UNIVERSITEIT TWENTE.

ASSET LIFE CYCLE MANAGEMENT

DR. A.J.J. (JAN) BRAAKSMA A.J.J.BRAAKSMA@UTWENTE.NL
R. (RICHARD) RUITENBURG, MSC R.J.RUITENBURG@UTWENTE.NL
M. (MAURITS) KORSE, M., BSC M.KORSE@STUDENT.UTWENTE.NL

CONTENTS WORKSHOP

- Asset (life cycle) management
- Investment decision making
- Feasability study and Business Case
- RAMS(HEEP)
  - Sustainability and circular value in investment decision making – Maurits Korse
- Life cycle planning – Richard Ruitenburg

RAMS AND INVESTMENT DECISION MAKING

Dr. A.J.J. Braaksma

INTRODUCTION

Asset Management:

"an organization's coordinated multidisciplinary practice that applies human, equipment and financial resources to physical assets over their whole life cycle to achieve defined asset performance and cost objectives at acceptable levels of risk whilst taking account of the relevant governance, geo-political, economic, social, demographic and technological regimes" *(Pudney, 2010, p. 8)*

INTRODUCTION

Asset Management:

"an organization's coordinated multidisciplinary practice that applies human, equipment and financial resources to physical assets over their whole life cycle to achieve defined asset performance and cost objectives at acceptable levels of risk whilst taking account of the relevant governance, geo-political, economic, social, demographic and technological regimes" (Pudney, 2010, p. 8)

To summarize: Asset Management is

1. a multidisciplinary practice;
2. the whole life cycle of a physical asset;
3. to achieve certain objectives;
4. limited by risk and relevant regimes; and
5. allocation of resources.

INTRODUCTION

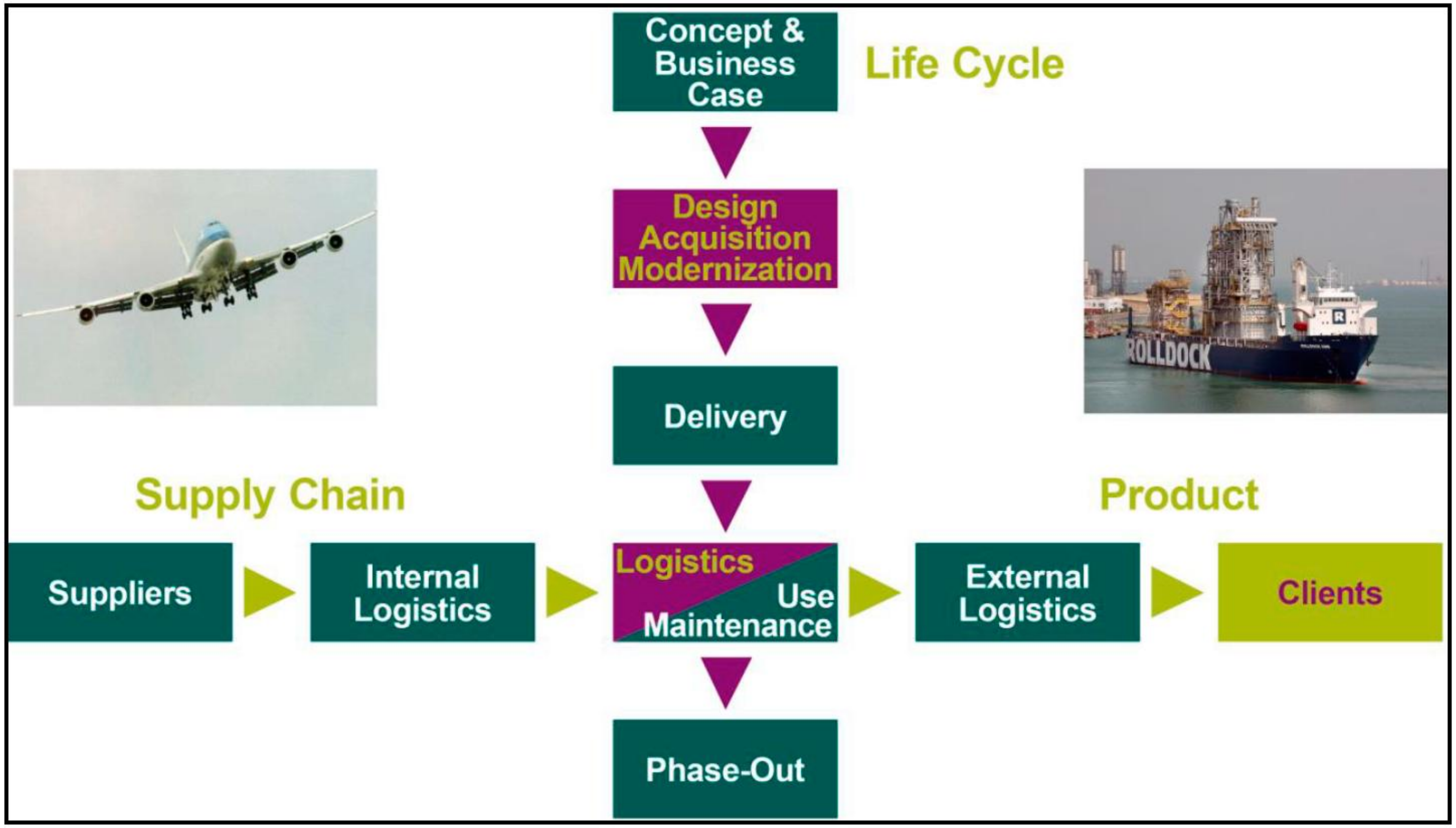
Asset Life Cycle Management:

