Steve Graf's Presentation at Ohio State University

On the Standard Celeration Chart

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Introduced by William Heward, Ph.D.

Fundamentalism and Reality Tunnels

As Bill said we need not only the hands on stuff, we have need to know how to chart with this new tool or this tool that you're going to show us, but we need a framework, a conceptual way to fit it in to our current picture. Here's the way I look at it: As you look around the world today, what you see on almost every level is a bunch of fundamentalists. Fundamentalism is running rampant in the world. How do you define fundamentalism? Fundamentalism is an individual whose belief structure is so tight that any attempt to challenge that particular belief structure or to change that individual's repertoire comes under very quick dismissal by the individual. So, in a sense, then, each of us operates in a "reality tunnel" or a "reality labrynth" which is our own little way of looking at the world. And we may have colleagues who are in there with us, very close to us, and yet there may be stuff that is outside our particular reality that we do not accept and we do not really respond to, and if we're challenged we either discredit it, ridicule it, dismiss it, or just completely ignore it. So, what I'm saying is, is that it's not just the fundamentalist preachers that we see on television who are the fundamentalists in our society today. Each of us is probably a fundamentalist within our own particular area. And so what I'm suggesting is that one of the things that may be necessary to do occasionally is to examine one's own beliefs to see where one stands, and whether that really taps in with some of the other consistencies in the universe that may be out there, and if not maybe we can do a little better job of getting to a different reality.

How many of you have any background in seeing this type of chart or data presented on this type of chart? I notice some of you have. How many are seeing it for the first time today, really, as far as ever experiencing it? Okay, so we're about half and half.

Skinner Chose Frequency

Here's what I'd like to do next: First, to follow up on Bill's framework idea. This is a quote from Skinner that I think is really apropos, both for the framework, and to follow up what I was just saying about the reality tunnels.

> **"In choosing rate of responding as a basic datum and in recording this conveniently in a cumulative curve, we make important temporal aspects of behavior visible. Once this has happened, our scientific practice is reduced to simple looking." BFS (1956), A case history in scientific method. Amer. Psych., 11, 221-233. (quoted on page 229).**

Choosing frequency: Skinner called it "rate." If you look it up in the dictionary, frequency is a little closer to the meaning. Rate tends to be confused by the average person with other things such as "first rate," which doesn't have anything to do with frequency. So, Lindsley suggested [frequency]. Ogden Lindsley suggested "frequency" as probably a better term, here. And Skinner was using cumulative records, or cumulative curves, and what we're talking about here are what are called standard celeration charts. The point here I think is very clear, that if you set up the prior behavior of data collection, and then putting the data on an appropriate chart, then the next step of the observing what happens and predicting what's going to happen is very straightforward.

Measurement Traps: Add Scales & Multiply Scales

However, there are some traps along the way. And some of these traps involve some rather sophisticated principles of add scales and multiply scales. It just looks as if our evolution, that is our history, is tied in to the fact that we're doing a lot with our hands all the time. They're moving, except in soccer, and only the goalie (laughs), but for the most part people are using their hands. And we've got 10 digits, and that gives us kind of an "add" structure. It's been suggested that if we had a one one digit, and then two digits on the other hand, that we might be a little bit different, or two digits on one hand and four on the other hand that things might have worked out a little differently. But we're kind of stuck in what is really an add situation, because there is one, two, three, four, from the time we first learn to count. We're talking one, add one, and so forth, and then we get in to add fives and add 10s, and so forth, but still in an add world. Well, what it turns out is that it looks like by the data that you look at, the world is multiply. That is, things grow by multiplying and they decay by dividing (a flip-flop; just as subtraction is the inverse of or the opposite of addition, so dividing is the opposite of multiplication). And the world seems to be built up as a multiply world.

Well, if that's the case, then there are some ramifications for how we measure things, and if we are looking at types of charts, then an add chart is a chart where you've got equal add intervals. So, for each equal space on the chart if every interval as you go up you're adding some equal amount. So, a very simple add chart would go something like this: You draw an axis. And you draw our equal intervals. Then, we could assign any numbers to these intervals. If we have a +1 chart it would be 1,2,3,4,5,6,7. If we have a +2 chart it would be 2,4,6,8,10,12, and so forth. So, this is a +2 chart, at least on that particular axis.

Multiply charts, we're not quite so familiar with. In a multiply chart the axis would look like this, where there still are going to be equal intervals, but every time we go up that interval, we are multiplying instead of adding. So, where this is a +2 chart, this is a X2 chart, and we go from 1 to 2 to 4 to 8 to 16 to 32 to 64. So, multiply chart and add chart.

And the chart that we're looking at today, we're looking at time across the bottom in an equal interval fashion, in an equal add interval, so the intervals across the bottom that we're concerned with are sort of successive units in calendar time; whether it is successive minutes, successive hours, successive days, successive weeks, successive months, successive years: Equal add times across the bottom. So, our basic framework, then, is time across the bottom.

Okay. So, we've got add-subtract charts and multiply-divide charts.

Add World or Multiply World?

Now, the question is, the really critical question is, what happens if the data that you're looking at is growing by adding, or growing by multiplying and then you put it on one of these types of charts? Well, if something is growing by adding--that's what's really happening--and you put it on an add-subtract chart, you're going to get a straight line function. So, nice and simple straight lines for behaviors that you measured that are growing by adding. On the other hand, if things are growing by multiplying, and you put it on an add chart, you're going to get curvilinear functions --

very hard to predict because you don't know how far. It's generally going to go off the chart if it's really growing. And it's a curvilinear function if that is decaying as well. So, if something is growing by multiplying, and you use and add chart, then you get into this situation, which is going to create illusions, rather than veridical observations, or reality types of observations. In other words, you're going to have a tough time being able to resort to simple looking, if in fact you are using an add chart and the world is growing by multiplying. So, I've already indicated to you that from our experience the world is growing by multiplying. That means that if you're in a multiply world where you're using add charts then you're going to see this sort of thing.

Multiply Charts

Now, the alternative is to use a multiply chart. Well, if stuff is actually growing by adding and subtracting, again gets a curvilinear function. But if things are in fact growing by multiplying, and you're using a multiply chart, then you get, again, straight line functions. What do I mean by these straight line functions? Well I mean, that that's what celeration is. That's the celeration in standard celeration charts. So, when you look at, and you see this, you see frequency up the left. That's count per minute--also known as 'rate', called 'rate' by Skinner--and time across the bottom. But what you're going to see on the chart is, usually, some sort of celeration. So, it could be something that's not growing. Or it could be something that's growing. Or it could be something that's decaying. Or, there may be a number of phases of something, so that it may be growing in one phase and decaying in the next. And now our job becomes simply being able to describe the growth or decay from what's happened. But notice that it's an easier situation if you can stay simple, and work with straight lines, rather than having to work with curved lines.

Stretch-To-Fill Charts

If we ever wanted to do the most confusing possible thing, that is, make the world as chaotic as possible, here's what we would do. Whenever we had something to chart, each of us, individually, on our own, would come up with our own chart. So, we'd all have different charts. And what we would do with that chart is, depending on what our data range was, and what our time range was, we would stretch that data out to fill the whole page of our chart. And we'd either stretch out or collapse the time to fill the other dimension of the chart. If we did that we'd have millions and millions of different charts, and even our own charts from one day to the next, or from one project to the next one piece of research, or maybe even within the same piece of research, the charts would all be different. That's what we would do if we wanted to make the world as confusing a place as we possibly could. That's the way the world is. So, we don't see standard charting, we see unique charts. We see, by and large, stretch to fill charts.

