THE PERFECT PAN

An Animation Scene-Planning Primer

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Sullivan Bluth Studios 1987

CONTENTS

TABLES

NOT JUST FOR SCENE-PLANNERS

Just what you always wanted ... another technical manual. But hold on -- before you toss this one in the shredder or use it to blow your nose, there's something you should know. This is the pamphlet you've been waiting for. It's the one that will save you at last from those nights you've been waking up in a cold sweat with Auxiliary Pegs on your mind, or those days you've spent pulling out your hair not knowing whether to "animate in place" or animate with the pan." Here it is. The answers to your life's deepest quandaries. Whether you animate or check or xerox, this information is relevant to you. The animation camera set-up, exposure sheet format, and knowledge of scene preparation is the basis for everybody's work. So use some other pamphlet to kindle that fire and keep this one around. Who knows? It just might make you the life of the cocktail party.

THE MOVERS AND THE SHAKERS

Somewhere in the deepest, darkest reaches of the sub-basement, a monitor glows green. Someone pushes a button. Suddenly, a chain creaks and some gears grind and, out of the shadows, something lurches. With a single touch, the camera has come to life, creeping toward you, rotating and shifting until it's found the precise position, to a thousandth of an inch. And in an instant, the computer beeps. It is ready for your next frame.

You're watching the magic of our latest in technology, a computerized camera system designed by Cinetron. It allows us more accuracy and less room for error than ever before, but as complex as it is, the camera stand still operates around the same basic axes it ever did. In all the ruckus, there are truthfully only three movable sections on the camera stand that, in combination, allow for every possible sort of movement.

They are: the camera, the bed, and the peg bars.

The Camera.

The camera itself is affixed to a vertical crane. It is capable of only two types of movement: it can travel up and down or rotate.

C-VERT (camera vertical)

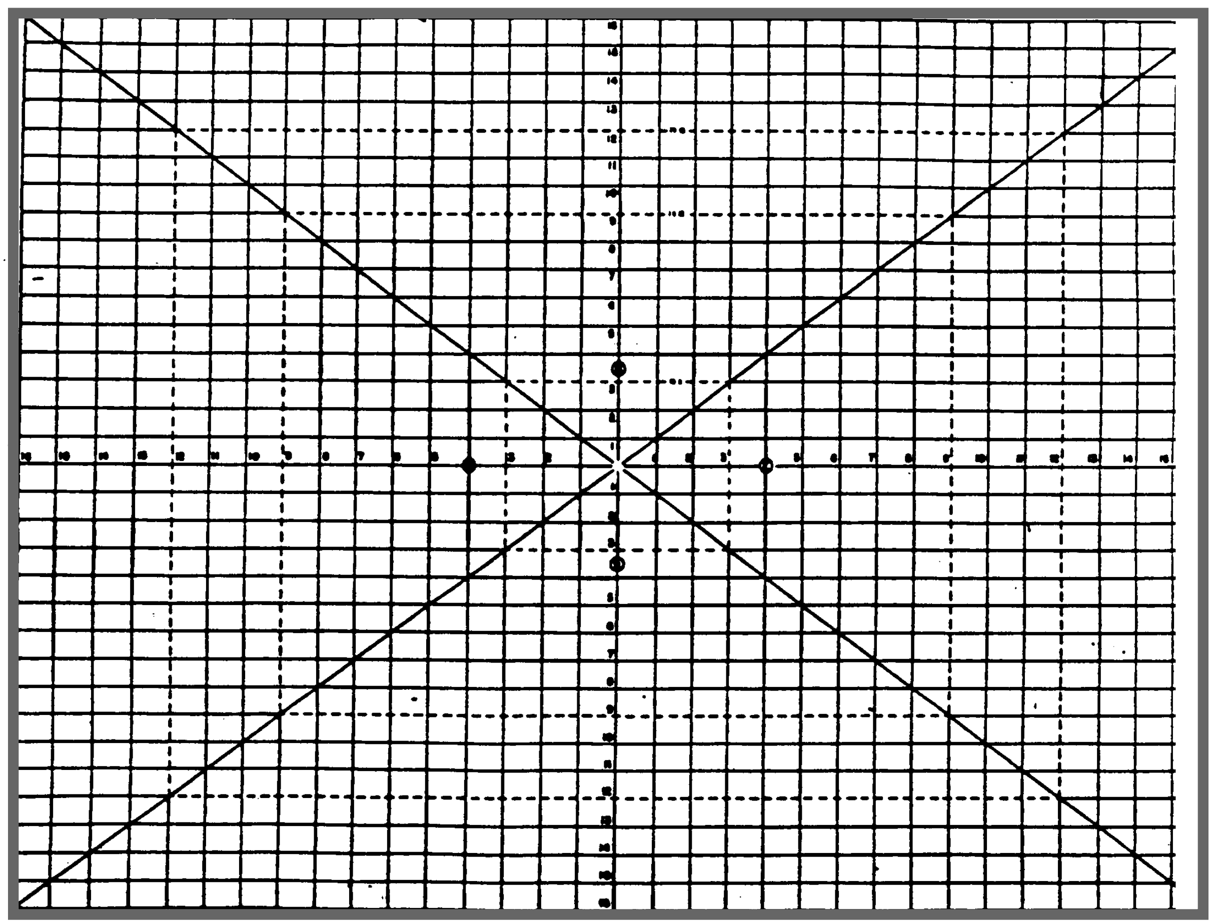
Up-and-down movement (away from or toward the artwork) is called "trucking." A "truck-in" refers to a movement toward the artwork, while a "truck-out" denotes a movement away.

The increments we use revolve around inch-markings on the crane the camera travels down. The camera cannot go below a certain point on the crane, for a number of reasons: (1) focus, (2) the grains of the artwork will become too apparent, (3) the camera will smash into the platen (the glass that holds down the artwork). A 3-field, or 3” x 2.16”, area is the absolute closest our system allows the camera lens to see. With a normal 55mm lens, the position on the crane at which the camera sees a 3-field area is called zero, and the inches are marked up from there, all the way to a height of 72 inches or so.

So, for normal 16-field sized artwork (16” x 11.52”), to take in the entire 16-field area we would instruct the camera to move to 32240, or 32 and 240/1000 inches.

“32240” means very little to the artist, who is more concerned with what the camera sees than where it is on the crane. The artist usually thinks in terms of “fields” and uses a “field chart” to describe the camera movement.

Field Chart



This is a reduction of a field chart (NOT FOR USE) to serve as an example.

As the camera trucks coward the artwork, the center of its field of view will remain the same, while the outer edges of that field will shrink from a 16-field (the full area of the field chart) to a 15-field (the rectangle enclosed by the lines marked "15") to a 14-field and on, successively enlarging the image that will appear on the film. Each concentric rectangle on the grid represents a one field change from the rectangle before it. As it happens, a change of one field enlarges or reduces the field of view by 1 inch horizontally and .72 inches vertically.

The illustration on the last page is of a 16-field chart. This is used when working with 16-field sized artwork (a majority of the scenes). There are two other sizes, and field charts that correspond to them: 12-field and 24-field.

The following table is used to correlate a given field size with the height the camera will have to be to achieve that field. That height, in thousandths of inches, is referred to as the "camera-vertical sometimes shortened to "C-Vert". Any C-Vert increment can be called for, but for reference purposes, the ones given on the table are those that match up to even fractions of a field.

VERTICAL COUNTER NUMBERS 55 mm LENS

FIELD	VERT INCREMENT	+1/4FLD	+1/2FLD	+3/4FLD
32	71920	-----	-----	-----
31	69440	70060	70680	71300
30	66960	67580	68200	68820
29	64480	65100	65720	66340
28	62000	62620	63240	63860
27	59520	60140	60760	61380
26	57040	57660	58280	58900
25	54560	55180	55800	56420
24	52080	52700	53320	53940
23	49600	50220	50840	51460
22	47120	47740	48360	48980
21	44640	45260	45880	46500
20	42160	42780	43400	44020
19	39680	40300	40920	41540
18	37200	37820	38440	39060
17	34720	35340	35960	36580
16	32240	32860	33480	34100
15	29760	30380	31000	31620
14	27280	27900	28520	29140
13	24800	25420	26040	26660
12	22320	22940	23560	24180
11	19840	20460	21080	21700
10	17360	17980	18600	19220
9	14880	15500	16120	16740
8	12400	13020	13640	14260
7	9920	10540	11160	11780
6	7440	8060	8680	9300
5	4960	5580	6200	6820
4	2480	3100	3720	4340
3	00000	620	1240	1860

2480 INCREMENTS BETWEEN FULL FIEL
620 INCREMENTS BETWEEN 1/4 FIELD
1240 INCREMENTS BETWEEN 1/2 FIELD
1860 INCREMENTS BETWEEN 3/4 FIELC

This table is almost always applicable. With multiplane set-ups, however, the camera must be kept higher on the crane to allow for additional planes of artwork. In order to do this, a longer lens is used. Namely, the 105mm lens. In such situations, this table is applicable:

VERTICAL COUNTER NUMBERS 105mm LENS

FIELD	VERT INCREMENT	+1/4FLD	+1/2FLD	+3/4FLD
16	72170	-----	-----	-----
15	67430	68610	69800	70980
14	62690	63870	65060	66240
13	57950	59130	60320	61500
12	53210	54390	55580	56760
11	48470	49650	50840	52020
10	43730	44910	46100	47280
9	38990	40170	41360	42540
8	34250	35430	36620	37800
7	29510	30690	31880	33060
6	24770	25950	27140	28320
5	20030	29210	22400	23580
4	15290	16470	17660	18840
3	10550	11730	12920	14100

