HANSA GCR

Time and Motion Study

Finding Runts and Glitches in Digital Signals: An Examination of User Experience with Three Oscilloscopes

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This white paper examines user experience with and reactions to using three different oscilloscopes to find runts and glitches in a signal. *Users were able to find runts and glitches in a signal twice as fast with the Tektronix oscilloscope compared to the Agilent and LeCroy scopes*, significantly improving testing productivity. Users found the automated search feature and available triggers particularly useful in completing these tasks, and Tektronix receives the highest satisfaction ratings overall.

Overview of the Oscilloscope Market

Troubleshooting digital signals is a common use case for an oscilloscope. Since runts and glitches are symptoms of frequent digital design problems such as timing errors and physical layer issues, finding and analyzing runts and glitches in digital signals is a common test task for today's engineer.

This Time and Motion Study examines user experience when performing this common task using three different brands of oscilloscopes: Agilent, LeCroy and Tektronix.

Research Objectives and Methodology

The goal of this research is to measure the amount of time it takes experienced oscilloscope users to observe, capture, and determine the rate of occurrence of runts in digital signals, and how the time needed for these tasks differ between three different brands of oscilloscopes.

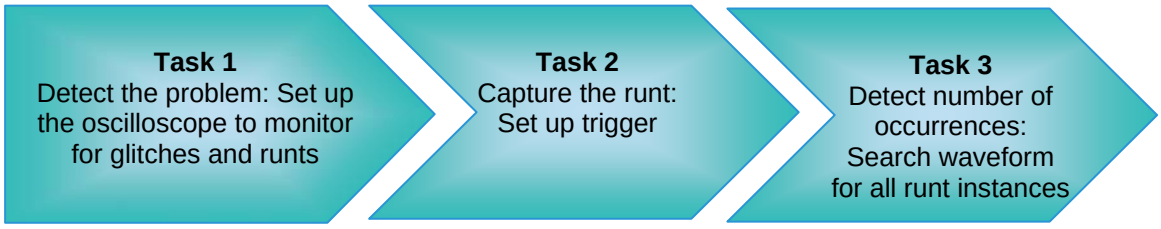
In December 2009, Hansa|GCR conducted 47 in-person interviews with experienced oscilloscope users. Scope users were recruited from publication lists, and from panelists who had been pre-qualified as experienced scope users. Interviews were conducted in Austin, Texas and Boston, Massachusetts; interviews lasted approximately 45 minutes. Research participants included users of all three oscilloscope brands.

During the interview, participants met with a researcher and completed the same series of tasks on three different brands of oscilloscopes. Each participant completed tasks on all three scopes and the order in which the scopes were tested was rotated to prevent order bias. After completing tasks on each scope, participants described their initial reaction to the scopes. After completing the tasks on all three scopes, participants discussed in more detail their experience with the scopes and the tasks.

The three scopes selected for testing were all from the $19,000 to $21,000 price range and included:

- Agilent MSO7000 Series
- LeCroy WaveRunner Xi Series
- Tektronix MSO4000 Series

Participants were asked to complete three tasks on each of the scopes:



Participants were provided instructions for how to complete the tasks on each scope. These instructions were drawn from user manuals. Some of the language was expanded to provide more clarity around the goal of the task. Participants were encouraged to follow the instructions since these instructions gave the closest approximation of what the manufacturer would recommend to complete the task. However, participants were also allowed to try different ways of completing the tasks based on their previous experience with the scopes, if they preferred. The same signal was used for completing the test tasks on all three scopes.

Participants were given up to two minutes to complete each task; if they were not able to complete the task in two minutes, they were given the option to move on to the next step. For tasks individuals were unable to complete, a time of two minutes was assigned for that task; therefore, the average time for LeCroy and Agilent will be a conservative estimate since many participants were unable to complete at least one test task on these scopes. In a real-world situation, more than two minutes would be required to complete these tasks resulting in longer average test times.

A sample size of 47 enables strong directional findings, especially in areas where participants' experiences were either strongly similar or dissimilar. In other words, these findings strongly suggest what we are likely to find if we conducted a study with a larger, statistically representative sample size.