Advantages and Disadvantages of Chart Types

Well, let's look at some of the advantages, and consequently the disadvantages of the two types of charts we're zeroing in on: Standard celeration charts, SCC, and stretch-to-fill charts, or STFC --stretch-to-fill chart. First of all, if everybody's chart is standard--the standard celeration chart--then, if you've seen one chart you've seen enough charts. You know what you're looking for. You know what you're looking at. And it cuts down on the communication time for anyone who is looking at a piece of new data, because you know the framework for the chart. So, time saved: 2 minutes per chart is what we've generally used at an ABA Chart Share for example. The person is limited to 2 minutes and can generally get through in that. However, if everybody has their own chart, it's much more time consuming to explain what it is that they're looking at. So, you're likely to see 20 minutes spent going over a chart which is an individual, idiosyncratic chart. You can directly see effect quantities if you're using a multiply chart when there's a multiply world, because you are going to be projecting into areas that are probably still on the chart. So you can see those effect quantities right there in front of you. On the other hand, if you're looking at some sort of a curvilinear function, then it's likely that you're not going to be seeing the effect quantities because of the fact that it's gone off the chart. Or it may be the fact that you've stretched to fill the chart, and you're not going to see the effect quantities because you've laminated out some of the information in the time scale. We'll come back and go over that again.

Notice, that you can project the outcome date if you're based in real time, successive time units. If you laminate out the time, the real time between sessions, or between the time that the data are collected, then you've lost the ability to project the outcome date, because you don't know how much time there is between one session and another. So, very likely, if we go back to our confusion model, that is, how do we best confound everything by making it highly possible. One way we could do that in addition to everybody building their own chart is instead of using real time across the bottom, what we can do is just use those days where we actually gathered data, and call it a 'session.' And then every day that we didn't gather data, then throw that out, because no data on that day. And then just squeeze the next session right into the space next to the previous session. So, if you've got a chart, and if your data has been done that way, then you're going to have difficulty projecting outcome dates, because you've laminated out the real time component, and you won't be able to project an outcome date.

Standard Celeration Chart Advantages

Also, if you're using a standard celeration chart you ought to be able to compare it with other cases. Everything is going to fit into the same mold. Why is that? Because you gather so much difficulty in everybody making their own chart, the add-subtract charts, how can you do it with a celeration chart? What gives it the advantage here? Well, the fact that it covers such a large amount of ground. The realm, the range of behavior that the standard celeration chart covers is a factor of one to a million. So, one a day, to a thousand a minute, which is a million a day, is the range for the standard celeration chart. So, any behavior that falls into that range, between one a day and a million a day is going to fall onto the standard celeration chart. On the other hand, with an add chart, if you've got some data that is between five and ten, and you've got some other data that is between 400 and 600, you're almost always going to use two different charts, and you're not going to be able to compare them.

[Audience comment, John W. Eshleman: "That's a good point. I once calculated how high an equal interval chart you'd need if you had like eighth of an inch increments, to capture that same kind of range, from one a day to a thousand per minute, you'd have to have a chart that you could probably hang from the top of the World Trade center, and it'd reach all the way down to the ground. That will cover the same vertical range."].

Uh, yeah, well, you're sort of stuck in an add world. Here's an add interval chart of +10. And with behavior, this would look pretty standard, except that it's only going to cover 0 to 100, and you're not going to come close to coming to 1 million. Now we don't get too many behaviors, in human behavior, that are up in the range of 500 to 1000. In fact, anything over, even the most hyperactive of hyperactive children doesn't do too many things that will go above 300 a minute. Probably the only area is brain waves, where the lowest brain wave, the theta range is 4 a second, then you're starting to get behavior that is not seen except on a very good measuring device.

Okay, another advantage for standard celeration charting is separating 'jumps' from 'turns'. What's a 'jump' and what's a 'turn'? That's Og Lindsley.

Ogden Lindsley Bio

Did I tell you--I didn't even--who knows Og Lindsley? Gee, I, uh, maybe we better take a look at who this guy is. Og Lindsley is the father of standard celeration charting **[audience laughter]**. And this character was one of Skinner's students. He was a prisoner of war in the United States Air Force; shot down; a prisoner of war for 15 months or so; went to Harvard after the Second World War; hooked up with Skinner; and became one of Skinner's bright young, Ph.D. students. So, Lindsley in his graduate days at Harvard was the first person to use a human operant chamber, a human Skinner box, which was then called the Lindsley apparatus. He had psychotic patients at Met State Hospital in Massachusetts, pulling plungers, and they were in these room-sized Skinner boxes, essentially an apparatus that Lindsley had that looked like the rat lab apparatus except the insides of the boxes were bigger. And of course they had plungers instead of key pecks or bar presses. So, Lindsley totally committed himself to the notion of **frequency as a universal datum**. And that's probably the lead-in to how he got into the notion of celeration, and then eventually into standard celeration charts.

Frequency is a count over time. A count over time, if that is looked at over time, then becomes a celeration. So, frequency is any sort of count over time. Count per minute is one example. If you then look at count per minute over days, or weeks, or months, or years, then that frequency over time is celeration. And, again, that's what you're looking at on a standard celeration chart.

Og and The Lone Ranger

Well, what else about this character, Lindsley? One of the things that is quite distressing to me personally is the fact that the Lone Ranger has ridden into the sunset. This was the comic strip which finished up in '84. Only 8 months ago the Family Network canceled the option on the rebroadcasting of the shows on television. So, our youth of today at this point are lacking that particular hero figure. And awhile back in my career it became obvious to me that what we need are these types of heroes.

Lindsley, I think, sort of fits the bill. Where you have the great horse, Silver, Lindsley on his ranch outside of Lawrence, Kansas, has his mule named Silver Butte. Where the Lone Ranger had a faithful Indian companion named Tonto, Lindsley has a faithful female companion named Nancy **[giggling by audience]**. Where the Lone Ranger had a pair of six-shooters and silver bullets, Ogden Lindsley has a pair of overheads and the standard celeration chart **[laughing by audience]**. Where the Lone Ranger wore a mask, the Lindsley character wears a goatee and eyeglasses. So, if you put them all together you've got the Lone Ranger, and if you put them all together, and you've got Ogden Lindsley. That's a little background... **[applause by audience] [audience question {hard to hear}] Graf's answer**: "Not to his face." **[more audience laughter]. [Audience comment, Jim Cowardin: "The Lone Ranger never had a barn. Lindsley's got the most magnificent stone barn on that farm, it's amazing..."] [various comments & laughter {could not decipher}].**

So, Og around 1955 was in the study of human behavior. Then he realized that the ratios aren't really appropriate for changing the world in the psychiatric or clinical psychology world because the ratios of patients to perpetrators or clinicians or psychiatrists is 1000 to 1. So, he thought, well better go into other possibilities. Education was much better. Something like 30 to 1. Parenting was even better because it was down to about 2 to 1 or 1 to 1 in single parent homes or not. And, so, that's when he moved into the area of education, and got a chart for kids, and a chart for people that would encompass all of human behavior. The background was in the laboratory in Skinnerian conditions. The applied behavior analysis is in the real world, in schools, it started in special education, and then spread to all sorts of education, and then to other realms as well.

Jumps and Turns

When we say separate jumps from turns, this is perhaps one of the newer concepts that you're going to really be hit with today, from the standpoint of what is different about the world of behavior that we're overlooking when we're engulfed in a Stretch-To-Fill-Charting world, or our present little reality labrynth in behavior analysis. A way of talking about a jump is simply saying that when a behavior jumps then it very dramatically increases or decreases, and virtually immediately. So, in some cases, when you have a phase change, where you're making some sort of change with your independent variables, then that may produce an effect of a jump. If it's an increase in behavior then it's simply a 'jump up'. If it's a decrease in behavior it is simply a 'jump down'. Lindsley's dictum is that the terminology should compel, **SHOULD COMPEL**, the appropriate interpretation on the part of the listener. That's one way in which he found Skinner to be on kind of the wrong track, because continuous reinforcement is not compelling the appropriate interpretation. "Positive reinforcement" and "negative reinforcement": How he's gotten in trouble with those. Again, they don't compel the appropriate interpretation. And we could go on and on. But, "jump up" and "jump down," as far as a change in behavior is fairly straightforward and compelling to most of us when we are describing behavior change.

