Standard Celeration Society

ACCELERATING LEARNING & PERFORMANCE

Displays that Maintain Standard Celeration

(Critical and Variable Features)

For a variety of reasons (e.g., publication restrictions, use of only a portion of the Standard Celeration Chart [SCC] in practice, need for different number of celeration periods or different number of x10 ratio cycles), persons may alter the SCC. In these situations, four features are critical if a person wishes to maintain *STANDARD CELERATION* as a standard measure of graphic change of performance. These features are presented below followed by variable features that do not impact the viability of the graphic standard celeration measure.

Standard graphic displays and standard measures are grounded in B. F. Skinner's measurement contributions. O. R. Lindsley honored this tradition in the development of the standard celeration technology and brought it to a variety of applied disciplines and settings.

Beyond education, standardized displays of celeration have beneficial applications in therapies of all kinds, sports and fitness, management, economic and social trend analysis, process and quality improvement, and many other fields in which performance and changes in performance are targets of investigation and improvement. Displays of celeration provide a framework for standard and universal displays of frequency (i.e., performance level), celeration (i.e., change in trend of performance across time), and bounce (i.e., variability). In addition, the unique standardization of celeration allows analysis across data sets in different fields and supports efficient and reliable evaluation, data monitoring, and decision making.

SCCs are universal tools with broad reach and applicability. But with the development of new paper-based and electronic graphic displays, there is a need to clearly define what features do and do not comprise a standard display of celeration. In 2017 the Standard Celeration Society (SCS) authorized the formation of a Standards Task Group charged with (1) identifying the critical features that do and do not comprise a standard display of celeration, and (2) specifying variable features of such a display based upon on application and audience. This document describes those features, based on meetings and electronic communications of the Task Group between 2017 and 2021.

Critical Features of a Standard Celeration Display

Critical features are those characteristics essential to a concept. They define when an example meets all the criteria that enable the concept to be accurately identified and have shared meaning. After extensive review and discussion, the Task Group identified four critical features of displays of standard celeration as illustrated and described below. A graphic display missing or modifying any of these four critical features is not considered a display of standard celeration by the SCS.

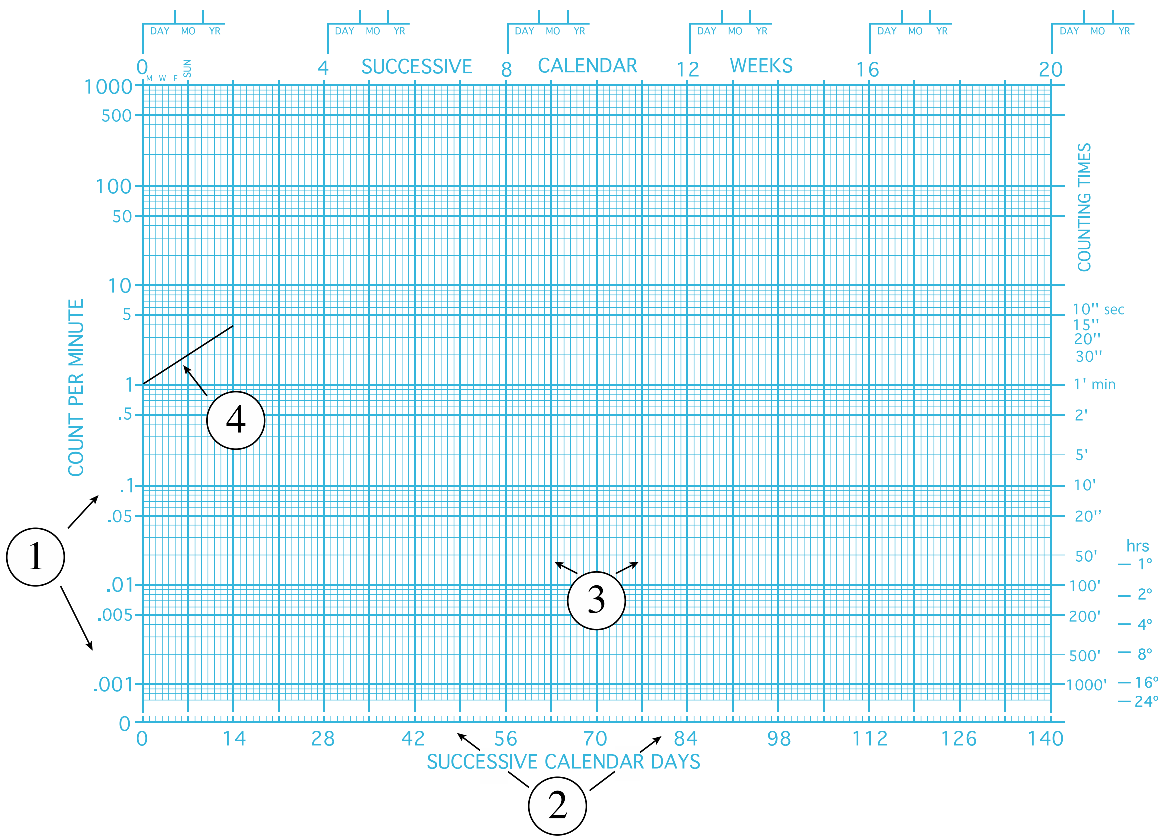

Figure 1. 4 critical features shown on a six cycle by140 day standard celeration display. (Note: This example is modeled after the commonly used daily per minute SCC.)