This research was sponsored by Tektronix and took place in December 2009

Key Findings

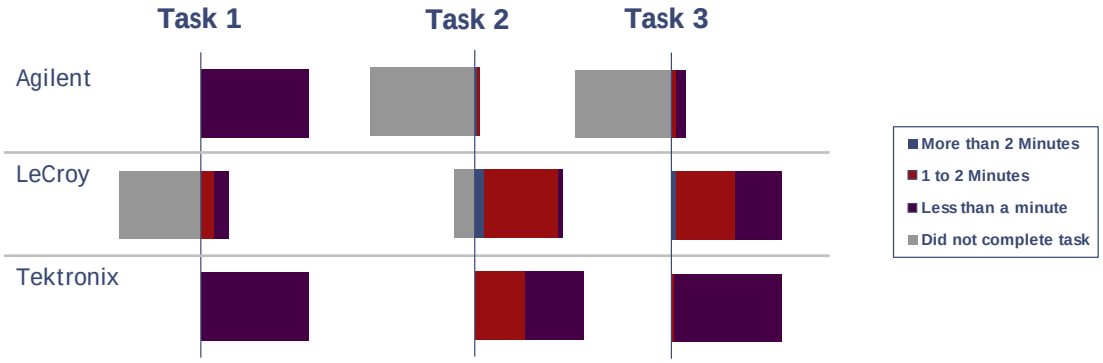
The Tektronix oscilloscope was the best suited for the tasks participants were asked to complete. Participants were able to complete the task in less than half the time on the Tektronix scope compared to the other two scopes tested. The Tektronix scope was also chosen as the preferred scope by over two-thirds of participants.

Participants also reported that it was important to have a runt trigger and automated search to successfully complete these tasks; these features are only available on the Tektronix and LeCroy scopes (of the three scopes tested).

Time Taken to Complete Tasks

Most research participants completed all three tasks in the least amount of time on the Tektronix scope. In task 1, most participants were unable to observe the runts and glitches with the LeCroy scope. And in tasks 2 and 3, most were unable to capture the runt and determine rate of recurrence on the Agilent scope.

Graphs below show the proportion of participants completing the task in less than a minute (purple), 1 to 2 minutes (red), or over two minutes (blue). Gray bars represent individuals who were unable to successfully complete the task.



Time to complete each task: Averages given in seconds

	Task 1	Task 2	Task 3	Total Time
Agilent	10	120*	110*	242
LeCroy	106*	100*	69	275
Tektronix	16	61	35	112

**Averages include 120 seconds for individuals unable to complete the task.*

Priorities for Oscilloscope Features

When asked which oscilloscope feature they most preferred for successful completion of the tasks they were asked to execute, participants said that the automatic search function (of the LeCroy and Tektronix scopes) and the runt triggers (on the LeCroy and Tektronix scopes) were particularly preferred for these tasks.

Triggers

"The presets on the Tektronix (for the trigger types)."

"Being able to set the runt triggers with a minimum and maximum."

"Triggering on the Tektronix and LeCroy."

"The triggering on the Tektronix."

Automated Search

"I liked the runt-counting on the LeCroy and Tektronix"

"Tektronix' Wave Inspector feature. LeCroy had this too, but it was very clear on the Tektronix."

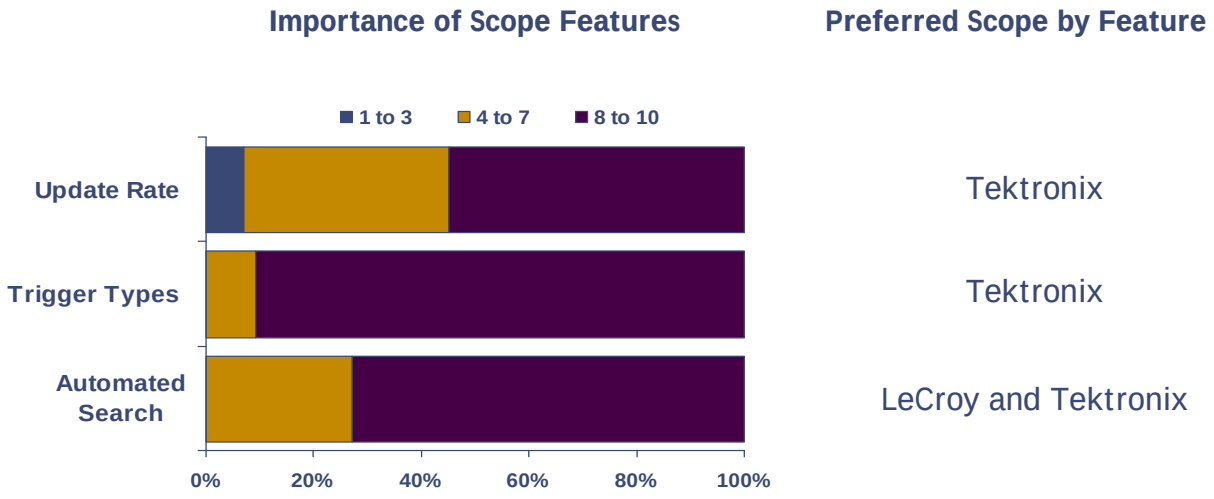
"The search functionality...on Tektronix, this was a little easier to execute."

