

Before we dive into walks and all the articulation stuff, there are some other important camera techniques we should know about.

The X-SHEET

On the next page is a 'classic' exposure sheet called the X-sheet or dope sheet – the first sight of which is guaranteed to put any beginner or artist off the whole business. When I was a kid and first saw one of these I thought, 'Oh no, I don't want to be an animator anymore. I'll just make the designs for other people to move around.'

Actually, it's awfully simple when you make friends with it.

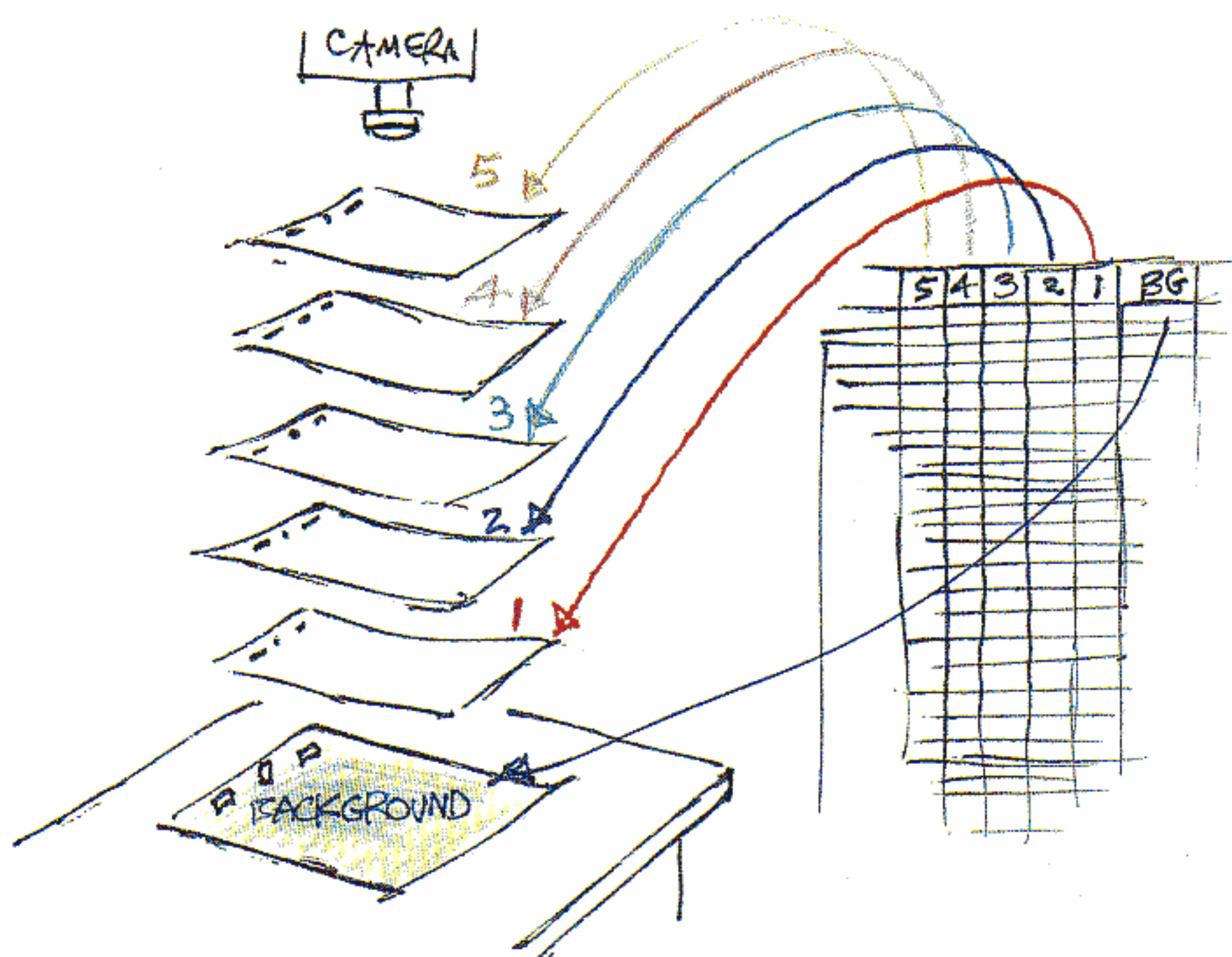
It's just a simple and efficient form where animators write down the action and dialogue (or music beats) for a scene or shot – plus the information for shooting.

