



## High volume CRT's cost less, perform better

### Sal Kadri, Manager High Volume CRT

It is my pleasure to present to you the High Volume CRT line project. By the way, if I get excited during this talk, I hope you will bear with me. During the last two years, many employees of Display Devices Group have worked with a great deal of enthusiasm on this project. Their excitement, energy level and enthusiasm are indeed contagious.

We make a total of 73 generically different CRTs. There are some 280 different CRTs if you include variations such as graticule and phosphor options.

Of these 73 generically different CRTs, four CRT types make up 56 per cent of the unit volume. If we project into 1984, there will be two tube types which will make up more than 60 per cent of unit volume. These two CRTs also support the portable oscilloscope business which is approximately \$250 million sales in the next year.

These same CRTs make up anywhere from 10 to 25 per cent of the cost of the oscilloscope. The variation depends on how complex the instrument using the CRT.

So, if we concentrate our attention on these two CRT types, we can certainly make a significant impact on Tek's business. That is why we wanted to have the High Volume CRT line.

Now, how can we improve quality and costs of these two CRTs? The answer is, taking advantage of High Volume and automating the process. We also improve quality and costs through "characterization," or understanding how the manufacturing processes work and then controlling those understood processes.

Today, for example, we understand how the phosphor settling process works, where previously with some combinations of temperatures, concentrations and settling time, the process worked some of the time and did not some of the time. With a great deal of laboratory research and technical analysis, we are now able to predict the impact of changes in the variable which control the process and are able to optimize the settling yield.

Another opportunity is to significantly improve the material handling methods. One example is this faceplate used in all our CRTs. We are very sensitive of quality of this faceplate since it makes up the screen or display which our customers look at when using the instrument. We do not allow any visible scratches on the faceplate surface. Theoretically, faceplate edges should be handled only six times where we found it was handled 82 times and went through seven doors before a very simple silkscreening operation was finished.

Another opportunity is to automate those operations which could be economically justified.

With this in mind, we set out to design the High Volume CRT line.

The leaders and their respective teams helped develop some guiding principles for design and operation of the line. We call them the HV CRT Line Ten Commandments. These commandments (boiled down to eight) are:

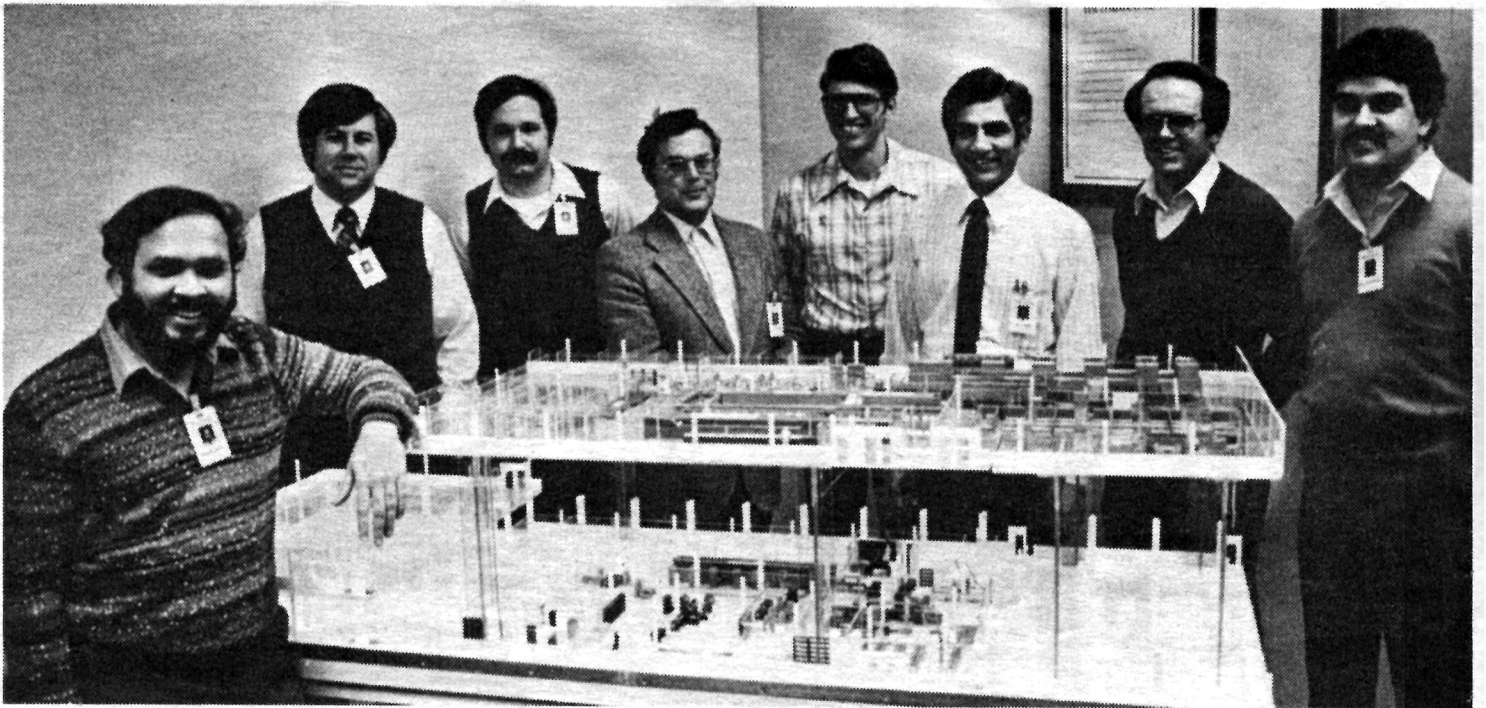
**1. If a part is touched, value must be added.** Learning from the faceplate example, if we are to manually handle a faceplate, we would allow ourselves six handlings; in and out of the silkscreen machine, bake oven and washer unit to put the graticule on the faceplate.

