Polaroid case study

Education

BACKDROP Polaroid is manufacturer of photographic equipment, accessories and related items used in instant photography. The organization was divided into two main divisions – The Consumer Photography Division and the Technical and Industrial Division with each of these divisions contributing around 40% of Polaroid's revenues of $ 1. 3 billion in1984. The company produced two main types of films: 1. The peel apart film which required the user to physically pull the film out of the camera and, 2. The integral film, which came out of the camera automatically.

The integral films were manufactured in the R2 building at the Waltham Massachusetts site. The operations at R2 included production of sheet metal springs, pods, plastic cartridges and plastic end caps and then assembled these into film cartridges. R2 ran three shifts, five days a week, employing approximately 900 workers out of which 700 were part time. QUALITY AND PROCESS CONTROL PROCEDURES AT R2 All films were vetted by the Quality Control Department before being released into the market. The QC procedure included sampling of 15 finished cartridges (each containing 10 frames) out of every lot of 5000 cartridges.

If the sampled cartridges contained defects in excess of allowable limits, the lot was held and further testing was done. Additional testing usually led to reworking, or rejection of a portion or all of the lot. Subsequent lots were the subjected to even more rigorous testing by increasing the sample size tested. Quality checks were not the soleresponsibilityof the QC department. The operators usually sampled around 32 samples out of every lot. If the measurements went against the knowledge of the operator, the sample was rejected.

After process control was initiated in R2 in the late 1970’s, process engineering technicians were made responsible for gathering data and making rough analyses. PROBLEMS WITH EXISTING QUALITY CONTROL Since the testing of cartridges was destructive, it resulted in sampled scrap. This, along with the product that failed acceptance sampling resulted in $3. 28 million in 1984. Another issue was that sampling did nothing to improve quality, it only improved the AOQ. In fact, due to the large production and low defect rates, if the production and quality control sampling were halved, the outgoing defectives would be 0. 3% of production. On the other hand, increasing the AOQ further would lead to prohibitively high costs due to increased sampling. The sampling process employed was also inaccurate. Time was spent on trying to reduce beta or consumer risk. Cartridges which were inspected and passed were sent back to production to be repackaged. But the handling of these cartridges itself increased the chances of their developing defects which resulted in a vicious cycle of tests and retests and did not contribute to improving quality significantly while increasing costs considerably.

To avoid losing production, operators often ‘ salted’ boxes. Operators did not record frequently collected data and if they were in doubt, they would pass the component on to the QC Department believing that they would be able to detect the defect and reject the component if the defect was serious enough. “ Tweaking” machines was an accepted practice in the plant. The objective of the exercise was to enable machines running and different speeds and variations to produce at their maximum capacity. The QC

department did not focus on defects that were normally detected by consumers.

For example, the most stringent auditors tested for excess reagent by flipping the film over right after exposing it, a defect that would not be noticed by a consumer. These stringent auditors averaged about 10% defectives. The conditions under which the tests were simulated were also out of sync with current market realities. External customers often used cameras which did not function precisely to specification, whereas the QC Department used ‘ perfect’ cameras to test the film. This precluded the possibility of finding defects which would occur with imprecisely functioning cameras. GREENLIGHT

The project objective was quality monitoring costs reduction while at the same time improving the quality of the product. The improvements in quality control processes were focused along with reducing the number of samples. The plan consisted of three distinct elements: 1. Statistical process control would be adapted as processes in control and capable of producing within specifications would produce more consistent quality. 2. Production operators would be given the process control tools that the process engineering technicians had been using and in conjunction with sampling would be expected to make disposition decisions themselves. 3.

Quality control auditors would concentrate on training operators and operationalizing specifications on their new products. The statistical process control system involving both acceptance sampling and automated process control was to be implemented. SPC involved testing for productions within a

pre-specified range. If the production went beyond the range, the production process had to be shut down maintenance was to be called to perform maintenance and recalibration. As a part of the process, the operators were to take six random measurements of a process characteristic during the course of their shift and then plot the mean measured value.

This led to a drastic reduction in the number of samples tested and consequently the scrapping costs. The central problem in this project was the estimation of the central level and the control limits. Initially, the Quality Control auditors helped the operators in plotting the ranges and the operators' protocol was to immediately shut down the machines and call for help whenever, the characteristic crossed the specified range. Moreover, eight consecutive mean values lying into the upper or lower zones near the control limits, or consistently upward trends were to be investigated by maintenance as well.

