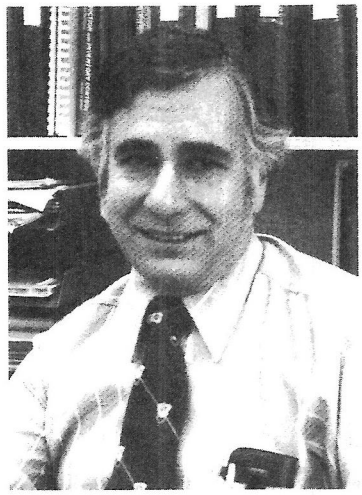
Making our own CRTs gives advantages to Tek

area rep employees report

Ed Srebnik
CRT Manufacturing Manager



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When Tek started building scopes, we purchased CRTs from RCA and Dumont. We soon found that improved CRT design was critical to improved scope performance. Attempts to negotiate with our suppliers met with no success.

In 1953, we decided to build our own CRTs. The first Tek CRT, the T51 used in the 530 scope, was introduced in 1954. It must have been a good design—we're just now phasing it out after 21 years.

Building 86 was built for making CRTs and, at that time, the planned output was 30 a day. Now we're averaging some 500 CRTs per day, with a capacity of approximately 900 per day.

The helix we used in the first Tek-made CRT was quite an innovation for its time. It wasn't a Tek invention, but we were the first to use it in a commercial CRT.

Making our own CRTs gives us a number of advantages. One is that we can optimize the CRT design to match the scope performance requirements. Another is that we can control our own supply and quality. This makes it difficult for competitors to obtain high-performance CRTs commercially. Therefore, our competitors in the scope field have had to develop their own CRTs also.

We have about 800 people in CRT today. About two-thirds, 580 people, are directly in production and the rest in staff and support. This ratio has stayed about the same over the years.

We produce about 110 distinctly different CRT types, and this is growing at about 10 per cent per year. Taking into account phosphor changes and other variations, we produce some 450 CRT part numbers.

Our output last year was about 120,000 CRTs; 38,000 storage tubes and 82,000 non-storage. We expect next year to run about the same. Customer Service represents a significant part of our demand—about 20 per cent of our output.

If we measured our output at catalog replacement price, our "sales" would be about $50 million per year.

We produce a greater variety of CRTs than any other plant in the world. Some television companies make a greater volume of tubes, but not a greater variety of types. Ours range from mini-tubes with a 1.5x2.5-inch view area to the 19-inch storage CRT. The mini-tube used in the 214 is the smallest storage CRT now being used commercially, and the 19-inch one is the largest. Our 7630 CRT is the fastest storage tube available. We make some special non-viewable CRTs as the videcon for the RSS and scan converter for the 7914.

Producing a CRT is a complex operation using state-of-the-art processes and technology. Some Tek processes are unique, and require unique equipment; we have some 25 people in the group responsible for designing and building process equipment.

One of Tek's major contributions to the CRT field was the simplified bistable storage tube designed in 1962 by Bob Anderson, the 564. Bistable storage tubes account for approximately 25 per cent of our output in units and 40 per cent of our output in dollars. Thirteen years after its introduction, the 564 is still our highest-volume tube, besides giving birth to a whole new product line. It is also used in the new T900 product line.

Other Tektronix innovations were the internal graticule, the ceramic funnel, and transfer storage tubes. The ceramic funnel has given us a number of advantages, allowing us to produce CRTs in a variety of shapes and sizes not readily available in glass.

