

Product Evaluation for Performance and the Effects of Variation

Chapter 10

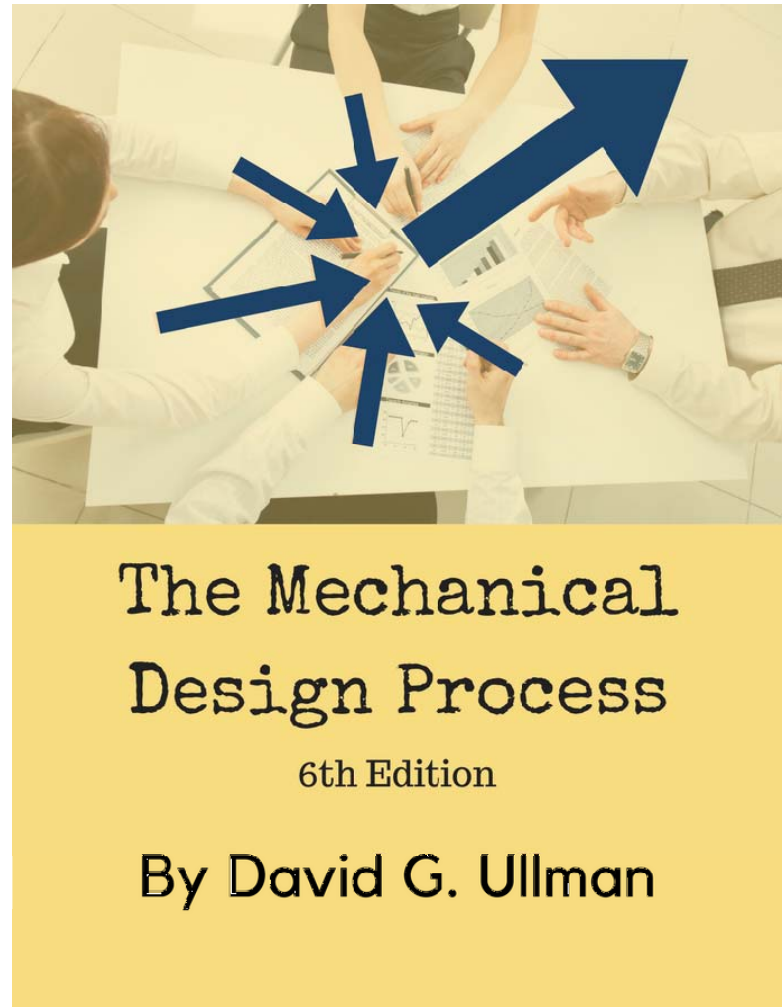


Table 10.1 Best practices for product evaluation

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- Monitoring functional change (Section 10.2)
 - Goals of performance evaluation (Section 10.3)
 - Trade-off management (Section 10.4)
 - Accuracy, variation, and noise (Section 10.5)
 - Factor of Safety as a design variable (Section 10.6)
 - Modeling for performance evaluation (Section 10.7)
 - Tolerance analysis (Section 10.8)
 - Sensitivity analysis (Section 10.9)
 - Robust design (Sections 10.10 and 10.11)
 - Design for cost (DFC) (Section 11.2)
 - Design for manufacture (DFM) (Section 11.3)
 - Design for assembly (DFA) (Section 11.4)
 - Design for reliability (DFR) (Section 11.5)
 - Design for test and maintenance (Section 11.6)
 - Design for sustainability (Section 11.7)
-