“refers to the management of assets over their complete life cycle, from before acquisition to disposal, taking into account economic, environmental, social and technical factors and performances”
(Haffejee & Brent, 2008, p. 286)

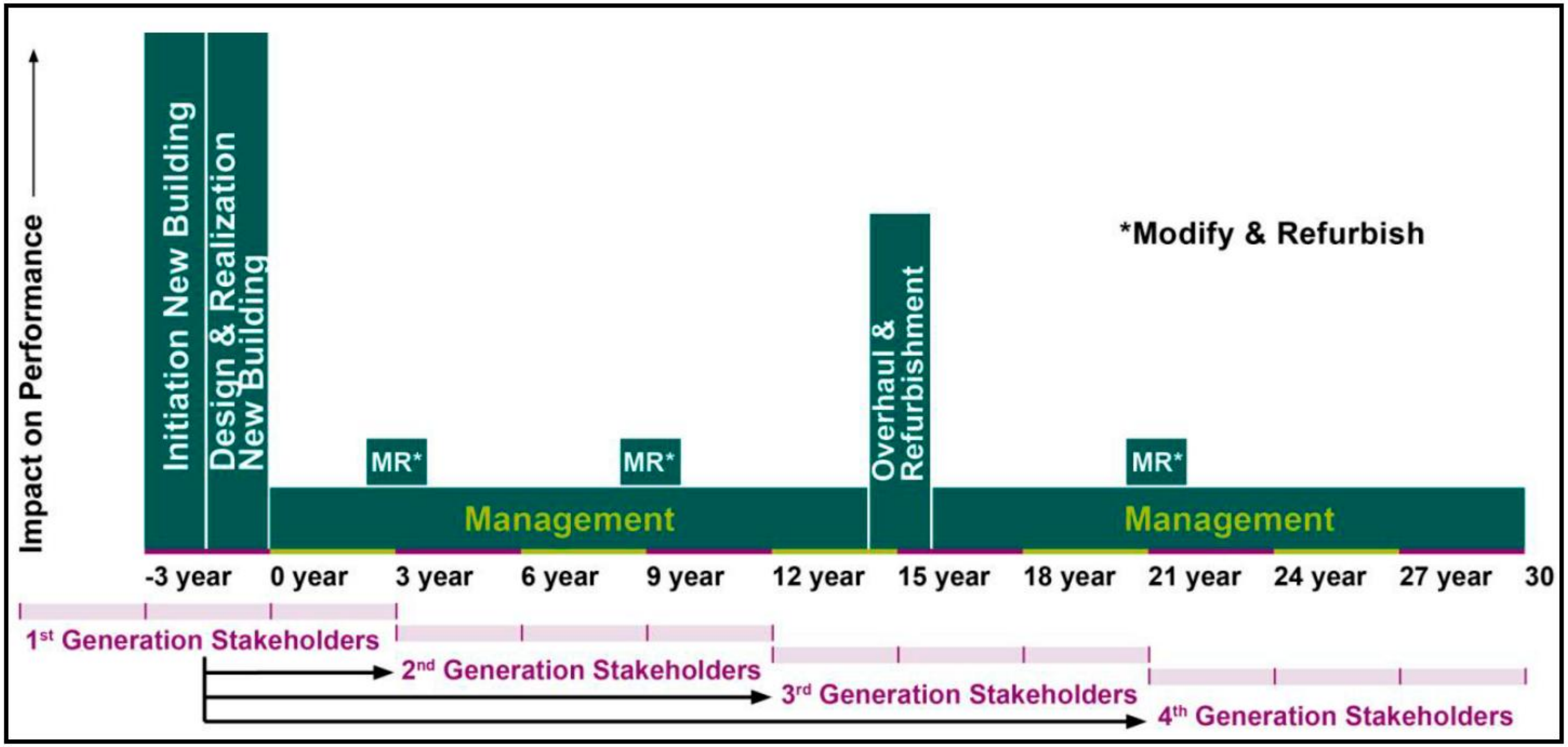
To summarize: ALCM is

- Asset Management
- with emphasis on the complete life cycle
- and a multidisciplinary approach

LIFE-CYCLE OF CAPITAL ASSETS



EXAMPLE LIFE-CYCLE OF A TYPE OF TRAIN (NEDTRAIN)



RAMS(HEEP)

Various aspects which can be used to **describe, determine** and **monitor** the quality for an asset or system.

Used to be focused on:

- Reliability
- Availability
- Maintainability