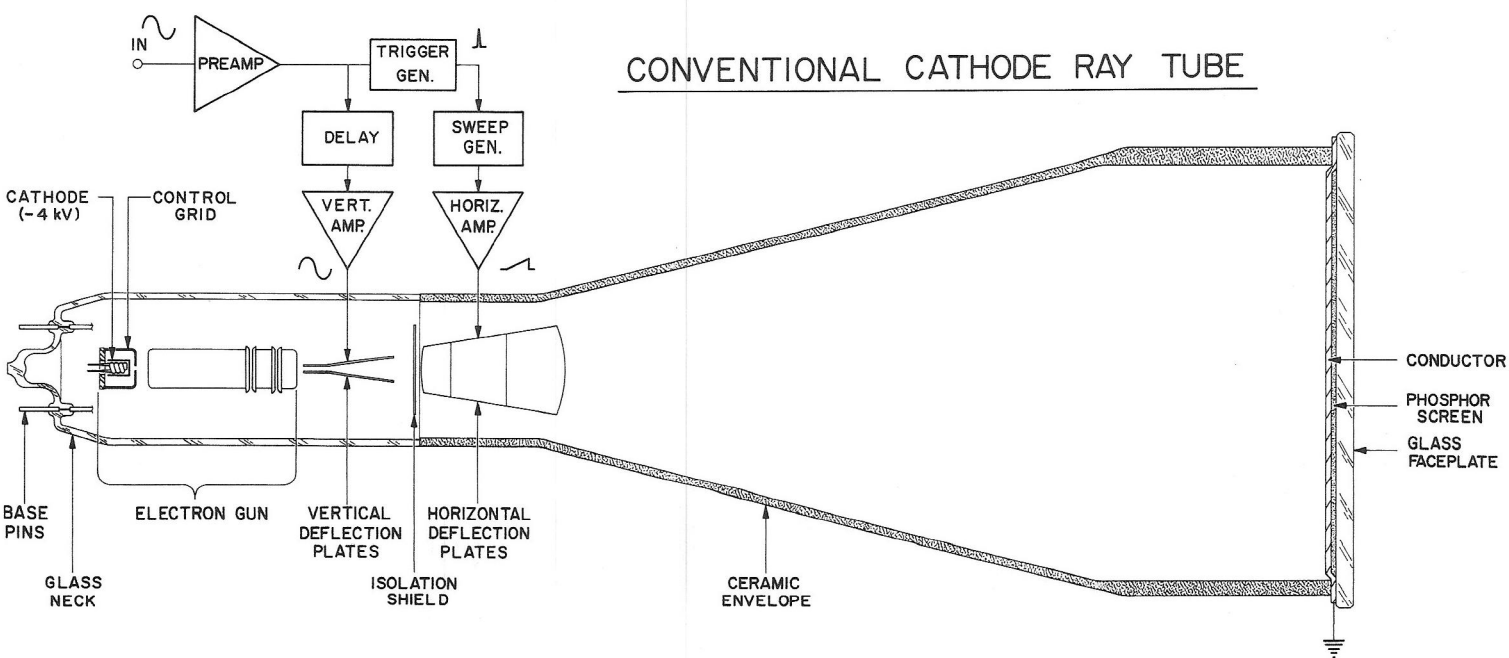
Cost advantage of the ceramic funnel has become more apparent since the glass bulbs tripled in cost while the ceramic ones stayed almost constant. Transfer storage tubes have allowed us to build tubes that write almost twice as fast as those made by our competitors, which gives us quite an advantage in the marketplace.

Materials play a key role in building CRTs. They must be carefully selected to maximize tube performance. Many times we purchase one or two years' supply of materials to get consistent quality.

The high technology and complex processes required to build CRTs cause a high scrap rate. We reclaim and salvage materials from rejects, including some $2.5 million in parts and assemblies per year. We keep trying to increase what we can save.

You read about new devices that may replace CRTs, but we expect CRTs to continue a bright role in the future.

The bistable storage CRT has



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a cost-performance edge over the refreshed-display type of storage. We expect this to continue for the next decade.

People have been working on flat CRTs or panel displays for the past 20 years. Solid-state and plasma panels with storage capability will become competitive in future years, but not now. Tektronix keeps abreast of progress in this field, though at a low level, and we'll be able to compete here when and if necessary.

Scan converters are a vacuum tube using cathodes, but we don't usually think of these as CRTs, since they don't show a visual display. We expect these to continue a limited use in high-performance instruments, as they're very expensive.

In summary, we expect to see continued growth in CRT over the next ten years. Emphasis will be on improved reliability, writing speed, brighter bistable displays, lower cost and larger displays.

Questions for Guest Speaker

Do problems with the 19-inch CRT usually show up after it reaches the customer, or do we detect them before shipment?

Some process-related problems can be detected before the CRT is even completed, and we find many others at the test stage of the finished CRT. Differential aging or hard-copy noise problems may show up in the instrument assembly stage or in the field.

What causes a tube to become gassy?

It can happen just in handling; it's easy to bend the pins and cause leakage. In the hard-copy mode, the tube is very sensitive to gas leaks.

What is OSHA?

It's the federal Occupational Safety and Health Act.

I understand that when a CRT breaks, it's a potentially hazardous situation; can you explain?