**2. Material flow shall be in-line.** This means that the area layout will be such that material once started will flow from one station to another without being diverted for storage or other reasons.

**3. If a process is used, it must be characterized.** This means we must understand thoroughly the processes we use, otherwise we are not allowed to use the process.

**4. The customer shall be treated as the king.** Since all our CRTs are used by internal customers who are instrument assembly plants, we need to be particularly sensitive to their needs and desires.

**5. Quality excellence at each workstation shall be a condition of employment.** Addresses our commitment to quality. This says that **knowingly**, we are not allowed to pass along a bad part to the next operation. If one does, one has committed an unforgivable sin.



***THE ONLY WAY*** to get an overview of the high volume CRT line is by looking at this pre-construction model. Persons pictured here are the project team leaders: from left, Sudhir Joshi (Material Handling); Jim Waddell (Finishing & Support); Lynn Noffsinger (Facilities); Lee Van Nice (Face Plate, Bulb Assembly & Screen); Doug Behrend (Seal, Exhaust & Activation); Sal Kadri (Project Manager); John Wanner (Test); and Joe Gonzales (Gun Assembly & Wiring).



***A MONORAIL*** runs throughout the high volume area to move CRT's from one work area to the next. Here, Joe Jimenez unloads CRT's from the activator monorail and places them in a carousel for distribution to test stations that are within an arm's reach of the carousel.



*JIM LOYEZ inspects bulb phosphor screen.*

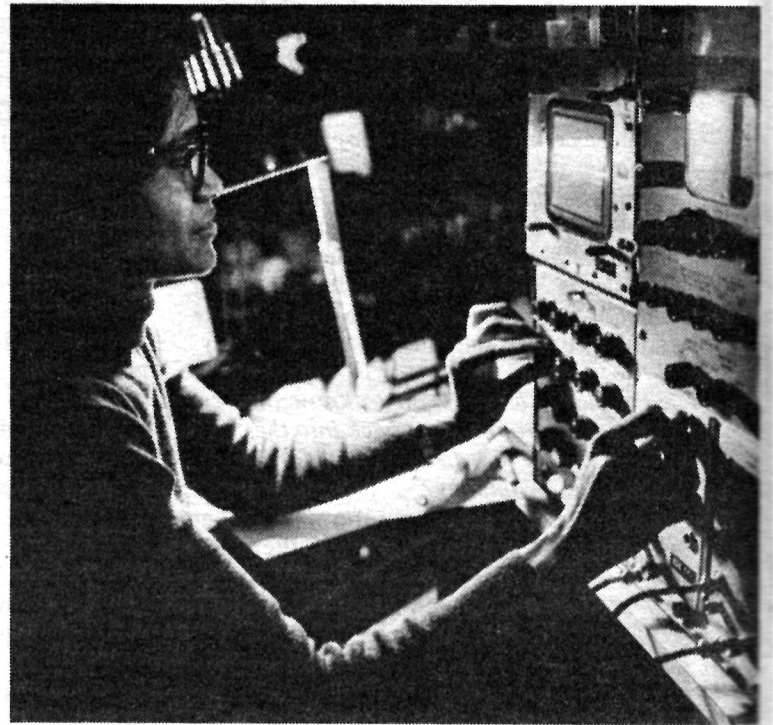
**6. Thou shall treat all employees equitably with dignity and respect.** This commandment we feel strong about since it is also the basic principle and Tek philosophy of how we want to interact with each other.

**7. Inventory shall be of finished CRTs, not in-process parts.** CRTs are very sensitive to contamination; as a matter of fact, most yield losses are related to contamination. Even in a cleanroom, there are some contaminants. If we process a part as fast as we can after starting it, the chances of contamination gathering on it are reduced. Thus we do not allow any excess in-process inventory. Once we start manufacturing the CRT, we want to finish it as fast as possible.