Figure 10.1



Fox Racing

Figure 10.2

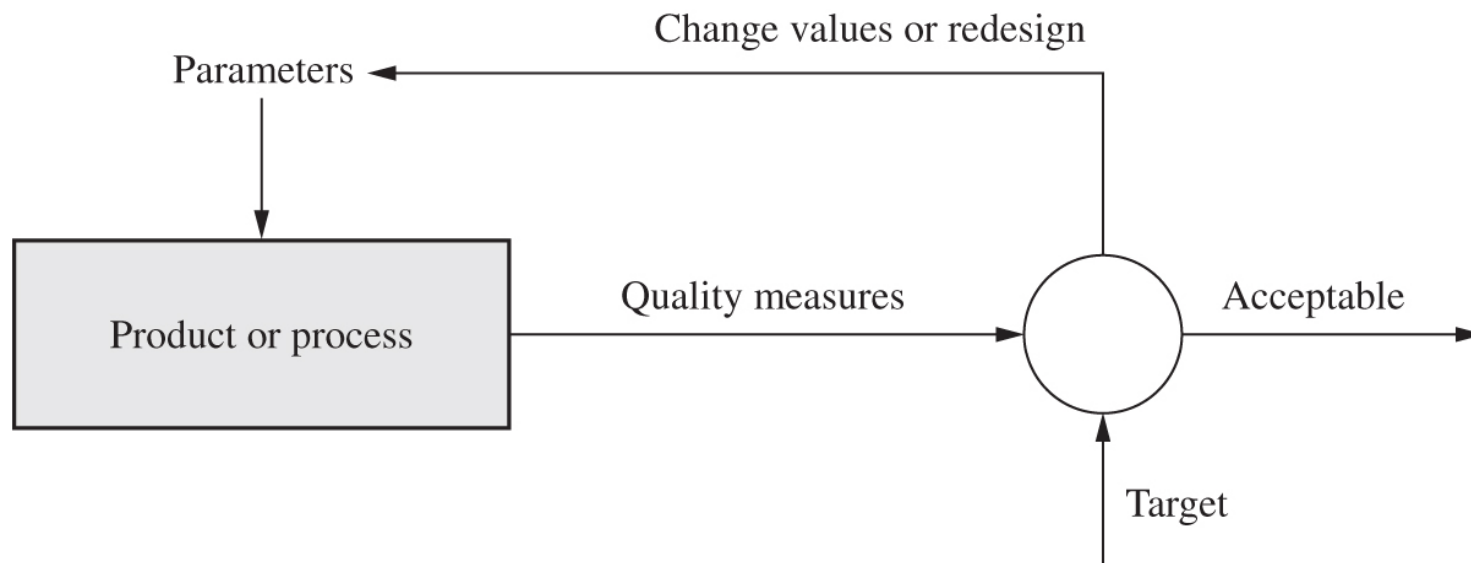


Figure 10.3

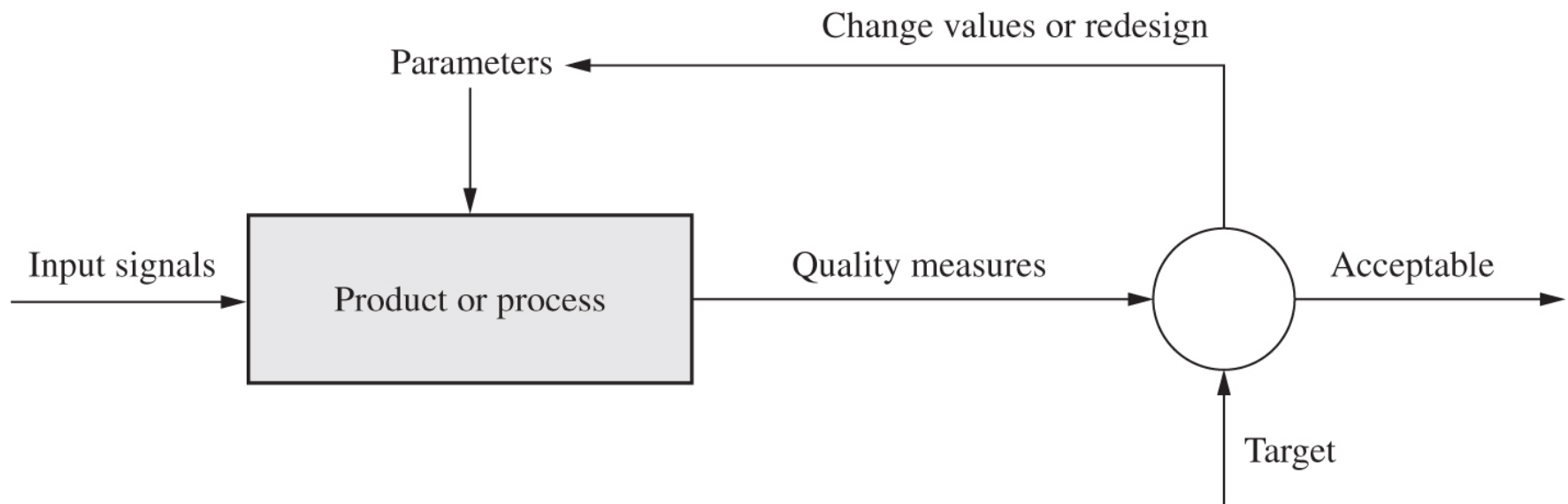