1. The vertical axis displays frequencies in count per standard time units in ratio cycles of x10.

A display with a standard celeration shows measures of frequency (count per unit of time) on a ratio scale "up the left" (i.e., the vertical axis). While traditional SCC applications focused on frequencies of human behavior, the same ratio axis can be used to display counts of other phenomena over time. Examples of this use include production outputs, dollars or other monetary units, population counts, and other phenomena for which frequency and changes in frequency over calendar time are of interest.

Frequencies on the vertical axis appear in multiplicative "cycles" of 10. For example, on the daily count per minute SCC (shown in Figure 1), there are six frequency cycles starting with .001 per minute at the bottom, .01 per minute, .1 per minute, 1 per minute, 10 per minute, 100 per minute, and 1000 per minute at the top. The multiplicative cycles allow the display to reflect changes in the trend of frequencies over time, or differences between two values on the chart, as a multiplying or dividing factor, independent of frequency level. This is a powerful feature because it yields the first standard measure of change in trend. The multiplicative value that quantifies the frequency changes over time is termed celeration. Any graphic display that does not present frequencies in multiplicative cycles of 10 up the left is not a display of standard celeration.

2. The horizontal axis displays continuous equal time intervals in celeration periods.

A standard celeration display shows standard calendar time units "across the bottom" (i.e., the horizontal axis). The values presented on the most common SCCs are calendar days, weeks, months, and years. Other versions could have decades or even centuries across the bottom. Graphic displays that list sessions, opportunities, or similar discontinuous time markers prevent viewers from seeing the phenomenon being displayed in real calendar time and distorts the data interpretation. Thus, continuous calendar time along the horizontal axis is a critical feature of a standard display of celeration.

A graphic display that does not present continuous equal time intervals on the horizontal axis is not a display of standard celeration. For example, what is known as the "timings chart" uses celeration in multiple frequency cycles, yet also allows discontinuous timings that may or may not be spaced equally in time along the horizontal axis. Hence, while serving as a powerful goal-setting and decision-making tool, the timings chart is not a display of standard celeration because it does not require continuous equal time intervals as a dimension of the visual display.

3. Dark vertical lines mark the celeration periods as continuous calendar intervals.

At equal intervals across a display of standard celeration, dark vertical lines mark the celeration period for that display. The celeration period is the calendar duration used to calculate the multiplicative or dividing rate of change in the frequencies that appear on that display (i.e., the celeration or celeration value). For example, on a daily SCC (shown in Figure 1) with count per minute up the left, and calendar days across the bottom, the dark vertical lines occur every 7 days. These 7-day intervals indicate that the celeration period for the daily SCC is one week. A frequency that doubles every 7 days has a celeration of x2.0 per week, and one that divides in half every 7 days has a celeration of ÷2.0 per week.

Other displays of standard celeration may display calendar weeks, months, or years along the horizontal axis. If the visual distance between celeration periods is the same across standardized displays of different continuous time intervals, the visual angle of the celeration is identical. Because this is a critical feature, a data display that does not use equally spaced dark vertical lines to mark celeration periods is not a display of standard celeration.

4. A line across the chart at an angle of 34°[3] represents a x2.0 or ÷2.0 celeration.

Each slope on a standard display of celeration represents a unique celeration value. A trend line with a 34°angle[1] is a "times two" or x2.0 celeration, meaning that the data are doubling each celeration period. A downward trend line of 34° represents a "divide by two" or ÷2.0 celeration, meaning that the values are halving across celeration periods. Any trend angle above or below 34° represents identical celeration values, no matter the size or version of the display (e.g., count per minute, count per week). This critical feature allows for immediate comparison between changes in trend in any sequence of frequency measures displayed. The standardization of the celeration angle is the reference for the phrase "standard celeration." The visual representation of any given celeration (trend) is a consistent visual angle and represents a

[3] Ogden Lindsley indicated that the angle of an SCC was 33 degrees [Lindsley, O. R. (1990). Precision teaching: By teachers for children. *Teaching Exceptional Children*, *22*(3), p. 11] or 34 degrees. [Lindsley, O. R. (1992). *Skinner on Measurement* (p. 56). Kansas City, KS: Behavior Research Co.] An analysis of the Behavior Research Company daily per minute SCC (grid of 8 in. × 5.28 in.) indicates that the precise angle from corner to corner is 33.52 degrees. See Figure 43 in Kubina, R. M. (2021). *Reflections on precision teaching* (p. 107). Lemont, PA: Greatness Achieved Publishing Co. Other unpublished analyses suggest that across the various SCCs there is some slight variation but all close to 33 or 34 degrees.

standard quantitative unit of measurement. Thus, celeration is a standard measure of change in trend. Celerations are independent of the frequencies they comprise. This feature allows viewers to immediately compare trends (i.e., rates of change) across any phenomenon quantifiable as a series of frequencies over time. It enables users across disciplines to quickly compare the impact of interventions on the rates of change in natural or man-made phenomena.