4740 INCREMENTS BETWEEN FULL FIELDS
1180 INCREMENTS BETWEEN 1/4 FIELDS
2370 INCREMENTS BETWEEN 1/2 FIELDS
3550 INCREMENTS BETWEEN 3/4 FIELDS

ROT (rotation)

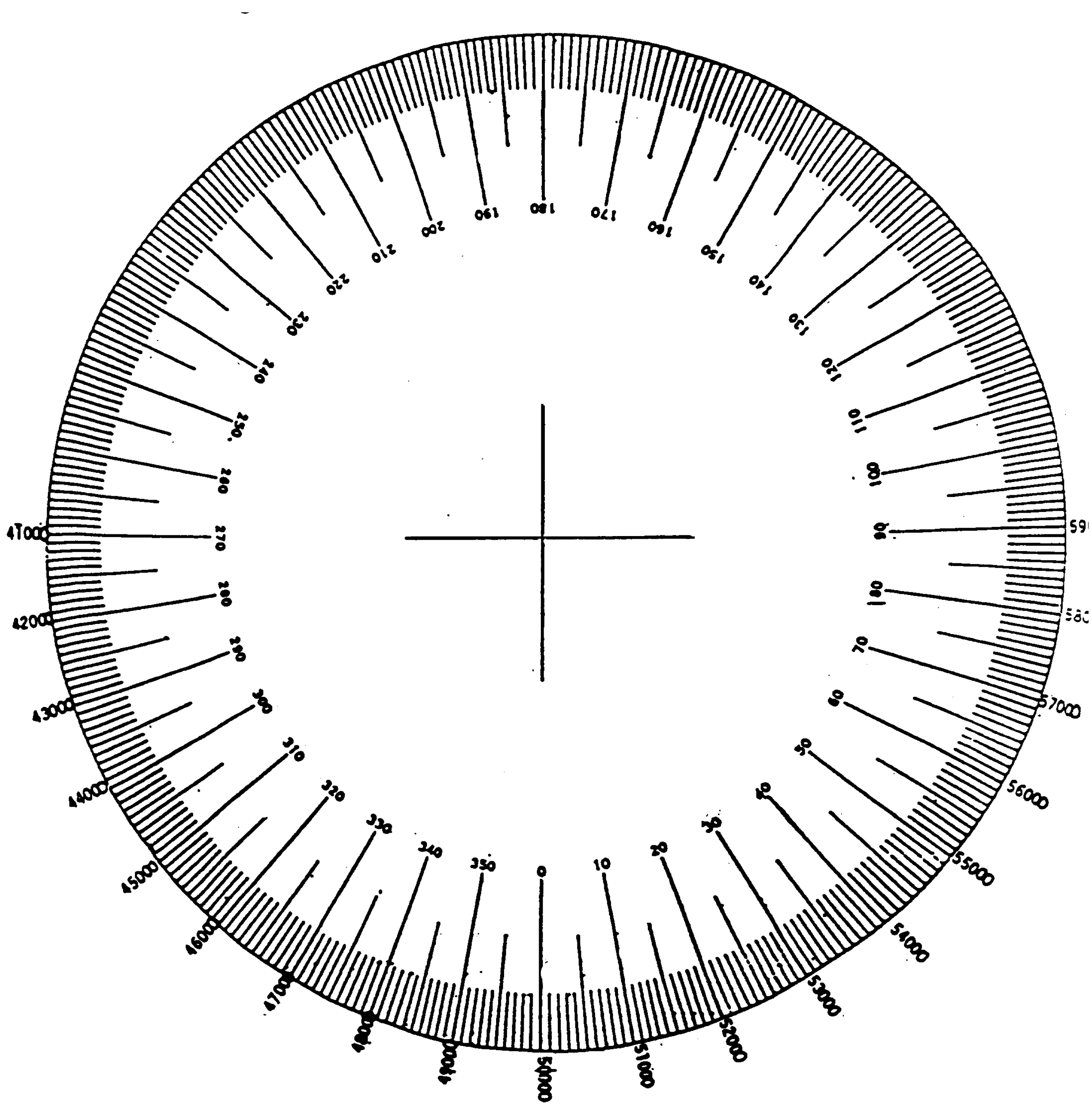
The camera can also “rotate” or “tilt” clockwise or counterclockwise (CW or CCW) over the artwork. The term “tilt” usually refers to a static rotation of the camera that is held for the entire scene. “Rotation” refers to one that changes during the course of the scene. For the sake of this section, I use the terms interchangeably, because the same information applies to both.

Rotation instructions refer to the camera, not the artwork. If a clockwise tilt is called for, the camera moves clockwise, even though on film the artwork will appear to move counterclockwise. This is critical to remember.

ALL MOVES ARE SPOKEN OF FROM THE CAMERA’S POINT OF VIEW, NOT THE ARTWORK’S.

90 vertical tilts are very common. The camera is set up at a ninety degree rotation from its normal position, in order to allow what is normally horizontal pan movement of the artwork to appear vertical. All artwork for such scenes is prepared sideways on the paper, with the ground line typically on the right. Traditionally, the 90 tilt is counterclockwise (CCW).

The rotation increments correlate to degrees on a protractor. At equilibrium, or zero degrees, the increment is 50000. Each degree the camera moves from there means a change of 100 increments, rising as you move counterclockwise and lowering as you move clockwise. So a 1 CCW tilt would mean an increment of 50100. A 10 CW tilt would likewise be 49000, and so forth. The following is a reduction of a **“rotation chart”** for example purposes:



Using this “rotation chart” along with a “field chart”, you can determine the increment of your rotation. Simply line up the two charts, center to center, and rotate the field chart over the rotation chart to the desired angle on the artwork. The vertical center line of the field chart now lies over one of the degree ticks along the circumference of the circle. Read the increment of that ticks marked around the outside of the circle, and there you have it!

Any time a rotation is called for, a compensation in the camera- vertical position must be made, to assure that the edges of the artwork won t show up in the canted field. The following is a rough table of what maximum field the camera can be at, at a given rotation. (CW or CCW does not matter for this table.) Note that 90 vertical tilts allow a maximum fielding of 11 1/2 F₵.

ROTATION	MAXIMUM FIELD SIZE
2.5°	15F
5°	14F
10°	13F
15°	12F
20°	11 1/4F
25°	10 3/4F
30°	10 1/8F
35°	9 7/8F
40°	9 2/3F
45°	9 1/2F
50°	9 1/3F
55°	9 1/3F
60°	9 1/2F
65°	9 2/3F
70°	9 3/4F
75°	10F
80°	10 1/2F
85°	11F
90°	11 1/2F

The bed.

Onto Movable Part Number 2. The “camera bed” is the body, or base, of the camera stand, on which lies the artwork that the camera looks down upon. No matter what wild and vicious rumors you may have heard, the bed is capable of only two axes of movement East-West and North-South. (It doesn’t rotate, it doesn’t move up and down, it doesn’t do cartwheels.)

E-W (east-west)

The bed can move side to side as far as 9 1/2 inches to each side from center. “East” and “West” are spoken of from the camera’s point of view, meaning that the bed actually moves in the opposite direction of what is called for. If an "east" move is called for, the camera will appear to be travelling east over the artwork when the bed is moved west. Don't let this confuse you. It is very simple.

Take a field chart. Lay it down over your artwork. Take another field chart. Lay it down center-to-center on top of the first field chart. Then shift it to the right or to the left as far as you want your field to move. Read off the position on the lower field chart that coordinates

with the center of the upper chart. (The lower chart represents the bed, while the upper represents the camera's eye.) The field chart, you will note, is marked N, S, E, & W, and has a number ascribed to each line on it. Whatever coordinate you read off (e.g. "3 East") is what you want to call for, straight and simple.

However, you still have to translate that into increments the computer will understand. As with rotation increments, equilibrium, or center, is called 50000. The numbers decrease as you move east, and grow as you move west. Each movement of one field on the field chart is equal to half an inch, or 500. So "1 West" would be 50500, or "3E" would be 48500, or "8W" would be 54000. Get it?

Here's a table matching numbers on the field chart to increments on the camera bed:

CONVERSION FOR PLANE-1 CAMERA COMPOUND FIELD POSITIONS

E/W AXIS COORDINATES

CAMERA POV- WEST

FLD	COUNTER	
	(LIMIT)	
19	59500	
18	59000	
17	58500	
16	58000	
15	57500	
14	57000	
13	56500	
12	56000	
11	55500	
10	55000	
9	54500	
8	54000	
7	53500	
6	53000	
5	52500	
4	52000	
3	51500	
2	51000	
1	50500	
0	50000	CENTER

CAMERA POV- EAST

FLD	COUNTER	
0	50000	CENTER
1	49500	
2	49000	
3	48500	
4	48000	
5	47500	
6	47000	
7	46500	
8	46000	
9	45500	
10	45000	
11	44500	
12	44000	
13	43500	
14	43000	
15	42500	
16	42000	
17	41500	
18	41000	
19	40500 (LIMIT)	

1 FLD = 500 INCREMENTS
3/4 FLD = 375 INCREMENTS
1/2 FLD = 250 INCREMENTS
1/4 FLD = 125 INCREMENTS

When moving east or west, you must be careful that you are not going to move smack off the artwork. Or, even if you have long artwork, you may well move smack off the platen glass, which isn't all that much larger than a 16-field area. It is easy to figure how much to compensate the field size, using your trusty friend, the field chart. Very simply, if you move 2 field lines over from center, you're going to be hanging over the edge by 2 fields if you are at full field. So you must truck-in 2 fields. Likewise, you would truck-in 8 fields to compensate for an 8-field move.

