As an example of two types of defects, consider a resistor with the leads bent close to its body. If the stress imposed during bending caused the body to chip, this is a quality defect. However, had the stress been inadequate to chip the body, the defect would go unnoticed by conventional inspection. When the body is cycled through a temperature range, small cracks can develop in the body. This would allow moisture and other gases to contaminate the resistive element, causing resistance changes. This is a reliability defect. Note that this defect can also be a design defect if the design specifications require a right bend to fit the component properly in a board. However, if the improper bend is due to poor workmanship, the defect is classified as a process-induced reliability defect. Consequently, the types of defects to which a system and its subsystems are susceptible are determined by the parts selected and their processing, while the presence of these defects in the finished item is a function of the quality controls, tests and screens that are applied.

Figure 11.2.2.1-2 pictorially shows the reliability impact of the part and process defects. As shown, an upper limit of reliability is established by design based on part derating factors, application environment, quality level, etc. The shaded area indicates that the estimated inherent reliability level may have a relatively broad range depending on the parts that comprise the system and the values for the parameters of the part failure estimating models.

The reliability of initially manufactured units will then be degraded from this upper limit; subsequent improvement and growth is achieved through quality inspections, reliability screening, failure analysis, and corrective action. The extent and rigor with which the tests, failure analysis and corrective actions are performed determine the slope of the reliability improvement curve. As such, process defects, along with the inherent part estimates, must be evaluated in order to accurately estimate reliability, particularly during initial manufacturing.

11.2.2.2 PROCESS RELIABILITY ANALYSIS

The infant mortality period (as was shown in Figure 11.2.2.1-1) is composed of a high but rapidly decreasing quality component, a relatively high and decreasing stress component, and a low but slightly increasing wearout component. Because of this non-constant failure rate this life period cannot be described simply by the single parameter exponential distribution; computation of reliability during this period is complex. It would require application of the Weibull distribution or some other multi-parameter distribution to account for the decreasing failure rate. Controlled life tests would have to be performed or extensive data compiled and statistically evaluated to determine the parameters of the distributions.

A practical approach, however, that would perhaps be useful during pre-production planning or during early production is to compute an average constant failure rate (or MTBF). This average MTBF represents a first approximation of the reliability during this early period. It can