A CRT implodes when it breaks because of the vacuum inside, causing the glass pieces to fly. We test CRTs periodically in an implosion chamber; they must withstand three atmospheres of pressure. On the 19-inch tube we pre-stress the faceplate so it meets UL standards. We have a good safety factor in the ceramic tubes—if they break at all, it's usually just at the faceplate seal, and they don't shatter. They're still potentially dangerous, of course, if they're mishandled.

If 19-inch production takes over the east end of 46, where will targets and gun production go?

The present 19-inch production space would become available for a couple of gun-wiring groups. For others, we have some options, such as combining groups. We're trying to make better use of process floor space by utilizing conveyors to store tubes off the floor.

What per cent of the reject rate comes from the manufacturing area—CRT production compared with assembly plants?

When we seal the tubes to guns, the test yield is about 72 to 74 per cent; of those shipped to the assembly areas, six to eight per cent on the average is scrapped out. Some of our specifications are very tight, and there's a lot of judgment involved on some test parameters.

What are we doing to improve the reliability of the 19-inch CRT?

Several changes have been recently incorporated to significantly increase tube reliability. Further work is continuing.

What's the difference between a storage and conventional tube?

On a conventional tube you see information only while it's being fed into the scope. On a storage tube, you put the signal in once and remove the signal; the target stores the charge and the trace stays on.

Did you say that 25 per cent of our CRTs go to Customer Service?

About 20 per cent goes to Customer Service, amounting to 20 to 30 thousand tubes per year.

What per cent of the tubes you supply to Customer Service are for warranty replacements?

I would guess about 15 per cent of what we send them.

Why do we call the storage tube "bistable?"

It has only two stable points—it's either written or not. The variable persistence storage tube used in the 7613 gives different degrees of brightness in the stored trace.

What do you do with the tubes you get back with a burned spot?

Sometimes we can age the screen but usually we reprocess them.

Are all warranties for CRTs the same now?

Yes, they are for one year.

Is the year of warranty measured in hours of operation?

Technically, it's one year from purchase or delivery to the customer, but the field engineers have some latitude for interpretation.

Will the cursor lines on the 19-inch tube be made orange?

They may look orange with some phosphors.

Have we ever thought of using two guns, one for readout and one for display?

We have, but it's an economy to "time-share" with one gun.

Could we prevent jitter by using two guns?

Possibly.

Was using one gun just a cost decision, then?

Two guns would have raised other problems besides cost, such as needing a larger neck diameter.

Is there any major cause of CRT failures in the field?

It varies with the tube family. With storage, it's differential aging.

Is all CRT production now being used, or are we building inventory?

Up to period 604, our finished CRT inventory was continuing to increase. It peaked out in 604. Our goal is to reduce our finished CRT inventory by about 35 per cent by the end of year 600. With a balanced, lower inventory we can maintain a high service level to all our customers at minimum inventory cost.

When reclaiming CRTs, how much is actually saved?

Currently we are reclaiming all the bulb assemblies and most of the guns on our conventional CRT rejects. On storage CRTs we just started to salvage some of the ceramic funnels and some faceplates. We do salvage many of the guns. Also the faceplate panel and funnel on the 19-inch CRT is reclaimed. At the present rate, the value of reclaimed material is approximately $2.5 million per year.

Do you see solid-state devices replacing CRTs in the near future?

No, not over the next ten years.

The CRT is a very versatile and economical display device. In oscilloscope applications it is expected to remain the dominate display medium in the foreseeable future. There may be some shift from storage tubes to solid state memories, but the display itself will undoubtedly by on a CRT.

What special safety procedures are required for CRT?

In general, the safety program is consistent with the rest of the company. We have a few special problems resulting for the high usage of flammable solvents and glass. The CRT Safety committee plays an active role in insuring that all of our operations meet OSHA requirements.

There has been trouble with CRTs breaking after they have been evacuated. Any truth to that? Also, what is being done about it?

We experienced a low level problem (about 2 per cent) of glass breakage on a shipment of glass envelopes received last winter. After the problem was detected, all bulbs for this shipment were inspected. All those that exceeded our acceptable level of strain were annealled to relieve the strain. Since then, we have had several tubes break that were not annealled. Therefore, the decision was made to anneal all remaining bulbs for this shipment.