N-S (north-south)

The bed can move toward you or away from you as far as 5.04 inches in either direction from center. Like E-W, N-S is spoken of from the camera's point of view, so a "north" move would actually require the bed to move south. Use the same field chart technique as for E-W to simplify this for you.

The increments are slightly different from the E-W axis. 50000 is also center, north increases the numbers, and south decreases them. Each movement of one field on the field chart is equal to .36 inches, or 360. So, "1N" would be 50360, "2 1/2 S" would be 49100, and so on.

Here's the N-S table:

CONVERSION FOR PLANE-1 CAMERA COMPOUND FIELD POSITIONS

N/S AXIS COORDINATES

(SET-UP USING 12FLD. PEG BARS OR 16FLD. PEG BARS ON OPTICAL CENTER)

CAMERA POV- NORTH FLD	COUNTER		CAMERA POV- SOUTH FLD	COUNTER	
	(LIMIT)		0	50000	CENTER
14	55040		1	49640	
13	54680		2	49280	
12	54320		3	48920	
11	53960		4	48560	
10	53600		5	48200	
9	53240		6	47840	
8	52880		7	47480	
7	52520		8	47120	
6	52160		9	46760	
5	51800		10	46400	
4	51440		11	46040	
3	51080		12	45680	
2	50720		13	45320	
1	50360		14	44960	
0	50000	CENTER		(LIMIT)	

1·FLD = 360 INCREMENTS
3/4 FLD = 270 INCREMENTS
1/2 FLD = 180 INCREMENTS
1/3 FLD = 120 INCREMENTS
1/4 FLD = 90 INCREMENTS

There are two different field "set-ups" available on the camera-bed, the normal 16-field set-up and the smaller 12-field set-up. I will explain how the set-ups differ more thoroughly in the following section on peg bars. Suffice it for now that both set-ups have their center in the same place, so there is no difference in planning E-W and N-S moves, except for the size of the artwork. (Center is often abbreviated by the symbol ₵.)However, because of the difficulty of changing the set-ups, camera generally shoots 12-field artwork on a 16-field set-up. In this case, the center of the 12-field artwork will not be the same as the center of the 16-field set-up. It will be 4 field lines south of the 16-field chart center. This is apparent if you place a 12-field chart on the same pegs as a 16-field chart. To compensate, we tell the cameraman to move the bed 4 South. With the camera trucked in to 12F, this will perfectly frame the 12-field artwork. Normally, 4S is an increment of 48560, but due a slight inaccuracy in the calibrations, we set the center for 12-field artwork at 48500. Use this table for reference in such cases:

CONVERSION FOR PLANE-1 CAMERA COMPOUND FIELD POSITIONS

N/S AXIS COORDINATES

(SET-UP USING 16FLD. BOTTOM PEG BAR SHIFTED TO 12FLD. BAR (NORTH) LOCATION)

CAMERA POV- NORTH

FLD	COUNTER	
	(LIMIT)	
17	54620	
16	54260	
15	53900	
14	53540	
13	53180	
12	52820	
11	52460	
10	52100	
9	51740	
8	51380	
7	51020	
6	50660	
5	50300	
4	49940	
3	49580	
2	49220	
1	48860	
0	48500	SHIFTED CENTER TO 12FLD.

CAMERA POV- SOUTH

FLD	COUNTER	
0	48500	SHIFTED CENTER TO 12FLD.
1	48140	
2	47780	
3	47420	
4	47060	
5	46700	
6	46340	
7	45980	
8	45620	
9	45260	
10	44900	
11	44540	
12	44180	
	(LIMIT)	

1 FLD = 360 INCREMENTS
3/4 FLD = 270 INCREMENTS
1/2 FLD = 180 INCREMENTS
1/3 FLD = 120 INCREMENTS
1/4 FLD = 90 INCREMENTS

With N-S moves, like E-W, you must be careful not to move the field off the edge of the artwork, and the fielding compensation works the same way.

CAMERA SHAKES

“Camera shakes”, or “jars”, are actually bed shakes. At points of impact, or when an earthquake or a stampede create a rumble, the N-S and E-W axes are zigzagged back and forth for a number of frames (anywhere between 8 and 16 frames for an impact depending on its intensity - and perhaps for the whole scene in the case of a rumble). A small impact would probably move a maximum of 80 increments from center (in all directions), while a horrendous collision would probably take up to a maximum of about 150 or 160 increments from center.

The idea in a shake is to vibrate the image. Consequently, the fine-tuning that might go into planning a pan move is unnecessary. Even so, there are a couple pointers I would keep in mind. The shake usually has a dominant direction to it. If, for instance, Wile E. Coyote runs east into the cave wall, the E-W axis will be dominant in the shake. Make those increments more extreme than the N-S increments, and begin the shake with a strong eastward move at the frame of impact. To highlight the E-W axis, hold each increment for two frames , alternating every two frames from one side of center to the other. Meanwhile, alternate the N-S increments from one side of center to the other every frame. The E-W part of the shake will now be more visible, besides creating a figure-8 pattern with the N-S axis.

Be aware that in any scene containing a camera shake, the camera needs to be fielded in at least a quarter of a field so that the edges of the artwork don’t show. For a 16-field scene, this would mean a maximum fielding of 15 3/4F₵.

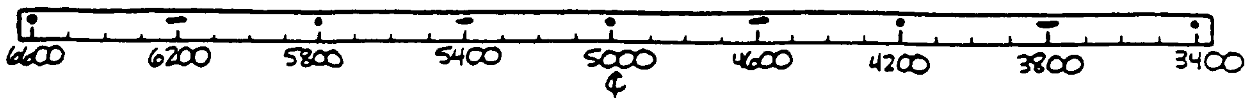
Like most other moves, shakes are now computerized. There are special data forms to be filled out to order camera shakes, and these will be covered in the section called “The Numbers.”

The Pan bars.

The sliding peg bars are used to fasten the artwork in place on top of or from below the camera field. There are two of them and they are 32 inches long; that’s twice the length of the ones on the animation disks. They can “pan” artwork east or west, in a way that the camera bed cannot. For one thing, the bars allow for different levels of artwork to move independently. For another, an E-W bed move would quickly expose the platen edge, while peg-moves move only the artwork and not the platen.

The center position on either bar is called 5000 (one less zero than the other axes, because the bars are calibrated to the nearest hundredth, instead of thousandth).

Each inch represents 100 increments, and is marked sequentially from 5000, rising by 100's to 6600 on the left and lowering to 3400 on the right.



Mr. Camera has tick marks on his crank that allow him to move these bars as tightly as one hundredth of an inch per frame. We stretch that sometimes and make him squint to reach a half a hundredth. In other words, the exposure sheet might call for frame 1 to be at

5000 and frame 2 at 5000.5. This is the smallest feasible increment on a manual pan. As of this writing, the pan bars are not computerized.

Once again, all moves are spoken of from the camera's point of view. A "pan to the left" means moving the artwork to the right.

As previously mentioned, there are two configurations, or "setups" in which the pegs can be arranged: 16-field and 12-field, to correspond with our different sized paper and cel stocks. The top and bottom peg bars can work in either of two side-by-side grooves, the outer set for 16-field and the inner set for 12-field. Like I said, Mr. Camera generally keeps the bars configured for a 16-field set-up, even when he's shooting a 12-field scene he just fields in and down four field lines. (This is why 12-field backgrounds are painted on the lower part of 16-field board.) 24-field artwork (usually used in optical scenes in which a background painted on 24-field board needs to be trucking while the character animation must remain at a constant distance) is also shot on a 16-field set-up. There are markings on the camera bed indicating to Mr. Camera where to tape down the oversized artwork so that its center will jive with the center of the 16F set-up. The platen is removed for these shots. As a result, you can use bed moves with 24-field artwork, but it **cannot** pan (it is not on a peg bar) and it **cannot** animate (it is taped down).

It is important to remember that

SET-UP IS NOT THE SAME AS FIELD-SIZE.
THE FIELD IS DETERMINED BY THE CAMERA-VERTICAL POSITION.
SET-UP IS DETERMINED BY THE PEG-BAR CONFIGURATION.

On a 16F set-up, there are only two pan bars, so there can be no more than two elements panning at different speeds. Once in a blue moon, we've been able to rig something to allow for three different speeds on a 16F set-up, but don't count on it. If there needs to be more than two speeds (which is unusual), the scene must be 12-field and a 12-field set-up must be specially requested. (Mr. Camera will hate you forever.) The 12-field set-up uses the inner set of pan bars that lie just inside the 16-field ones, leaving open the possibility of utilizing the outer grooves to pan some additional overlays (O.L.'s). One point to beware is that when using this option, the physical pegs have to be removed from the inner bar to allow artwork to lie over it. The element on the inner bar must be taped into place, and **cannot** animate.

T.P. (top pegs)
Refers to the peg bar that lies over the artwork.

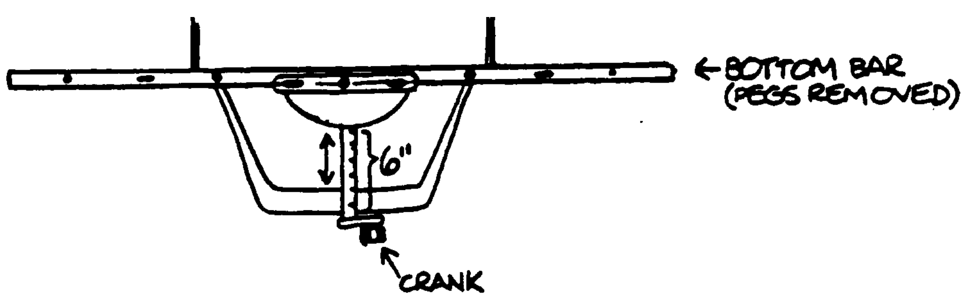
B.P. (bottom pegs)
Refers to the peg bar that lies below the artwork.