The idea behind the project was to cut down the defect and testing losses. However, the idea backfired when the average defects detection by auditors shot up to 10% from 1% while at the operator level, it halved to about 0. 5%. Another problem was the lack of trust between the auditors and the operators. Standardized maintenance procedures also met with a lot of resistance as they were seen as making the whole maintenance process impersonalized and bureaucratic. The operators believed that they could obtain better results by ' tweaking' the machines.

At the same time, operators refused to come out of the " maximize output" mindset and kept adjusting the machines for increased output. Also, the

operators were sampling and testing more units than they were recording and adjusted the machines on the basis of the unrecorded defects. The nature of defects also changed. The variability in the kinds of defects detected increased, as the defects recorded by the auditors were markedly different from the defects recorded by the operators. ANALYSIS The purpose of inspection is to determine the level to which the product manufactured conforms to the specifications.

Control charts and run tests are used for process control with the objective being to identify the causes of assignable variation, and to leave the system alone if the variation is random and the process is under control. The data given in exhibit 5 was used to calculate the means and ranges of the variables (pod weight and finger height) and the control limits for them were calculated. These have been plotted on control charts. Pod Weight · Both the X bar and the R chart show that the process is in control, and that the process is capable. The variation present is random variation. Although the X bar chart shows that the process is in control, the last four readings may indicate a trend if further values move towards the lower control limit. Also, between the 16th and 28th readings, there are making of trends. · The R chart shows that though the values of R lie within the control limits the range variation is high. Also, the behaviour of the readings is erratic which is a reason for investigation. Finger Length · The X bar graph shows that the process is out of control very often, signifying that an assignable cause of variation may be present. The values in the R chart are within the control limits. Thus, although the process mean is out of control, the process variability is in control. Other Analysis · The random sample of defects from

Exhibit 4 is tabulated below. Operator Defects Auditor Defects Excess Reagent 4 11 Excess Flash on box 2 2 Negative sheet defect 3 2 Positive sheet defect 3 3 Double feed 3 3 Frame feedfailure2 9 Damaged spring 3 3 Malformed box 1 3 Insufficient reagent 1 4 Misalignment 1 3 Marginal lamination 1 2 Dirt from assembly 0 5 After Greenlight was initiated, the number of defects reported by operators has halved from 1% to 0. % while those reported by auditors has increased from 1% to 10%. This may be due to the fact that the operators are not recording all the defective samples which they are using to adjust their machines. Also, since the auditors feel that asking the operators to be incharge of the quality is like handing over the henhouse to the foxes, most of them may have shifted to stringent checking of the cartridges which would explain the jump from 1% rejects to 10% rejects, which was the level of rejects which only the stringent auditors had earlier. There is some evidence for both the above points.

The tweaking of the machines by the operators may explain why so many readings are out of the control limits, though the machine should have undergone maintenance and calibration as soon as the first reading was outside the control limits, which explains why the auditors are finding many more rejects due to the feed than the operators. Also, the auditors are finding more rejects due to the reagent, although the process is under control. This may be due to stringent checking. Another indication of stringent checking is that cartridges are being rejected due to their having dirt which has been attributed to assembly. RECOMMENDATIONS Control measures need to be incorporated at the injection molding machines in order to minimize defect rates, and defects need to be prioritized, to help in setting

control limits and the ratings on the quality of products. · The operators need to realize that the process downstream is the customer, and they need to shutdown the machine for maintenance as soon as the process goes out of control rather than waiting for the machine to start producing defective pieces. · Polaroid can carry out a market research exercise on consumers, to determine which attributes need compliance from the customer’s point of view.

It will also need to establish the technical specification limits for various components. These will need to build into a 6-sigma process to increase quality by improving the processes and reduce variation in outputs. · The people, especially the top management, need to be convinced about the effectiveness of process control, which doesn’t have any problem with the quality apart from above observations. · Proper documentation of all the procedures and processes should be assured, in order to keep people focused on quality once defect rates drop significantly below 1%.

This documentation should be accessible to all concerned people and they should be instructed unambiguously to adhere to the norms. · Automated methods for data collection need to be adopted, like the ones mentioned in the case, since the operators have proved to be unreliable. The investment is not large enough to make a serious dent in the company’s bottom line, and should be considered. · A better and more comprehensive training model needs to be introduced to train the workers and supervisors in basic statistics and the application to process control The high-volume driven mindset of the people needs to be changed, and an atmosphere needs to be built which engenders mutual trust between operators and auditors.