Each horizontal line represents a frame of film.



The columns 1 to 5 show five cel levels of animation we can use if we need them. (Usually you need just one or two.)

ACTION	DIAL	5	4	3	2	1	B G	CAMERA



The **ACTION** column is for us to plan out our timing – how long we want things to take.

The **DIAL** column is for the measurement of the pre-recorded dialogue and sometimes the breakdown of music into beats etc.

This 'classic' X-sheet is designed to hold 4 seconds of action (1 second = 24 frames).

It has darker lines to show the footage, which is 6 feet of film (1 foot = 16 frames). Many animators always number the footage going down the page.

I've also written in the camera dial numbers – the frame numbers in the camera column.

Some animators time things out by thinking in seconds. Others think in feet = 2/3 of a second.

Ken Harris thought in feet and would tap the end of his pencil every foot. I think in both seconds and feet, but seconds is easier for me.

Also, you can think in 1/2 seconds = 12 frames to a half second. That's march time, which is quite easy.

(Computer animators please bear with me here – you obviously have your own systems of timing.)

SEQUENCE	SCENE	OUR DRAWINGS								CAMERA DIAL NUMBERS	SHEET
ACTION	DIAL	5	4	3	2	1	80	CAMERA INSTRUCTIONS			
	W					1	R	1			
	E					2	A	2	THE CAMERAMAN		
	E					3	C	3	FOLLOWS WHAT		
	U					4	K	4	WE'VE INDICATED		
	S					5	G	5	AND		
	E					6	P	6	IN THIS COLUMN		
	T					7	O	7	WE PUT ANY		
	H					8	U	8	CAMERA MOVES		
	I					9	N	9			
	S					10	D	10	LIKE TRUCK-INS		
	C					11		11	OR		
	O					12		12	ZOOMS IN OR OUT		
	L					13		13			
	D					14		14			
	E					15		15			
	T					16		16			
	H					17		17			
	I					18		18			
	S					19		19			
	C					20		20			
	O					21		21			
	L					22		22			
	D					23		23			
	E					24		24			
	T					25		25			
	H					26		26			
	I					27		27			
	S					28		28			
	C					29		29			
	O					30		30			
	L					31		31			
	D					32		32			
	E					33		33			
	T					34		34			
	H					35		35			
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	S					37		37			
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	E					42		42			
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	H					44		44			
	I					45		45			
	S					46		46			
	C					47		47			
	O					48		48			
	L					49		49			
	D					50		50			
	E					51		51			
	T					52		52			
	H					53		53			
	I					54		54			
	S					55		55			
	C					56		56			
	O					57		57			
	L					58		58			
	D					59		59			
	E					60		60			
	T					61		61			
	H					62		62			
	I					63		63			
	S					64		64			
	C					65		65			
	O					66		66			
	L					67		67	OR PANS		
	D					68		68			
	E					69		69			
	T					70		70			
	H					71		71	EAST		
	I					72		72			
	S					73		73			
	C					74		74			
	O					75		75			
	L					76		76			
	D					77		77	OR WEST		
	E					78		78			
	T					79		79			
	H					80		80			
	I					81		81			
	S					82		82	OR CAMERA		
	C					83		83	SHAKES ETC.		
	O					84		84			
	L					85		85			
	D					86		86			
	E					87		87			
	T					88		88			
	H					89		89	NORTH		
	I					90		90	SOUTH		
	S					91		91			
	C					92		92	EAST		
	O					93		93			
	L					94		94	WEST ETC.		
	D					95		95			
	E					96		96			

We'll plan out the action using the action column.

Ken Harris always said, 'Come on, now, you can have fun doing the drawings later, but do the important part first – time it all out.'

So we'd use a metronome or a stopwatch and I'd act it out several times, and we'd mark down on the sheet where things would happen.

Let's take our man walking over to pick up the chalk:

We've got him taking five steps to reach the chalk.