Additionally, there are currently two types of "auxiliary pegs" we employ. That is, extra pegs that attach onto the bottom bar. There are other varieties of aux. pegs that we might at some point add to our collection. As for now, these are the only two: Flip-pegs and north-south pegs.

FLIP PEGS
Flip pegs lie directly atop the bottom peg bar, and the pegs on it line up precisely to the position of the pegs on the bottom bar when that bar is at its 5000 center placement. In order to use flip pegs, the pegs must be stripped off the bottom bar.

The primary advantage of flip pegs is that they will remain centered at 5000, holding animation in place, while the bottom bar beneath it is free to pan back and forth, carrying a taped-down background or underlay. They are used in scenes that require two different pan speeds, as well as a level that doesn't pan at all. For instance, a background may be taped down and pan at one speed on bottom pegs, while the animation works in place on flip pegs, while an overlay pans over everything at a faster speed on top pegs.

N-S PEGS (north-south pegs)
NEVER CONFUSE N-S PEGS WITH A N-S BED MOVE. They have nothing to do with each other. N-S pegs is an auxiliary peg unit that attaches to the bottom bar, but, unlike flip pegs, does pan with the bottom bar. Pegs are removed from the bar, so that the pegs of the auxiliary unit can lie directly on top of it. What N-S pegs allows you to do is move your artwork north and south on a stationary camera bed, while panning east or west at the same time. Specifically, the N-S pegs can be cranked below the normal position of the bottom pegs southward by a maximum of six inches. The auxiliary unit will not allow the pegs to move any further north than equilibrium, their normal position. In order to achieve northward movement, the artwork must begin below equilibrium and be cranked up toward it.



The increments are in hundredths of inches. 0000 is equilibrium,the normal 16-field set-up position. As the pegs move south, the numbers rise (100 increments each inch) to 0600 at 6 inches south. So:

0000 --> 0600 = SOUTH MOVE

0600 --> 0000 = NORTH MOVE

0000 = 16 FIELD SET-UP

Some things to watch out for: if the desired camera fielding is 16F, tall paper and cels need to be used, so that when the pegs are lowered, the top of the artwork doesn't descend into the frame. However, this means the pegs will need to be stripped from the top bar in order to fit the oversized artwork. An element may be taped to the top bar underneath the N-S pegs level, but never over it. An easy solution, if possible, is to establish the scene at a 12F/4 South fielding, which will allow the use of regular 16F artwork on N-S pegs. The unseen area at the top of the16F set-up will keep the artwork edge from entering the frame, and you will not be restricted in the use of top pegs.

A Review

CAMERA COMPONENTS	MOVES	ABBREVIATIONS	CENTER POSITION
Camera	Truck Rotation	C-VERT ROT	16F=32240, 12F=22320 50000
Bed, or"compound"	North-South East-West	N-S E-W	50000* 50000
Peg bars	Top Pegs Pan Bottom Pegs Pan	T.P. B.P.	5000 5000
Auxilliary Pegs	Flip pegs North-South Pegs	 N-S PEGS	5000 0000

*12F on a 16F set=48500

SETTING THE SCENE

When a scene is cast, the director indicates to the animator what kinds of camera moves are called for. If there is any doubt, a “Blue Book” is kept: a scene by scene log of the movie which itemizes camera moves, layout information, and a listing of expected levels. The Blue Book can be located in the Music Room and is for everybody’s reference.

Before plowing into a scene that involves camera moves, it will save a lot of time and frustration later if the artist analyzes the scene first. Scene-planners are always available and glad to help with this initial process of determining the best possible way to set up the scene.

Animating “in place” vs. animating “with the pan.”

The most predominant type of move is the pan. There are two ways of animating in such a situation. “Animating in place” means that the character is animated on bottom pegs which are held stationary, against a background that is to be panned on top pegs. The animator in this case needs to “slip” the character’s feet some amount each drawing, to keep it working over the panning background.

“Animating with the pan,” the other method, refers to animating the character actually moving across long paper/cels that will pan along with the background. Here, both character level and background are put on bottom pegs and pan together.

Each animator has his/her own favorite way of going about this. That is certainly a factor in deciding whether to animate “in place” or “with the pan.” There are some other factors, however, that should be weighed equally before staring the scene.

“Animating in place” is advantageous in that it does not require long paper or cels, which means cost-efficiency and greater ease in packaging artwork. To animate in place, the pan **must** be planned **first**, and the animator refers to it as a guide for each drawing. There is no guesswork, as a result, in knowing what area is in the camera’s field of view’ for any given frame. This process doesn’t require the complexity of labelling the pegs on every drawing, as long paper requires. Animating in place is sometimes desirable artistically, because it is easier to watch the “arcs” when the drawings are one on top of the other, as in a walk cycle.

Unfortunately, there are some serious blows against animating “in place”. For one, there are some situations in which the scene will need to be put “on ones” (a drawing every frame, instead of every other) because of the choice to animate in place. This creates unnecessary double-work. Also importantly, because the sceneis animated to a pre-set pan move, the artwork is locked into that move, There is no flexibility later on, if the pan isn’t working quite right.

“Animating with the pan” is often the better choice, because of this. If a character stays put for a duration, it can be animated on twos using this technique instead of the ones that animating in place would require. This method also “frees” the pan move to be altered a hundred times over, if the director so wishes. Additionally, it makes it easier to accommodate an overlay moving at a different speed, because all other levels are on bottom pegs, leaving top pegs free. This is done quite often to add dimension to the scene - usually, the top pegs overlay pans 2 or 3 hundredths of an inch faster each frame than the bottom pegs background.

On the negative side, animating with the pan necessitates unwieldy long paper and cels, which need to have peghole labels on every drawing. The animator should know that he/she does not initially have to animate such a scene on long cels. The character can be animated across a regular-sized sheet of paper, and then continued on another regular-sized sheet when it nears the edge of the first sheet. Cameramen will butt blank paper up against the sides of these sheets as they pan, so the paper edge won’t be apparent. Animation checking will then call for proper-sized cels to be used in xerox.

The only hitch in all this:

ARTISTS MUST LABEL PEGHOLES.

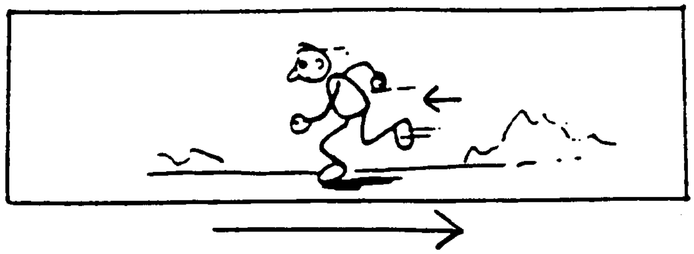
Otherwise, the cameraman nor the checker will have a clue as to what the artist intended. On pan layouts. pegholes are labeled alphabetically from left to right. The first round hole that is in the camera’ s field to the left is automatically “A” (even if camera begins on the right side of the background. Holes are then labeled successively, “B,” “C,” “D,” etc. `when a peg bar is panning, all drawings must have the letter that corresponds to the layout printed clearly beside each round hole.

Here’s a summary of the differences between the options:

ANIMATING IN PLACE	**ANIMATING WITH THE PAN**
Animation on bottom pegs. Background on top pegs.	Animation and background on bottom pegs.
Panning overlay at different speed possible but complicated.	Panning overlay at different speed is simple.
Does not require long paper/ cels.	Requires long paper/cels.
Animation requires built-in foot-slippage.	Animation works straight across paper with no slippage.
Animation is locked into pan move.	Pan move is free to be changed after animation.

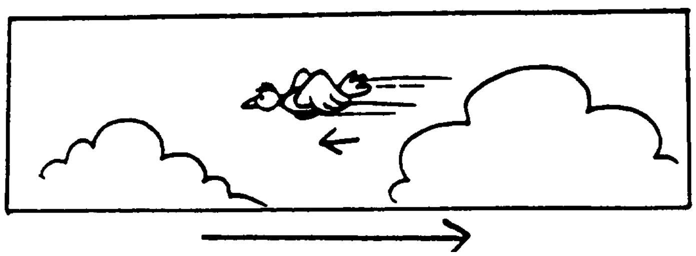
(Continued)

ANIMATING IN PLACE | **ANIMATING WITH THE PAN**



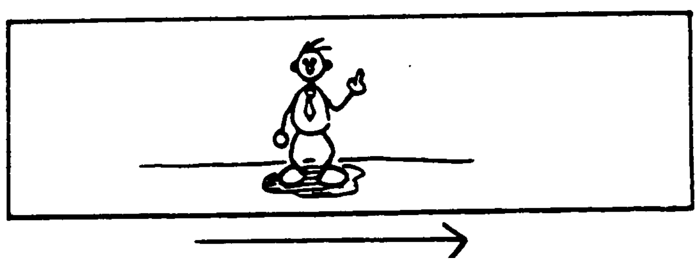
(Character moving opposite direction of pan, making contact with background)

Must be animated on ONES. | Must be animated on ONES.



