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TRAINMOS II
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TrainMoS II

"An FSA exercise with regard to ship propulsion"

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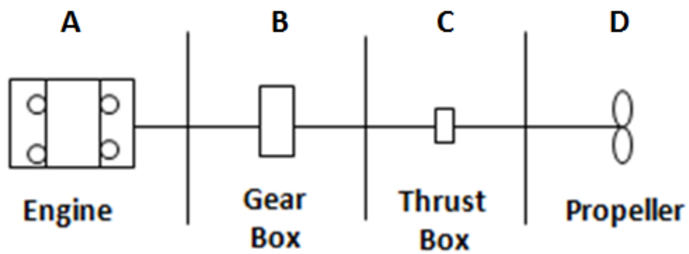
Problem definition

During the last 20 years in a fleet of 5000 passenger ships with the following propulsion system, there were recorded 200 failures of the propulsion system which led to 500 losses of human lives.



The reliability of the individual components of the system is: engine = 70%, gear box = 70%, thrust box = 90%, propeller = 90% and shafts = 100%

In order to reduce the risk of human loss due to the propulsion system failure, it is proposed that newbuildings should replace:

a. the single engine with two engines of equal individual reliability to the original at an additional annual NPV cost of 200 thousand USD.

or

b. the single propulsion system with two systems of equal individual reliability to the original at an additional annual NPV cost of 500 thousand USD.

Assess the cost-effectiveness of the above options, assuming that the useful life of a newbuilding extends over 25 years and the cost of averting the loss of life equals 3 mil. USD.

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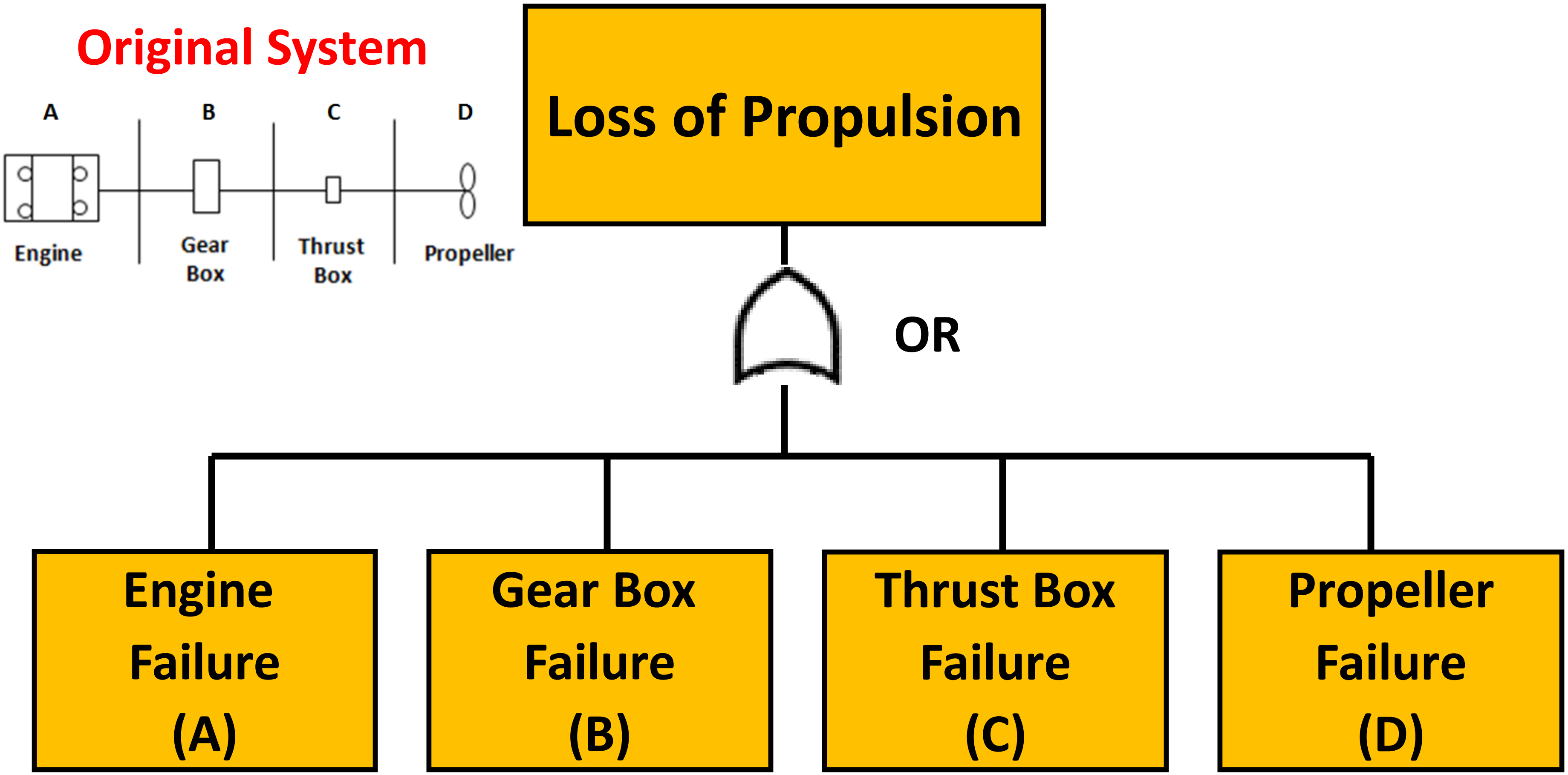
Problem solution – FTA representation

