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## Six Sigma Measurements: An Application

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Six Sigma requires an understanding of the measurement system to be applied effectively. Ensuring that a practical measurement system is in place helps to improve the process much faster than debating the accuracy of the measurement system. In Six Sigma methodology, the absolute value of measurements is less critical than the rate of improvement. The main objective of the program is to improve a process faster than the variance—due to a questionable measurement method. All organizations consist of processes; all processes are a collection of activities.

Six Sigma implementation consists of two key components: 1) methodology and 2) the measurements. The methodology is customer-centric and focuses on improving processes to achieve desired results. The measurements ensure that the methodology works correctly.

### Factors to Make Six Sigma a Reality

In the current Six Sigma environment, the methodology has become a project-based institutionalization of process improvement. Considering the success (and failure) stories of well-known corporations, one should remember that leadership, goal setting and the applied measurement system are the factors that really make the program work. Leadership emphasizes the cultural aspects of Six Sigma, goal setting is a process for aggressive improvement, and measurement is a verification and quantification of that improvement. The flowchart (Figure 1) shows various processes in an electronics assembly operation. Each box identifies the process, the process' defective rate (D for defects per unit (DPU)) and average number of opportunities for error (O).

FIGURE 1: Electronics assembly processes flow chart.

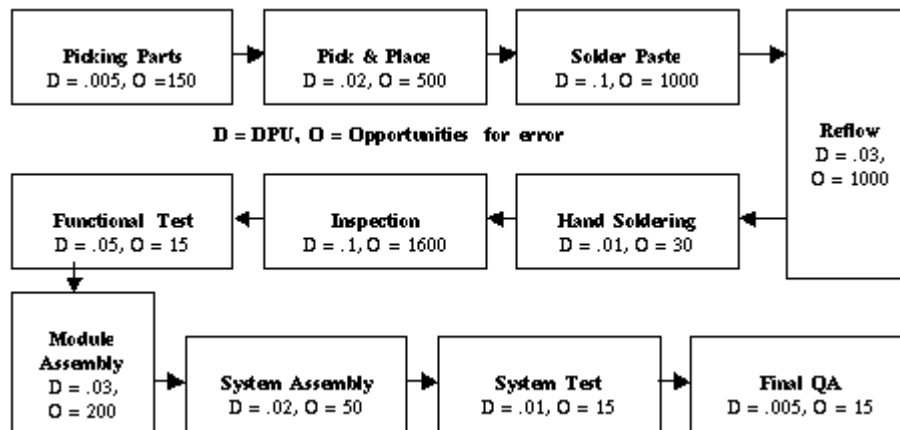


Table 1 summarizes the data for the assembly operations noted in Figure 1 and lists DPU, opportunities for error, defects per million opportunities (DPMO) and corresponding Sigma level. For the entire manufacturing operation, the DPMO of each process is added to equal 8482.3, which corresponds to a 3.88 sigma level. From the manufacturing side, assuming the inspection efficiency is approximately 90 percent, the 10 percent defect rate is experienced in the system assembly

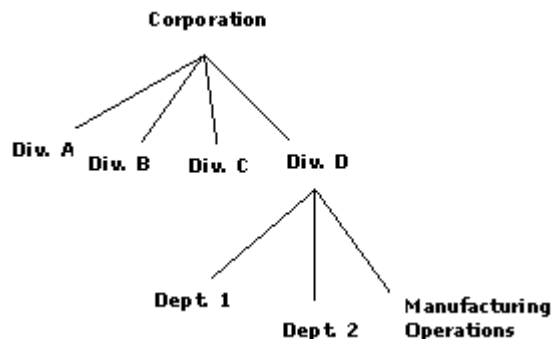
operations. The quality (DPU) of the received part is then determined to be 0.047, with a 5.34 sigma level going to the system assembly area. However, when the customer receives the product, with the defect rate of 1/1000, DPU equals 0.001. For the customer the entire unit is considered as one part; therefore, the sigma level equals 4.59.

**TABLE 1:** Product performance summarized in DPU, opportunities for error, DPMO and estimated Sigma levels.

Operation	DPU	Comments	Opps. for Error	DPMO	Estimated Sigma
Picking Parts	0.005	Count number of unique parts selected	150	33.3	5.49
Pick and Place	0.02	Number of parts to be placed	500	40	5.44
Solder Paste	0.1	Number of pads	1000	100	5.21
Reflow	0.03	Number of connections	1000	30	4.59
Hand Soldering	0.1	Number of leads	30	3333.3	4.2
Inspection	0.1	Number of connection and parts	1600	62.5	5.33
Functional Test	0.05	Number of steps	15	3333.3	4.2
Model Assembly	0.03	Number of parts	200	150	5.11
System Assembly	0.02	Number of parts	50	400	4.85
System Test	0.01	Number of steps	15	666.6	4.7
Final QA Test	0.005	Number of steps	15	333.3	4.9
<b>Total Internal Level</b>	<b>0.47</b>	<b>NA</b>	<b>NA</b>	<b>8482.3</b>	<b>3.88</b>
Total (System Level)	0.047	Number of total parts	780	60.26	5.34 Sigma
<b>Customer Level</b>	<b>0.001</b>	<b>Customer experience the whole unit</b>	<b>1</b>	<b>1000</b>	<b>4.59</b>

For a multi-division facility, the data is aggregated and integrated from various segments of business to establish measurements company-wide. Management then can respond to the performance level and make necessary adjustments in the approach, or reward successes as necessary.

**FIGURE 2:** Performance information flow.



## Conclusion

Figure 2 shows that while performance reports move upward, management direction flows downward. A comprehensive, not over-burdening, approach to implementing a measurement system will enable management to identify opportunities for improvement, define projects and gain benefits from implementing Six Sigma.