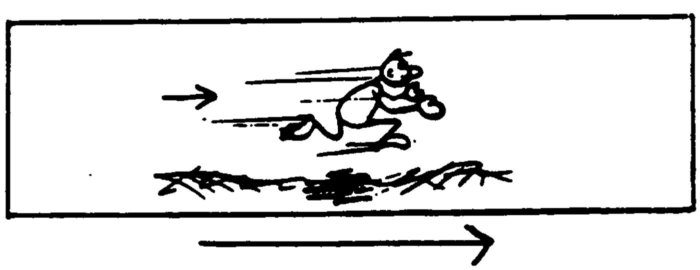
(Character moving opposite direction of pan, not contacting background)

Can be animated on TWOS. | Should be animated on ONES.



(Character not moving feet as background pans)

Must be on ONES. | Can be animated on TWOS.



(Character moving same direction as pan. (Unusual))

Must be animated on ONES. | Can be animated on TWOS.

“STROBING”

This is the dreaded term used to describe that phenomenon when a character is animated on twos against a pan that is moving on ones. The character will appear to slip against the background every other frame, creating a very disturbing uttering effect. This is why many of the above cases call for animation to be put on ones.

“JOGGING PEGS”

The Fallacy & The Reality

At one time, we thought we had a brilliant innovation to save artwork from ever having to be put on ones due to a pan. In the case of a character moving opposite the direction of the background, we would animate the character in place on twos, and slide the bottom peg bar backward, or “jog it,” a slight bit every other frame to match the movement of the pan. In theory, this would keep the character’s feet pinned to the ground, and would eliminate the strobing effect created when the ground slips under the feet every other frame. In practice, this led to strobing of an even worse breed -- the entire character jittered back and forth relative to the screen edge, which proved to be terribly distracting.

In modern times, “jogging the pegs” is used in only certain instances. One viable usage of the technique is in cases such as the last two listed in the above diagram, When a character is stationary, or moving the same direction as a panning background, jogging the pegs will eliminate having to put the scene on ones when it is animated in place. In effect, the jogging in-betweens the drawings for the artist, and does not create a strobe, because the pegs are jogged in the same direction as the character’s action. This cannot always be relied upon, though, if there is any other animation on bottom pegs which is moving against the pan. Jogging the pegs will strobe these elements in a Bad (with a capital `B’) way.

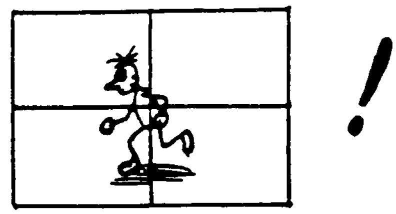
Following the action.

If the audience doesn’t notice a camera move, it’s been a success. Moves should never call attention to themselves - they should complement the action in a subliminal way. If the character starts moving out of the frame, we naturally want to follow it. The camera is our eyes, and should do what our eyes are motivated to do. If there is some tiny action taking place in the distance, our eyes want to truck toward it, to see what’s going on. We won’t be conscious that the camera is moving, because the movement is only helping us pay attention to the action.

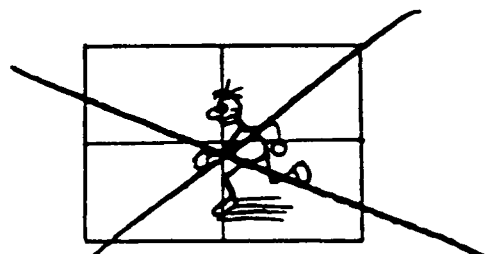
No-no camera moves are ones that betray our eyes, or that move before our eyes are ready to. These moves will break our involvement in the movie (or our “suspension of disbelief,” as film scholars like to call it). A frequent expression is that the camera move should always “follow the action,” and never anticipate it.

A pan or bed move should never begin, until the character has crossed over the center of the field, and has offset the composition enough that our eyes want to follow it. Likewise, the camera should keep the character just in front of the center line as the action continues.

RIGHT



WRONG



Sometimes, if the character decelerates, you will want to overlap the speed of your move - the human eye would take a moment to react to the change in speed, so the camera might be best to overtake the character for a bit, and then slow or retreat to center him again.

There is a finesse in planning a good move. If the action is not considered before setting down the increments, you may end up with a jarring, “mechanical” pan. ?art of this finesse is in properly following the action, and part is in properly pacing and tapering the moves, so that they are never too abrupt.

The taper at the start of a move is called a “slow-out” and the one at the end, a “slow-in.” This refers to easing very casually into and out of held camera positions. Saturday morning cartoons are full of examples of moves that lack sufficient slow-outs and ins. The result, as you’ll notice, is mechanical and rather jolting. The specifics of planning proper tapers are in the section called “The Numbers.” Suffice it for now that the longer the tapers the better - at least 1 or 2 feet each, usually a third or more of the total pan footage (except in extraordinarily long pans, when the proportion may be much less, or in very short pans, when the tapers may be as much as half the footage each).

Beside the taper speed, the entire speed of the move should be kept leisurely enough to avoid a rushed or unmotivated feeling. (Unless, of course, a “rushed move” is motivated by the action.) To figure the proper speed, use your hands as the camera lens and move them over the artwork as you would eventually like to have the camera move. Don’ t mind all the people laughing. Keep doing it until you are happy with the move.

Then time it by counting seconds or using a stopwatch. Just below is a conversion table to translate the time into frames, so that you can plot the move for the right length on the exposure sheet.

As an additional guide, there is a Pan Test Reel in the MusicRoom which you can view, showing all the different pan speeds (from .01 inches per frame to 3,00 inches per frame) to help you determine your desired speed.

SECONDS	FRAMES	FEET
⅓sec	8	0–08
⅔sec	16	1–00
1sec	24	1–08
1⅓sec	32	2–00
1⅔sec	40	2–08
2sec	48	3–00
2⅓sec	56	3–08
2⅔sec	64	4–00
3sec	72	4–08
3⅓sec	80	5–00
3⅔sec	88	5–08
4sec	96	6–00
4⅓sec	104	6–08
4⅔sec	112	7–00
5sec	120	7–08
5⅓sec	128	8–00
5⅔sec	136	8–08
6sec	144	9–00
6⅓sec	152	9–08
6⅔sec	160	10–00
7sec	168	10–08
7⅓sec	176	11–00
7⅔sec	184	11–08
8sec	192	12–00
8⅓sec	200	12–08
8⅔sec	208	13–00
9sec	216	13–08
9⅓sec	224	14–00
9⅔sec	232	14–08
10sec	240	15–00

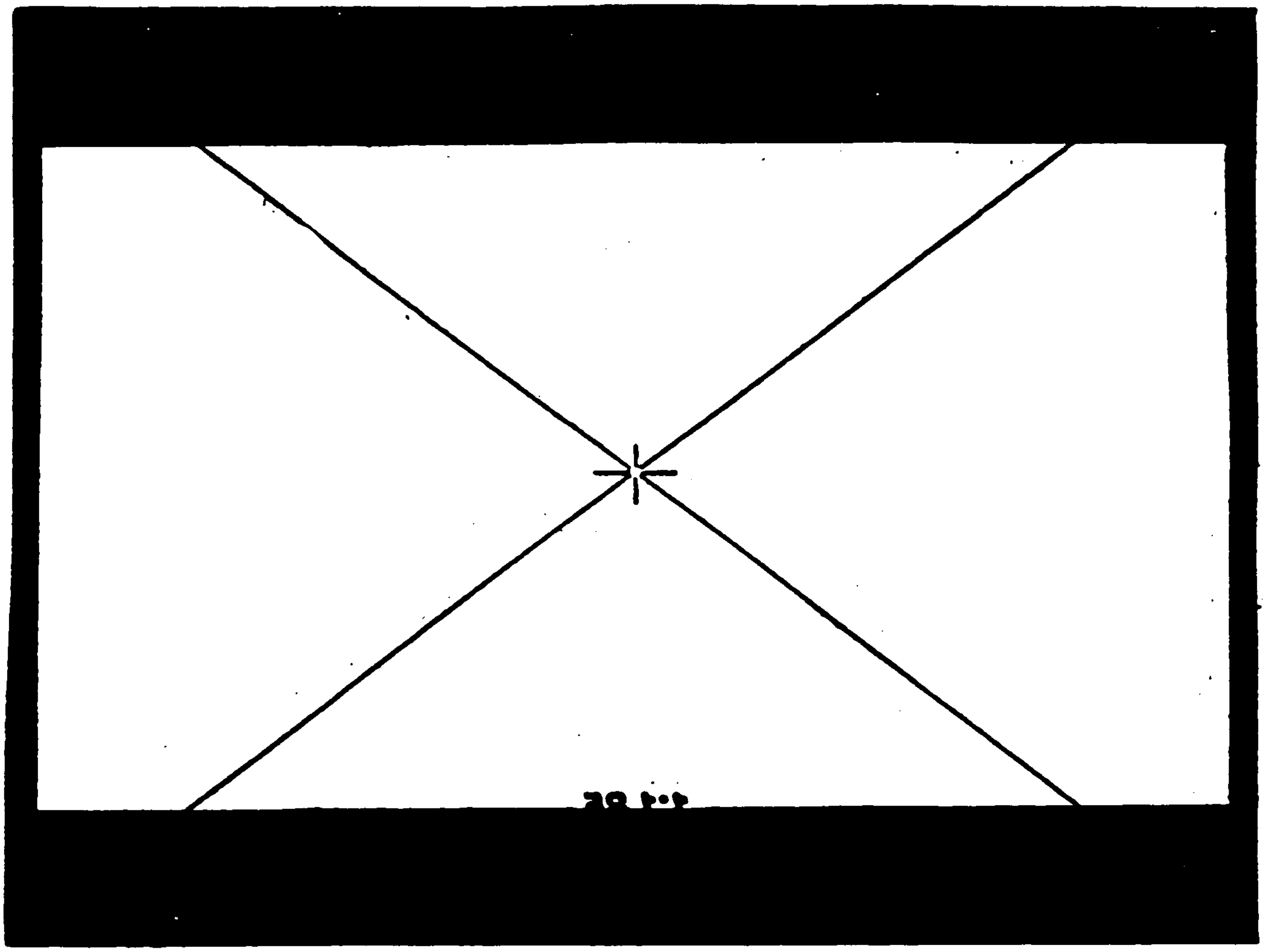
The 1:1.85 Cut-In.