- Supportability

But nowadays also other aspects are included:

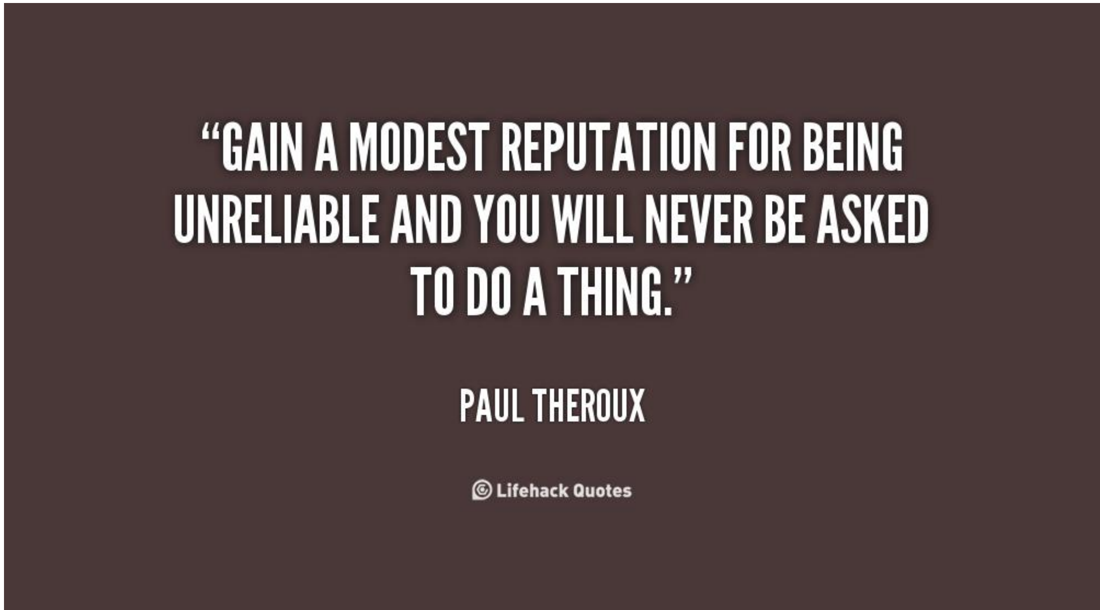
- Health
- Environment
- Economics
- Politics

THE CONCEPT OF FUNCTIONABILITY

- The state of a product in which it is functionable will be called the state of functioning.
- During its operation certain irreversible changes will occur.
- These changes are the result of processes such as: corrosion, abrasion, accumulation of deformations, distortion, overheating, fatigue, diffusion of one material into another.

RELIABILITY

- “Reliability is the inherent (natural/inbuilt) characteristic of an item related to its ability to maintain functionability when used as specified”.