However, that's not the only way in which behavior changes. Because sometimes the change effect is not discerned immediately. And then you've got a different type of change. So that, what that's called is a 'turn'. So, if you've got a 'turn', what that means is is that the behavior celeration has changed, even though the frequency may not be clearly different. So, if we were looking at a behavior and we saw it going along, and then for some reason, something happened, and if behavior was now going like that, we'd say that that behavior's celeration has turned. So, the celeration was increasing, and then at some point it flattened out. And would that be a 'turn up', or a 'turn down'? **[audience: "Turn down"].** 'Turn down'. So, celeration 'turns', then, are the other way in which you can change. Now, when you are looking at it from our traditional behavior analytic viewpoint **{end of side 1 of tape/ tape changed to other side}**... positioning of effects. So that you could get a 'jump up', let's say that the behavior goes from here up to here, so you've 'jumped up', but then 'turns down'. Or, you could have a 'jump down' and then a 'turn up'. So, then, not only can things 'turn up' and then 'turn' again, but you can have the 'jumps' and 'turns'. Here there is no 'jump' in the change, but in the cases here we've got a 'jump' and a 'turn' combined. So, our traditional behavior analytic framework doesn't really handle that very well. A standard celeration chart allows for separating the 'jumps' from the 'turns'.

Bounce

There are some other things here that are also interesting from the broad scale perspective of the stretch-to-fill versus standard celeration charts. From the stretch-to-fill charts, if you've got variability, and your behavior is increasing, there is a tendency for the behavior to get more bouncy or more variable as your rate or frequency increases. So, the more the behavior, the bigger the bounce. And if you're using an add, stretch-to-fill chart, then your variability around that particular behavior, not only is your chart going to be curvilinear, but your bounce, from small here, gets bigger, and bigger, and bigger, and bigger. So, what that means is you don't have homogeneous, or homogeneity of variance. And therefore you really aren't justified in using any sort of statistical type test that would assume that type of homogeneity. With the standard celeration chart, not only is the behavior itself describable in a straight line function, but in a multiply chart the bounce stays the same even as behavior grows. So, if behavior gets bigger, the bounce is getting bigger, but the chart is taking care of that. So as you look at it, and again, we're going back to the notion of seeing as a way of interpreting, then the bounce stays the same. And that holds for behaviors that are growing, and behaviors which are getting smaller, bounce until they are getting close to the absolute minimum of the floor.

This has been sort of a cold situation so far. I've given you some of the concepts behind what's involved. What I'd like to do next is to expose you to some charts: Charts that have actually been done rather than just ones that I have been drawing free hand here, so you can get a little feel for both the realm of the chart, and also for some degree of the rapidity at which they can be presented and still leave you feeling somewhat comfortable because the scales remain the same. What we're going to do is look at these quickly, and then some of them we'll come back to and look at a little more carefully when we slow down. But, for a start, what you are going to see are standard celeration charts.

Different Standard Celeration Charts

The way a standard celeration chart can sometimes differ is when you are looking at different time units. Notice the similarities here between the so-called daily chart and yearly chart. The distance from heavy line to heavy line -- heavy up and down line to heavy up and down line -- is the same distance in each case. So we can check that as you see here. So, those heavy lines line up. The difference is that when you're using years, then years across the bottom are 0 to 100. Here, these are weekly units, because our time measurement per week is seven days. Our time units for years is generally five year increments, or decades. These are two of the types of charts. Daily is the one you probably are going to be most comfortable with -- that's the one we're going to be getting a hands on experience with. But it's also possible to have weekly charts, where again, the same units across. Or monthly charts, where from heavy line to heavy line is 6 months, and again now 120 months across, or 10 years. It's also a 10 years period.

So, the other difference that you might have noticed, is that here it goes from .001 to 1000. Well, that's really the same as 1 to 1,000,000, as you see here. It's just that in talking about count per minute, we usually are talking about amounts of time within a day less than the entire day. Sometimes we may be counting the entire day. In that case then, this one, .001, is really representative of 1 per day. There's about 1000 waking minutes in a day. That's something like 17 hours. And so, .001, or one per one thousand minutes, is this line on the chart. It goes from 1 a day, to 10 a day, 100 a day, 1000 a day, 10,000, 100,000, to 1,000,000 a day. So, the fact that the numbers are a little bit different on the left shouldn't put you off the fact that it's the same 6 cycles: 0 to 10 six times.

Chart Examples

Okay, let's look at a little bit of stuff on the chart and see where we get the picture.

This is a yearly chart. These are bachelor degrees earned in all fields, education, and psychology and computer science. Which one is growing fastest? Okay, if we come back: we're in a kind of educational framework here.

If we look at a calendar week chart, within my own individual courses on particular tasks from five different quarters in which the students were getting five opportunities on. Here was how many succeeded on tasks on successive calendar weeks. Once they had succeeded on a task they no longer had a task to do, so part of the curviness in this is the fact that it's a decreasing population. If you look at the number that failed the task, notice how not much of a straight line function, how easy it is to predict how many more tasks you would need to do to get everybody succeeding on the tasks -- that straight line function tends to follow out. So, that's a weekly chart of some weekly data.

If you wanted to look at something across years within your particular university, one of the things that you might be interested in are your reactions of the students to your instruction. By and large that's a very confusing picture because they usually assign arbitrary numbers to it and then come up with a number between 1 and 4 or 1 and 5, and it doesn't make a whole lot of sense. If you reduce it to frequency and say, okay, the number of students that rated this professor in the top category, or the top two categories, we have that be one set of data points. And the number that chose any of the other categories as the other data point. Then you can look at the frequency, and then the celeration of that across time. So that's a ratio: The top two over the other three, or the top one over the other four, the top two to the other three. And that's student ratings for an instructor.

If you wanted to look at grades you could, again, get away from the notion of the grade point average, because that's really meaningless, and look at the number of A's per quarter, or per year. And you can look at the college, the department, the particular section, or a particular instructor. And you could do the same thing with each of the grades. So, we look at A's, we look at B's, or C's, or D's, or F's. All of those grades have their own celerations, and have their own celerations for each of those entities: college, department, instructor, and particular course. So that's some of the sort of administrative, structural sorts of things.

Now, if you get down to some more things happening in the world, then you might look at still within the yearly chart something like the amount the individual spends on healthcare per year. And we're looking at calendar years, and seeing how that -- what's happening to that one. And what you should be seeing is something that is easily predictable, and easily interpretable based on what you see. I don't have to give you a whole lot of explanation about what these data mean, or how to interpret these data. You see it, and once you get a little experience with the chart then you can make those types of statements appropriately.

Well, if you look at the gross federal debt outstanding -- it looks something like that. If you do it at different points in time, sometimes the sources are different, sometimes you add on a different source, sometimes you redo charts that you've done before, or students redo them and don't realize that's an old trend and you've already done that. It gives you sort of a way of seeing whether your charting is reliable or not. This past week I was reading Critical Path by Buckminster Fuller, and Fuller was -- I just found this out recently -- Fuller was a very enthusiastic charting person. It looks as if, however, he was stuck in the add chart world. Here's his add chart of the same data of the gross, total national debt, and notice, if you will, that, as typical with an add chart, when behavior is multiplying, that we see this curvilinear function. Well, that's a little gloomy, so let's move on to something else.

Here's the number of people that get arrested in the United States each year. Here are the number of people who kill themselves with firearms **[giggling by audience].** Here are the number of people who get killed by firearms or explosives in the United States each year **[Audience question, Jim Cowardin: "That's not normed for the population, you're getting**

more people; you've got more people to kill themselves."]. What Jim is saying is as sort of a background chart you need for all of these would be population estimates, okay? So, there's your population estimate. Now, there's a multiply factor of X6 here. This arrow indicates that you're shifting this line up by this distance to say that **[JC: "I'm not a plant, either." {audience laughter}].**

There were some other things that we looked at across years. Here's received death sentences, and sentenced criminals, or criminals released from death row, and so forth. It goes on and on. Total crimes in the United States, again, something which is growing. And again, all of these are yearly charts. All of them, well this particular sample is not the most optimistic. **[Audience question, Bill Heward: "Are these data related in any way to the fateful night on the Arps Hall fire escape?"]** An interesting hypothesis.

It did lead me to wonder what the rudiments are of our violent nature happen to be. And that lead me several years ago to a sabbatical studying the Lone Ranger. I thought that it would be interesting to use charting, and our standard celeration charting methodology, to actually analyze fictitious behavior that was well represented across a long number of years. The Lone Ranger had been started in radio in 1933, so we have 50+ years of data in a number of different media. And so, that is what lead me to an analysis of gun play. That's an oxymoron if there ever was one. So, if you look at gun play, so this is within the Lone Ranger comics, and the span here was from the late 40's through the mid 60's.