When our film is projected in most theatres, the audience does not see the complete image that is on the frames. Theatres use wide screens with an aspect ratio of 1,85 horizontally to 1 vertically. Therefore, part of our image is lopped off with a mask, to make the remaining area fit the 1:1.85 ratio.

This is important to keep in mind in both the drawing and planning of a scene. The action should be contained in the area of thefull field that will be seen once the”Cut-in” cuts in.

Field Guides

There is a set of “field-guides” you can use to determine the cut-in for any field size. The proportions of the area that will be masked off look like this:



On a 16-field area, the cut-in will mask off the top and bottom of the frame to approximately the 111/2 F mark on the field chart.

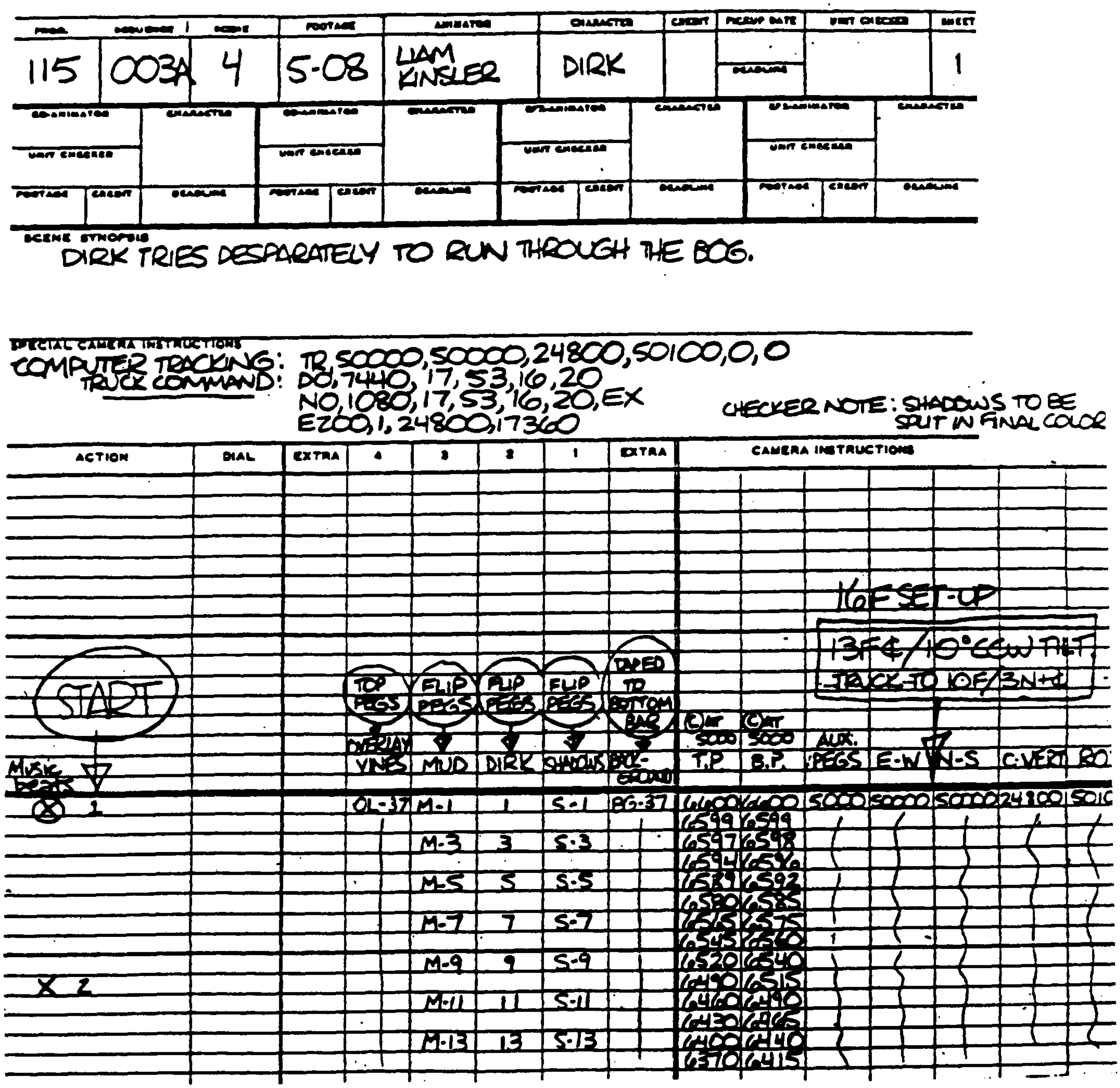
When we shoot story sketch at camera, we shoot the sketches with the 1:1.85 cut-in masked off with a black exeter matte, There are 3 such masks for different sized story sketches:

MASK A	Regular 8F story sketch, shoot at 11 1/2 F₵
MASK B	Enlarged 11 1/2F story sketch, shoot at 16F₵
MASK C	Vertical pan story sketch, shoot at 11 1/2F₵. ROT: 59000

GETTING IT DOWN

The exposure sheet is the only communication between the departments as to the exact contents and nature of a scene. If the exposure sheet (x-sheet) is filled out wrong, everyone will be confused, and the cameraman will commit suicide. Or murder. If the x-sheet is filled out right, everyone will "get it" and Mr. Camera will be happy. It's all in your hands...

Here's a teacher's pet, A+ example of a properly filled out x-sheet:



PROD.	SEQUENCE	SCENE	FOOTAGE	ANIMATOR	CHARACTER	SHEET
115	003A	4	5-08	LIAM KINSLER	DIRK	1

SCENE SYNOPSIS
DIRK TRIES DESPARATELY TO RUN THROUGH THE BOG.

SPECIAL CAMERA INSTRUCTIONS
COMPUTER TRACKING: TR,50000,50000,24800,50100,0,0
TRUCK COMMAND: DO,7440,17,53,16,20
NO,1080,17,53,16,20,EX
E200,1,24800,17360

CHECKER NOTE: SHADOWS TO BE SPLIT IN FINAL COLOR

16F SET-UP
13F¢ / 10° CCW TILT
TRUCK TO 10F / 3N+2

START

TOP PEGS / FLIP PEGS / FLIP PEGS / FLIP PEGS / TAPED TO BOTTOM BAR

ACTION	DIAL	EXTRA	4	3	2	1	EXTRA	T.P. (@ AT 5000)	B.P. (@ AT 5000)	AUX. PEGS	E-W	N-S	C.VERT	RO
MUSIC BEATS			OVERLAY VINES	MUD	DIRK	SHADOWS	BACK-GROUND							
⊗ 1			OL-37	M-1	1	S-1	BG-37	6600	6600	5000	50000	50000	24800	5010
								6599	6599					
				M-3	3	S-3		6597	6598					
								6594	6596					
				M-5	5	S-5		6589	6592					
								6580	6585					
				M-7	7	S-7		6565	6575					
								6545	6560					
				M-9	9	S-9		6520	6540					
X 2								6490	6515					
				M-11	11	S-11		6460	6490					
								6430	6465					
				M-13	13	S-13		6400	6440					
								6370	6415					

“What was That???” you’re wondering out loud. You’ve never encountered an x-sheet that looked anything like that. Well, that’s the problem right there.

For one thing, the computer coding at the top is a fairly recent development. I will get to that in the next section, For now, here’s a review of the basic points to note about x-sheet format in 1987 (and hopefully beyond):

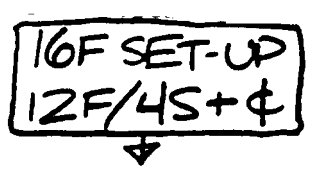
1. Note the order of the Camera Instruction columns. This is correct. You need not list them all - only the axes that are moving, but list those according to this order: T.P., B.P., AUX PEGS, E-W, N-S, C-VERT, and ROT. All bed and camera moves are now computerized, but if desired, a computer printout of those moves can be copied into the appropriate columns.

2. The levels of animation are listed in columns from topmost level to bottom-most level as you read from left to right. The BG (background) is always on the bottom, and has a number which should be written on the first line of the column, The names of the levels are written atop each column, and letter symbols are used before the numbers to distinguish the levels.

DON’T EXPOSE YOUR ANIMATION IN ANY OLD COLUMN.

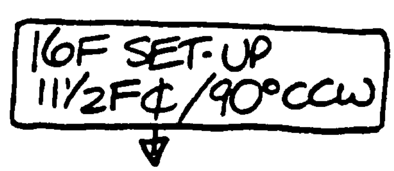
3. There are generally only 4 levels allowed for a single camera pass. Keep this in mind. Refer to the Blue Book to see what other levels will be in the scene, and determine in which column your level will probably be in when all is said and done, You can eliminate confusion and the necessity to copy over the columns into their proper position later on. Ask if you’re unsure,

Note the “fielding block” atop the camera section. It contains three bits of information: set-up, fielding, and movement (if any). Previously, I explained the difference between set-up and fielding. A 16F₵ scene must say also that it is a 16F set-up. A 12F scene, almost without exception should be written as such:



This means the camera bed is set-up for 16 field peg bar spacing, but the camera is fielded in to a 12-field, 4 fields south and none east or west.