Original System



Note: Shafts are assumed to be 100% reliable.

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Problem solution – FTA representation

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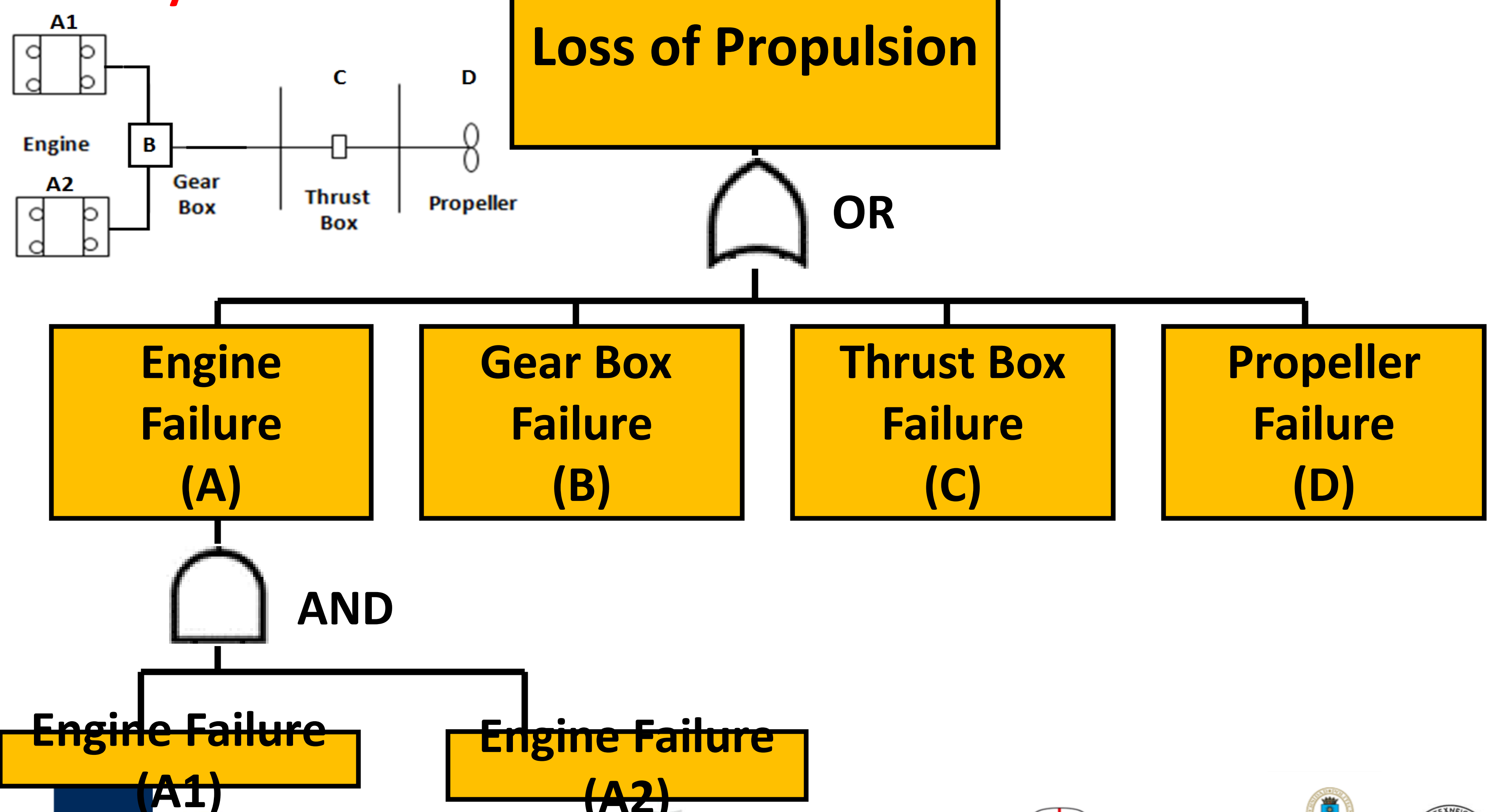
System “a”