When I act it out, the first two steps are leisurely – 16 frames long (2/3 of a second).

Then during step 3 he sees the chalk, and this step is slightly quicker – 14 frames.

His fourth step is quickest – 12 frames.

On step 5 he slows up slightly – 14 frames and he's already started bending down, which takes over 2 feet till his hand contacts the chalk.

I've got him tucking up his pant leg above the knee as he goes down – which takes 8 or 10 frames.

Of course, we can change all this as we work, but this becomes our guide and the points to aim for as we go along.

Now we can put the numbers of these drawings on the page as I've done here.

Incidentally, although numbers 1 and 96 are keys and we've circled them, we don't circle the numbers on the X-sheet.

SEQUENCE		SCENE		DIAL NUMBERS									
ACTION	DIAL	5	4	3	2	1	BG	1	CAMERA IN				
STROLLS IN						1		1					
								2					
								3					
								4					
								5					
								6					
								7					
								8					
								9					
								10					
								11					
								12					
								13					
								14					
								15					
								16					
(1) X STEP 1						17		17					
								18					
								19					
								20					
								21					
								22					
								23					
								24					
								25					
								26					
								27					
								28					
								29					
								30					
								31					
								32					
(2) X STEP 2						33		33					
								34					
								35					
								36					
								37					
								38					
						39		39					
								40					
								41					
								42					
								43					
								44					
								45					
								46					
X STEP 3						47		47					
								48					
(3)								49					
								50					
								51					
								52					
								53					
								54					
								55					
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								57					
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						59		59					
								60					
								61					
								62					
								63					
								64					
(4)								65					
								66					
								67					
								68					
								69					
								70					
								71					
								72					
X STEP 5						73		73					
								74					
								75					
								76					
								77					
								78					
								79					
								80					
(5)								81					
								82					
								83					
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								89					
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								92					
								93					
								94					
								95					
(6) X STEP 6						96		96					
								97					

The five available 'cel' levels on this X-sheet are there so we can treat each character or element separately.

Why have different levels – why not draw everything on one level?

Answer: You can, but what do you do if you want to change the timing on one or two parts of the action and leave the other bits as they are? However, it's a good idea to try to keep to just one or two levels for simplicity.

If we wish to use all five levels, start with the main action on level 1. Say a man walks in from one side of the screen and a cat walks in from the other. We animate our main action man on level 1, and the cat on level 2, adding a 'C' after the cat numbers: 1-C, 2-C, 3-C etc., so as not to confuse it with the man drawing. The man drawings, or main action, don't need an identifying letter.

If a woman passes in front of them, we'd put her on level 3, adding a 'W' behind her numbers.

If a truck was to stop in front of them, we'd use level 4 for the truck and add a 'T' to the truck drawings.

If it's raining, we'd put the rain drawings on level 5, adding an 'R' after the numbers.

The X-sheet would look something like this:

		RAIN TRUCK WOMAN CAT MAN						
ACTION	DIAL	5	4	3	2	1	B G	CAMERA INSTRUCTIONS
		1-R	1-T	1-W	1-C	1	BG#1	1
		2	2	2	2	2		2
		3	3	3	3	3		3
		4	4	4	4	4		4
		5	5	5	5	5		5
TRUCK X		6	6-T	6	6	6		6
STOPS		7		7	7	7		7
		8		8	8	8		8
		etc	etc	etc	etc	etc		9

This system obviously enables the cameraman to stack his levels correctly – working from the bottom up – and take a frame of film with all the numbers across matching the dial number on his camera.

But there is one very important thing here:

ARE YOU A MEMBER OF K.I.S.S.?

Keep It Simple, Stupid!

Use simple numerical sequences! Animation is complicated enough without making it any worse.

My years in England taught me that the English just love complexity. A very brilliant friend, who is a top Oxford mathematician, called me up and said, 'We're about to penetrate your principality.' I said, 'You mean you're coming to visit?' 'Indeed.' 'Wow,' I said. 'You just used nine syllables to say what a North American would say in two! Vi-sit!'

We sure used to pen-e-trate-our-prin-ci-pal-it-y with our exposure sheets until Ken Harris joined the team.