Here were the total number of individuals firing guns in the Lone Ranger comics. Then here was the Lone Ranger, firing guns. You can see that he grew more violent across years. Here's Tonto firing guns. Not as high a frequency, but notice that even the celeration was not that great either, but it did increase across years. Then, people shooting at the Lone Ranger and Tonto, as this picture depicts **[audience giggling]**, also increased across years, but again not as great as they shooting at other people. And then if you look at other people shooting at other people, that's where you have a turn-down. So, it accelerated over the first portion of the interval, and then decelerated over the last portion of the interval. **[Audience question, Jim Cowardin: "Any explanation for that?"].** Well, I tried to tie it in, Jim, to the data that I showed you before. So, that's why on some of these things such as "gets killed by firearms or explosives, I've got this '45 through '62 time period marked off, so I can see what's happening in that same time period in the real world, to see whether this behavior in fiction is a leading indicator, or a following indicator, or a simultaneous mapping of what's going on in the real world. **[Audience question: "It's a little hard to do with a stretch-to-fill chart"?]** Yes, because again you can't compare one thing to another very easily because the charts have all been done differently. So, that's some of the Lone Ranger stuff.

Also, if you try to get more on a positive note, I like to think of as being hit by a pitch as something very positive. That would be perverse, perhaps, but I dwell on some perverse things. So, this is the number of hit by pitches per year in my baseball career **[audience giggling]**, and this is up to date through '89, and these were 7 per year. Then now the complete -- well not all the stats, but here's at bats and hits per year. And it's really a source of wonderment on my part, at my advanced age, to have a little 'jump up' in hits at this stage of my career. So, these are sports... **[{audience comment/ cannot decipher} {audience laughing / Graf laughing /several comments at once / cannot decipher}].**

One thing about baseball, they have a lot of stats available, and they have books on that, and I saw some of them on Bill's bookshelf. So, you can do, you can follow your favorite team. I should have done the Chicago Cubs, rather than the Detroit Tigers, but here's Tigers hitting home runs across years, and American League hitting home runs, and saves, and so forth. All of that stuff is, again, comparable to you using standard charting.

Well, the other thing that I think you have to look at if you're doing charting is, well what good can it do me. It's nice to kind of keep track of your own behaviors, but we can't be entirely self-centered. We've got to look at the next generation, or at our current students. And how can charting help them? Well, one way, still within the sports realm, is to get a better picture of what's going on with say, a team. So, now these are, we're going back to our daily chart here. This is a real quick chart picture of the 7th and 8th grade girls basketball team, allowing points in the 1988 season. That's, each x represents the number of points per game that was allowed. And the data are the x's. If we add the celeration line -- that's the line; that's sort of the thing that you see as you look at the data. And then if we add the bounce, then that's the yellow coloring. That's the variability, up bounce and down bounce. And notice, you do get the situation here where the up bounce time equals the down bounce. Not true if you were doing stretch to fill charts, or add charts. But the up bounce equals the down bounce. If you wanted to see the following year, how the same team, or how the team did the next year, then notice that the bounce has changed. There's still not a whole lot of celeration through the season. It's pretty flat. But you can do the same for the offense and the defense, so that you can see whether the offense improved. In the first year the offense actually improved across the year. The second year the offense sort of stayed the same. The bounces overlap, so that means you could be beaten; games aren't runaways. But this was a 7 and 9 team and this was a 15 and 1 team.

You can also track individual players. If you've got a daughter playing on the team, then you can look at the number of points scored per game by the particular individual that you're interested in. Again, this is getting now a little closer to charting usefulness. It's still just descriptive, though. It doesn't tell you really where you're going. But my own eldest daughter -- I have three -- and the eldest daughter decided that pop wasn't the -- if you look at the chart for the cost of higher education, pop was not going to be heading toward the grave with a whole lot left if he put three girls through school, and paid for it all out of his own professor's salary. So, it seemed like if you're going to be an applied behavior analyst, the thing to do was to get some behaviors going that had real pay offs in the real world. So, back in 1986, actually in '85 we started a 9 year old shooting baskets. And then about '86 she was finally able to get it there from the free throw line, so we started looking at shots from the free throw line, and then we kept that up ever since. So, this represents approximately 33 or 34 thousand free throws on the part of a single individual. This is now a monthly chart, and this is the number of free throws made and this is the number of free throws missed. There's some variability there because it is still a seasonal sort of thing when you're involved with other things as well.

This is the accuracy. This is when you look at "makes free throws" to "misses free throws" as a ratio. So, "makes free throws" and "misses free throws", and notice that at certain points here you've got a pretty good predictive capabilities of how the accuracy is increased. **[giggling by audience].** Notice that the whole family has kind of a mass around that **[laughing by audience/ laughing & Graf talking / cannot decipher]** ... National free throw champion last year **[applause by audience].**

[Audience question, Darryl Siedentop: "Steve, how would you show time-based data? Instead of counted data? Like if you were doing track and field types & your daughter was a 100 meter sprinter instead of a free throw shooter."].

Yeah, she just finished her first cross country season. And what we did was to look at the count of the number of people she beat; that she finished ahead of; and the number of people she finished behind. And then you can look at that as two separate counts, or again as an accuracy. In many of the track and field events you can represent it on a chart, but when you get down, when you can see it for example, first or sixth place is something like 200ths of a second or something, incredibly small fractions, then that's out of the charting world as we know it on the chart that we're familiar with here.

[Audience question, []].

There are really two components here. One is the frequency, the feet per second, but the other is the endurance, or the duration. So your feet per second for a hundred yard dash isn't going to be the same feet per second for the 2 mile. And so, the whole notion of the time involved is one of endurance is one that we're going to get to in just a little bit when we start looking at how to do that. I can say a little bit now; let's say in two sentences, to sort of keep Darryl's interest focused on the topic, because it is a great question. Essentially, you represent the time on the chart, and the frequency, with two different symbols. So, when you've got a time goal, that is simply one way of representing where you want to head on the chart. And then as your frequency toward that goal progresses, then that would be the thing that you'd be charting. So, you can use time-based goals on the chart, and if you have some data that involve that, we'll perhaps get the chance to look at some examples of that in a little bit.

Doing Charting and Using The Chart

Okay. Next, let's pass out the chart. Take two please.

{Charts distributed}

Okay. Everybody have a chart. One of our primary rules--to sort of stay rule governed--is to use a pencil on the chart. So, if you don't have a pencil, I brought some extras along. How many don't have a pencil?

The first thing boring in on the chart is the bottom here. This is just for information that tells you what the chart is all about. So, the key, of course, is the 'behaver,' who is the 'behaver'. And sometimes age is appropriate, and in cases where people are sensitive about their age then they just fill in here "Fall Quarter," "Fall '89", or something like that. The 'label' generally tells you, what the behaver's appropriate label is for this particular pinpoint, or this particular data. And then the count is what you count, on this particular chart. The manager is someone who is involved with this particular person. It could be a teacher. The advisor is somebody that they see less frequently than the teacher. The supervisor would be like a building principal or the superintendent, or at the university level, this might go, the professor, the chairman, and the dean. So, that's the bottom of the chart--fairly straightforward. Nothing really complicated there.

The top of the chart: Notice has got 0, 4, 8, 12, 16, and 20. These represent weeks ... **{Side 2 of Tape 1 ends here; about 7,400 words spoken per ~hour}.**

If you're using the chart and you're four years old or five years old--this is the sort of entry level for charters, then you may need this Monday, Wednesday, Friday above the appropriate day line in that first week there as cues for the day lines for the chart.

Calendar Synchronization

Now, notice that the 0, 4, 8 and so forth Sundays have spots to fill in above. That is for what Lindsley calls 'calendar sync', or calendar synchronization. What we have here is a calendar sync paper that shows what the appropriate days are for it--goes up to 1999. And so, why would that be important? Well, remember that we're trying to build a **standard** measurement system here. So, if you've got people in Lawrence, Kansas and Columbus, Ohio -- both are with kids doing things -- and you want to compare them, then if you start both charts at the same day, then you've got calendar synchronization. But why just Lawrence, Kansas and Columbus, Ohio? The whole of North America -- and I don't know if this is used across the oceans yet -- but North America is synchronized then to particular dates here. And the typical synchronization date in use is for the public school system. So, for the current one it would involve 3/Sep/89. If you brought data along, and it falls into the time frame following the 3rd of September then you would be synchronizing with this particular start date.

