

ECE 4000  
Quiz #2 Solution

RC  
4/7/03

1. (a) ADVANTAGE OF Prototype over simulation  
MAY BE MORE realistic model;  
CAN DISCOVER UNFORSEEN INTERACTIONS;  
USEFUL IN MARKETING.

DISADVANTAGE OF Prototype compared to simulation  
CANNOT CONSTRUCT AS MANY CASES.

(b) Recycling might NOT BE economically feasible because  
MATERIAL MAY HAVE little VALUE;  
MIXED MATERIAL COMPONENTS MAY BE DIFFICULT TO SEPARATE.

(c) Perceived Risk MAY BE DIFFERENT FROM ACTUAL  
Risk BECAUSE:

higher tolerance if  
FAMILIAR  
VOLUNTARY  
CONSEQUENCE IS DEFERRED  
PEOPLE AFFECTED AREN'T LIKE YOU  
ONE IS IN CONTROL

lower tolerance if  
UNFAMILIAR  
INVOLUNTARY  
CONSEQUENCE IS IMMEDIATE  
PEOPLE AFFECTED ARE LIKE YOU  
ONE IS NOT IN CONTROL

(d) MOST STANDARDS ARE DESIGN STANDARDS BECAUSE  
DESIGN STANDARDS ARE MORE COOKBOOK AND, THEREFORE,  
EASIER TO REGULATE.

2. DUTY-BASED: NO ACTION SHOULD VIOLATE THE  
OBLIGATIONS TO OTHERS. (b)

RIGHTS-BASED: NO ACTION SHOULD VIOLATE THE  
RIGHTS OF OTHERS (e)

UTILITARIAN: DO THE MOST GOOD FOR THE GREATEST NUMBER  
(a)

VIRTUE-BASED: VALUES ARE EMPHASIZED (c)

$$3, C_p = 2.0 \quad C_{pk} = 1.6 \quad \text{TARGET MEAN} = 600 \\ \text{ACTUAL MEAN} = 560$$

$$C_{pk} = C_p(1-k)$$

$$1.6 = 2(1-k) \Rightarrow k = .2$$

$$k = \frac{\text{Actual} - \text{Target}}{((USL - LSL)/2)} = \frac{2(600 - 560)}{USL - LSL} = .2$$

$$USL - LSL = 400$$

$$USL = 600 + 200 = 800$$

$$LSL = 600 - 200 = 400$$

$$C_p = \frac{USL - LSL}{6\sigma} = 2 \quad \Rightarrow \sigma = \frac{200}{6} = 33.33$$

$$\text{Defects Below LSL} = Z \left( \frac{560 - 400}{33.33} \right) = Z(4.8)$$

$$\text{Defects Above USL} = Z \left( \frac{800 - 560}{33.33} \right) = Z(7.2)$$

$$4. A. \text{ Per-unit failure rate} = \lambda = 4 \times 10^{-3} \text{ hr}^{-1}$$

$$\text{Number surviving to } t_1 = N_0 e^{-\lambda t_1}$$

Number

$$\text{Number failing between } t_1 \text{ AND } t_2 = N_0 e^{-\lambda t_1} - N_0 e^{-\lambda t_2}$$

Number failing between 200 AND 300 =

$$10000 \left( e^{-(4 \times 10^{-3})(200)} - e^{-(4 \times 10^{-3})(300)} \right) = 10000(.448 - .301)$$

$$\text{Number} = 1480 \text{ (lr)}$$

$$B. \text{ Prob}(k \text{ defects}) = \frac{dpu^k}{k!} e^{-dpu} \quad dpu = 1.6$$

$$\text{Prob}(k > 1) = 1 - \text{Prob}(0) - \text{Prob}(1) = 1 - e^{-1.6} - 1.6e^{-1.6}$$

$$\text{Prob}(k > 1) = 1 - .202 - .323 = .475 = 47.5\% \quad (c)$$

$$C. \text{ FTY} = e^{-dpu} = .301 \quad dpu = 1.2$$

$$\begin{aligned} \# \text{ of Tests} &= (1 + dpu)(\# \text{ of units}) \\ &= 2.2(1000) = 2,200 \text{ (lr)} \end{aligned}$$

D.  $N^{\text{th}}$  payment of a Geometric Gradient Series =  $F_1 (1+g)^{N-1}$

$$20^{\text{th}} \text{ payment} = F_1 (1+g)^{19} = 200 (1.06)^{19} = 200 (3.0256)$$

$$20^{\text{th}} \text{ payment} = \$605 \text{ (a)}$$

E. The decision of whether to treat commuting miles as a cost or as a reduction of benefits is representative of the idea of classification of a tangible (a)

F. Intellectual property examples are copyrights, patents, trade marks and trade secrets. An oil rig is a real, tangible asset, but not intellectual property.