They looked something like this:

CAR
WINDSHIELD BABY YAK TRUCK
OVERLAY YAK RUNNING AND ZEBRA

ACTION	DIAL	5	4	3	2	1	B G	CAMERA INSTRUCTIONS
			WOL-1	RY-1	Y2B-1	TXB-1	BG-1A	1
					Y2B-2	TXB-1A		2
					Y2B-2½	TXB-2		3
				BY-2	Y2B-3			4
						TXB-2½		5
					Y2B-4	TXB-2¾		6
				BY-3	Y2B-4A			7
					Y2B-4B	TXB-3		8
					Y2B-4C	TXB-3A		9

Can you imagine trying to make any changes or improvements when you're weighed down with numbers like this? It would be like re-numbering the *Encyclopaedia Britannica*.

Not only were our numbers complicated, but our action went from two frames to three frames then to four frames, bumping along then back to two frames etc., giving a jerky stop-start result to the movements.

When we had just one level of action – say it's a tiger – everyone would call the drawings T1-1 and T1-2 and T1-3 etc. One day I asked, 'Why are we doing this?' The answer from the head of the department came, 'So we know it's a tiger.' 'But we can see it's a tiger! Why not number it simply 1 and 2 and 3?' Answer: 'That will just confuse the painting department.'

And it's not just the English who can overcomplicate! I once saw the working sheets of an established American animator who's written two books on the subject, and his numbers looked like this:

All smudged and rubbed out and re-entered . . .

30A	104
BX-31x	104½
BLANK	104¼
(384)	104½
BLANK	104¾
(10)	104⅔
11	X-1
11-B	X-1A

CAME THE DAWN...

And then the first real live master animator arrived to work with us. On his first day Ken Harris lightly pencilled in simple numbers going down the page on 'twos', that is, two exposures per drawing. That was the first time I ever saw anyone go down the page on twos!

Ken usually planned his action on twos: twelve drawings per second, shooting each drawing for two exposures, instead of working on 'ones', one exposure for each drawing, which is twenty-four drawings per second – twice the amount of work.

Ken was from Warner Bros – used to tight budgets; the animators had to produce an average of 30 feet (20 seconds) a week or be fired.

Since most normal actions work well on twos, Warner animators tried to avoid putting actions on ones.

When he needed to go onto ones for fast actions (runs etc.), he'd just number it in on ones. i.e.

Then he'd go back on to twos

'Ok, Ken, but what do you do when you've worked it out on twos, but you find you want to add in ones to smooth it out more?'

Answer: Add 'A' drawings.

Great, so now all this TXL-1 and PP-2 3/4 stuff goes out the window. We're not weighed down with meaningless technology. It becomes simpler to work and easy to make changes and improvements and we start getting better.

But there is an even better and simpler system!



1	B G
1	
2	
3	
4	
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7	
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15	
16	
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The BEST NUMBERING SYSTEM

Milt Kahl called it his system, but I suspect that the good guys at Disney all discovered it around the same time – it's so logical.

Just use the camera dial numbers for the drawings. Go down the page on twos but use odd numbers.

Then if we do need to smooth something out or we need very fast action, we just add in the ones.

Milt told me, 'Whenever I see my drawings with odd numbers on them, I know I'm on twos and when I see even numbers, I know I'm on ones.'

I asked, 'What do you do when you want to get into a hold – just indicate you're holding that drawing with a line? And when you come back in do you start again on the dial number?'

Answer: 'Yes. Come back in on the dial number.'

Not only does this make it easy for shooting, but it's easier when you *do* need several levels of action. We've now got the same dial numbers horizontally across the frame of film.

5	4	3	2	1	
1-E	1 D	1-C	1-B	1	1
			2		2
3	3		3	3	3
		4-C	4		4
5	5		5	5	5
			6		6
7	7	7-C	7	7	7
			8		8

CAMERA
DIAL
NUMBERS

So, just go down the page with odd numbers – on twos – and drop in ones when you need them.

It's simpler and frees you to concentrate on the work.
Boy, did my output and quality improve!

There are a couple of other things to mention before we start in on the great argument of ones versus twos.

