art work at infinity. Speeds progressively less than this will locate planes progressively closer than infinity, until an absence of any movement will locate the plane on the surface of the screen.

The locate subject matter behind the screen in a horizontal panning shot in which the subject matter is traveling eastward, frame #1 for the left eye should be placed opposite frame #2 for the right eye (L1 = R2). For westward traveling subject matter, R1 = L2.

If in the above shot with eastward traveling material the stagger is reversed, or the left and right eye films are switched (R1=L2), then the planes are located stereoscopically between the surface of the screen (for the plane with no movement) and a point midway between the spectator and the screen (for the plane with maximum speed); similarly with westward traveling subject matter when R2 = L1. To state this more briefly:

To locate planes in back of screen,
with eastward traveling subject matter – L1 = R2
with westward traveling subject matter – R1 = L2

To locate planes in front of screen,
with eastward traveling subject matter – R1 = L2
with westward traveling subject matter – R2 = L1

In the latter two cases, faster travel can be used for locating planes closer than halfway between the spectator and the screen; but in the former two cases, if faster travel is used the planes will be located beyond binocular infinity.

If a two-frame stagger is used and the same stereoscopic effect desired, the speed of travel of each plane has to be halved; if not, the total gamut of depth will be doubled.

A three-frame stagger will triple the depth gamut, unless the speeds of travel are divided by three, and so on.

In *Around is Around* a seven-frame stagger was used for the white on magenta horizontal panning clouds, and a two-frame stagger in the last sequence of the film for the cyan stars on a blue background.

The frame-stagger technique was also used to create the stereo depth of all the linear animated images in *Around is Around.*

These revolving images, lissagous figures and other patterns were produced on an oscillograph, and a brief description of their means of production is given in an appendix to this paper.

A standard Bell & Howell camera was trained on an oscillograph, and the patterns photographed while in motion. The growth and change of the patterns was controlled by manually operating the control knobs on the oscillographic set-up. The camera was run at 12 and also 8 frames per second, rather than normal speed, to permit greater control of pattern modulation.

The movement of the patterns was kept predominantly horizontal, so that the monocular dynamic parallax would produce binocular parallax, when two identical prints were staggered as a stereo pair. The movement had to be slow enough to prevent the parallax between two adjacent frames from exceeding the tolerable limits of parallax infinity. On the slower patterns a two-frame stagger was possible; on the quicker, a one- frame. Any vigorous vertical movement within the patterns was avoided, for this, due to the frame-stagger, would have created undesirable vertical parallax in stereo-viewing.

Parallax by Frame-stagger Plus Lens-shift

Rotating patterns which traveled to and from the audience achieved their depth by combining stagger frame and lens-shift techniques.

An optical print from the original negative was shot twice on the optical camera, once for each eye, the parallax relating to the eventual to-and-fro movement of the pattern being introduced by camera lens-shift while shooting; the two resulting negatives were then staggered to produce the parallax relating to the rotational movement.

5. Conclusion

The above covers the various techniques used in the two films under review, and leaves untouched a number of others which were considered but not tried out.

Our particular choice of techniques was dictated by the set-up at the National Film Board of Canada, and by our desire not to stimulate reality (a thing which natural stereo photography can do most ably) but to create a new kind of reality more in keeping with the graphic method by which the films were produced. We were also interested in dispensing with some of the non-stereoscopic depth-assessing factors normally present in stereo films, such as interruption by opacity, light and shade, chromatic hue, and tonal perspective, and to some extent diminishment (in the oscillographic patterns – which, however, have dynamic fore-shortening) in order to discover to what extent and in what order the human mind relies upon these factors for depth information.

To sum up, our production experience would suggest that the major methods of introducing parallax into flat drawing and animation are probably:

1. Stereo pairs of cards or cells, the parallax being drawn into the images.

2. Double punching of single cards or cells.

3. Moveable cut-outs.

4. Movements of the horizontal panner under the animation camera.

5. Horizontal panning or lens-shifting in the optical printer.

6. Frame-stagger on horizontal action shots.

Each method would seem to be effective for different purposes; obviously Method #1 has the greatest flexibility, and would recommend itself for cartoon work, particularly when combined with #2 for static backgrounds. On the other hand, for diagrammatic and cartographic animation some of the other methods may well be more suitable and economical, especially when the final visual is built out of several superimposed elements. At all events, it is quite safe to

predict that the combinations of all these methods will be useful for stereo animation, and that they will, in the future, become part of the technical ammunition with which the animated film will meet the challenge of stereoscopy.