How many in fact do have data with them that falls into this time frame? Okay. And how many have earlier data, that do have data with them today? Okay.

Three daily charts a year will cover the whole year. The first one starts in January -- well, start one in January; start one in September; and then add one that covers the summer if some left over. For the notion of synchronization, the point that I had made here is that this allowed comparisons; immediate comparisons of data across people, across behaviors, across behavers, when you've got calendar synchronization and you're using a standard chart system. So, we can look at questions. We can have questions answered almost immediately if they are synchronized. So, how does your 'number of people absent per day' compare to ours before and after the earthquake that hit? And you can look at that real quickly and compare those two real quickly synchronized.

Okay. Anybody who is interested in having synchronized charts can consult this particular form. And note that this is one of your references.

Okay. So the top of the chart involves successive four week periods. I'm going to fill this one in because if any of you don't have data, I've brought some along that you're welcome to use as examples to sort of build your charting repertoire. So, this was 3/September/89. The next one is 1/October, then 29/October; 26/November; 24/December; and then 21/January/90. Okay, that's across the top again.

What To Count By, and What To Count From

The next thing is the up-the-left. This is the count per minute. We've talked about that. Frequency is a count over time. Anytime you have a behavior, if you're in our universe -- this phase of reality -- it's got to occur in time. So, all behavior occurs in time. Sometimes we sort of forget about the time and disregard it, but behavior is always occurring in time.

The next thing are these numbers up the left. There's sort of a way of understanding that, that was set up by Michael Maloney in the Direct Instruction influence of Engelmann and Carnine. And you may have heard of it before; some of you may be familiar with it. But here's the way it goes: The number in the margin that starts with 1 -- could be this going right to left, or left to right -- the number in the margin that starts with 1 tells you what to count by, and what to count from. The number in the margin is 10. What do you count by? 10. What do you count from? 10. So, the next lines would be 10 -- counting by 10 from 10 -- 10, 20, 30, 40, 50, 60, 70, 80, 90, 100. Again, the rule is: "The number in the margin that starts with 1 tells you what to count by and what to count from." Heard it? Nice little rap that makes it easy to learn that. So, if we look at the number in the margin, does it start with 1? No. Does this number in the margin start with 1? **[Yes]**. What are you going to count by? 100. What are you going to count from? 100. How would the count go? 100, 200, 300, 400. Is this a number in the margin? Yes. Does it start with 1? No. So, disregard it. Is this a number in the margin? Yes. Does it start with 1? Yes. What are you going to count by? .01. What are you going to count from? .01. How would you count? .01, .02, .03, .04, .05. Okay. And the same with the other cycles. So, you're counting from 1 to 10; in powers of 10 really is the way the chart cycles work. Okay, questions on those sort of basic ground rules around the chart?

All right. Next, what will we do with the counts once we get them? Well, we need a time; and the two components of a frequency are going to be its count and its time -- how long were we looking it at during which it happened some number of times. For a count over time, then, what we're doing is generating a frequency. So, frequency equals count over time. And again, this is what Skinner called 'rate', Lindsley calls 'frequency.' And another way of looking at it is: On the chart that's going to be represented by a little snapshot of a particular day. So, behavior which occurs on a particular day -- occurs in time, had a count of so many -- that's going to be a dot or an x on a particular day line.

Now, let's use an example. Let's say we had a count of 40, and how long did it take; how long was the sample were we looking at? Well, let's say we looked at one minute. Okay. Something that happened 40 times in one minute. What is our frequency? 40 -- the count -- over 1, which is our time. On the daily chart we will always put that in minutes. So, if it's less than a minute we use decimal minutes. If it's more than a minute, if it's some number of seconds we convert it to again decimal minutes: 3.2 minutes, or something like that. Once we've got a frequency of 40 per minute, where does it go on the chart? Well, here's where we start looking -- up the left for frequencies, and seeing where this is count per minute -- so where would you find 40? It's going to be above 10, less than 100. And, again, use your rule: so, it's 10, 20, 30, 40. So, 40 per minute, say it is on the first Sunday, would be a dot right there.

Charting Conventions

Now, one of the conventions we use with putting down or dropping dots, or x's, is that if the behavior we are looking at has an acceleration target -- that is, if it's a behavior you're trying to increase -- you use a dot. So, a dot for a behavior that you're trying to increase. So, the target is an increase; so the dot is something that is targeted for acceleration.

If it's a deceleration target then we would use an x. If we have in that same minute something occurring 120 times -- pretty high frequency at two a second, 120 a minute -- and this was a deceleration target, then 120 over 1 equals 120. So, now we're talking of about a frequency of 120. And if it took place on that same day on that first Sunday, then where's the range for that particular frequency? Well, again, looking at the chart, what's the nearest number that you can find? And, again, going back to the rule, what does the next line represent? 200. So, where would 120 fall? Well, somewhere between 100 and 200, a little closer to 100 than 200. And 120 goes there. And again, since it is a deceleration target you use an x as the convention to show us that.

Now, notice that simply because you've targeted something as a deceleration target does not mean that that is what is going to happen to the behavior. So, you might have something which, in fact, is increasing. If you saw something like this, immediately, what does that tell you? You have got a problem, because you wanted it to decrease, and it is going the other direction. Likewise, the dots could be in fact decreasing even though the target may have been an 'increase.' In some things where you are just monitoring them and there is not any target per se, dots are the usual convention; they are a little easier to draw than the x's. An x: What you are trying to do is put the x in such a way that the cross part of the x falls where you would have put a dot if you were dropping a dot. Okay.

The Record Floor

There is one other component to a frequency that we show with virtually every standard celeration chart. That is some way to represent this time. Because, notice, 40 a minute, a fairly high frequency of one every two seconds, 40 a minute is something that is happening at a fairly high frequency, and what we would like to know is, how long did that go on? How long were you watching? How long? How much of a window do you have on this particular behavior? The way that that is described is with the term "floor": Record floor, or counting period floor. Essentially, "floor" is the key term. And what a floor is, is a representation of the time that is involved within a particular chart. The rule for finding it is: It is the reciprocal of the time. So, it is 1/T, or for a daily chart, 1 over minutes.

If we have got an example here of a one-minute time, then that is an easy floor, because now substituting for T, we have got 1/T, or 1/1. That is just 1, and therefore our representation of the floor is going to be on the 1 line. And we use a dash to represent it. That goes through the day line that we were talking about. So, this little dash is the mark that represents the time -- the time that you were counting this particular behavior over. So, components of the basic chart, then, basic chart frequencies are a count and a time, expressed as a frequency, would be hits and misses, corrects and errors, both dots and x's are conventions there. Those are frequencies, and then a record floor representing a time basis for a particular frequency.

So, 40 per minute with a record floor at the 1 minute line is a very different situation from something which is 40 a minute with a record floor at the .001 line. Because this represents something that was done and counted for 1000 minutes.

So, then, why the floor? Because if your time is varying from day to day, then you are keeping track of it as well as the frequency. If you have got different record floors you can see at a glance that that is the case. As the record floors move down the chart towards the bottom, what you are doing is building endurance in the behavior if you are maintaining the particular frequency. So, if the 40 per minute is maintaining, and you see the floor going down, down, down towards the entire day, which would be the .001 line, then you are seeing endurance in that particular behavior.

You can also measure latency and duration, which refers back to the question that Darryl asked about using time goals. So, you could have a floor, or a time goal here, represented as a record floor, where that was in fact the time that you wanted to get the behavior to. So, your feet per second or feet per minute would be your frequency, and then as it approached that particular time goal you would see that as approaching closer and closer to the floor.