Figure 10.4

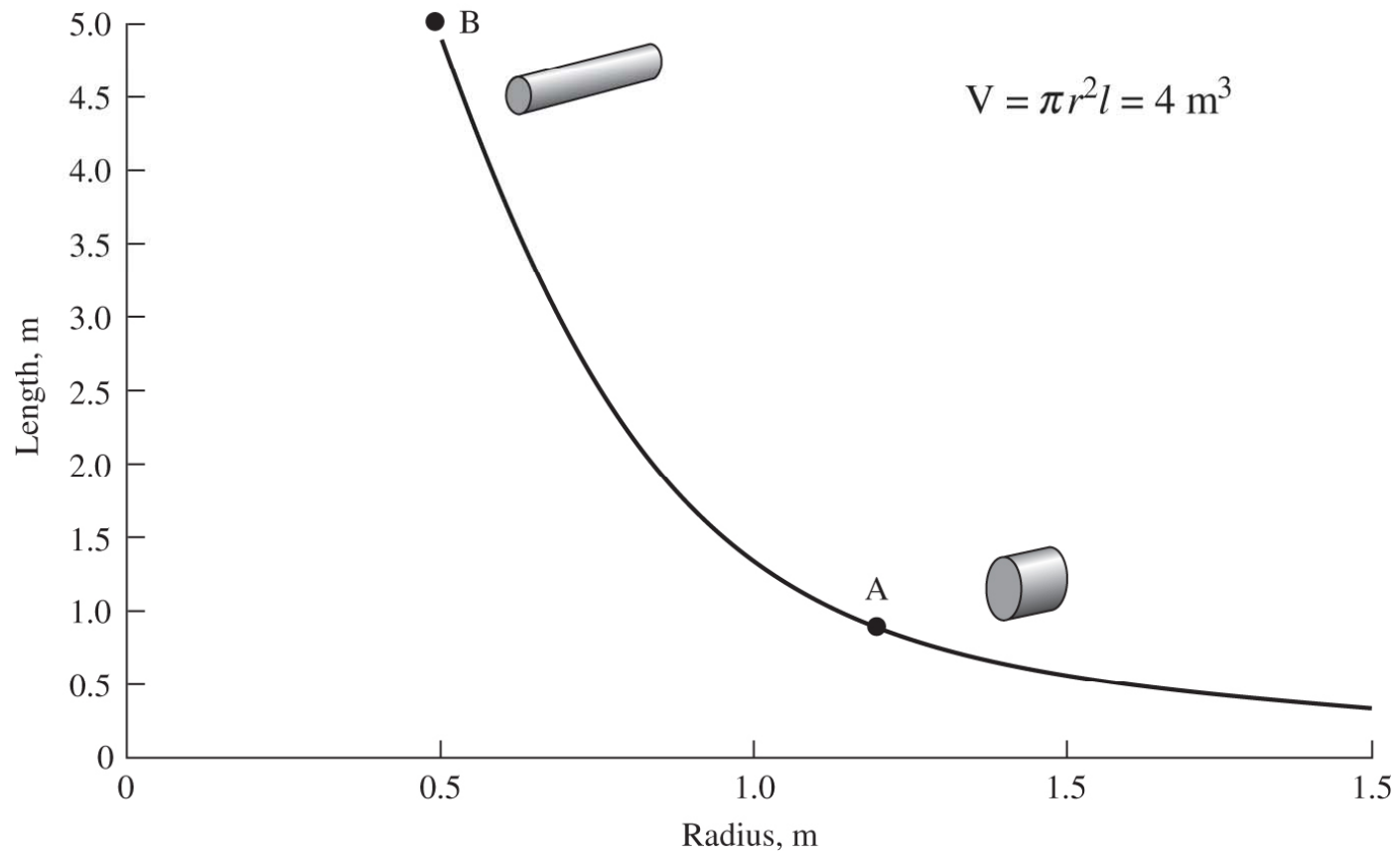


Figure 10.5

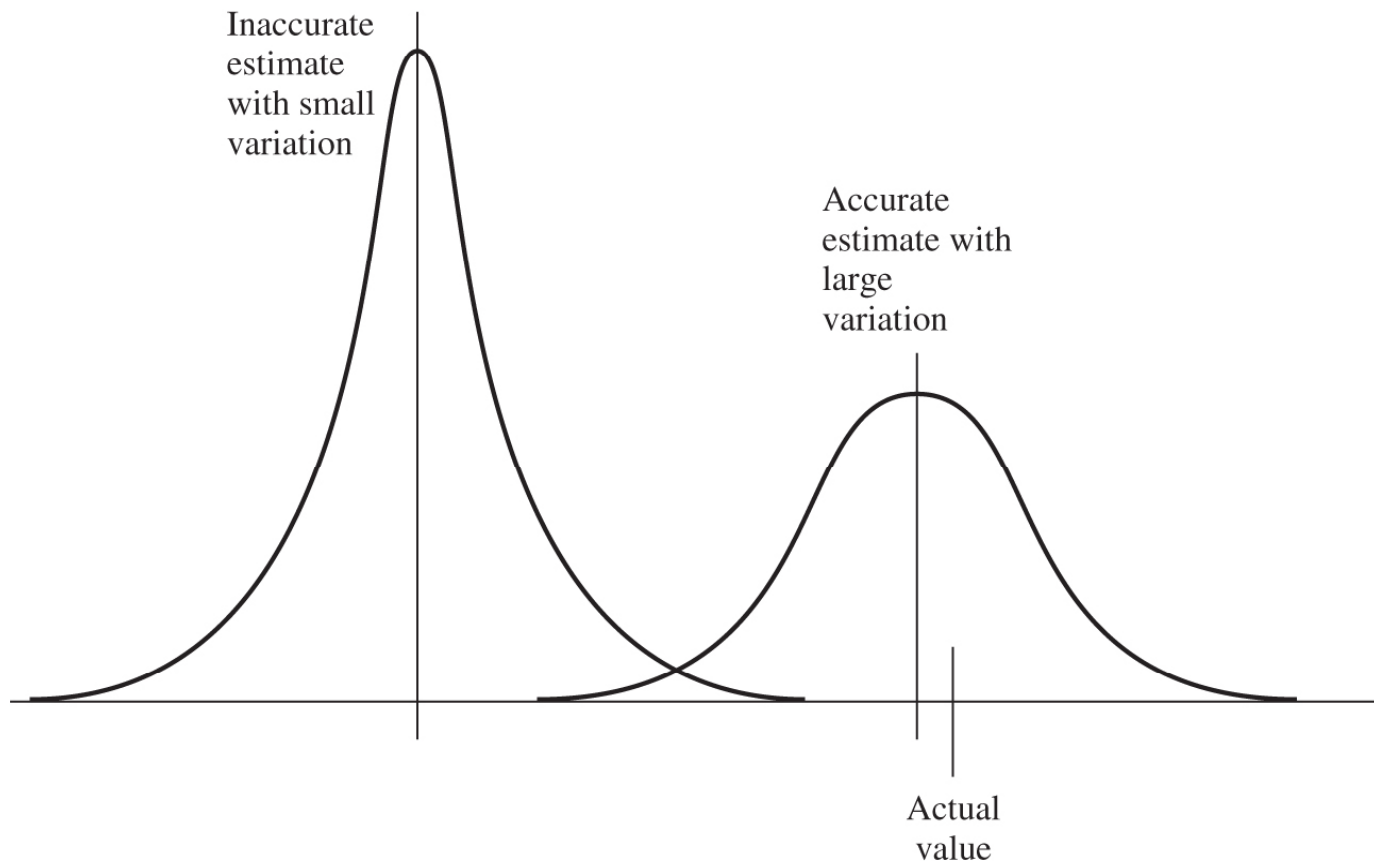