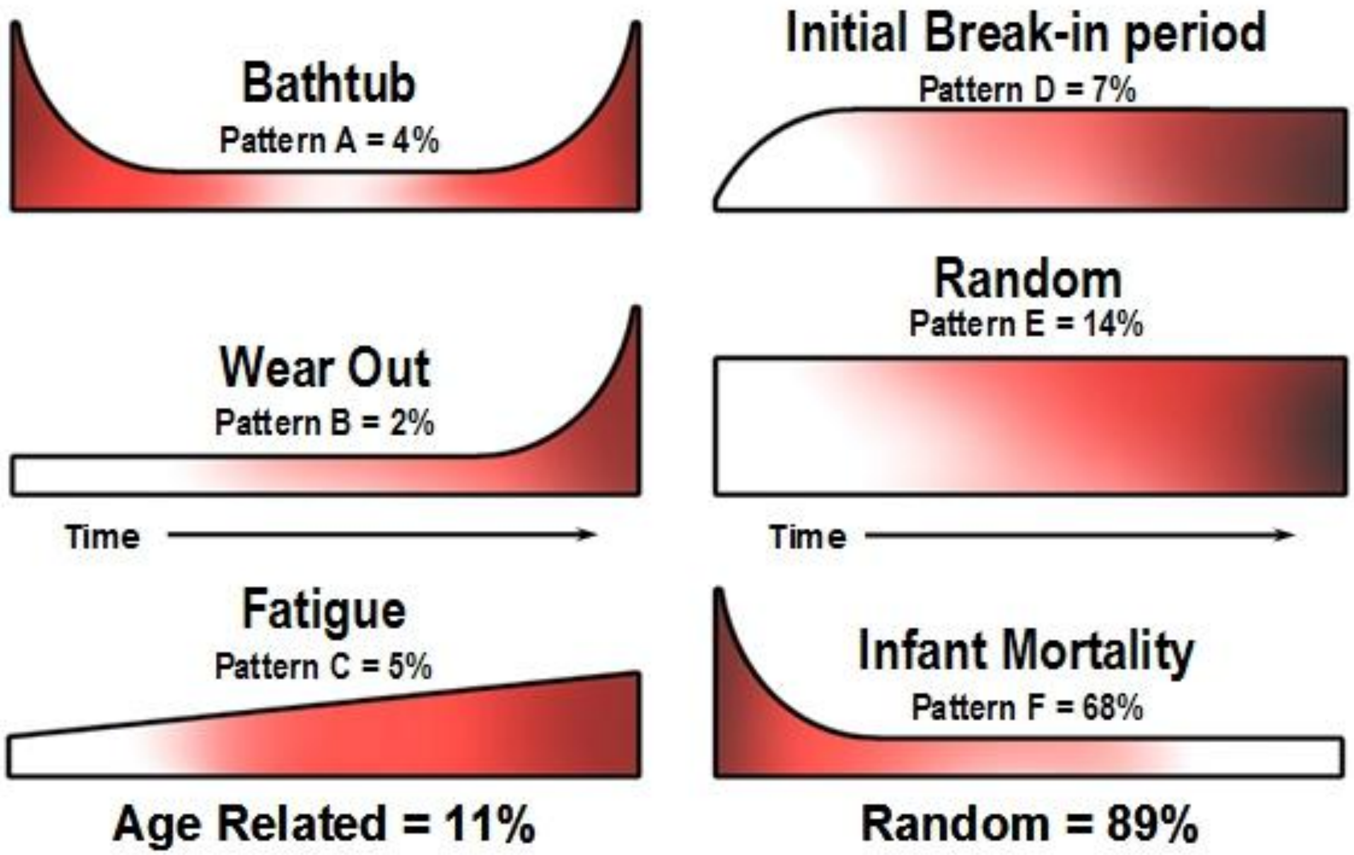
THE FAILURE OF AN ASSET

- The failure of an asset can be defined as an event whose occurrence results in either the loss of ability to perform the required functions.

- the loss of ability to satisfy the specified requirements.