Now, then, again, there are in some sports activities the time gradations are so fine for skilled performance that you are beyond the chart and into other things. That is, you are really -- I thought we might have reached that point in free throws, but it hasn't turned out to be the case yet. But there becomes a point when you no longer need the chart once you get fluent behavior to the point where it is in there, it is consistent, it is reliable, and you are going to see it anytime the behavior appears at the same frequency. That is sort of the ultra. The professional athlete is probably operating on that type of level. Very, very little bounce. Very small changes in frequency from day to day, unless you do something like put the top 10 basketball players on the floor together and let them play, record points, and you get some bounce there from day to day. **[Question from Jim Cowardin: "The concept of floor, I've heard it three of four times before: If you can give me an example of two different measurements of two different floors, so maybe I can understand that--I'm just not getting that floor idea. What is floor?"].** Yeah.

One of the learning devices is something on the order of flashcards or SAFMEDS. If you have a SAFMEDS deck, and your students have SAFMEDS decks, and you are trying to get them to learn to see the front and say the back -- you are trying to get them fluent on these cards, then you probably want to see how they are doing on a daily basis, and have them chart it, because as we have said before, use the standard celeration chart you can set a goal, and you can follow progress towards that goal. Now, you can look at that, but in Jim's question, he is saying let's see an example of where you might use, where the floor would be different for a real example. Well, in some case what you would do is have everybody do a one-minute timing simultaneously and pair off. Everybody does one minute on their SAFMEDS. The first minute we have pairs. One person is the counter, the other is the behaver. The behaver holds the cards. I say, "Is everybody set? Please begin." The coach starts the timer. The kids start the saying the facts and then the counters keep track of how many hits and how many misses. The end of the minute the timer goes off. The coach says, "Please stop." And now each person that was the behaver has a count of hits and misses. We may do that everyday on Monday through Friday of class, and do it for one minute. So, our floors are going to be at the one minute line from Monday through Friday. Our frequencies all tie into that one minute line. So, we always do it for one minute, then that's the one minute example. Don't feel -- I realize that you've got this inflexibility. I'm in sort of a tunnel here that I've got to run through to get out, but if you have to leave, please don't hesitate to do it this way, rather than another **[as a couple of people left]** Okay, that is the one minute record floor.

Now [there is] another way in operating these cards. We shuffle these cards. [The student] may not get through them all in a minute. If a person wanted to do them all, and time how long it took him to do that, then they could just use a stop watch, and maybe they are now practicing at home on the weekends by themselves, so they say, "Okay, I'll see long it takes me to do that. I have a count down timer. I could have a stop watch. So, I'm going to start right now, and start my watch, and I go through the whole deck, and at the end I turn it off." Okay, now it took me, let's say, 4 minutes and 30 seconds, four and a half minutes. Using our formula for floor, you say 1 over 4.5. And now we are going to have to put that on a chart as a representation for the floor. Well, 1 divided by 4.5 How many college students can do that arithmetical operation? How many of us professors can do it -- embarrassing. There is a kind of an easy way out that involves the use of a device that has variously been called a 'frequency finder,' a 'celeration finder,' or a 'floor finder.' What it is is a throwback to an obsolescent piece of the student's toolkit. That was the slide-rule. Now, this one class I was asking about this recently: Only one person had ever heard of a slide rule, much less used it or knew what it was for.

Notice, there are several ways in which this can be oriented, and it is going to be right side up one way for some things, and the other side up for other things. What I would like for you to locate is where is says 'floors' -- get that in the lower right hand corner for yourself. Who is having trouble with finding the floor? Notice, it says 'rates,' 'floors,' and 'ceilings.' Okay, our problem was, we had this four and a half minutes, one over four and a half, and we wanted to put a floor on, but we are not really thrilled about doing the arithmetic of 4.5 into 1. So, what do we do?

Well, we find the scale above where it says 'floor.' We are looking up the right, there. We see on the scale .1, .5, 1, 5, 10, and so forth. The key to this, the interesting thing here: If we took the scale, and you do this: line the one-line up of the scale with the one-line on your chart. Notice that they fit. So that you have two multiply scales, one of which can slide up and down the other one. Functionally, you have a slide rule. What was the slide rule used for? Division. Multiplication. And so that is why it comes in handy here.

How do we do this particular operation? Well, 4.5. If we look at the 5 line, you can see underneath that the 4 line, because this is the 1 through 10 cycle, 4.5 is going to be about midway in there. What we do is locate the 4.5 on the finder, and line that up with the 1 line on the chart. So, we've got 4.5 lined up with the 1 line on the chart. Then, we are going to align it also with the particular day line that this behavior occurred on. So, in my example it occurred on this Sunday. So, 4.5 or between 4 and 5, lined up with the 1 line on the chart, drop down to the 1 on the finder. Notice, there is sort of a little arrow there, and then you draw the floor as the floor right beside the 1 line on the finder. You draw that dash on the chart. Again, you're using a pencil, so you don't even have to draw it in, but that is how you are drawing in the floor.

Now, still, focusing on Jim's question, now what does this all mean? Well, when you look at that after you have become familiar with some of these different time periods, you start to immediately get a sense for the time that was involved here. So, anything, when you see the line right there on the 1 line you say immediately a "one-minute timing." Whatever they were doing, they were doing for one minute. You see something down here: That tells you that it is in this cycle, that means it was between a minute and 10 minutes. Okay. In fact, a way to kind of get some insight into that is to focus over on the far right hand side of the chart, and it'll show you the counting period floor here. So, a one minute floor, a two minute floor, a five minute floor, a 10 minute floor, and it goes down to a 1000 minute floor.

Again, what the floor does is give you immediate visual information of the time period involved in the behavior.

Now, while we are fiddling with the finder, the other thing that we would do: Let's try one other example. Let's say you had a 10 minute floor this time, or 10 minute time period. So, our floor is going to be 1/10. So, again, the rule is, find the 10 on the finder; line it up with the 1 on the chart; go down to the 1 on the finder, and draw in your floor where it would go on the chart. And then keep it in that position. What you would be doing if you were charting using this finder is holding it in that position, and now entering in your counts. So, let's say in this count where the floor was equal to 1/10, let's suppose it was a SAFMEDS deck, and took 10 minutes to get through. And let's suppose you got 70 corrects in that 10 minutes. Well, holding the finder in place, you look on the finder, up until you come to the 70. And that is where you put the dot. That would represent your 70 in 10 minutes. **[Audience question from John Cooper: "Steve, I was daydreaming. I was thinking about charting something here, something else. Would you start back on that again? What are you doing?"].**

Take us back to where we started. Ten minutes is our floor. So, 10 minutes there, lined up with the 1 line on the chart. Drop down to the 1 line on the finder. That is going to be your floor. Now, what we are doing in addition is putting in the frequencies of the hits and the misses -- the frequencies, the counts per minute, by charting the counts on the finder. What that is going to do is do the division for us, so that we don't have to use a calculator or perform the arithmetic operation. So, let's suppose we had 70 hits in that 10 minutes. What we can do is just, once we have put this in position for the floor, go up to the 70. And let's suppose we had 5 misses in the 10 minutes. We would go up to the 5. That is where we would put our x, at the 5 line. And so, we've done our frequencies for that particular day. And notice if you pull away now and look at the chart, what we have is 70 hits in 10 minutes. How many hits per minute is that? Seven. And notice, that is exactly what our chart tells us. So, we have done the conversion here from the count over time into the frequency, and plotted it directly on the chart. These take a little while to get used to, but they are a kind of handy thing to have if you do a lot of charting, particularly if you are doing these odd minutes, that, if you were doing a whole SAFMEDS deck or some other time period that involved more than 10 minutes or more than one minute of time.

Okay, you people probably need a break at some point for about 5 minutes **[banter].**

[Break].

Help With Charting

A number of you may have data that you may have questions on, and rather than go through individual ones while the rest of the people are sort of floundering, we will try to handle that at the end for people who have questions. My goal would be that at some point you are going to run into having a problem with, or a question on this chart. And so the goal is, is that you not just drop the chart at that point, because you have come into an insurmountable obstacle. But rather, that you ask somebody. Because if you ask somebody, and if they know, they'll probably share it with you. If they don't know, it should eventually come back to me. John is a resource person here close by in town. I'm certainly available by telephone. And I am encouraging you if you have charting questions to, if you are a student, to ask the professor, who in turn will either answer you or ask me. If you are a professor then ask a student **[Graf chuckles; audience giggles]**. Then, if they don't know, then ask me as well, because learning to chart, learning to do this is something that you're going to come up with some questions, and some good questions, in as many places as you can. We're trying to kind of anticipate some that will come up now in what we're covering, but we won't cover everything, and some of the things that I am going to touch on are just sort of anticipate questions that you are going to have, or skills that you might want to eventually develop, to show you what is the potential here, but not something that I'm expecting you to be able to do today. Okay.