Figure 10.6

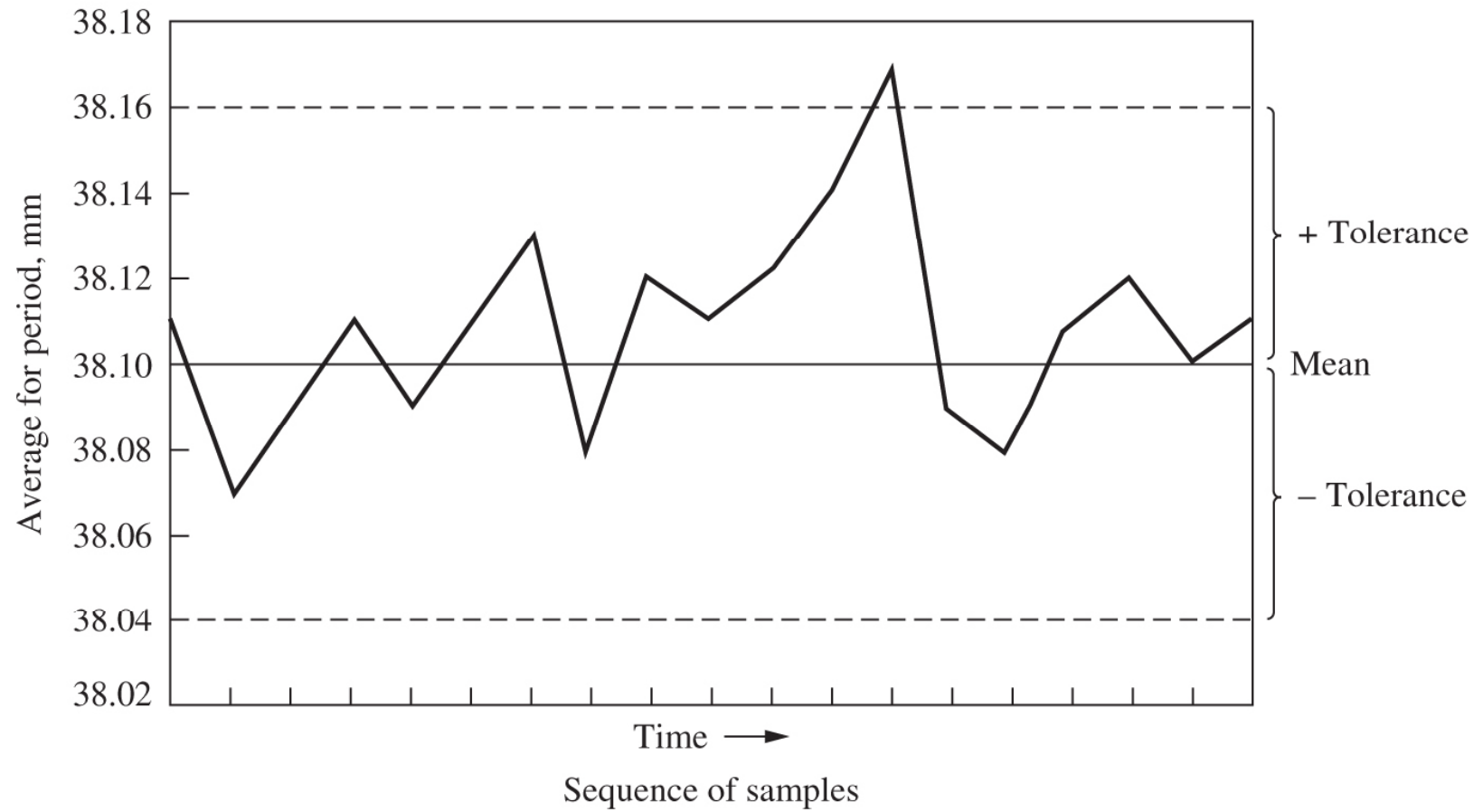


Figure 10.7

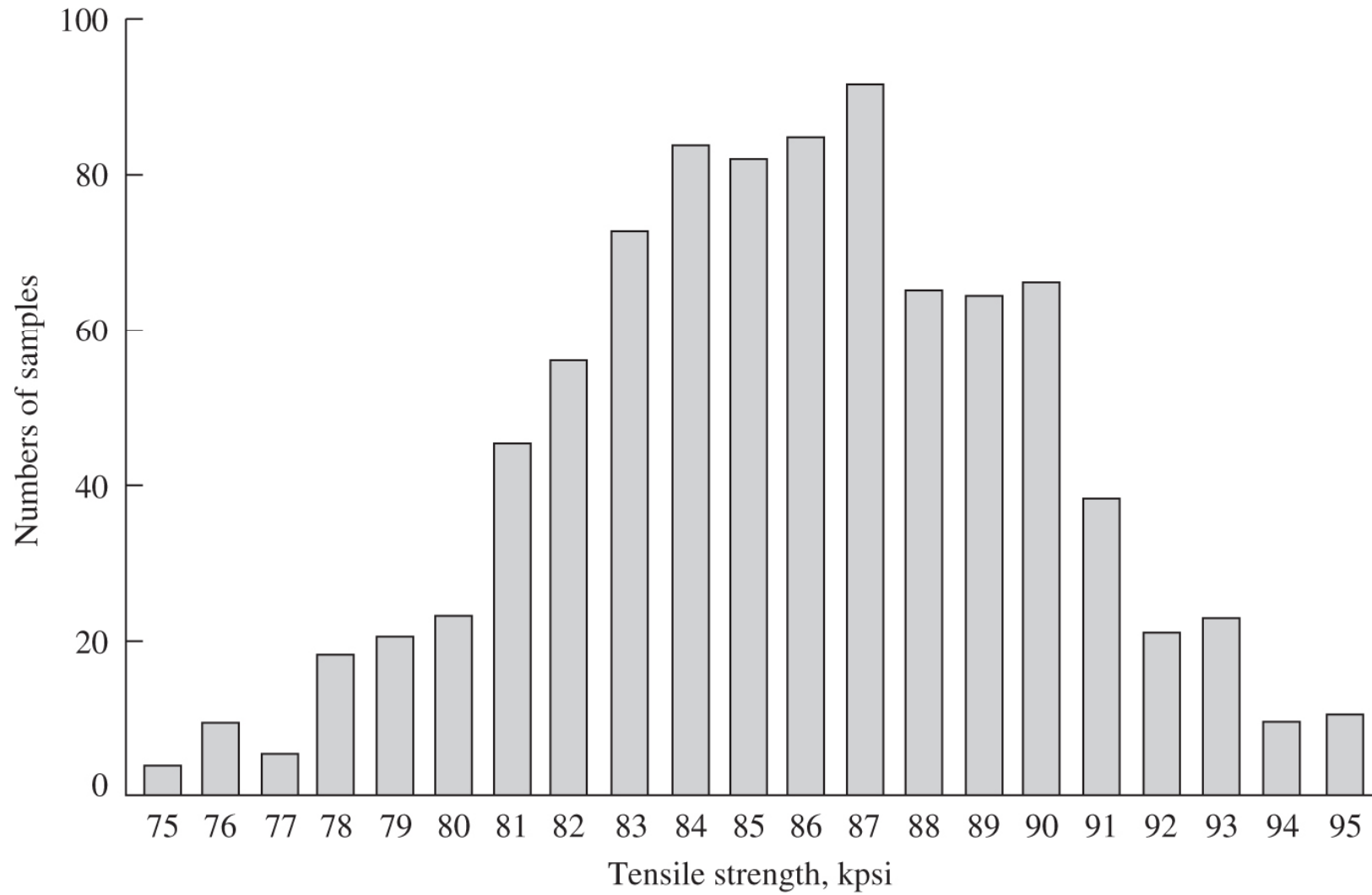


Figure 10.8