Note: Shafts are assumed to be 100% reliable.

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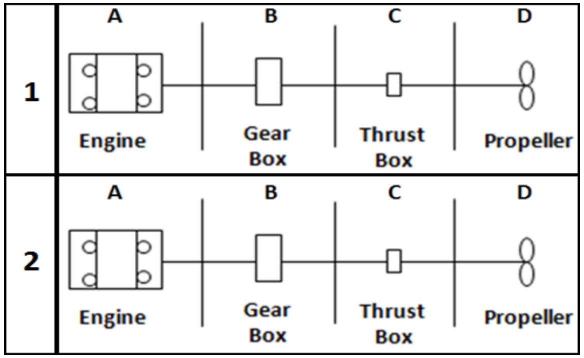
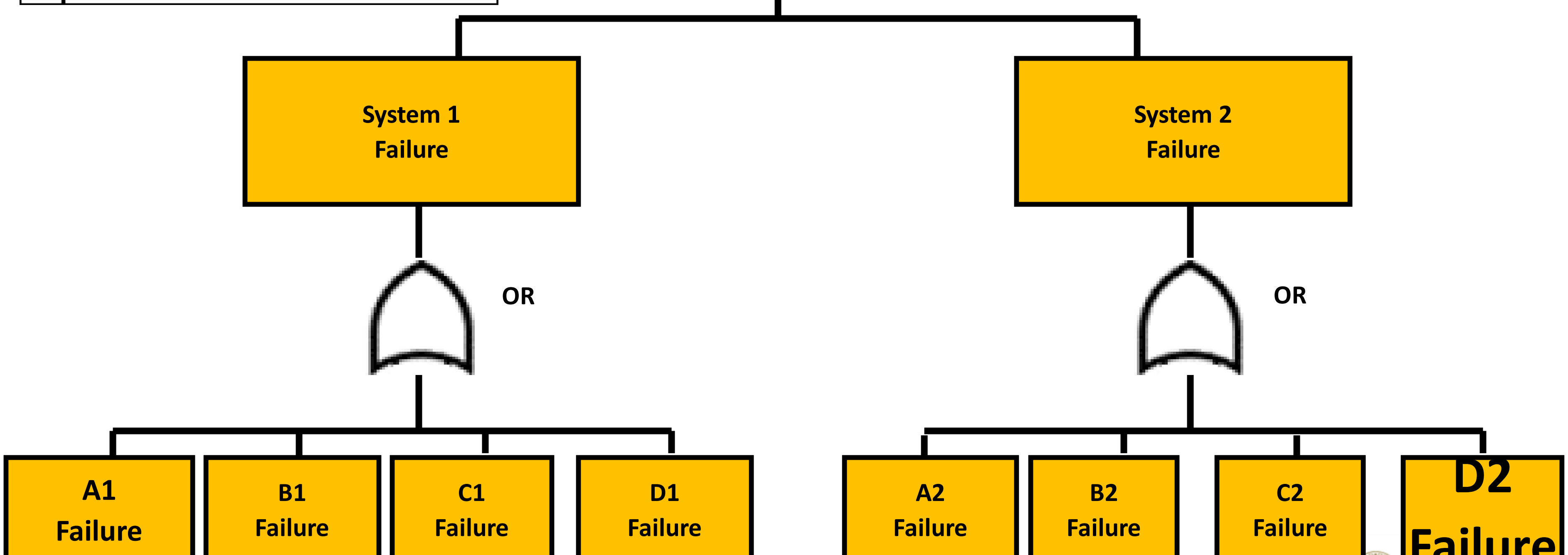
Problem solution – FTA representation

System “b”





Note: Shafts are assumed to be 100% reliable.