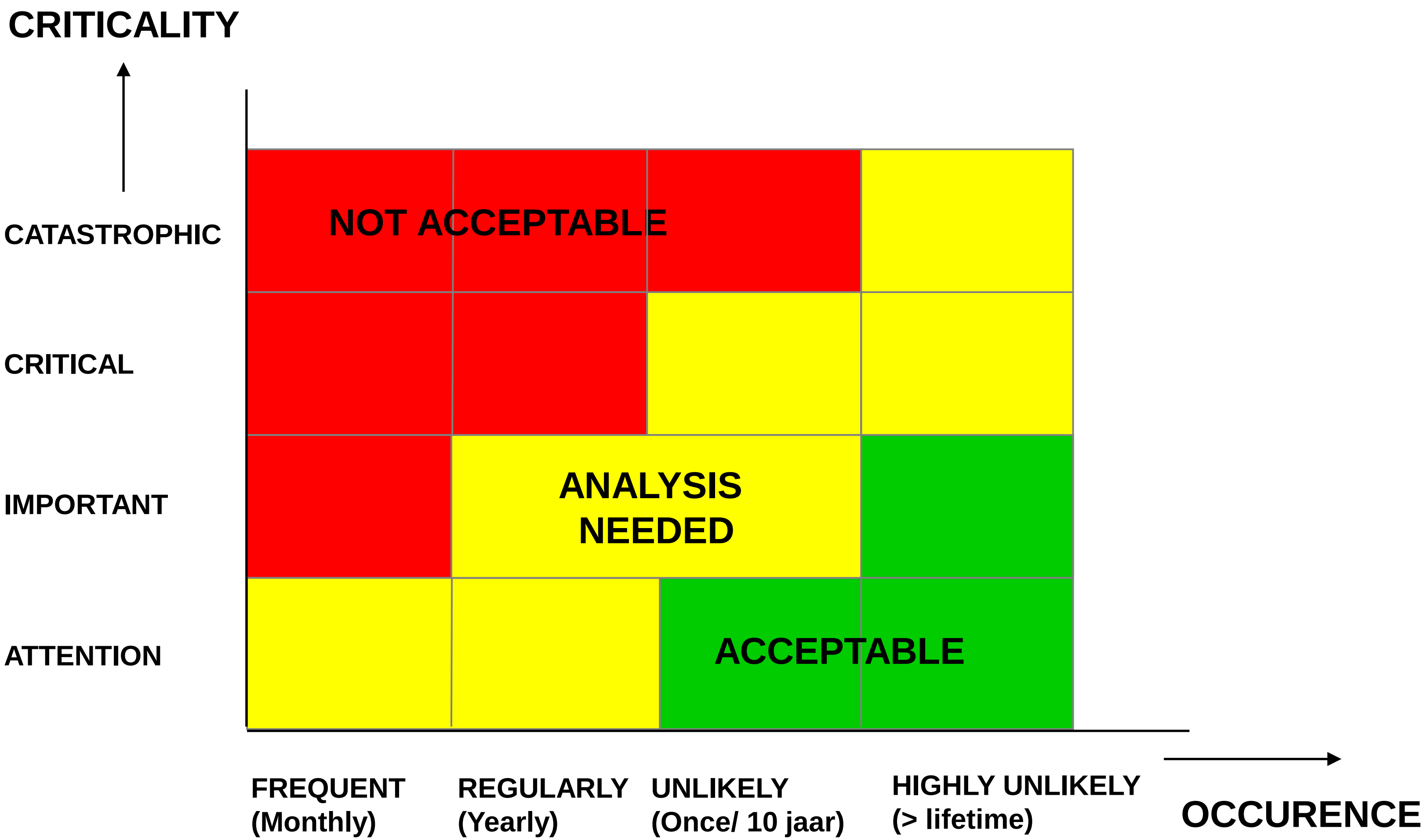
- In this case a failure will cause the transition of a product from the state of functioning to a new state, known as the state of failure

FAILURE AND PROBABILITY OF FAILURE



RELIABILITY CENTRED MAINTENANCE

GENERIC RISKMATRIX (RISK = OCCURENCE X CRITICALITY/SEVERITY)



AVAILABILITY

- Availability is the probability that the system is operating satisfactorily at any point after the start of operation,
  when used under stated conditions, where the total time considered includes:
  - operating time
  - active repair time,
  - idle time,
  - preventive maintenance time
  - (in some case), administrative time and logistic time.

AVAILABILITY AND RELIABILITY

- **AVAILABILITY**

  Availability is a measure of the % of time the equipment is in an operable state

- **RELIABILITY**

  Reliability is a measure of how long the item performs its intended function.