Coop's question that related back to something that we were talking about before is he said that, suppose that I wanted to start a personal improvement project. I wanted to start it today, and I want to incorporate this standard celeration chart. Well, what would I do? Would I use -- this is a Friday -- so would this line, this zero line be my start line? Would that be my start date? No. What would you say? **[Audience member: "Me?" "Ah, no."]**. Where would you say? **["In November, third, or whatever, Friday."]**. Yeah, so we are going, if you are going to synchronize your chart, even though you started today, you are going to come over to November.

Helpful Charting Cues

Here is another little cue that I find helpful when you are in a daily chart. That is, in small print, put the dates for that particular month above the Sunday lines. So, the next Sunday coming up is the 5th, 12th. That allows you to orient, to zoom in on today the 3rd much more easily. So, if we are starting a personal improvement project today, and wanted to synchronize, we would put it in here. That way, if somebody else, somewhere else in the country in North America also started a self-improvement project anywhere in here, they could compare it to ours. They could plot theirs right on top of ours. We could compare them without having to do any other manipulations: Just look and see how those projects were going.

Now, that tendency is one which you are going to have as a reality tunnel, if you have been using stretch-to-fill charts. So, notice, in the stretch-to-fill charts you start with what your reality is: You start at either the case birthdate, or whenever you start, that is over in the far left, not calendar sync. And what we are doing is using this calendar time synchronized across the bottom on the plus scale. So, these are the issues we're hitting at right there.

Lamination and Truncation

We have already talked, incidentally, about the "sessions" across the bottom, being truncated and laminated to fill the screen, or fill the page and so forth. And we have also talked about the frequencies up the left being truncated on the stretch-to-fill chart. If you are coming from that background, then that is your reality to get away from.

[Audience question from Bill Heward: "Steve, what's the connotation of 'laminated' there? I understand the meaning, is it the lamination?"] Okay, have you ever heard of a laminated bat? **[Heward: "Layer on layer?"]** Yeah, layer on layer. So, each session is a layer. And, to laminate those sessions, what you do is you take out: If you are doing Monday through Friday, for example, and you are not running subjects on, or not gathering data on Saturday or Sunday, you just drop out each Saturday line and each Sunday line, and then compress the sessions across.

[Heward: "Meaning it's truncated?"]. Well, truncated here we're using as.... **[Heward: "The vertical axis."].** Yeah, or also in the sense of being -- well, a lamination has a real world reference of a process or a procedure. **[Audience comment by John Eshleman: "In the lamination it looks like the Session 1, Session 2, Session 3, it looks like they're all the same time period apart, or whatever, and it's obviating that totally. You don't know what it is."]. [Heward: "It's important you don't have the data. That is a data display here that is commonly made with equal interval charts, but it is not an inherent feature of equal interval charts."].** Right, correct. **[Heward: "If you learn how to graph accurately you show real time on the horizontal axis."].** Right. Here's an add chart, 0 to 100, which has the same 140 successive calendar days across the bottom, so yeah, you wouldn't run into it. If you're making you're own stretch-to-fill chart, and you could make a stretch-to-fill chart out of a multiply chart, but it wouldn't necessarily be standard. We've run into that with a lot of people within standard celeration charting. Well, not standard celeration, but precision teaching. You've gotten two cycle charts, or other charts that don't have the same properties, and they have been laminated across.

The truncation notion is when you have generally just one end left off the bottom, which is what you were thinking of. So, if you've got data that all falls between 300 and 400, then you typically would go, show some sort of truncation down to 0. So, when you look at it, you don't see that area between, anywhere below 300. That's the truncation notion that I was thinking of there. Okay.

Back to what we would need now within our toolkit of chart skills, if we wanted to do standard celeration charts. The picture here: We talked about frequency; we talked about record floor; and a frequency as hits per minute, misses per minute, something like that.

Drawing Celeration

We haven't mentioned much about celeration. And remember, celeration is what we're looking for when we are doing these charts. That's the big picture, is celeration. As it turns out, that is also one of the easiest features to do. So, anytime you've got a chart that you want to do the celeration for, then all you have to do is get a straight edge, see the dots, the frequencies that you're interested in, and draw a line through them. Now, this is not a commercial device. It is simply taking a piece of mylar, cutting it up, putting a hole in two spots, so you can put a pencil through there or a pen, and locate the end of your line. But if you wanted to draw a celeration line then through points beyond this phase change, notice I just eyeball it. You put a dot here, a dot here, and then with a straight edge, I find my celeration. So, again, what I'm saying is that celeration by and large is an eyeballing part. You see it and you fit the line through it in a way in which it seems to best fit.

Now, there are other ways of obtaining celeration that we are not going to cover today. There is one that I would never cover, and that is the arithmetic least squares method. Computational methods will get you a line, but it takes a while to do it even if you've got a programmed, or programmable calculator, or whatever. It is a time consuming process. You wouldn't want to do it very often. And also, what's called a 'quarter-intersect' method, which uses medians, divides things up into four stages, and looks at things within those quarters. And that's fairly simple. You can do one in less than a minute. If you've got some practice you can probably do, depending on not too many data points, do it in half a minute; maybe two a minute. But when studies were done comparing the accuracy of making appropriate predictions based on celeration lines, which has been done through the three different methods, the finding was, and this was one of Lindsley's doctoral student's dissertations, the finding was that what we have just described here when we're putting a line through it visually, which is called the "free-hand" method -- that's just as accurate as either of the other two, and quite significantly faster. So, it turns out that the easy way, the most parsimonious way, is no less accurate than the other ways in order to determine a trend.

Measuring Celeration

What if we wanted to measure a celeration? How do you measure a celeration? What does it mean? Well, it means how much behavior either increases or decreases within the heavy line sequence. So, for the daily chart, celeration tells you what the increase is per week, or what the decrease is per week. And the standard celeration chart is set up with this as its basis: Corner to corner is doubling per whatever the time period is. On the daily chart it is per week. So, corner to corner celeration is doubling per week. What that doubling **[End of Tape 2 Side 1...].**

...across all standard celeration charts, X2 corner to corner. It also means that if you go halfway up that, and all the way across, anything parallel to that particular line, that particular slope, is X1.4 per week. It's not one. Times one is flat; X1 isn't increasing; X1 or ÷1 is just staying flat. And that would be represented by a celeration line which goes straight across. But anything parallel to this is X1.4, or the square root of 2, in other words, because this is a multiply scale. The square root of doubling is 1.4. So, halfway of that [vertical axis] is X1.4 per week.

The other sort of benchmark that we use is one cycle. Going up one cycle across the whole chart is multiplying by X1.1, in a counting period, in this case a week, X1.1 a week. And then the other one that you might see is where you go X4 per week. Now this is getting into steeper celerations. And you will occasionally see some that are even steeper.

I did an analysis of the running explosion several years ago -- some of the marathons -- and those were some of the steepest celerations that I have ever charted. And some of them were in the neighborhood of X100 every 5 years. So, those are very steep celeration lines.

This is another way of measuring celeration lines that is available from the Behavior Research Company, which is the sort of the quality control of the chart, which sells the charts. But the one way of determining the value from a line is to simply use a finder line this.

Another way would be to use your little frequency finder, we have called a floor finder at this point. Notice, that you flip it over now, and locate the slopes side; that it can be used to find the value of a celeration line. So, the way to do that is, with the slope side on the right hand side, find the line that you are interested in measuring -- we will use this line -- what you do is, first of all, locate on the left hand side the 1 arrow. Put that anywhere along the celeration line. And then, so that it is parallel to the day lines, go over to the other side, and read out the value after it runs the course of your finder. Notice that it's 4 here, so that's X4 per week, which is the line that we are measuring. So, you are using, really, a little four week sample from one corner of your finder to the other, of celeration, to figure out a particular celeration value.