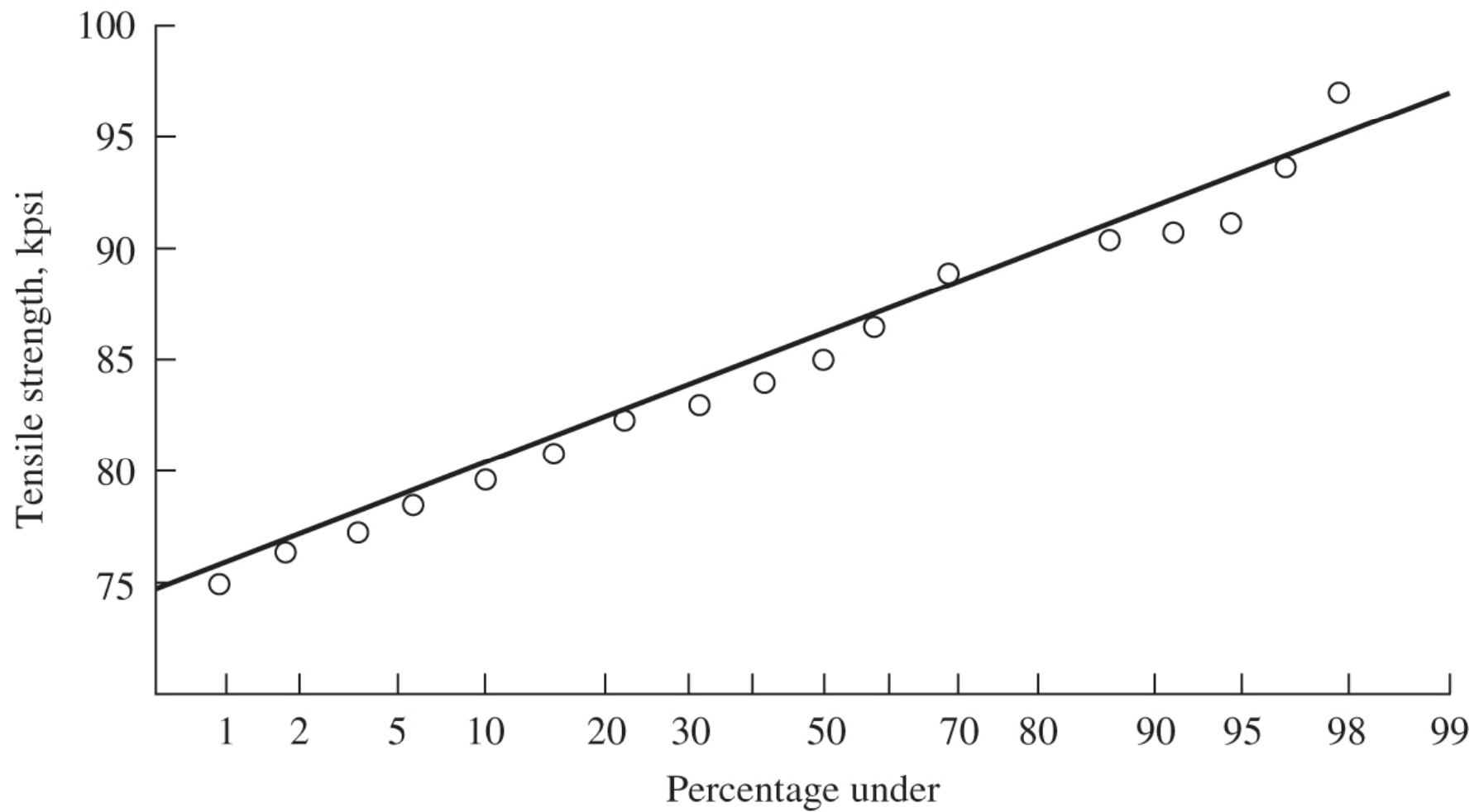


Figure 10.9

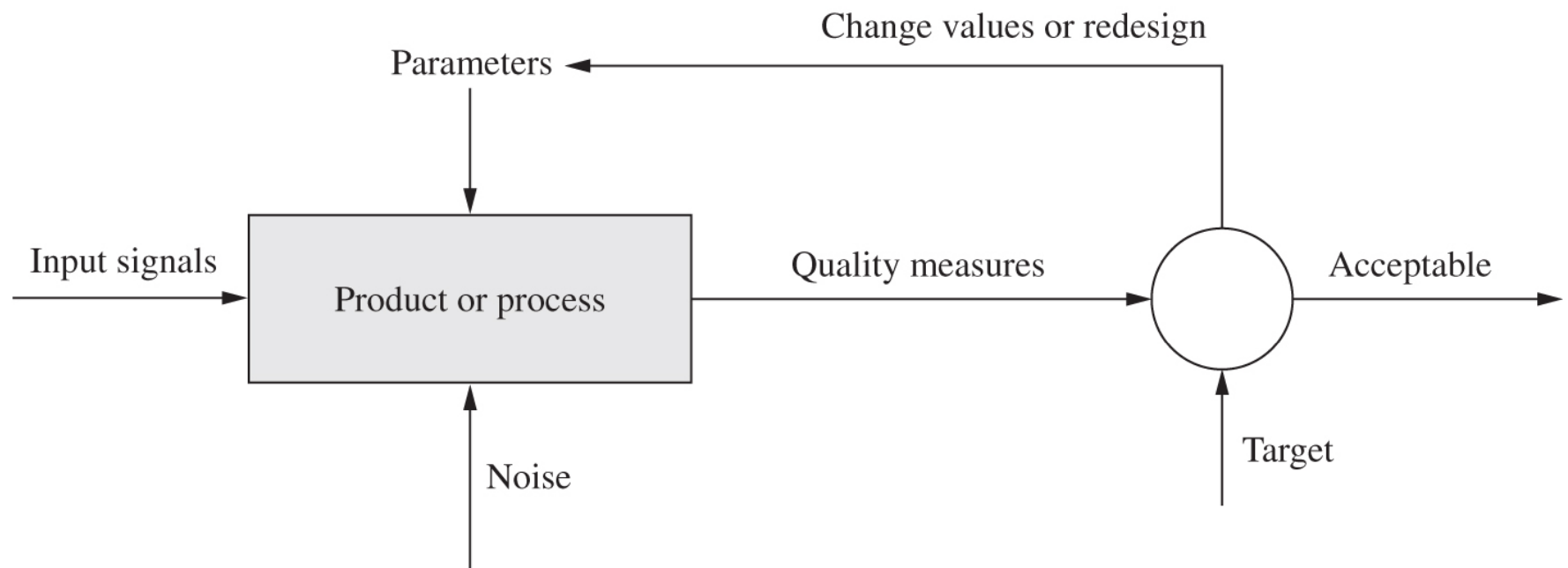


Figure 10.10