**8. Cost, quality and schedule shall be the primary measure of performance.**

With these commandments in mind, the project was designed and implemented. Some of the benefits of the new line are as follows:

- Service level for the past two years has been 100 per cent—which means we have '0' shortages. Whenever our customer wanted a CRT, it has been available.
- In-process inventory has been reduced by almost a third of what it used to be.
- Our contamination related rejects have been reduced



*ELEANOR ARNOLD works in CRT Test.*

by a factor of 5.

- The manufacturing cycle time has been reduced from 5 weeks to 4 days and our goal is to be at 2½ days.

- Lastly, you recall the faceplate scratches and handling problem we discussed earlier; today our buff rate is less than 1 per cent coming down from over 50 per cent. This alone used to cost Tek more than \$250,000 annually.

Now let us look at the value analysis project which was first started with the 4651 gun. The scan expansion mesh, high voltage can, horizontal and vertical deflection plates, focus and first anode ring were evaluated for value and redesigned for improved cost and quality.

In total, the cost of parts and labor alone were reduced by almost \$10 per CRT. This and quality improvements related to these changes will have an impact of over \$2,000,000 per year in reduced cost to Tek.

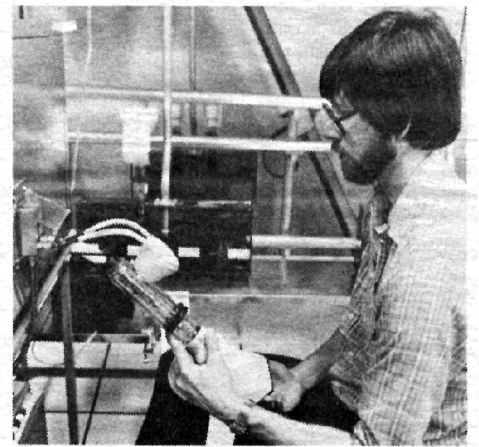
The High Volume CRT and Display Devices employees have done one magnificently superb job. They have demonstrated that Tek is committed to manufacturing excellence.



**SANDRA GOOD** packs CRT's for shipping.



**SAL KADRI**  
Conference Speaker



**BRUCE BOECKMAN** does basing preparation (puts on base cap and neck protector) flashes the getter, and loads the CRT's onto the monorail where they are activated while traveling to the test area.

## Questions from the floor for Sal Kadri

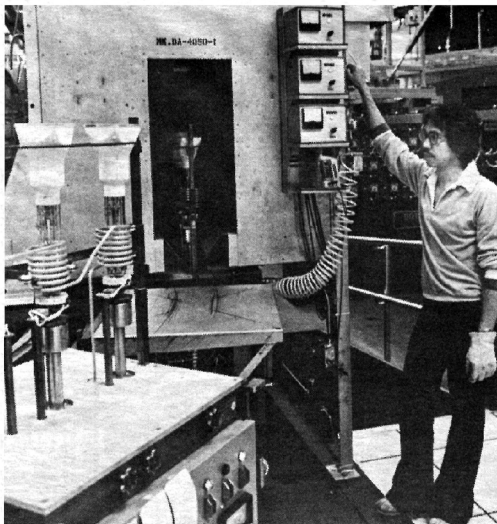
*Before the bulbs and guns are attached there are four inspections at various points. What is the yield at the point of attaching the bulbs and guns?*

**The yield at that point is between the low 80's and high 90's.**

*What exactly is the purpose and function of the High Volume line?*

*What was the cost of the total project and when will the return pay for itself? Is this better or worse than expected—by how much?*

**The purpose is to reduce cost of manufacturing, increase quality level and decrease in-process inventory. There were specific goals for each of these categories, the line has achieved or surpassed those goals. The function of the line is to manufacture those CRTs which have high unit volume demand such as those which are used in portable oscilloscopes. The benefits as measured in return on investment, has been better than 50 per cent, or we anticipate paying off the investment in the first two years of operation.**



**BRUCE BOECKMAN** does basing preparation (puts on base cap and neck protector) flashes the getter, and loads the CRT's onto the monorail where they are activated while traveling to the test area.



**GAIL KING** loads the phosphor settling machine.

*Are you at liberty to say how much it cost to install the line and what is the return on that investment?*

**I am at the liberty to say that the return on investment is more than 50 per cent; we will pay off what we spent in approximately the first two years of our operation. I'm not at liberty to say what we spent on it.**

*Would you identify the finished CRTs that will come through the High Volume line, and also identify what Tek equipment uses these CRTs?*

**Portable oscilloscope models 465B, 465M, 2213/15, 2445/65, 475, 468, 2235/36, and some new products. CRTs are the 4651, 4655, 475 and 2440 models.**