5. (a) To undertake a project as a PE, one must be qualified by virtue of experience, education, or training, not by discipline in which exam is passed. One is a PE not a PE/EE or PE/ME.  
False

(b) For strict liability, negligence does not have to be proved. All that must be shown is product defective and unreasonably dangerous defect existed when product left defendant's control defect caused harm  
harm appropriately assignable to defect.  
Intent of defendant is not the issue. True

(c) Most government standards are design standards. - See Question 1, part (d) True

- (d) The PATENT APPLICATION MUST CONTAIN A "PREFERRED EMBODIMENT" IN SUFFICIENT DETAIL THAT ONE OF ORDINARY SKILL IN THE ART COULD PRODUCE A DEVICE. THE PATENT APPLICATION DOES NOT REQUIRE A WORKING MODEL. TRUE
- (e) THE HINDENBERG DISASTER WAS NOT DUE TO LACK OF UNDERSTANDING THAT HYDROGEN GAS WAS POTENTIALLY HIGHLY EXPLOSIVE. ALTHOUGH AWARE OF THE RISK, HYDROGEN WAS USED BECAUSE HELIUM WAS UNAVAILABLE. SOME CAUTIONARY MEASURES WERE TAKEN. THE HINDENBURG IS BELIEVED TO HAVE BURNED BECAUSE THE PAINT (COATING) ON THE SKIN WAS HIGHLY FLAMMABLE, AND A SPARK FROM STATIC ELECTRICITY IGNITED THE SKIN. FALSE
- (f) UKASE IS A REGULATORY RULING WITH THE FORCE OF LAW. THIS IS SIGNIFICANT BECAUSE A GROWING LIST OF UKASES AFFECTS US DIRECTLY, AND THESE ARE NOT INACTED BY ELECTED REPRESENTATIVES. TRUE
- (g) TWO SUBSYSTEMS IN PARALLEL ARE ALWAYS MORE RELIABLE THAN EITHER BY ITSELF, SO IF THERE ARE THREE SUBSYSTEMS OF EQUAL RELIABILITIES, TWO IN PARALLEL ARE MORE RELIABLE THAN JUST ONE.  $1 - (1-R)(1-R) = 2R - R^2 = R(2-R) > R$ , FOR  $0 < R < 1$ . FALSE

(h) For constant per unit failure rates  $h_1$  and  $h_2$ , the parallel combination reliability function is

$$R = 1 - (1 - e^{-\lambda_1 t})(1 - e^{-\lambda_2 t})$$

$$= e^{-\lambda_1 t} + e^{-\lambda_2 t} - e^{-(\lambda_1 + \lambda_2)t}$$

The above cannot be expressed as  $e^{-\lambda t}$ , where  $\lambda$  is a constant. Therefore the statement is false. False

### 6. System Alpha

Cost \$400 per year

Benefit \$600/year,  $p = .6$

400/year,  $p = .3$

200/year,  $p = .1$

### System Beta

Cost \$600/year

Benefit \$800/year  $p = .4$

\$600/year first 4 years

\$800/year last 4 years }  $p = .6$

(a) Expected Annualized Benefit of Alpha and Beta

$$\text{Benefit}_\alpha = 600(.6) + 400(.3) + 200(.1) = 500$$

$$\text{Benefit}_\beta = 800(.4) + \left\{ 600(P/A, 6\%, 4) + 800(P/A, 6\%, 4)(P/F, 6\%, 4) \right\}$$

$$\left\{ (A/P, 6\%, 8) \right\} (.6)$$

$$\text{Benefit}_\beta = 320 + \left\{ 600(3.4651) + 800(3.4651)(.7921) \right\} \left\{ (.1610) \right\} (.6)$$

$$= 733$$

$$(b) \left( \frac{B}{C} \right)_\alpha = \frac{500}{400} = 1.25$$

$$\left( \frac{B}{C} \right)_\beta = \frac{733}{600} = 1.22$$

(c) choose ALPHA