Why can't Tek include a plastic "protective" cover for CRT faceplates along with the rubber protector which fits around the faceplace, to protect from scratches, etc., prior to installation in a scope frame?

Good suggestion. These have been ordered and you should see them on CRTs soon.

Do we build the biggest tube for a Tek terminal ourselves?

Yes, the largest terminal is the 19-inch which is built by CRT.

The CRT department produces CRTs for information display instrumentation. Why doesn't CRT as a department make use of these instruments for production reporting, engineering data analysis, accounting information, etc., instead of using the 360 computer which results in long information available time?

CRT uses information display instrumentation where it is feasible and can be cost justified.

CRT has been using two 4010 terminals for several years connected to either Tek's IBM 370 or some other large computer.

Our applications primarily involve engineering data analyses along with some accounting, budgeting and scheduling applications.

The function of the terminal is to provide timely access to the processing and storage capability of the computer to which it is connected.

How many people work in CRT?

We have approximately 780 people in CRT now with the following breakdown:

Direct Production 571; Production Engineering Engineers 27; Production Engineering Technicians 29; Mechanical Equipment 64; Electronic Equipment 47; Quality Control 14; Reliability 10; and Staff 18.

What is the status of providing more space within CRT (i.e., office space over the cafeteria, CRT shop move, etc.)?

The CRT shop will be moved from Building 46 to 48 to provide additional space for the 19-inch operation. This move will take place in 1976. Other alternatives to provide additional office type space, as building above the cafeteria have been considered in the past year. At the moment, no definite decisions have been made as we have adequate space for the near future.

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What is the method for deriving the CRT Seal Plan?

First of all, our seal plan is the number of tubes we will seal per week; gun to bulb assembly. The steps in developing the seal plan are:

1. The planned CRT requirements are summed up. This includes requirements for Beaverton assembly areas, International and customer service.
2. The expected test yields are tabulated for each tube type. Process improvement projects and process changes are considered.
3. Current finished CRT inventory in compared to desired inventory levels.
4. Using the above input, a seal plan is developed to satisfy both our current requirements and inventory goals. In the case of low volume CRTs, these are batched and built only once or twice a year.

The seal plan is reviewed each period to determine if any changes are required due to yield changes. In addition, the total seal plan is updated quarterly.

What is the future trend with respect to production output for year 600 and 700?

The trend is flat during the first half of year 600 and should increase during the latter part of the year and into 700.

Do you have advance plans for the move to Wilsonville?

No. At the present time we estimate we have enough capacity in Buildings 46 and 48 to handle the forecasted requirements through 1978. To provide this capacity we will be moving our machine shop from Building 46 to 48 and moving the 19-inch production operation to the east end of Building 46.

Also, to meet our expected requirements we will work most of our operations two shifts and some critical, high investment areas, three shifts.

If our requirements change we will have sufficient time to evaluate our space needs and determine the optimum location of a new building. Wilsonville is sure a possibility.

About how long does it take to build a CRT from start to finish—say, for a 465?

The processing time to produce our CRTs varies considerably with the complexity, but is generally between 4-6 weeks. A 465 takes about four weeks. This assumes that all purchased parts are in house. Some of our purchased parts, as glass, have 6-9 months lead time. If a small number of CRTs are needed urgently, they can be supplied in 2 weeks.

What exact process does a CRT go through before being complete (chemically)?

It's difficult to describe in a few paragraphs all of the processes used to produce CRTs. The following is a list of many of the processes used in CRT:

1. Metal stamping and forming
2. Plating
3. Heat treating
4. Resistance welding
5. Glass forming and sealing
6. Vacuum processing
7. Induction heating
8. Silk screening
9. Coatings are deposited in numerous ways; collodial, cataphoretic, photoprocessing, spraying, evaporation, to just mention a few.

The above list is not complete but should give you some idea of the complexity of CRT.

Describe the impact of the T4014 product on Corporate income.

The T4014 is one of the leading products of the Information Display Group. Therefore, it has a major impact on corporate income. The 19-inch CRT is the most expensive component in the 4014 terminal and critical to the success of this instrument both in sales and profits. Our manufacturing cost is currently on target and we expect significant reductions during the coming year.

How and where does one get professional education for working in CRT?

The operations employed in CRT are many and varied. We use mechanical, chemical, photoprocesses, welding, glass flame sealing, to just mention a few. The academic backgrounds or our engineers are just as varied. Most of our production engineers have either a physics or chemistry background. We also utilize mechanical and electronic engineers in our equipment groups.