"The feature to find the runts."

"I liked the search feature that finds the runts in a single trigger."

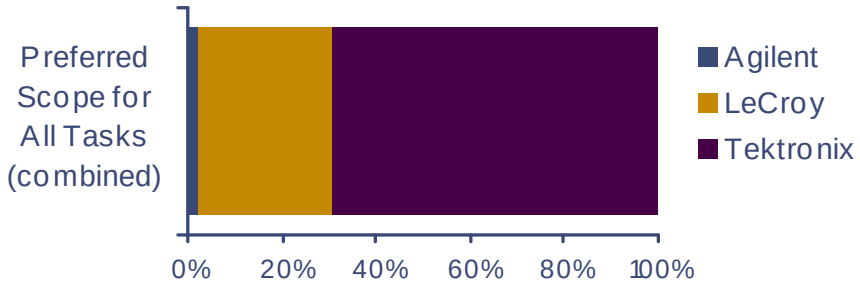
When asked to indicate how important each feature is to troubleshoot digital signals, trigger types are cited as most important, followed by automated search and update rate. The trigger types and update rate of the Tektronix is preferred above other two scopes, while participants preferred the automated search of the LeCroy and Tektronix similarly.

The graph below shows the importance of scope features in completing tasks. The purple bars represent highest importance (ratings of 8 to 10 on a 1 to 10 scale). Participants also selected which scope they preferred for each feature; preferred scopes are listed on the right.



Perceptions of the Oscilloscopes

The Tektronix scope was strongly preferred for these tasks, with over two-thirds of participants selecting it as their preferred scope. Even though the LeCroy scope had similar trigger and automated search features, the Tektronix scope was still preferred by a margin of more than two to one over LeCroy.



Tektronix. While the runt trigger and the automated search feature of the Tektronix scope allowed participants to complete the tasks in the least amount of time, and received frequent mentions as the favorite feature, there were several other benefits associated with the Tektronix. The Tektronix scope took participants directly to the runt in their waveform, displaying it at the end of the third task, while the LeCroy completed the task behind the scenes, without offering participants the visual representation. The softkeys on the Tektronix were highly praised by some as allowing the front panel to remain uncluttered. There was also positive feedback on the multipurpose knobs for the same reason. In general, the Tektronix scope received mentions as being the most user-friendly because its setup and tasks were the most intuitive.

> "As far as finding glitches and runts, Tektronix was clearly the best for this task. Once you set it up, it triggered on it immediately."
>
> "I had to navigate through fewer menus. It was automatic. The machine was able to figure it out."
>
> "This display is easy and straightforward...it's just: 'Here is your signal.'"

LeCroy. Although taking over twice as much time to complete the tasks, on average, the LeCroy scope also received mentions for favorite scope from over one-quarter of the participants. The features and functionality for finding and counting runts and glitches was similar to Tektronix, combined with a touchscreen feature, which some participants liked. Navigation through the menus required on the LeCroy was challenging for some participants who said it was too complicated, or that some functions were buried too deep within menus.

> "There were more keystrokes required, but...it was menu structured, and you were able to do it pretty fast."
>
> "I like the touchscreen...it felt fastest."

Agilent. Agilent received the fewest mentions for preferred scope because of the lack of a runt trigger and automated search. Absence of a runt trigger required participants to manually search the waveform looking for the runt, and most participants were not able to successfully complete two of the three tasks using this manual search procedure. However, the Agilent does receive credit for being intuitive and easy to use, like the Tektronix. Participants also like the large screen on the Agilent scope.

"Had a good layout in terms of knobs, but fell short in terms of performance."

"I liked the layout, but it failed to find the runt."

"The manual search was unproductive. If the runt was one in a million, I wouldn't have caught it."

Conclusions

Findings indicate the Tektronix scope is the best suited for searching for runts and glitches of the three scopes tested. All participants completed tasks successfully on this scope, while participants did not experience similar success with the other two scopes. The time needed to complete the tasks on the Tektronix was half the time needed to complete the same tasks on the other two scopes.

Participant feedback further indicates that oscilloscope users appreciate the runt trigger and automated search feature as enabling them to search for runts and glitches more quickly and effectively.