Appendix Sample Statistical Process Control Measurements Pod Weight (grams) Sample Number Day Shift 1 2 3 4 5 6 Mean Range 3-Aug A 2. 800 2. 799 2. 760 2. 802 2. 805 2. 803 2. 795 0. 045 B 2. 750 2. 820 2. 850 2. 740 2. 850 2. 790 2. 800 0. 110 C 2. 768 2. 807 2. 807 2. 804 2. 804 2. 803 2. 799 0. 039 4-Aug A 2. 841 2. 802 2. 802 2. 806 2. 807 2. 807 2. 811 0. 039 B 2. 801 2. 770 2. 833 2. 770 2. 840 2. 741 2. 93 0. 099 C 2. 778 2. 807 2. 804 2. 804 2. 803 2. 804 2. 800 0. 029 5-Aug A 2. 760 2. 804 2. 804 2. 806 2. 805 2. 806 2. 798 0. 046 B 2. 829 2. 804 2. 805 2. 806 2. 807 2. 807 2. 810 0. 025 C 2. 741 2. 850 2. 744 2. 766 2. 767 2. 808 2. 779 0. 109 6-Aug A 2. 814 2. 804 2. 803 2. 805 2. 807 2. 804 2. 806 0. 011 B 2. 787 2. 802 2. 805 2. 804 2. 805 2. 804 2. 801 0. 018 C 2. 766 2. 805 2. 804 2. 802 2. 804 2. 806 2. 798 0. 040 7-Aug A 2. 774 2. 801 2. 805 2. 805 2. 805 2. 804 2. 799 0. 031 B 2. 770 2. 801 2. 833 2. 770 2. 840 2. 741 2. 793 0. 099 C 2. 832 2. 836 2. 794 2. 843 2. 13 2. 743 2. 810 0. 100 10-Aug A 2. 829 2. 846 2. 760 2. 854 2. 817 2. 805 2. 819 0. 094 B 2. 850 2. 804 2. 805 2. 806 2. 807 2. 807 2. 813 0. 046 C 2. 803 2. 803 2. 773 2. 837 2. 808 2. 808 2. 805 0. 064 11-Aug A 2. 815 2. 804 2. 803 2. 804 2. 803 2. 802 2. 805 0. 013 B 2. 782 2. 806 2. 806 2. 804 2. 803 2. 802 2. 801 0. 024 C 2. 779 2. 807 2. 808 2. 803 2. 803 2. 803 2. 801 0. 029 12-Aug A 2. 815 2. 815 2. 803 2. 864 2. 834 2. 803 2. 822 0. 061 B 2. 846 2. 854 2. 760 2. 829 2. 817 2. 805 2. 819 0. 094 C 2. 767 2. 804 2. 834 2. 803 2. 803 2. 803 2. 802 0. 067 13-Aug A 2. 850 2. 04 2. 804 2. 804 2. 804 2. 804 2. 812 0. 046 B 2. 810 2. 820 2. 814 2. 794 2. 798 2. 787 2. 804 0. 033 C 2. 850 2. 820 2. 750 2. 740 2. 850 2. 790 2. 800 0. 110 14-Aug A 2. 750 2. 765 2. 850 2. 760 2. 790 2. 840 2. 793 0. 100 B 2. 830 2. 770 2. 848 2. 760 2. 750 2. 830 2. 798 0. 098 C 2. 740 2. 770 2. 833 2. 770 2. 840 2. 800 2. 792 0. 100 17-Aug A 2. 753 2. 807 2. 805 2. 804 2. 802 2. 804