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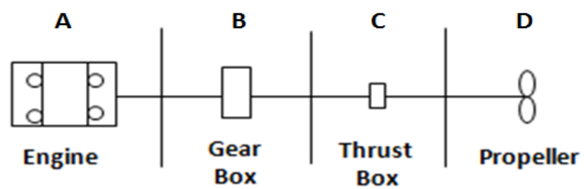
Problem solution - Reliability

Original system:

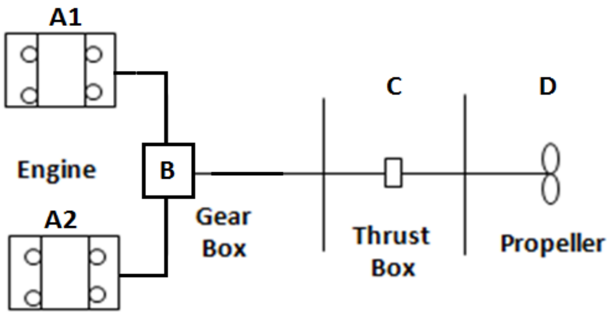


Reliability of original system, R_O =

$R_A \times R_B \times R_C \times R_D = 0.7 \times 0.7 \times 0.9 \times 0.9$

$R_O = 0.397$

System "a":



Reliability of system "a", R_a =

$\{1- ((1 - R_{A1}) \times (1 - R_{A2}))\} \times R_B \times R_C \times R_D$ =

$(1 - 0.3^2) \times 0.7 \times 0.9 \times 0.9 = 0.91 \times 0.7 \times 0.9 \times 0.9$

$R_a = 0.516$

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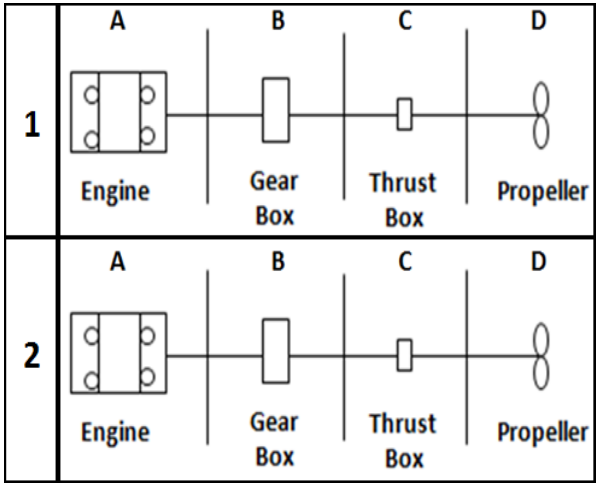
System "b":



Reliability of system "b", R_b =

$1- ((1-R_1) \times (1-R_2)) = 1 - (1 - 0.397)^2 = 1 – 0.364$

$R_b = 0.636$

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Problem solution

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➢ <u>Original Risk</u>

= {200/(5000 x 20)} LoP/ship-year x 250/200 LoL/LoP

= 0.002 LoP/ship-year x 1.25 LoL/LoP

= 0.0025 LoL/ship-year

where, LoP = Loss of propulsion and LoL = Loss of life

➢ <u>Reduction of risk</u> over the useful life of a newbuilding (i.e. 25 yrs):

- ΔR_a = (0.516 – 0.397) x 0.0025 LoL/ship-year x 25 years

  = 0.007 LoL/ship

- ΔR_b = (0.636 – 0.397) x 0.0025 x LoL/ship-year x 25 years

  = 0.015 LoL/ship

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- $\Delta C_a/\Delta R_a$ = 250000 USD/ship / 0.007 LoL/ship

  = 35.7 mil. USD/LoL (>> 3 mil. USD/LoL)

- $\Delta C_b/\Delta R_b$ = 500000 USD/ship / 0.015 LoL/ship

  = 33.3 mil. USD/LoL (>> 3 mil. USD/LoL)

Both of proposed changes in the propulsion system were found to be cost-ineffective and cannot be recommended for implementation.

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Thank you.