HOW THE TEKTRONIX SERIES 500 SCOPES CAME TOGETHER

By John Kobbe written as a third party observer.

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Starting at the Hawthorne plant in early 1951, it was decided to build a smaller more portable 3" scope, to be called the 315. Dick Ropiequet (Rope) visualized all the functions needed for an idealized triggered time base (sweep).

Rope along with Cliff Moulton came up with several other innovations including the trigger circuit, magnifier and DC coupled sweep circuits, which were incorporated into the 315. That sweep circuit was quite fast and being DC coupled could go as slow as anyone would need.

It seemed that the use of that sweep, along with a changeable vertical, would cover almost all of the customers' needs. Howard started pushing for a plug-in vertical front end along with a corporate decision to build our own cathode ray tube (CRT). In other words, the scope he visualized was to be called the 531.

Dick Rhiger worked with the shop, along with discussions with engineering about plug-in size and shape. As soon as the mechanics and a reliable plug-in connector were figured out, it didn't take long to put a prototype together, using the 315 sweep and a Dumont CRT.

Let's back up a couple of months. John Kobbe from test and calibration had put together a scope class. Their goal was not to directly copy anything but to design a simple scope that everyone in the class could build one to use.

About the same time Frank Hood was putting together another smaller portable to be called the 310. John invited Frank to look at what the scope class was planning. Frank used the unblanking in the 310, also modified it into the 315 before any were shipped, (as engineering had no other desirable solution). He also used the scope class sweep circuit, as it was somewhat simpler and less dependent on tube aging and variation. John was soon asked to join engineering.

Back to the prototype. Bill Polits had finished trouble shooting and was checking out the performance with most of the department watching and putting in their 2 cents worth. John joined Bill to help on some problems.

The sweep magnifier was not fast enough on the top 2 sweep speeds. The scope didn't need the top speed but it would be difficult to explain why to not trust the top speed. There were cathode followers (CF) driving the CRT deflection plates. The problems was simply that the down going CF needed more current at the 2 highest speeds. So a pulsed pentode was added to pull it down. A beefed up version of the scope class sweep was tried and used as the main sweep.

The trigger shaper has a fairly critical adjustment. If adjusted or drifted off, it would oscillate and make the scope nearly useless. Someone noticed that it would trigger on signals higher than the oscillating frequency. A little discussion erupted to really understand what was going on. Someone, probably Rope or Cliff said "Why don't we set the oscillating frequency low, maybe just a below power line frequency and call it automatic trigger." Another feature was born that nobody was looking for.

The vertical output amplifier wouldn't make bandwidth, so Bill added a pair of cathode followers to drive the CRT plates. It made bandwidth but was "rate of change" limited, OK, if the signal stayed on-screen, but not good, especially if the signal came from off-screen. It was decided to go with it that way and visit it later.

The plan was to use a single ended delay line. We had a balanced signal from the plug-in and the output amplifier was balanced. Shouldn't the delay line be balanced? Bill didn't think we had time to develop one. John wanted to throw one together and find what the problems might be. It turned out to be quite straight forward.

Someone came in early, switched on the scope so it would stabilize while turning lights on. They saw some weak sparkles from inside of a tube. It had to come from cathode to grid which was supposed to be protected by a 60V neon. More checking showed the neon was not going to work. Dean Kidd took on the job of figuring out the turn on time delay.

It looked like the CRT was going to delay the introduction of the 531. So, John was asked to move to the CRT department and help any way he could. They were having problems with the geometry, so he threw together a cross hatch generator so with a quick look would show any problem. The main problems were slightly magnetized gun parts and charges collecting on the glass. Degaussing the gun and more turns on the spiral resistance fixed most of the problems. There were a few compromises to be made and at the same time they were gearing up for production.

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As usual, Howard was nosing around and said “Why don’t we build a model with another sweep circuit and use that sweep as a delaying sweep.

Question; where to put it? Dick Rhiger looked at the scope and thought there was enough room for a vertical chassis along the side. It wouldn’t interfere with the airflow and would have plenty of cooling. The only problem was that it would make things difficult to service. Well, let’s make it swing out. So if you thought it looks like an afterthought, it was.

Then the next discussion. Operationally the main sweep (the sweep you are normally using) should also be the delaying sweep. In this case the delaying sweep was designed using minimum power, low drift and low noise and not fast enough. For now we will have to leave it this way and visit it later.