- **AN AVAILABLE MACHINE DOES NOT HAVE TO BE RELIABLE**

  Generally speaking a reliable machine has a high availability but an available machine may or may not be very reliable.

- For example a machine is down 6 minutes every hour
  - This translates into an availability of 90% but a reliability of less than 1 hour.

GOALS RAMS-MODELLING AND ANANYSIS

- **RAMS-ANALYSIS**
  - Establishing reliability-killers (subsystems, components)
- **RAMS-ALLOCATION**
  - Establishing R-requirements on lower system levels (top-down)
- **RAMS-PREDICTION**
  - Comparison prediction with requirements, design improvement
- **COMPARISON ALTERNATIVES**
  - Single and multiple component lay-outs versus cost
  - Higher and lower quality (R) components versus cost
- **PREVENTIVE MAINTENANCE**
  - Verification effects of preventive maintenance
- **AVAILABILITY AND LIFE CYCLE COSTS**
  - Prediction c.q. verification of requirements

R-MODELLING

EXAMPLE: SERIES CONFIGURATION

Assumption: constant failure rate $\lambda = 0{,}0001$ per hour

$R(1000) = e^{\lambda t} = e^{\,0{,}0001 x 1000} = 0{,}9048$

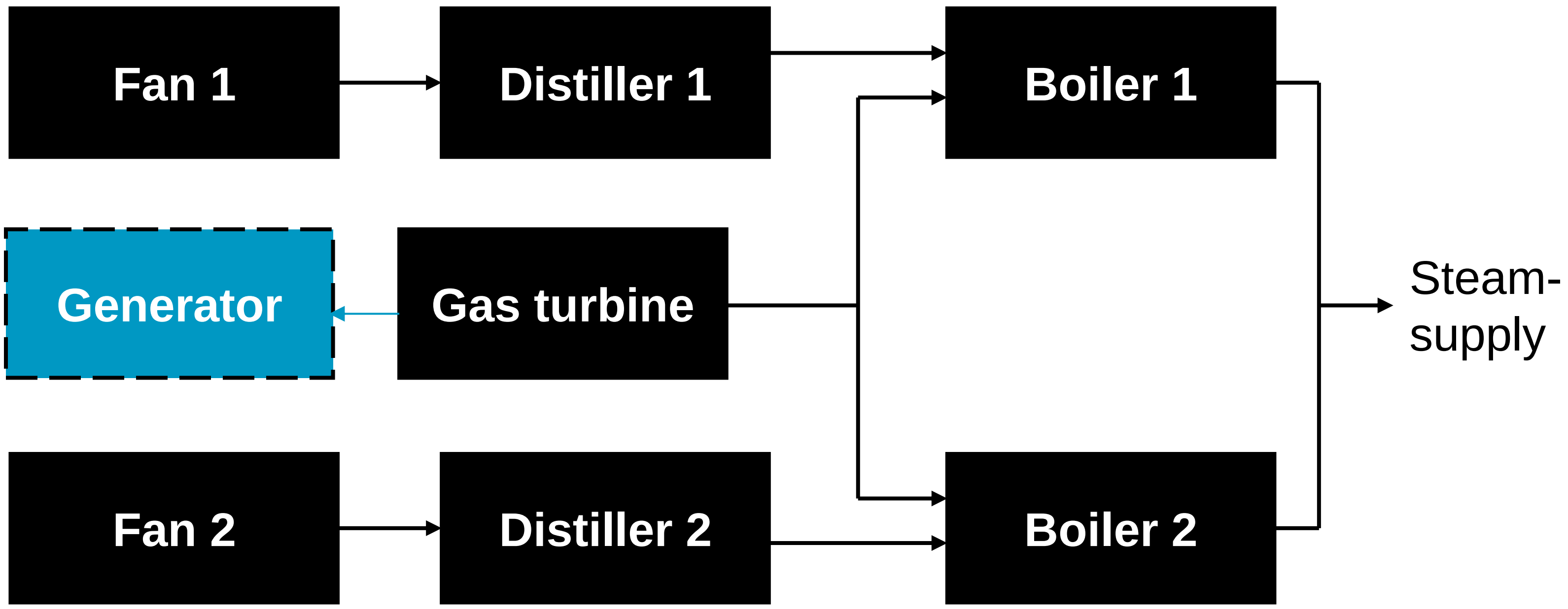
$R(1000)_{config} = R1(1000) \times R2\ (1000) \times Rn(1000)$