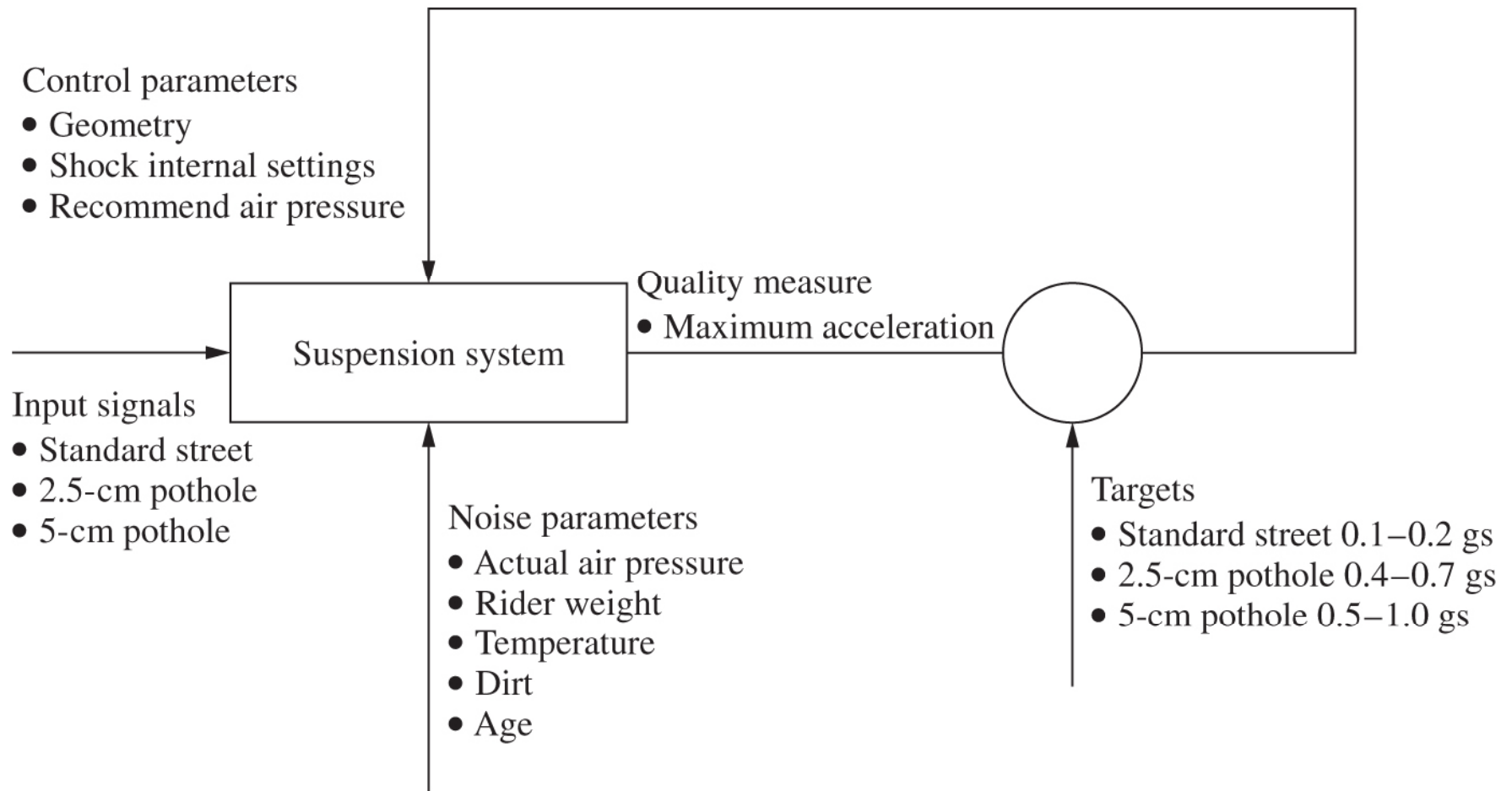


Figure 10.11

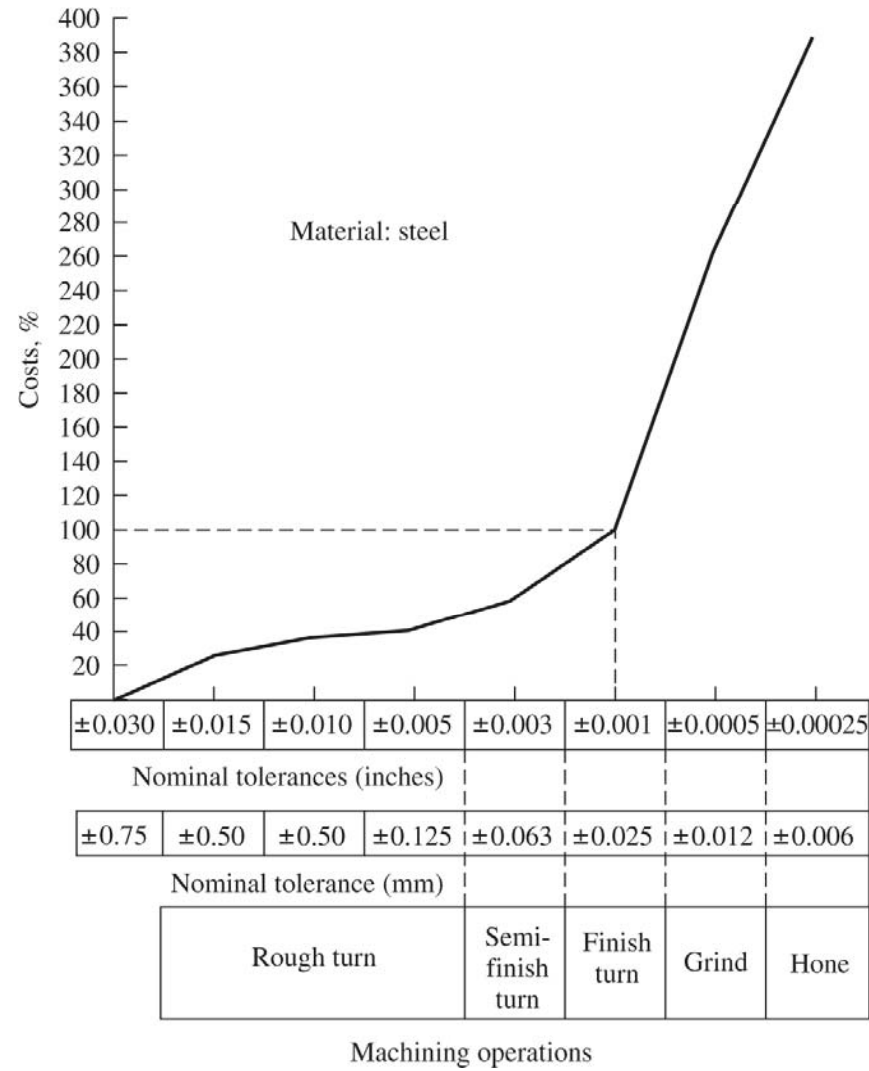
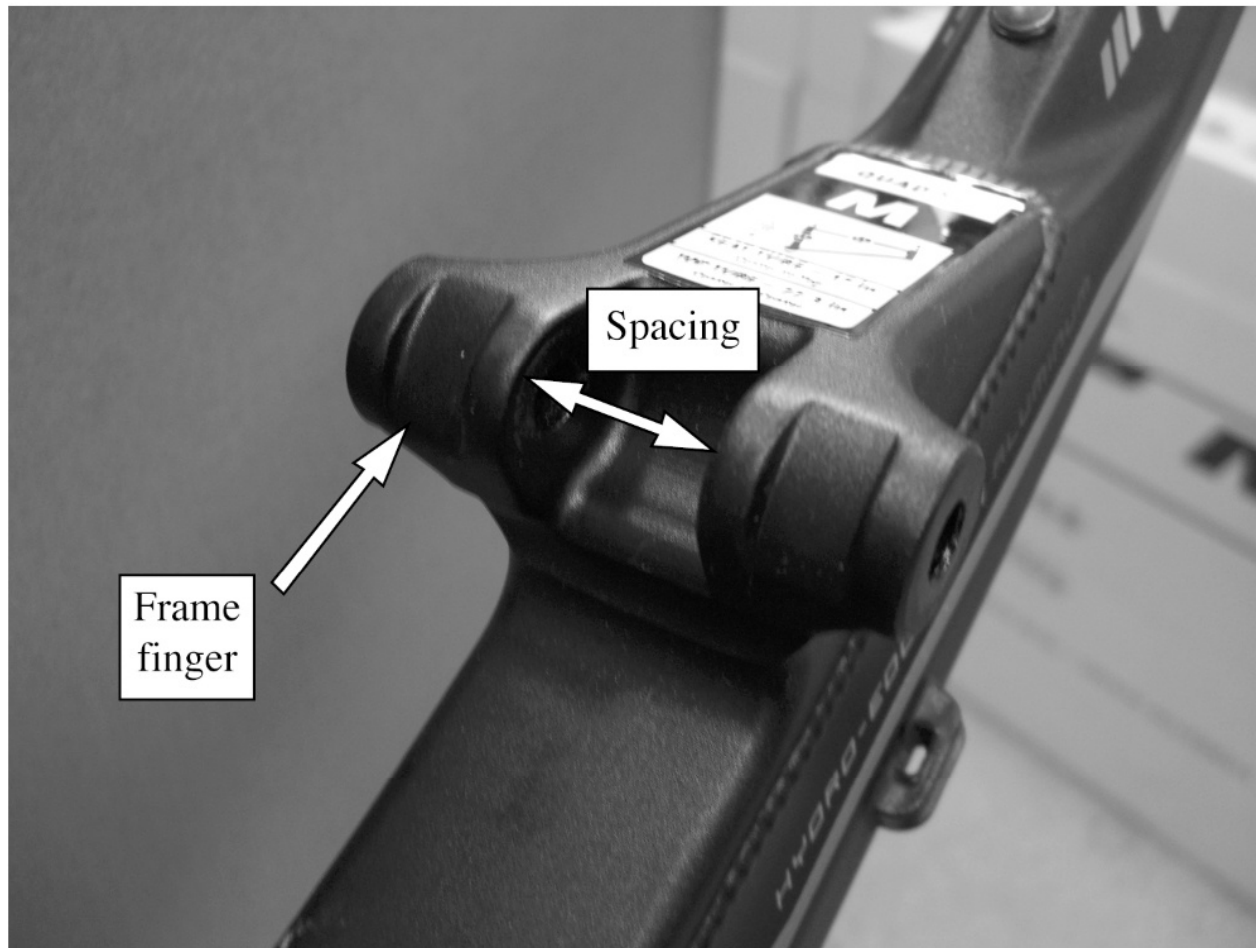


