Reliability

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TIP – FTP – UB

Outline

- ☑ ***Strategic Importance of Maintenance and Reliability***
- ☑ ***Reliability***
  - ☑ ***Improving Individual Components***
  - ☑ ***Providing Redundancy***

Learning Objectives

When you complete this session you should be able to:

1. ***Describe how to improve system reliability***
2. ***Determine system reliability***

Strategic Importance of Maintenance and Reliability

- ☑ *Failure has far reaching effects on a firm's*
  - ☑ *Operation*
  - ☑ *Reputation*
  - ☑ *Profitability*
  - ☑ *Dissatisfied customers*
  - ☑ *Idle employees*
  - ☑ *Profits becoming losses*
  - ☑ *Reduced value of investment in plant and equipment*

Maintenance and Reliability

- ☑ *The objective of maintenance and reliability is to maintain the capability of the system while controlling costs*
  - ☑ *Maintenance is all activities involved in keeping a system's equipment in working order*
  - ☑ *Reliability is the probability that a machine will function properly for a specified time*

Important Tactics

- ☑ **Reliability**
  1. Improving individual components
  2. Providing redundancy
- ☑ **Maintenance**
  1. Implementing or improving preventive maintenance
  2. Increasing repair capability or speed

Maintenance Strategy

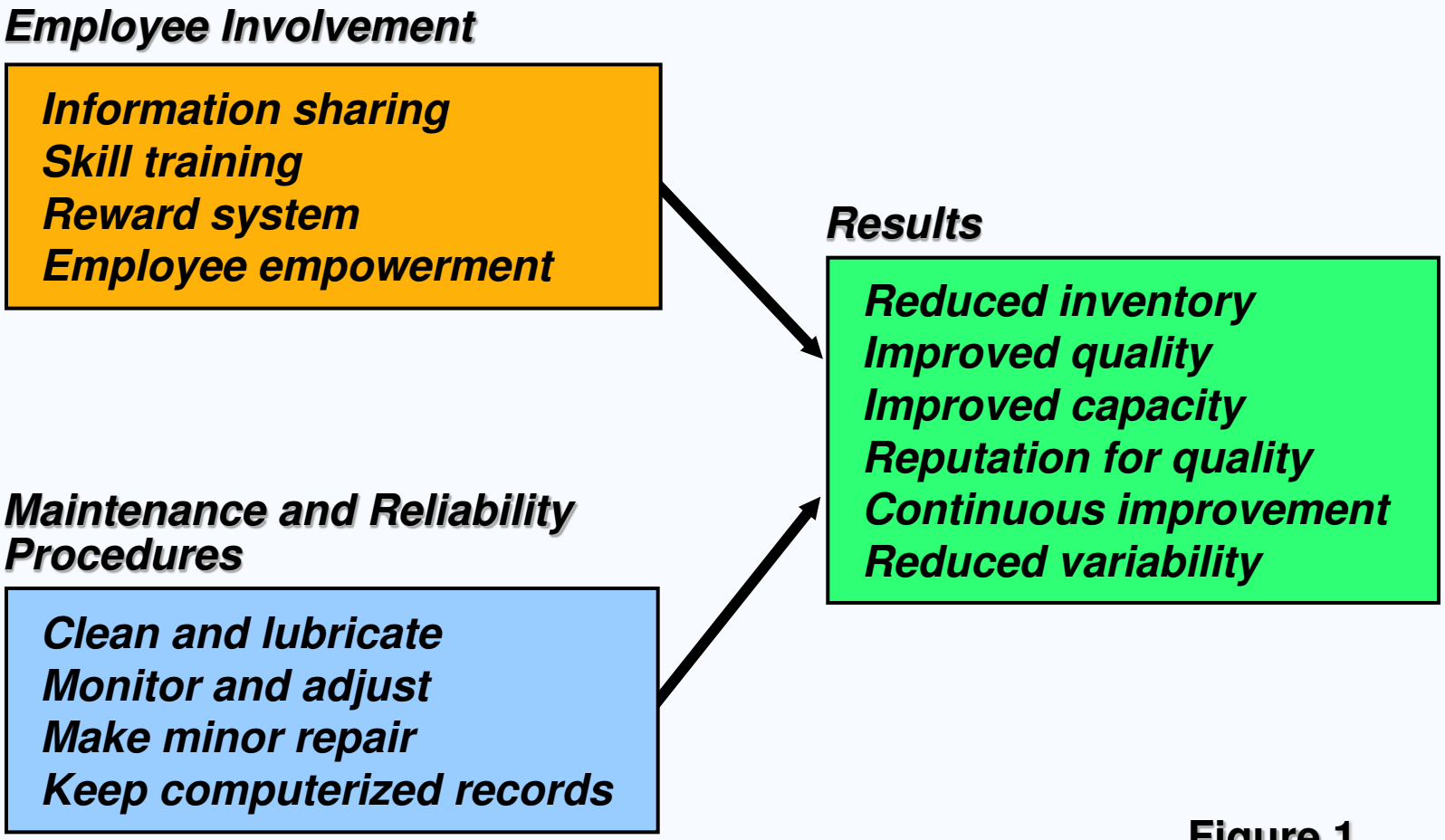


Figure 1

Reliability

Improving individual components

$$R_s = R_1 \times R_2 \times R_3 \times \ldots \times R_n$$

where R_1 = reliability of component 1
R_2 = reliability of component 2
and so on

Overall System Reliability

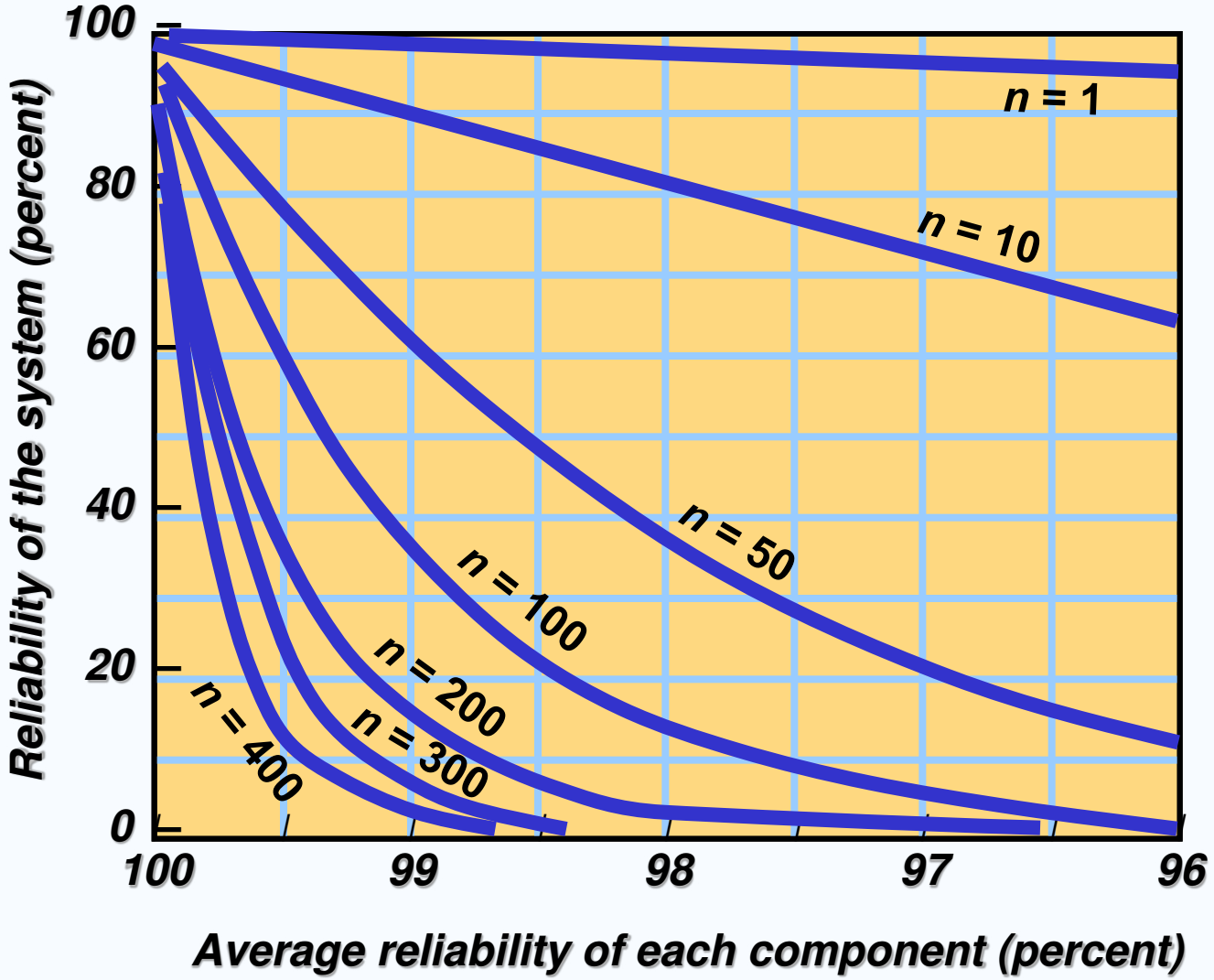
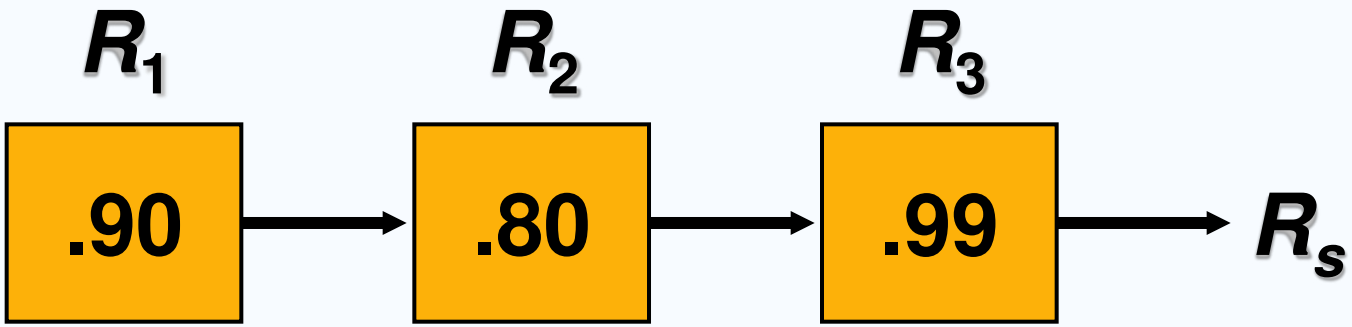