2. 796 0. 054 B 2. 851 2. 751 2. 752 2. 773 2. 849 2. 806 2. 797 0. 100 C 2. 845 2. 804 2. 803 2. 806 2. 805 2. 806 2. 812 0. 042 18-Aug A 2. 844 2. 777 2. 754 2. 791 2. 833 2. 811 2. 802 0. 90 B 2. 806 2. 839 2. 805 2. 804 2. 850 2. 740 2. 807 0. 110 C 2. 849 2. 801 2. 804 2. 762 2. 814 2. 791 2. 804 0. 087 19-Aug A 2. 820 2. 793 2. 812 2. 833 2. 853 2. 812 2. 821 0. 060 B 2. 790 2. 780 2. 764 2. 843 2. 843 2. 818 2. 806 0. 079 C 2. 850 2. 806 2. 805 2. 814 2. 807 2. 807 2. 815 0. 045 20-Aug A 2. 767 2. 831 2. 808 2. 793 2. 836 2. 811 2. 808 0. 069 B 2. 833 2. 825 2. 793 2. 813 2. 823 2. 766 2. 809 0. 067 C 2. 824 2. 799 2. 790 2. 764 2. 817 2. 805 2. 800 0. 060 21-Aug A 2. 778 2. 775 2. 799 2. 805 2. 833 2. 772 2. 794 0. 061 B 2. 801 2. 832 2. 758 2. 759 2. 773 2. 14 2. 790 0. 074 C 2. 770 2. 787 2. 744 2. 766 2. 807 2. 803 2. 780 0. 063 Average 2. 8025 0. 0640 UCL for mean = 2. 8332 UCL for Range = 0. 1280 LCL for mean = 2. 7718 LCL for Range = 0. 0000 Sample Statistical Process Control Measurements Finger Height (mm) Sample Number Day Shift 1 2 3 4 5 6 Mean Range 3-Aug A 1. 90 1. 95 1. 94 2. 00 2. 05 2. 16 2. 00 0. 26 B 2. 15 2. 17 2. 11 2. 13 2. 02 2. 03 2. 10 0. 15 C 1. 73 1. 90 2. 07 1. 89 1. 76 1. 88 1. 87 0. 34 4-Aug A 2. 30 2. 41 2. 54 2. 37 2. 32 2. 16 2. 35 0. 38 B 2. 28 2. 16 2. 19 2. 08 2. 25 2. 24 2. 20 0. 20 C 1. 92 2. 24 2. 1 1. 89 1. 88 2. 17 2. 04 0. 36 5-Aug A 2. 39 2. 28 2. 10 2. 36 2. 54 2. 25 2. 32 0. 44 B 2. 11 2. 21 2. 24 2. 21 2. 17 2. 24 2. 20 0. 13 C 1. 89 1. 90 1. 73 2. 07 1. 89 1. 76 1. 87 0. 34 6-Aug A 2. 51 2. 25 2. 08 2. 35 2. 29 2. 32 2. 30 0. 43 B 2. 22 2. 19 2. 22 2. 24 2. 01 2. 23 2. 19 0. 23 C 1. 89 1. 90 1. 78 2. 07 1. 89 1. 76 1. 88 0. 31 7-Aug A 1. 95 2. 07 2. 25 1. 95 2. 11 2. 16 2. 08 0. 30 B 2. 08 2. 03 2. 27 2. 23 2. 24 2. 13 2. 16 0. 24 C 2. 31 1. 90 1. 86 1. 91 1. 89 1. 87 1. 96 0. 45 10-Aug A 2. 23 2. 25 2. 21 1. 89 2. 15 2. 11 2. 14 0. 36 B 2. 23 2. 21 2. 05 2. 19 2. 7 2. 16 2. 15 0. 18 C 1. 73 2. 00 1. 79 1. 75 1. 84 1. 74

1. 81 0. 27 11-Aug A 2. 21 2. 11 2. 21 2. 44 2. 17 2. 30 2. 24 0. 33 B 2. 17 2. 19 2. 15 2. 04 2. 07 2. 22 2. 14 0. 18 C 2. 01 1. 90 1. 90 1. 81 2. 06 1. 89 1. 93 0. 25 12-Aug A 2. 08 2. 19 2. 28 2. 29 2. 21 2. 45 2. 25 0. 37 B 1. 93 2. 09 1. 90 1. 95 2. 04 2. 09 2. 00 0. 19 C 1. 84 2. 12 1. 90 1. 89 2. 01 1. 75 1. 92 0. 37 13-Aug A 2. 23 2. 01 2. 25 2. 11 2. 39 2. 15 2. 19 0. 38 B 2. 19 2. 22 2. 18 2. 15 2. 23 2. 04 2. 17 0. 19 C 1. 96 2. 05 2. 16 1. 87 2. 13 1. 90 2. 01 0. 29 14-Aug A 2. 27 2. 00 2. 06 1. 97 2. 13 2. 05