Now you haven't even generated any celerations, so we're talking sort of about future behavior, but that's the way to do it using this finder, and do it fairly easily. For most purposes, unless you are doing something where you are summarizing a lot of celerations, or you are communicating with somebody over the telephone, you don't have a fax machine, you are just telling somebody what the celeration is, notice that you can, once you can measure with a times 2 and you tell them that it was a times 2, or a times 4, or a times 3, they can visualize what that slope would look like on a chart because they are using a standard. They have seen the chart. They know what that slope is. So, the X 1, the X 1.1, the X 1.4, and the X 2 are going to cover probably 95% of your celeration examples that you would run into.

Summary

Okay, we have talked about frequency. We have talked about celeration. We have also talked about jump-ups and jump-downs, and turn-ups and turn -downs earlier on, and saying that that was one of the big differences in psychology or behavior analysis, sort of an emergent quality from the chart. The jumps are frequency changes. The turns are celeration changes. Now that we have added the frequency and celeration terminology in, that's how that relates back to those previous concepts. The bounce is the amount of variability, and we talked about that as being your large or small as well.

Practice

What I want you to do now: If you've got some data that you are interested in trying to convert to the chart, take it out, and let's spend a couple of minutes [] ourselves to that data. How many don't have data with them today that falls within the category of useful data to chart? A couple of people. Anybody who wants to start out by using this: This is some data from a class that I am currently teaching. It is just summary data. The day the class is meeting on is across the top. Notice that that is just non-standard stuff, but the chart day is the chart day corresponding to the calendar days across the bottom. And this chart day is based on the 3rd of September synchronization that we were talking about before. So, chart day 23 would be, find chart day 20, and then, one, two, three, and that represents day three of the quarter, for these particular data. And then you can pick out any line that you like, and then just follow it across. Notice that you are doing this as a daily count, and then you just start in the bottom category, or in the bottom cycle. So, let's say you were doing this last one. That is 14 per day. So, there is 1 a day, 10 a day, 14 a day, then 6 a day, 8 a day, 6 a day, and so forth. That would be on a per day basis. If you wanted to find out frequency per minute, then you could use this as the count, or anyone of these numbers as the count, and this is the minutes, and you get your chart by having 14 -- did not have the number of minutes there, so that is an ignored day -- but 6 in 17 minutes; 8 in 10 minutes, and so forth. Go through the same approach as you would....**[banter]**. These were just points given for particular classes of responses, so they are just point values. **[Heward: "How many 8 pointers, how many 6 pointers..."]**. Yeah, how many 8 pointers, how many 6 pointers, and so forth. And these were give aways; how many four point give aways and so on. So, here's the data. This is data which we could then chart.

How would we do this? Well, we would make a different chart for each one of the different point totals. So, we chart the 8 pointers on one chart; the 6 pointers on another chart. And you could put more than one on the same chart if they don't go together too much. Some of the charts I shared had more than one thing plotted. But at some point you are going to get too much to be able to do any further analysis of celeration or bounce if it gets too cluttered. So, one to a chart is probably a nice little rule to start with to keep it simple.

Okay, if you start in, if you jump in, and start trying to chart something, then, you've got your synchronization down, you know your minutes, and you know the count, then you are all set to go. In some cases you may not have the minutes available. Then your decision has to be, do I do it per day, and just look at it on a daily basis. Is that meaningful? Well, it is if all of the counts were fairly close. So, for here, notice that the minutes range from something like 10 to 22, 23, 24 -- 10 to 24 minutes. So, over the course of the entire day, that's not a big difference in a time frame -- you are talking about 1000 minutes in a day. A thousand minutes in a day, a 14 minute difference from top to bottom is not that big. So, you could go ahead. You could really try it both ways. If you did not have the minutes then obviously you could not plot the minutes, but you could try it on a daily basis.

So, how many people lack, with the data that they have with them, lack the minutes, or lack the time? If you have the time components and you have the counts, then you are ready to start. The only thing is, if it is prior data, prior to the 3rd of September, you'd need to look at this synchronization chart, if you wanted to get it calendar synced. There's a tendency to just kind of want to go back and start from the [] and you know that is not a sin. You could do that. It is just not going to be synchronized with anybody else's necessarily. It's still going to be easy enough to read, if you are used to seeing standard celeration charts, the synchronization is not that big a factor.

Okay, any questions that anybody has that they need before they can do any plotting of their data?

[audience members spend several minutes plotting data; various individual audience member questions to Graf; difficult to discern individual speakers].

[Question by Heward about plotting zero].

There are some conventions for several of the sorts of things that you are likely to run into. One that Bill mentions is the zero in the observation period. Let's say that you do a one minute timing here, and you are counting hits, and there weren't any. Where do you put your dot? Well, you don't put it down here, because down here would represent zero in a whole day. You are only counting per minute. So, the convention is, you go about a pencil width below the record floor, and that's where you would put your dot for zero in one minute. So, a dot underneath a floor means no behavior in that particular interval. Any time you see a dot underneath a floor, it means that it didn't occur in that interval. Now, there's no behavior in one minute, but this would be no behavior in 10 minutes. So, notice that your dot for zero behavior now is influenced by where the floor is. So, the longer you watch, when you finally get down to the point of the whole 1000 minutes, and you didn't have any behavior, then it is still about a pencil width below the floor. A pencil width is a number 2 pencil, is about the distance of a X2 on the chart. So, it is kind of a X2 distance below the floor is how we would do zero in that interval.

Other things that you run into, is what if you had a count of 1 in a particular interval? One in one minute. Well, then the dot would fall right on top of the record floor. And to see them both you have to kind of look a little more closely perhaps. If it is an x, if it is an x and a dot, one hit and one miss in one minute it would look like this. So, any time you have a record floor, that's 1/time, if you also just have one occurrence of the behavior over that amount of time, that's always going to be identical with the record floor **[audience comments].**

So the two things we talked about are zero behaviors in a time period, and then one behavior in a time period. Then the other thing that will happen occasionally is when you have two different frequencies, and you are charting them both on the same chart, and they both are the same frequency. Such as if you had 10 hits per minute and 10 misses per minute. Then, the convention is to put the dot there, and then the x just sort of surrounds it, suggesting the x goes through it. This represents 10 hits and 10 misses in whatever the floor was.

[Heward: "Steve, do you ever get where you connect zero data points in the data path, or do you leave them hanging out?"]. Connection of data points in the data path is something which is not standardized among standard celeration charters. Sometimes you may want to connect the data points. So, here is all those points connected. Here's the record floor. Here's the zero frequency. Notice, I have connected what Bill called the data path before and after the zero point. **[audience talking].** Convention is as long as you did it today, you continue to connect the dots. **[audience talking quite a bit]**.

[audience continues plotting data and talking; banter; minutes pass by].

Percent Correct Ramifications

The accuracy is that as we suggested, two a minute, or three a minute or even 10 a minute correct is not fluent behavior. And when you are not looking for anything beyond accuracy, and calling that fluent behavior, then you are going to get in college umpteen or some years from now students who cannot do arithmetic, who cannot take notes at more than 20 words per minute, when they should be able to write 40 to 50 words per minute, that's fluent handwriting, and people who cannot type faster than something like 10 or 20 words per minute on a keyboard when it is a computer age. So a lot of ramifications of a percent correct educational world, both in special education and in regular education, which is not attended to will, again, create a reality tunnel that doesn't allow you to see some of your other realities that exist.

Concluding Remarks

At this point, we have run out of time on sort of the group effort. I again, I really appreciate both your interest and your enthusiasm and attention. Again, let me suggest that you try to maintain that. And the charting world is a small world, compared to the rest of the world. There are some teachers. But if you look at the history of innovations, it is true for almost any innovation. Buckminster Fuller found it was 60 years from the germination of an idea to its actual practical application. That range varies from author to author, but it does seem to be a kind of constant. So, it still has not hit behavior analysis. That is probably the first place that it should hit. The whole educational establishment, somewhere down the line if the world is still on the [], and don't cut world population down in size by a divide 100 or something or some sort of cataclysm, then at some point you will probably see standard celeration charting throughout education. Once again, if you have got some charts that you would like to look at, and have me look at, I would really like to see those, so we will continue in that one on one mode. At this point thank you very much. **[audience applause]**.

[Heward: "Steve, fantastic!"].

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