Figure 2

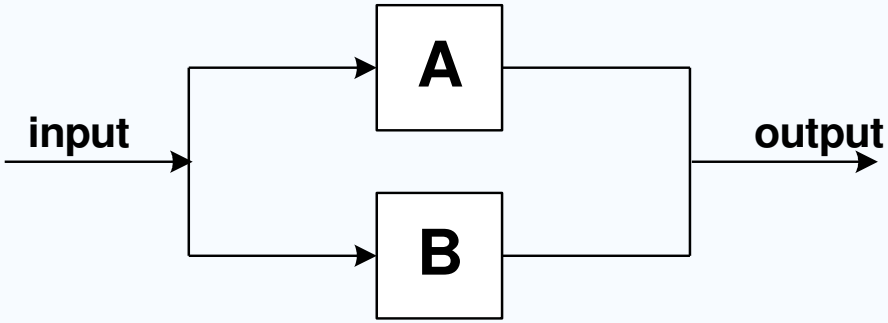
Reliability Example



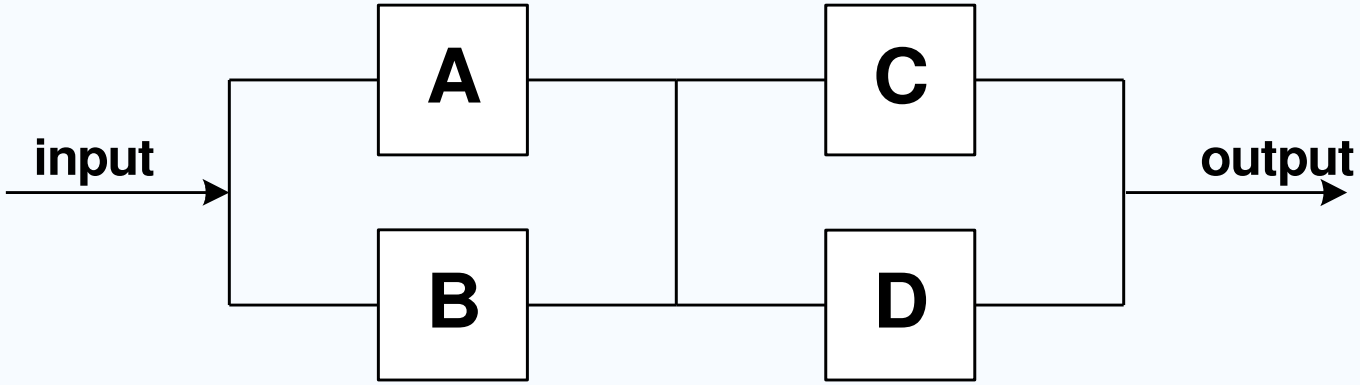
Reliability of the process is

$$R_s = R_1 \times R_2 \times R_3 = .90 \times .80 \times .99 = .713 \text{ or } 71.3\%$$