A vertical tilt pan should look like this:



This indicates an 11 1/2 F₵ fielding on a 16 field set-up, at a 90 degree counterclockwise tilt.

Lastly, if there is movement in the scene, the type of move and final position should also be listed in code form in the fielding box.

F = field
N = north
S = south
E = east
W = west
CW = clockwise
CCW = counterclockwise
₵ = center

16F₵ means 16-field, centered in all directions, **8F/4N+2W** means 8-field, moved 4 north and two west.

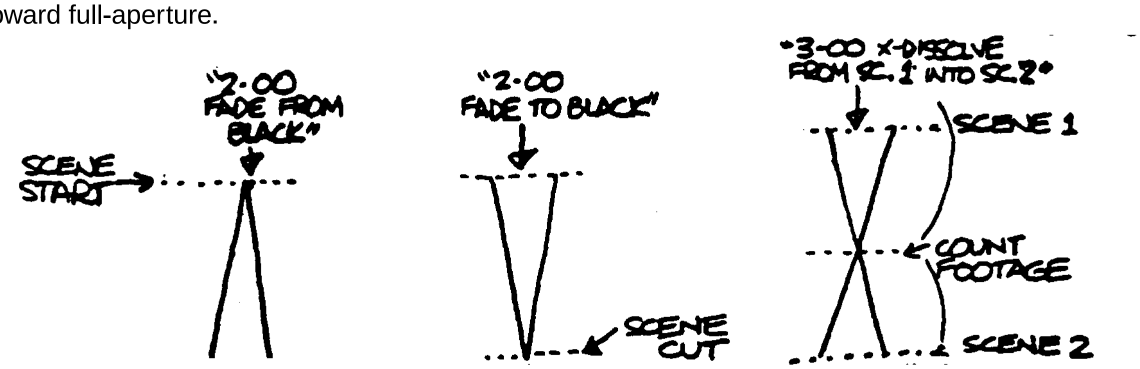
4. Pan increments are meaningless to the cameraman unless there is a notation as to which peghole he is to place at 5000 when he puts the background or overlay on his bar. “C” at 5000 written above the BG. column lets him know this.

5. **Changeovers** ~~ The pan bar is only 32 inches long. A background may be 100 inches long. Clearly, at some point, Mr. Camera will run out of pan bar and have to lift off his background to slide the bar back to its beginning, The background stays in exactly the same place, There will be no notice of this on the film. Only, the pegholes of the background will “change over” ,to different pegs on the pan bar.

Thus, if a pan starts clear at one end of the bar, at 6600, with peghole “C” at 5000, and pans to 3400 at the other end of the bar, you will want the bar to slide back to 6600 (where it is now at 3400), 50 that you can start the 32 inches all over again, In so doing, “C” will be lifted off 5000, and when the bar is slid back, peghole “G” will end up at 5000.

On the x-sheet, you would circle in RED the increment of the change-over (the numbers will suddenly jump from 3400 to 6600) and write in red beside it: `CHANGE-OVER TO “C” AT 5000’.

6. **Fades and cross-dissolves** -- There is a proper notation for these. A fade is indicated in a free column in the camera section by a red “carrot”, pointing toward the black end of the fade and opening toward full-aperture.



A cross-dissolve (x-dissolve) is indicated by a red “X” in the camera column, extending from dissolve start to finish, with the center of the “X” corresponding with the center of the dissolve. A x-dissolve scene requires additional footage to be exposed on the x-sheet, which allows the ghost of the old scene to still be dissolving out of the new scene, even after its "count-footage” has expired.

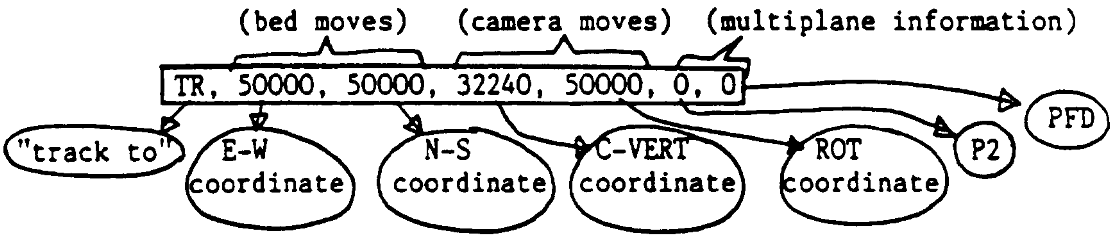
THE NUMBERS

After the types and lengths of the moves are determined, the actual increments must be set for the camera stand. All axes but the peg bars are presently computerized, so these moves are written out in a code form in the SPECIAL INSTRUCTIONS area atop the x-sheet.

Here is a run down of the codes, and what they mean:

Tracking.

The first code line is the tracking, or initial position the camera must be at to begin shooting the scene. For 16F₵ this would be the tracking code:



The order of the coordinates match the order of the x-sheet columns All coordinates must must be assigned a number even if they are at center position or not relevant (such as the two zeros at the end of the line, which are replaced with coordinate numbers when multiplane set-up is in operation - the coordinates are for the vertical position of plane 2 and the plane of focus displacement.)

Some more examples of common tracking codes:

For 12F/4S+¢,

```
TR, 50000, 48500, 22320, 50000, 0, 0
```

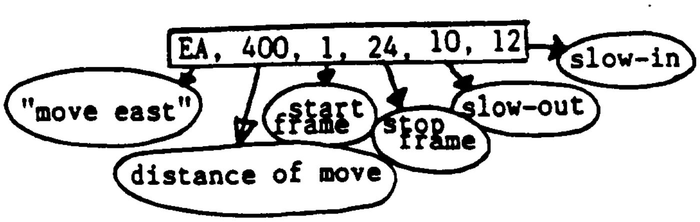
For 11½F¢/90˚CCW tilt,

```
TR, 50000, 50000, 21080, 59000, 0, 0
```

Successive lines are optional, depending if there are any moves during the scene. All x-sheets, however, require this tracking line.

Bed moves.

If there are E-W or N-S moves, they are indicated as follows:



All the necessary information is given here for the computer to plan a move of 400 increments to the east, from frame 1 to frame 24 of the scene, with a 10 frame slow-out and a 12 frame slow-in.

```
SO, 728, 53, 87, 20, 0
```

Likewise, this will call for a move of 728 increments south (from the N-S coordinate listed in the TRACKING line), from frame 53 to frame 87, with a slow-out of 20 frames and no slow-in. So the instructional codes for bed moves are

EA = east
WE = west
NO = north
SO = south

Computerized shakes.

When the E-W and/or N-S coordinates are meant to vibrate on the impact of a character or rumble with an earthquake, a special form is attached to the x-sheet to request and specify this type of movement. Here is a sample shake instruction form:

SHAKE COMMAND DATA FORM

SEQ # 007 SC # 4 DATE Jan 14, 1987

AXIS 1=EW 2=NS	MAX AMP	DIR 0=+ 1=-	HITS PER POSI.	START FRAME NUM.	MAX FRAME NUM.	HOLD FRS. QUAN.	END FRAME NUM.	TARGET FRAME NUM.
1	120	0	2	6	8	2	24	0
2	100	1	1	6	8	1	24	48

An infinite number of shake commands can be given for the same scene (they can overlap each other, as with all computer move commands), Each axis you want to shake requires a separate command on the above form. The sample shake I have described here would be an E-W and N-S impact shake, beginning on frame 6, reaching its maximum intensity at frame 8, and slowing in to a stop at frame 24. Its major thrust is westerly.

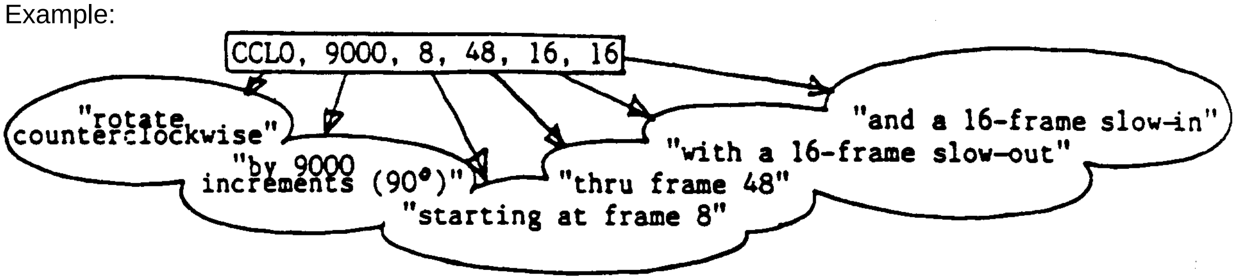
AXIS 1=EW 2=NS	This column informs the computer which axis the shake command is for. "1" tells it to move east and west of your tracking position; "2" tells it north and south.
MAX AMP	MAXIMUM AMPLITUDE is the greatest distance the bed should move in either direction of its initial position during the shake. (If 120 increments is called for, the bed will move a total of 240 increments between extremes.)
DIR 0=+ 1=-	DIRECTION denotes whether the first increment of the shake should rise or decrease (meaning west or east, north or south) from the bed's tracking command.
HITS PER POSI.	HITS PER POSITION is the number of frames the bed should remain at each increment for *
START FRAME NUM.	The frame you wish to start the shake on.
MAX FRAME NUM.	The frame at which the increment should be at its most extreme (the entry for "MAX AMP").
HOLD FRS. QUAN.	HOLD FRAMES QUANTITY calls for the number of frames the increment should remain at its maximum amplitude.
END FRAME NUM.	The frame you wish to end the shake on,
TARGET FRAME NUM.	The final frame of the scene, OR zero ("0") if another shake command is to follow.

Camera moves.