[illegible]

There's a very important thing I learned from Ken Harris. I know it sounds crazy – but if you have a series of B drawings – don't put the B in front of the number. i.e.

B-1	
	2
	3
	4
	5

Put the B *after* the number. i.e.

1-B	
2	
3	
4	
5	

We want to think as simply as we can. Ken said, 'Look, you don't call me *Mister* Ken. Put the letter behind so all you think of is the numbers.' Put any formality or whatever behind. It may seem mad but it helps you do more work. Try it. All we're really doing is thinking of series of numbers from 1 to 10. Anything to keep it simple. Nobody could figure out how this sick old man could produce so much work – and of such high quality. He just kept everything as simple as could be.

Two more things:

The *only* time you should circle a drawing on the X-sheet is when a cycle of action re-starts – when we're repeating the same set of drawings. We circle drawing (1) to alert the cameraman that it's out of sequence with the normal dial numbers.

Then we circle the drawing in the correct dial number when we come back to a normal sequence.

My rule is: The only time you ever put a letter in front of a number is when you have an overlay cel (of something in front of the characters).

Then you put O-1 (for the overlay cel) or for a held cel (somebody's stationary feet, for example) and call it H-1.

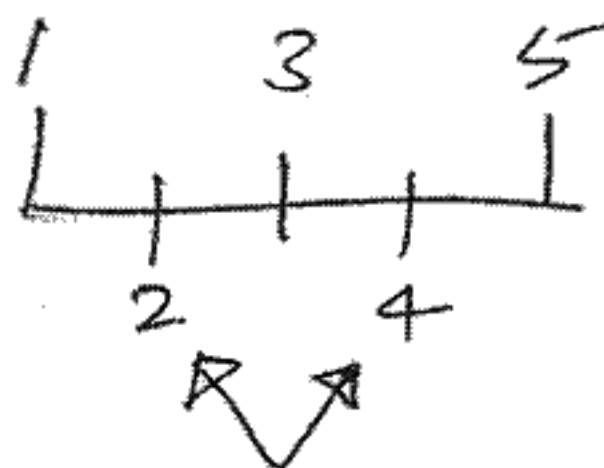
TABLE
OVERLAY HELD
 FEET ACTION

3	2	1	B G
O-1	H-1	1	
		2	
		3	
		4	

	1	B G
	1	
	2	
	3	
	4	
	5	
	6	
	(1)	
	2	
	3	
	4	
	5	
	6	
	(1)	
	2	
	3	
	4	
	5	
	6	
	(19)	19 ← CAMERA DIAL NUMBER
	21	
	23	
	25	
	27	

The GREAT ONES and TWOS BATTLE

Some people always complicate the numbering by calling ones and twos, 'singles' and 'doubles'. In fact 'singles' is from a 1940s term for inbetweening when the animator did drawings 1 and 3 and 5, made an evenly-spaced chart and said to the assistant, 'I've left you singles.'



i.e. single in between

But when to use ones and when to use twos?

The rule of thumb is – use twos for normal actions and ones for very fast actions. For instance, runs always have to be on ones – normal 'acting' on twos.

Walks can function nicely on twos, but they're going to look better on ones.

Obviously, life is on ones (or whatever speed we film it on), but twos work well for most actions and, of course, it's half as much work as doing it on ones. And half as expensive! Working on ones is twice as much work and expense all the way down the production line.

Apparently, in the early 1930s as Disney's animators got better and better, costs were skyrocketing, and since twos work for most things, they tried to stay on twos whenever they could.