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While John was assigned to the CRT department he visualized a circuit that if the vertical deflection was limited to 4 cm it could be 2 or 3 times faster (he came in on a week end and built the CRT). The plan is a distributed amplifier driving a balanced delay line straight to the CRT vertical deflection plates. The horizontal system was fast enough. All that needed to be designed was the distributed amplifier and a matching delay line. The previous distributed amplifiers and delay lines used a center tapped coil. An expert had calculated that the coil should have a 1.55 coil length to diameter ratio for optimal coupling between the sections, but he probably didn’t consider the stray capacity. When one looks at the transient response, it starts out slow and tends to overshoot. (The more sections, the worse the effect). By reducing the coil ratio too much causes a pre-shoot, which like an overshoot helps increase bandwidth, but is not good oscilloscope practice. The coils were adjusted for just a hint of preshoot.

We now have John Larsen who can build one from a circuit diagram. Starting with a 531 (minus the vertical system) and the CRT that John Kobbe built, he has it finished in few days. We fire it up and have a really good oscillator. Some common mode damping and a bunch of isolating capacitors, tames things down. We tune the delay line and things look pretty good. The 541 and 545 were born.

Not quite done yet. First there are several different plug-ins that have to work in 4 different main frames. First; their power supply needs to stay in regulation from a power line voltage from 105V to 125V with all the different plug-ins. Bill Polits takes the job of adjusting transformer voltages and shunts of each main frame. Second; the plug-ins all needed a flat transient response in all of the main frames. Several of the plug-ins needed modifications, especially the dual trace. It had been quite popular but would severely limit the speed of the 540’s. It also had problems with the dividers which brings the signal DC level down to the plugin interface of 67 volts. It really needed to be done without the dividers.

We now have a tube curve tracer that John Kobbe had thrown together for in house use. Let’s take a close look and see if there are any pentodes that can run at 30-35 volts. We looked at some we had around and got samples from several different tube suppliers. It looked safe to run the 6AU6\12AU6 down to 30 V or so. We completely redesign the C unit including the front panel. First called 53/54C and when the algebraic add was installed, it became the CA.

With a bandwidth of 25 or 30 MHz we knew we had to do something about our standard probe. A fast rise signal bounced back and forth through the cable at about 40 MHz. After thinking about it and how to dampen this signal, all of a sudden, why not use a resistive wire in the probe cable. Surprise, it worked better than expected and also lowered the input capacity.

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Along about 1957, something happened that we weren’t used to. Some competition. HP came out with a scope which had a sweep magnifier of up to 100 times which was much simpler and did quite a bit of what a delaying sweep would do. The bets were out that HP thought they had us! We were pretty much stuck to five times magnification because with the post accelerator CRT, when the beam hits the deflection plates, it’s secondary electrons are accelerated to the display area, showing a blob of light. It wasn’t too bad at five times magnification, but got much worse at higher magnifications. John thought maybe something could be done to the surface of the deflection plates, maybe a file like surface or something. So he went to CRT to talk to Darrell Pennington. Darrell said carbon emits very few secondary electrons and wouldn’t have the problem. Well, the material used for making the spiral resistor was mostly carbon. Why not paint the deflection plates with it. In 2 or 3 days they had one to try. It not only made the five times magnification look better but allowed us to produce a 533/543 with a 100 times magnifier.

(Others)

There were many involved from every corner of the company and we didn't have to wait around for their help. Naming some not mentioned previously, Ted Goodfellow with ceramic strips, Gordon Sloat with transformers, Joe Griffith for CRT glasswork.

Having our own CRT department allowed special CRTs, not only small variations like the distributed deflection plate that allowed the 100 Mhz 580s but some major CRT design, like two different dual beam scopes, the 551 with dual vertical deflection and common horizontal. The 555 with two totally separate deflection systems.

Except for silicon rectifiers, and a couple of plug-in for testing transistors and diodes, semiconductors did not find their way into the 500 series during the 1950s but at least we left a transistor curve tracer 575 to help with future transistor circuit design.

The 1950s started with about 100 employees and gross revenue of about $1million. It ended with about 3000 employees and revenues of about $40million.

The 500 series updates continued into the 1960s. Transistors as well as cross wound delay lines (similar to the 580s), found their way into the scopes vertical and plug-ins. The sweep and horizontal systems stayed pretty much the same. The 500 series sales finally came to an end in the early 1970's.