Figure 10.12



Marin Bicycles

Figure 10.13

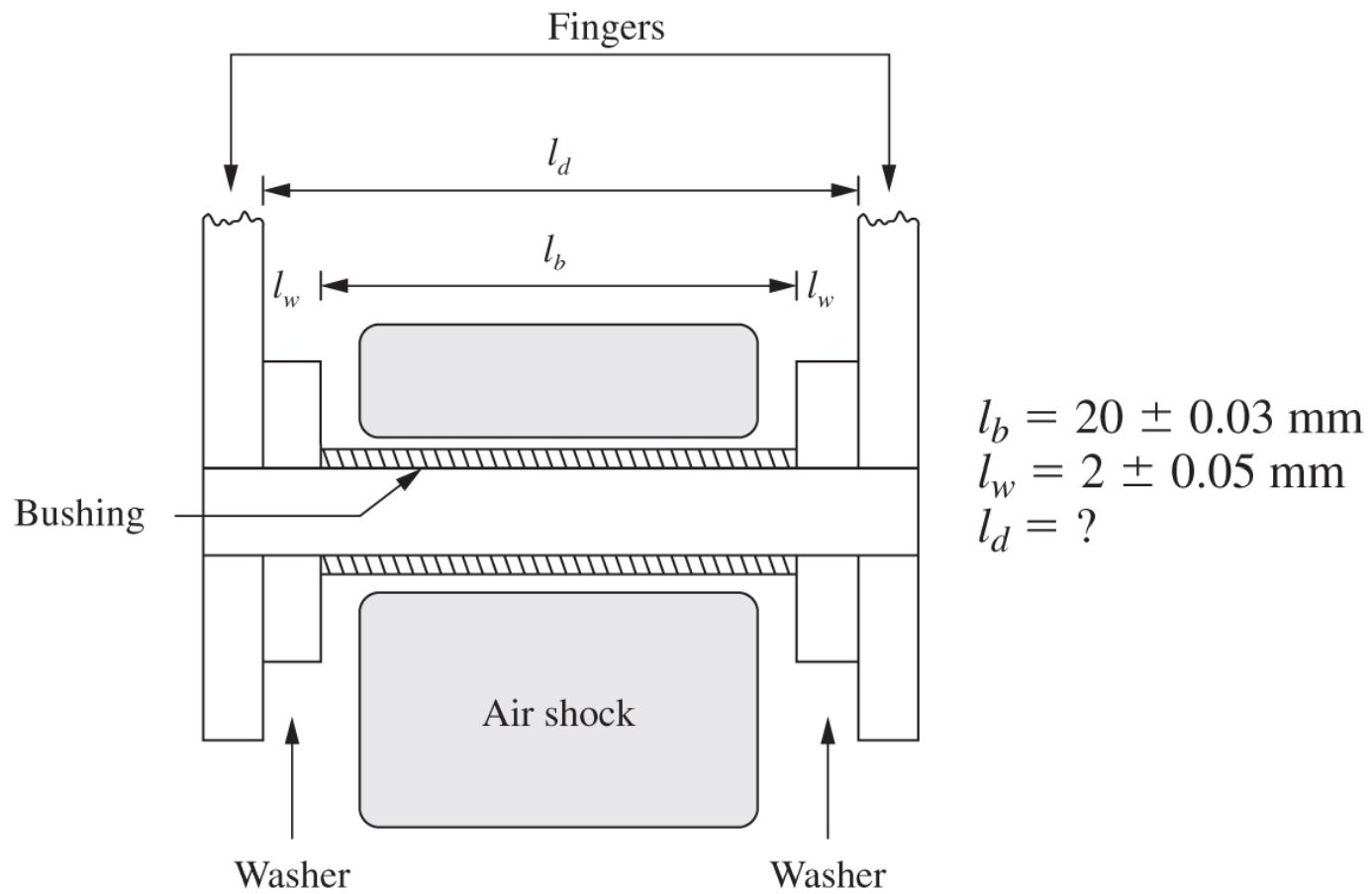


Figure 10.14

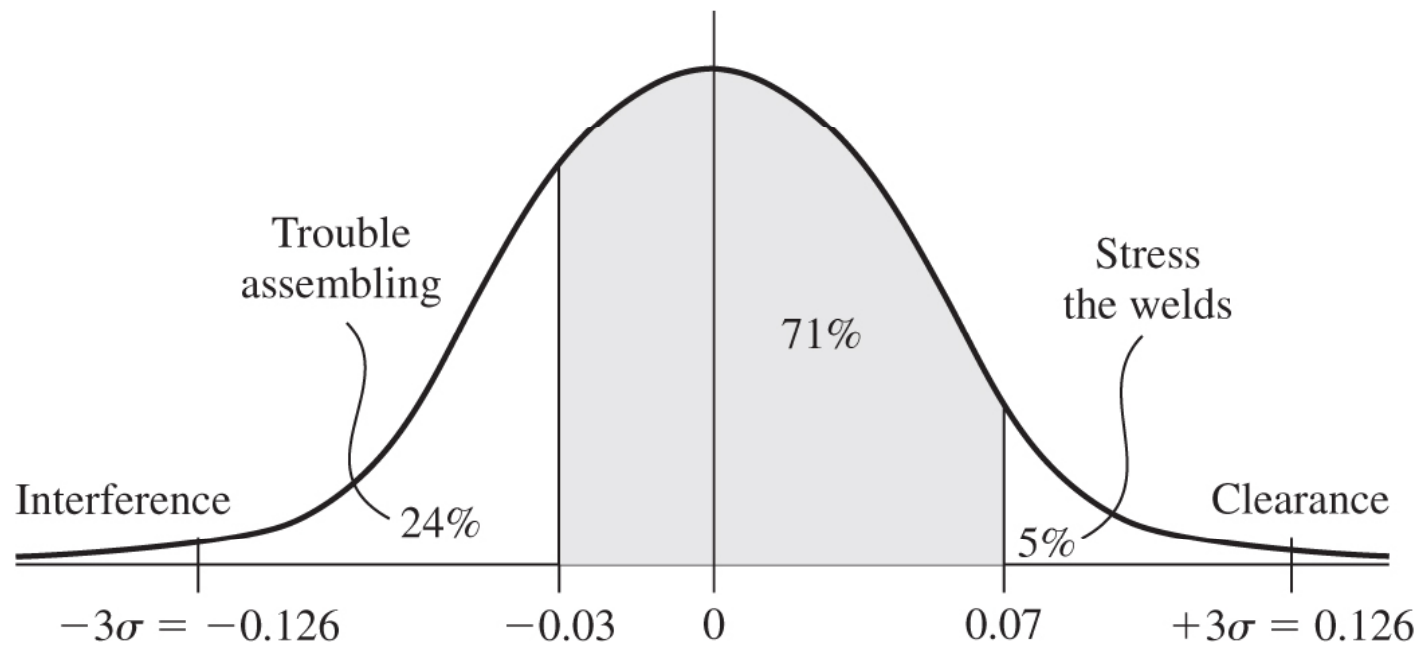


Figure 10.15

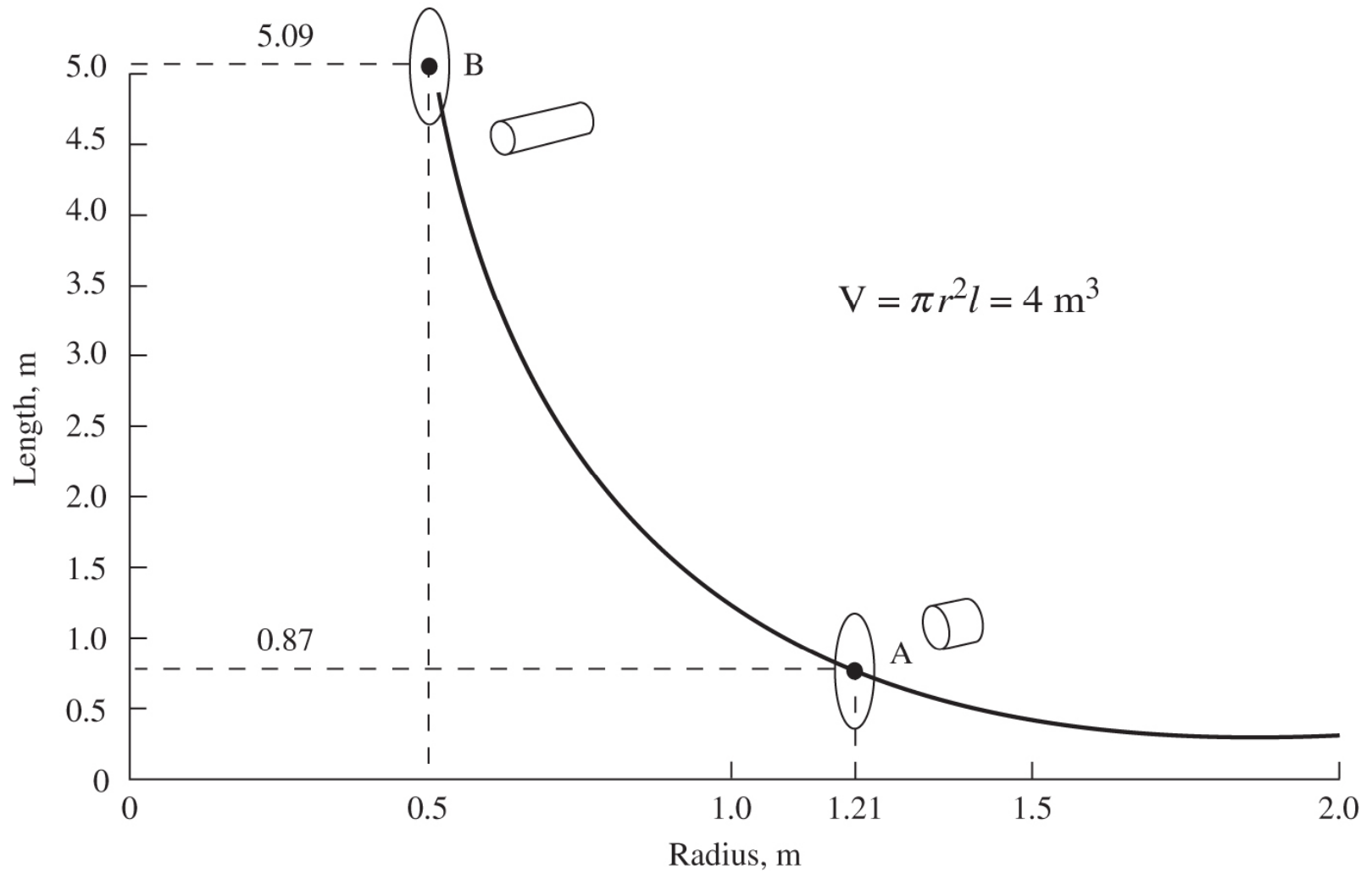


Figure 10.16

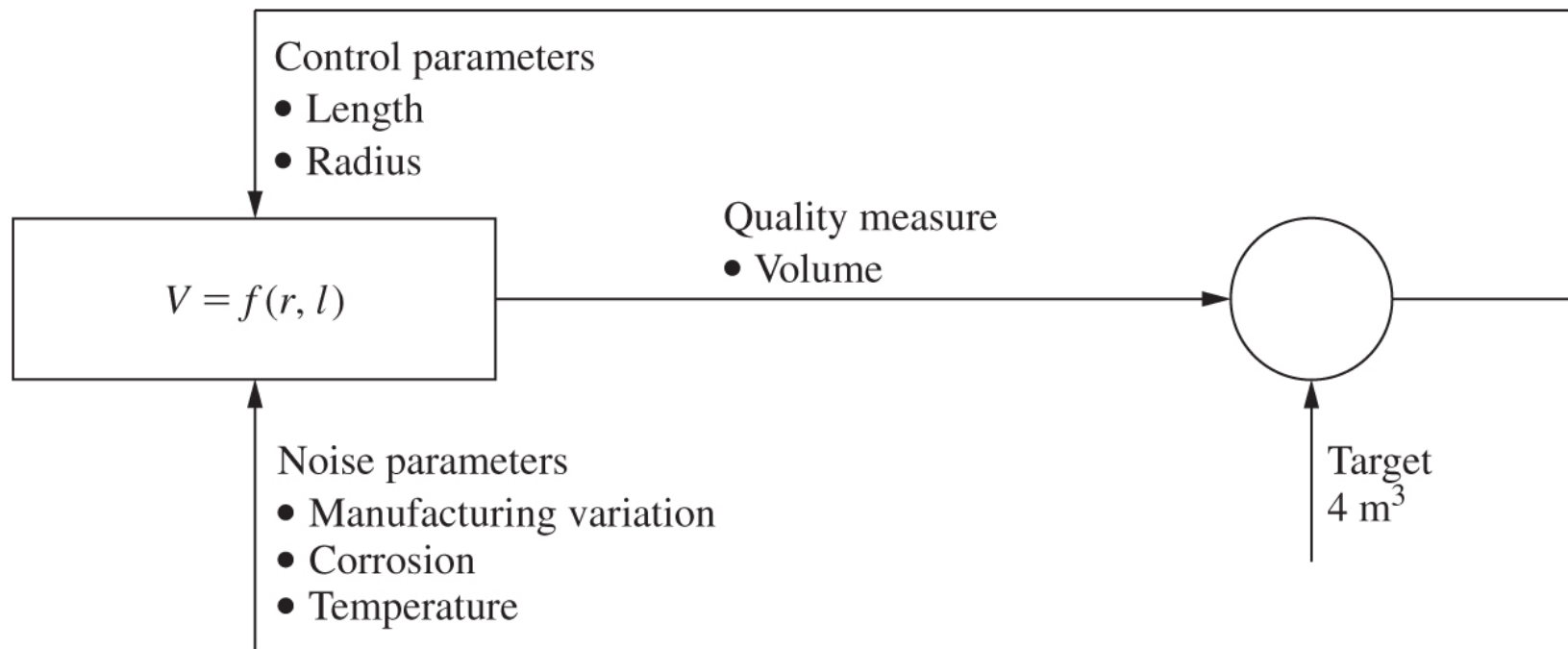


Table 10.2 Formulas for means and S/N ratios

Quality loss function	Mean square deviation (MSD)	S/N ratio
Smaller-is-better	$\frac{1}{n} \sum_{i=1}^n y_i^2$	$-10 \log \left(\frac{1}{n} \sum_{i=1}^n y_i^2 \right)$
Larger-is-better	$\frac{1}{n} \sum_{i=1}^n \left(\frac{1}{y_i^2} \right)$	$-10 \log \left(\frac{1}{n} \sum_{i=1}^n \frac{1}{y_i^2} \right)$
Nominal-is-best	$\frac{1}{n} \sum_{i=1}^n (y_i - \bar{y})^2 + (\bar{y} - m)^2$ $m = \text{target value}$	$= 10 \log \frac{1}{n} \sum_{i=1}^n \left(\frac{\bar{y}}{\sigma} \right)^2$ $\sigma = \text{standard deviation}$