Norman McLaren (1951)
National Film Board of Canada, Ottawa, Canada

6. Appendix by Chester Beachell

The Generation of oscillographic patterns in *Around is Around* by Chester Beachell, National Film Board of Canada.

There is no limit to the patterns obtainable on an oscillograph. This is easy to understand when we remember that a picture tube in a television receiver is a glorified oscillograph.

However, it was decided to keep the patterns relatively simple for two reasons:

1) the difficulty of photographing an extremely complicated trace due to the low actinity of the fluorescent screen at high trace speeds, and

2) the presence of vertical movement in the more complicated patterns.

The patterns themselves are mostly complete cycles – that is the sweep was sinusoidal – except for one or two patterns, notably the pillars. With a sinusoidal sweep the return trace is the same rate as the forward trace, and hence is visible, giving a closed loop.

There were never more than four component signals used to form any of the patterns in this film. The wave forms used were (a) sinusoidal, (b) square wave, (c) saw tooth wave, including varying shapes and distortions of the original wave forms. In some patterns varying degrees of phase shift were employed between vertical and horizontal deflection in order to produce such things as the revolving spring pattern.

The signal sources were two audio frequence signal generators, range 20 to 20,000 cycles per second. One audio frequency signal generator, range 7 to 70,000 cycles per second. One square wave generator, range 7 to 70,000 pulses per second and 60 cycle line frequency.

A number of external and separate controls were set up in order that the size, movement, brightness and shape of the patterns could be changed and accurately controlled during any one shot. These controls were: (1) vertical micro gain, (2) horizontal micro gain, (3) mixing controls for the various wave forms so that they could be mixed on either or both sets of the deflection plates, (4) phase shift controls were set up so that they could be inserted in any signal source to

either deflection system, and (5) a switch to rotate the pattern through 90 degrees on the screen. This was necessary in order to keep the movement largely in the horizontal plane.

As the revolving movement in the patterns is a graphical presentation of the beat between two frequencies, it was necessary that all signal sources be as stable as possible. Instability caused varying rates of movement on the screen and if a pattern moved too fast, then the optical parallax, in final stereoscopic viewing, became too great. This was our biggest difficulty in that regulation had to be absolute in the power source, as any change in voltage in the oscillators or in the scope itself brought on unwanted movement. It was found that saturable core regulation transformers were a partial answer to the supply regulation problem, but, even with this, most of the shooting was done at night when there was no heavy intermittent loads on the AC power.

Due to the low actinity of the phosphor used – the oscillograph tube was a 5LPI – it was necessary to shoot at varying frame rates depending on the complexity of the pattern. This was also an advantage as it permitted greater manual control of the figure during shooting. This brought on another difficulty, to slow the movement of the pattern so that the movement would be within reason when projected at twenty-four frames per second. As an example – the base frequency is 60 cycles per second. The beating frequency is the one-thousandth harmonic which is 60,000 cycles per second. In order that the pattern will move, it is necessary to charge one of the frequencies so that the beat frequency between them is 0,05 cycles per second. This would mean absolute stabilization of the 60 c.p.s. signal and absolute stabilization of the second frequency at either 59,999.95 cycles per second for clockwise rotation, or 60,000.05 for counter clockwise rotation. This meant that differences in frequency from one signal source to the harmonics of that frequency obtained from another signal source were as little as one-twentieth of a cycle per second. Crystal oscillators were impractical because a room full of crystals would have been required.

The fireworks effect was achieved by charging the capacitor on the vertical positioning supply through a high resistance to a voltage greater than that required to centre the beam and then bleeding it down to centre positioning through another large resistance.

The most simple description of these patterns is that they are graphical preservations of the sums of the equations of various wave forms at any given instant in time.

Chester Beachell

Index of Films