Reliability Example



$$R = 1 - (1 - R_A)(1 - R_B)$$



$$R = [1 - (1 - R_A)(1 - R_B)][1 - (1 - R_C)(1 - R_D)]$$

Product Failure Rate (FR)

Basic unit of measure for reliability

$$FR(\%) = \frac{\text{Number of failures}}{\text{Number of units tested}} \times 100\%$$

$$FR(N) = \frac{\text{Number of failures}}{\text{Number of unit-hours of operating time}}$$

Mean time between failures

$$MTBF = \frac{1}{FR(N)}$$

Failure Rate Example

20 air conditioning units designed for use in a production facility operated for 1,000 hours
One failed after 200 hours and one after 600 hours

$$FR(\%) = \frac{2}{20}(100\%) = 10\%$$

$$FR(N) = \frac{2}{20{,}000 - 1{,}200} = .000106 \text{ failure/unit hr}$$

$$MTBF = \frac{1}{.000106} = 9{,}434 \text{ hrs}$$

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One fai

$FR(N) =$

$MTBF = \frac{}{.000106} = 9{,}434\ hrs$

Failure rate per trip

$FR = FR(N)(24\ hrs)(6\ days/trip)$

$FR = (.000106)(24)(6)$

$FR = .153\ failures\ per\ trip$

Providing Redundancy

Provide backup components to increase reliability

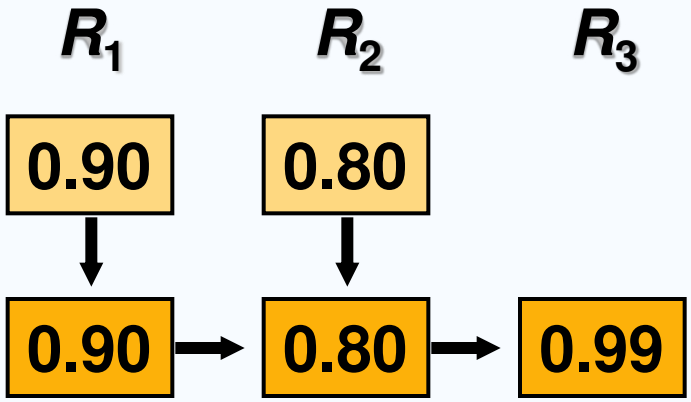
$$\left(\begin{array}{c}\text{Probability}\\ \text{of first}\\ \text{component}\\ \text{working}\end{array}\right) + \left[\left(\begin{array}{c}\text{Probability}\\ \text{of second}\\ \text{component}\\ \text{working}\end{array}\right) \times \left(\begin{array}{c}\text{Probability}\\ \text{of needing}\\ \text{second}\\ \text{component}\end{array}\right)\right]$$

$$(.8) + \left[(.8) \times (1 - .8)\right]$$

$$= .8 + .16 = .96$$

Redundancy Example

A redundant process is installed to support the earlier example where R_s = .713



Reliability has increased from .713 to .94

$$= [.9 + .9(1 - .9)] \times [.8 + .8(1 - .8)] \times .99$$
$$= [.9 + (.9)(.1)] \times [.8 + (.8)(.2)] \times .99$$
$$= .99 \times .96 \times .99 = .94$$

Maintenance

- ☑ *Two types of maintenance*
  - ☑ *Preventive maintenance – routine inspection and servicing to keep facilities in good repair*
  - ☑ *Breakdown maintenance – emergency or priority repairs on failed equipment*

Implementing Preventive Maintenance

- ☑ Need to know when a system requires service or is likely to fail
- ☑ High initial failure rates are known as infant mortality
- ☑ Once a product settles in, MTBF generally follows a normal distribution
- ☑ Good reporting and record keeping can aid the decision on when preventive maintenance should be performed

Increasing Repair Capabilities

1. Well-trained personnel
2. Adequate resources
3. Ability to establish repair plan and priorities
4. Ability and authority to do material planning
5. Ability to identify the cause of breakdowns
6. Ability to design ways to extend MTBF