Table 10.3 Layout for a two-control-factor experiment

		Noise 1:	<u>Level 1</u>	Level 1	Level 2	<u>Level 2</u>			
		Noise 2:	Level 1	Level 2	Level 1	Level 2			
Control factor 1	Control factor 2					Mean	S/N		
Level 1	Level 1	F11 ₁₁	F11 ₁₂	F11 ₂₁	F11 ₂₂	$\overline{F11}$	S/N11		
Level 1	Level 2	F12 ₁₁	F12 ₁₂	F12 ₂₁	F12 ₂₂	$\overline{F12}$	S/N12		
Level 2	Level 1	F21 ₁₁	F21 ₁₂	F21 ₂₁	F21 ₂₂	$\overline{F21}$	S/N21		
Level 2	Level 2	F22 ₁₁	F22 ₁₂	F22 ₂₁	F22 ₂₂	$\overline{F22}$	S/N22		

Table 10.4 Tank experiment results

$r(\mathbf{m})$	$l(\mathbf{m})$					Mean	σ	S/N, dB
		$\partial r(\mathbf{m}):$	0.03	0.03	-0.03	-0.03		
		$\partial l(\mathbf{m}):$	0.15	-0.15	-0.15	-0.15		
0.5	0.5	0.57	0.31	0.45	0.244	0.396	0.15	8.63
0.5	5.5	5.00	4.76	3.91	3.69	4.34	0.64	16.66
1.5	0.5	4.81	2.59	4.39	2.40	3.55	1.23	9.20
1.5	5.5	41.89	39.53	38.46	36.13	39.00	2.39	24.25