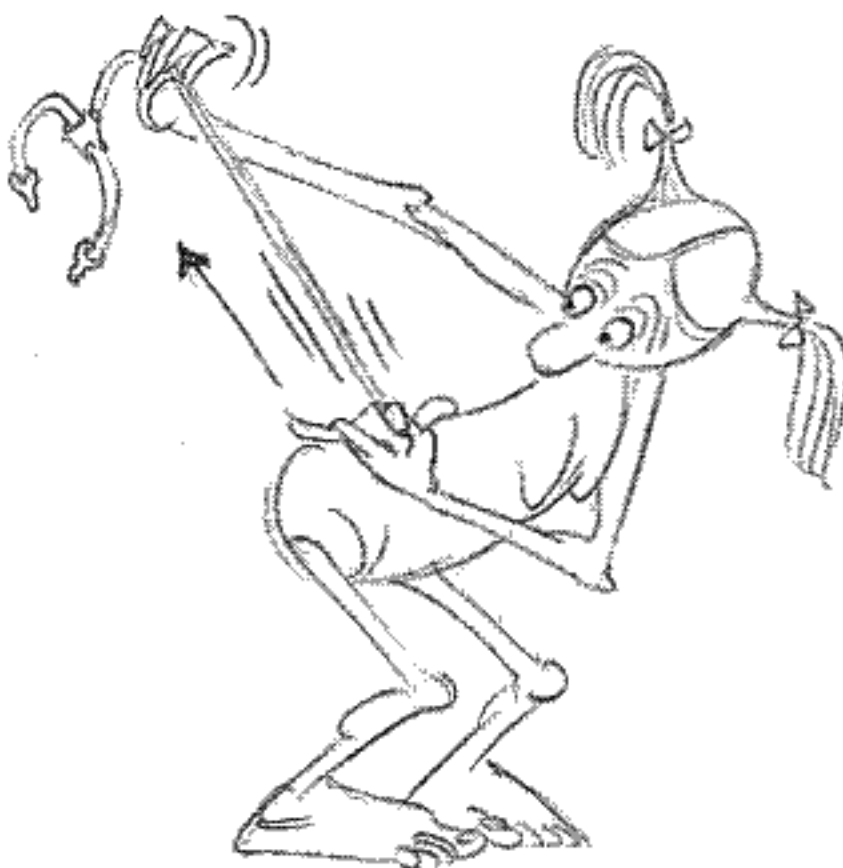
A lot of great animators even say that twos are really better than ones, that ones lead to a mushy result, that broad, fast actions on twos 'sparkle' and adding ones diminishes that vitality. Well, yes, this is true if the ones are just dumb, mechanical inbetweens.

My experience is different. I've found that if you *plan* for ones, the result is usually superior to twos.

I feel that twos are an economic answer to an artistic question. With twos being half the work, everybody gets to go home on time, and why would I make a case for ones? Hell, I was a studio owner.

When I was re-learning all this stuff, I would wait till my animation on ones was traced and painted, then I'd shoot it on ones as planned and then I'd take out every other cel and shoot the rest on twos to see if it 'sparkled' and was better.

In all but one case, ones worked better. The time the twos worked better was when I had an old lady pulling out a doctor's stethoscope from her pocket. The ones produced a very smooth movement.



It worked just fine, but then I removed every other painted inbetween and shot it on twos. It was better on twos! I cannot figure out why – it just was better. So they're partly right, I guess. But I became addicted to using ones whenever I could – ones seem to make for compulsive viewing and that's what we're after.

Art Babbitt used to nag at me for using ones. 'That's too realistic – one of the things about animation is that it's *not* like life!' But I would often add ones to Art's work when he wasn't looking and it came out better – and *he* liked it better.

Computer animators have everything on ones – with perfect inbetweens – and it hasn't diminished the appeal of their work – rather the reverse. And twos tire the eye after a few minutes. I feel that ones are twice as much work, but the result is three times as good. Compulsive viewing, easy to watch.

I think my co-animator Neil Boyle said it best :

'Twos work – ones *fly*.'

And Ken Harris, who spent most of his life working on twos, would say to me when I'd be putting ones into his stuff, 'Oh, it's *always* better on ones.'

There's one thing that always makes me crazy. When you have a character animated on twos and the camera is panning with it on ones you get stroboscopic jitter. Either pan with it on twos (not great) or add in single inbetweens so it doesn't strobe!

Some of the really good guys do this. It's a mystery to me. Why don't they add single inbetweens so it doesn't strobe?

Maybe its because a lot of things don't show up on the pencil test. It's when it's coloured in that we see the bumps.

CONCLUSION:

It's a combination of twos and ones. Not only but also.

Normal actions on twos – which is the bulk of our work anyway.

Fast or very smooth actions on ones.

Normal spacing on twos. Far apart spacing on ones.