Variable Features and Acceptable Display Modifications

Standard displays of a celeration maintain the four critical features described above. However, applying situation-based "conventions" or modifying "variable features" (i.e., characteristics that vary without affecting the critical features) of a display of standard celeration may occur for specific applications or settings and have become widely used in those contexts. While the following list is not exhaustive, it illustrates features of a display of standard celeration that some may consider standard within their user groups. However, these are not critical features that define a display of standard celeration. The following are some of the more common modifications:

1. Varied units of frequency on the vertical axis.

The most common versions include count per minute, count per week, count per month, or count per year on the vertical axis. These variations are considered conventions adopted for specific applications, and not a change in the critical feature of a count per standard time unit. Additional frequency measures up the left, such as count per decade or count per century, would be acceptable if they use an agreed upon unit of time in the denominator of the frequency calculation.

2. Varied time interval on the horizontal axis.

Based on the area of application, field of study, and analysis level (such as magnification with a microscope), users may make modifications to the continuous calendar time by which their data are displayed. The time intervals across the bottom are considered a convention selected for application areas and not a standard. Users may use additional units of continuous time (e.g., seconds, minutes, hours) as long as they are continuous in real time.

3. Celeration periods and frequency cycles.

In the most common applications to date, in the field of precision teaching, the original version of the SCC included 20 celeration periods across the top and 6 frequency cycles up the left. This standard view is a powerful convention because it enables viewers to visualize measures, with standard celerations, in a standard space up-down and across the chart. On these versions, a line drawn from the bottom left corner of the data display to the top right corner has been approximately equal to a 34°angle equaling a x2.0 celeration. Displays with standard celerations may include more or fewer celeration periods across the bottom, or more or fewer frequency cycles up the left.

While some might discourage using displays with different numbers of celeration periods or frequency cycles, these dimensions are considered conventions, not critical features, or standards. Various applications might require different numbers of celeration periods. The continuous monitoring of factory production and monitoring social phenomena over extended periods of time are examples of such variation. Other applications may require different numbers of frequency cycles. For example, in the physical sciences, one might compare phenomena with enormous differences in frequency, such as the frequency with which new stars form in the universe. In addition, publication editors of online and print publications may wish to conserve space and not publish 6-cycle by 20-celeration-period SCCs that display data in only one to three frequency cycles. Consequently, use of a fixed numbers of celeration periods and frequency cycles for a given application is a convention, not a critical feature of a display of standard celeration.

4. Physical dimensions.

Original versions of the SCC were printed to fit the U.S. standard 8.5- × 11-in. paper size. Users maintain this size to conveniently superimpose tracings or transparencies of multiple charts for comparison. However, the physical size of the chart is a variable feature. If the four critical features listed above are present, a display of standard celeration can be any size.

5. Inclusion of a standard celeration fan or protractor.

The original daily per minute SCC includes a graphic display of celerations in a "fan" or protractor-like image. However, this is not required, as long as the actual angles for celerations and dimensions of the display are consistent with the critical features.

6. Color of the original standard celeration charts.

Lindsley's early research on making the SCC as easy to use as possible concluded that light blue lines were easier to use than grids printed in other colors. This remains a useful convention for most applications, but a chart may appear in black and white, in gray scale, in another color, or without any grid lines at all other than the vertical and horizontal axes, if it includes the four critical features.

7. Credit lines with various labels.

In creating the SCCs, Lindsley emphasized the importance of giving "credit" to everyone involved with a given project. He included areas for naming the individual or group represented by the data, and the persons managing, advising, and supervising. He included spaces for the timer, charter, and other contributors and lines for indicating the organization, classroom, or other convenient identifier. The "labeled blanks" may be important features in different applications and for different users. While the SCS recognizes the importance of giving credit and of keeping detailed records to identify charts in files or archives, the specific number of credit lines are variable features. They may change based on the chart application.

About the Standards Task Force

Convened by Carl Binder for the Board of Directors of The Standard Celeration Society

Purpose: (1) Identify the critical features that do and do not comprise a display of standard celeration; (2) specify variable features of displays of standard celeration based upon application and audience.

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Andrew (Drew) Bulla provided some helpful edits in an earlier draft.

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