The background of our managers is just as varied, from science to business administration.

Does Tek plan in time to go entirely to ceramic CRTs and phase out glass?

All of our CRTs introduced since 1965 with the exception of the 19-inch CRT have had ceramic funnels. The 19-inch CRT uses a standard color TV glass envelope and is produced in large quantities (millions per year) and is therefore cheaper than ceramic. In addition, it is bigger than we can handle in our present ceramic presses.

As to the other glass funnels, we are in the process of converting to ceramic funnels, where it is economically justified. Glass envelopes have about tripled in cost in the last five years. CRTs with ceramic funnels can be used interchangeably with glass with only minor modifications.

Does any company other than Tek make its own CRTs?

I assume you're talking about oscilloscope companies. Hewlett-Packard and Phillips manufacture their own CRTs.

Do we sell our CRTs to other companies?

No, we do not sell CRTs to other companies except as replacements for failures in our instruments.

What is our biggest problem with the 19-inch CRT? Have the problems with the 19-inch CRT used by IDG been cleared up? Was this a Tek problem or an outside supplier problem?

To fully understand the production problems with the 19-inch CRT, you must just review its brief history. When we introduced the 19-inch CRT into production in June 1974, we planned to produce only about 600 to 800 in year 500. As it turned out the 4014 terminal was a "big hit" in the marketplace and orders greatly exceeded expectations.

The problems on the 19-inch can be divided into two categories: (1) Processing, and (2) Tube performance.

The major processing problems are tin oxide coating and target uniformity. The tin oxide is the first operation in our target processing and is currently the limiting factor in our capacity. The coating is applied at 530 degrees which is above the normal working temperature recommended for the glass used for the face plate panel. This leads to warpage and some rejects.

Target uniformity is a major problem on a faceplace this size. The target or phosphor screen is deposited by a photo-processing technique. Since the faceplate has a spherical shape, it needs to be rotated to spin the phosphor out to the corners at the same time the phosphor material is setting. A delicate balance of processing parameters is required to produce uniform targets. Non-uniform targets prevent us from establishing an operating voltage where the entire target will meet all performance criteria.

Are we looking into using our own tubes to replace the Sony ones we're buying?

No, it would be uneconomical as these are standard tubes made by Sony used in other applications.

What do you see in the future for color tubes for information display?

For the bulk of today's applications, the added value of a color display does not warrant the extra cost of color. There are, of course, some notable exceptions; for instance, military tactical displays and power company electrical grid maps; and color display will undoubtedly find increasing application. Nevertheless, single color displays will remain the dominate technology.

Do we supply CRTs to all Tek subsidiaries?

We supply CRTs to all of our subsidiaries for all Tektronix products. Some of the early Sony/Tektronix instruments used CRTs supplied by Sony. Also, Telequipment buys most of their CRTs in Europe. However, we do supply a major portion of the CRTs for their newer instruments. They use 465, 564 and 7400 CRTs.

How long has Tek made its own CRTs?

Tektronix began manufacturing CRTs in 1954.

How many finished CRTs do you produce per week?

We are currently producing about 2200 CRTs per week.

Are there any physical or technical limits to what we can build in the bigger tubes?

Equipment and glass availability limits us from going much larger.

How can production delay be reduced?

The processing time can be primarily reduced by reducing our work-in-process inventories. During year 500 we initiated steps to reduce our work-in-process (WIP) and processing time in our gun assembly area. We were successful and reduced the time from 15 to 5 days. Our goal in year 600 is to reduce our WIP inventory 25 per cent, or $750,000.

Another factor is process yield improvement and process control. A portion of our WIP inventory is required to compensate for variability in the yield of our complex, state-of-the-art processes.

Tektronix places seventh among growth firms in NW

Tektronix ranked seventh in the nine Northwest companies included in *Financial World's* 1975 listing of America's top growth companies.

The list, based on average annual compound growth rate in earnings per share during 1964-74, included only companies having a minimum of eight years of rising earnings during the 10-year period. Banking institutions weren't included.

Tek's 12.2 per cent earnings growth rate placed 228th in the national list.

The seven Northwest companies, from the top, were Amfac, Pay 'n Save, Sunshine Mining Company, Payless, Fred Meyer, Tektronix, Idaho Power Company, and Puget Sound Power & Light.