Trucks and rotations are indicated very much like bed moves. The order of the information is identical in these commands, but the move codes are different.

They are:
UP = truck-out
DO = truck-in
CLOC a clockwise rotation
CCLO a counterclockwise rotation

Example:



The computer can plot moves according to different mathematical curves. In general, a "sine curve" suits our purposes of creating steady moves with smooth tapers. "Sine" is the default, assumed by the computer if there is no command to the contrary.

However, in cases of long trucks, or trucks that hook up between two or more scenes, we will want to move "exponentially." Even if you can't pronounce it, an exponential curve is what you want. The reason is this:

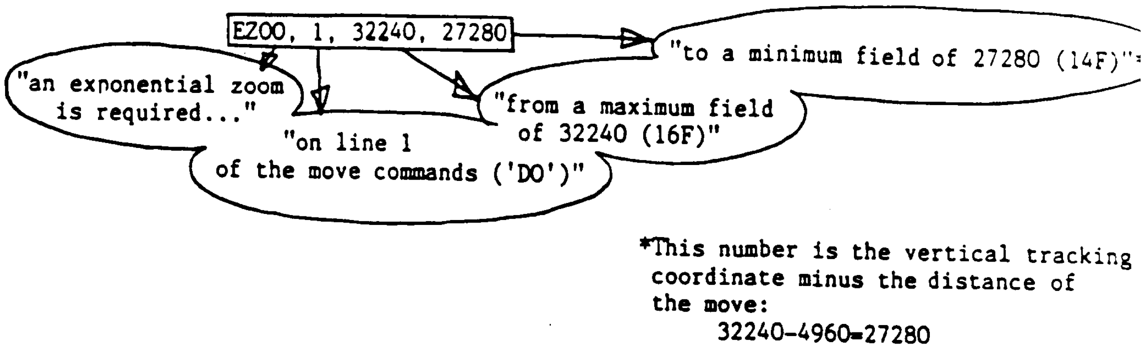
If you truck at a constant rate, there will be an apparent acceleration. This is because, although the camera is moving down the same amount each frame on the crane, the field that the lens sees is growing more and more rapidly relative to each previous field. In order to compensate for this illusion, an exponential truck slows down as it trucks in and speeds up as it trucks out. When compensation is desired, all other moves should match the same exponential curve used for the truck. This is done as follows:

Example:

```
           TR, 50000, 50000, 32240, 50000, 0, 0
(Line 1)   DO, 4960, 1, 79, 16, 32
(Line 2)   EA, 2400, 1, 79, 16, 32, EX
(Line 3)   NO, 1000, 1, 79, 16, 32, EX
           EZOO, 1, 32240, 27280
```

Tracking doesn't change. Neither does the camera vertical command, (It is the last line that tells the computer to compensate the vertical move.) But all other moves that are meant to link-up with the vertical move compensation require an "EX" at the end, as you see in the example.

The three move command lines have been numbered here. To inform the computer which move is the truck, and how much compensation on the truck will be desired, an additional command is required at the end. This is the “EZOO” line you see in the example below.



Multiplane moves.

P2 (plane 2) and PFD (plane of focus displacement) refer to the height of second (upper) plane of a multiplane set-up, and the plane at which the camera will focus on the set-up. Both can be commanded to move when multiplane is operative, using the same format as all other move commands in this section.

The instruction codes are:

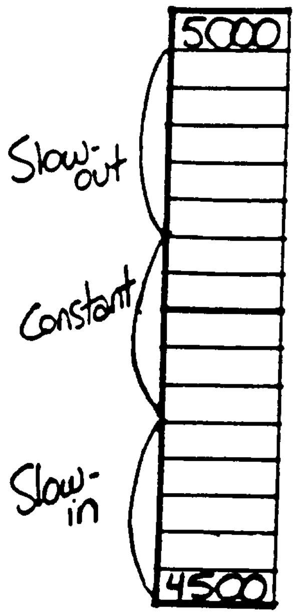
P2UP = move plane 2 up on the crane
P2D0 = move plane 2 down on the crane
PFUP = bring plane of focus up (toward lens)
PFDO = take plane of focus down (away from lens)

Planning by hand.

It might sound archaic, but it’s not. It’s important to be able to work out moves by hand. In the case of pan bar moves, it is necessary, until the day the bars are computerized, too. Even after the whole world is computerized, though, you will have a better understanding of what the computer does, and won’t be helpless if the microchips leave you in the lurch, if you learn the basics of scene-planning by pencil. (Pencils never leave you in the lurch,)

There are no hard and fast formulas here, There is some trial- and-error, a little guesstimation, and a good deal of algebra. There are some basic ground rules, but in order to illustrate them, I will work through a sample pan assignment,

Suppose there is a 15-frame pan to figure, starting at 5000 and moving to 4500. You will want a well-balanced slow-out and slow-in.



PLOT

In cases of shorter pans like this, I generally take a third or more as the slow-out or in. I'll divide the frames here into thirds. We are plotting a 5 frame slow-out, a 5-frame constant area in the middle, and a 5-frame slow-in.

AVERAGE

I then come up with an average increment per frame for the entire pan. I'm moving a total of

5000 - 4500 = 500 increments

in 15 frames.

500 / 15 = 33.33

which is the average increment per frame.

FIGURE CONSTANT

The constant incremental difference for the middle S frames will have to be higher than this average, to compensate for the fact that the slow-in and slow-out will start at zero on each side of the pan, far below the average. I'll take a guess at the constant. 45, I'll say.

45 x 5 = 225 = the total, distance covered by the constant area of the pan.

How much distance is left for the slow-in and slow-out?

Total- pan-distance minus Constant- area-distance
500 - 225 = 275

I'll divide that distance by 2, to find the distance allotted to each of my slow-out and slow-in. It is 137.5.

How do I know at this point whether I'm heading in the right direction? One easy test - that 137.5 distance number divided by the number of frames for the slowout (which is 5) should come~ out to Just about half of the constant I chose (which is 45). If the test works, I know my slow-out and in will have a nice curve to them, If it's way off, the curve is going to be lopsided.

I'll find out.
137.5 / 5 = 27.5

which is more than half of 45. It could work, but it's not ideal.

I'll try raising my constant a bit to see if I can find a better solution. Instead of 45, I'll go 50.

50 x 5 = 250 - the distance of the constant area.

500 (total distance) - 250 = 250 - the distance covered by the combined slow-inand out.

250 / 2 = 125 a the distance covered by Just the slow~out

Now for the test again.

125 / 5 (frames of slow-out) = 25

which happens to be exactly half of 50, the constant! The perfect set-up! Now to plan it.

PLAN TAPERS

The holy rule of planning slow-outs:

THE DIFFERENCE BETWEEN THE INCREMENTS IN A SLOW-OUTOR SLOW-IN SHOULD NEVER BE THE SAME FOR MORE THAN 2 FRAMES IN A ROW.

If they are, you stand to see a "catch," or "glitch," in the move when it's filmed.

There are three sets of numbers you want to keep in mind when planning tapers:

(A) THE INCREMENTS
(B) THE INCREMENTS BETWEEN THE INCREMENTS
(C) THE INCRD{ENTS BETWEEN THE INCREMENTS BETWEEN THE INCREMENTS.

(A) is the set of numbers Mr. Camera will crank his bar to:5250, 5251, 5253, 5257, 5264, etc. (B) are the differences between these. Taking the list Just mentioned, they would be 1, 2, 4, 7, etc. It is this set of numbers that you pencil in beside the pan column on the x-sheet. The slow-out will first be planned using these numbers and only then will we actually subtract from or add to our starting position to write in each frame's camera increment. The constant, 50 in our case, is also from this set of numbers -- it is the difference between the camera increments. (C), the third set, is composed of the differences between the numbers in (B). It is always important to keep these in mind, even though I don't usually write them out.

Here’s a sample slow-out, not the answer to our pan assignment, but one which we can use as an example.

A	B	C
5250	1	1
5251	2	2
5253	4	3
5257	7	4
5264	11	4
5285	15	3
5300	18	2
5318	20	1
5338	21	1
5359	22	0
5381	22	.
.	.	.
.	.	.
.	.	

Beside these camera increments (A) are listed two additional sets of numbers: the differences between the increments, and then the differences between those. These indicate how smooth a curve the slow-out would have, if you graphed it out. The (B) set of numbers should demonstrate a steady rise, while the (C) set should reveal a “slow-out” and “slow-in” even within that rise.

I have learned to automatically think of the (C) set as I plan any move - it’s not difficult to keep in mind.

Back to the assignment at hand.

We need to fill in the (B) set, an accelaration from 0 to 50 in 5 frames, the sum of which will equal 125.

Take a stab. If it doesn’t add up right the first time, add to or subtract from the numbers here and there to make it add up.

	A	B	C
	5000	0	
slow-out			
constant		50	
		50	0
		50	0
		50	0
		50	0
slow-in			
	4500		

	A	B	C
	5000	0	0
slow-out		4	4
		12	8
		25	13
		38	13
		46	8
constant		50	4
		50	0
		50	0
		50	0
		50	0
slow-in			
	4500		

This, at last, seem’s to work, so the actual camera increments can be determined by subtracting the (B) numbers frame by frame from the initial position, which is 5000. to the final destination, 4500.

As mentioned, I simply. reverse the slow-out numbers in the (B) column for the equal-lengthed slow-out.

A	B
5000	0
4996	4
4984	12
4959	25
4921	38
4875	46
4825	50
4775	50
4725	50
4675	50
4625	50
4579	46
4541	38
4516	25
4504	12
4500	4

Voila..... The Perfect Pan!

Camera Setup Diagram