Configuration in series: ($R1 = R2 = Rn$)

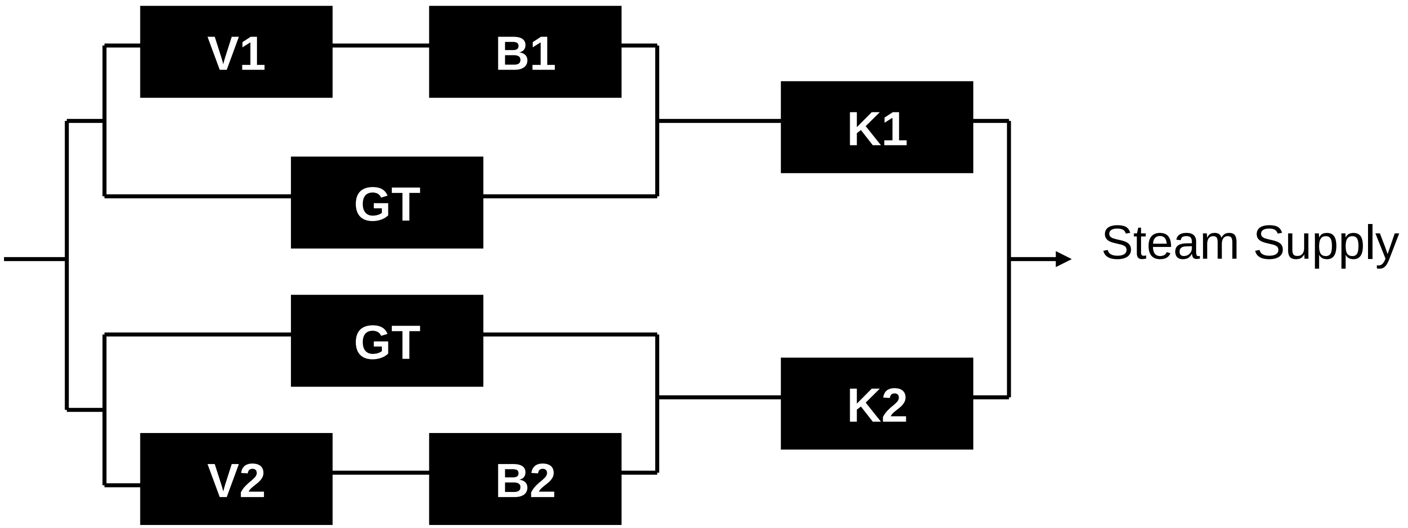
2 components:	R = 0,81
3 components:	R = 0,73
10 components:	R = 0,35

R-MODELLING

RELIABILITY BLOCK DIAGRAM – WITH REDUNDANCY



RAM MODELLING



Reliability model

Failure rate: B1 and B2: 6E-5 (1,9 year) K1 and K2: 3E-4 (0,4 year)
V1 and V2: 1E-4 (1,2 year) GT: 9E-4 (1,3 year)

Chance of failure F of system:

F=(GTxK1xB2) + (GTxK1xV2) + (GTxV1xV2) + (GTxK2xB1) + (GTxK2xV1) + (GTxB1xB2) + (GTxV1xB2) + (GTxV2xB1) + (GTxK1xK2) = 9E-8 **(1425 year)**

DATA USED FOR RAM-MODELLING

SPECIFIC

- Historic data of specific and components under comparable usage conditions
- For example: Data of 50 trains of a certain traintype

SEMI-SPECIFIC

- Historic data of identical components under varying usage conditions
- For example: KEMA-data of power plants

GENERIC

- Historic data of similar components under varying usage conditions
- For example: OREDA Offshore Data Bank, MIL-Hdbk 217

SUPPORTABILITY AND MAINTAINABILITY

- Supportability is the inherent characteristic of an item related to its ability to be supported by the required resources for the execution of the specified maintenance task”.
  – ease of restoration!

- “Maintainability is the inherent characteristic of an item related to its ability to be restored when the specified maintenance task is performed as required”
  – likelihood of restoration!

Who recognizes this?

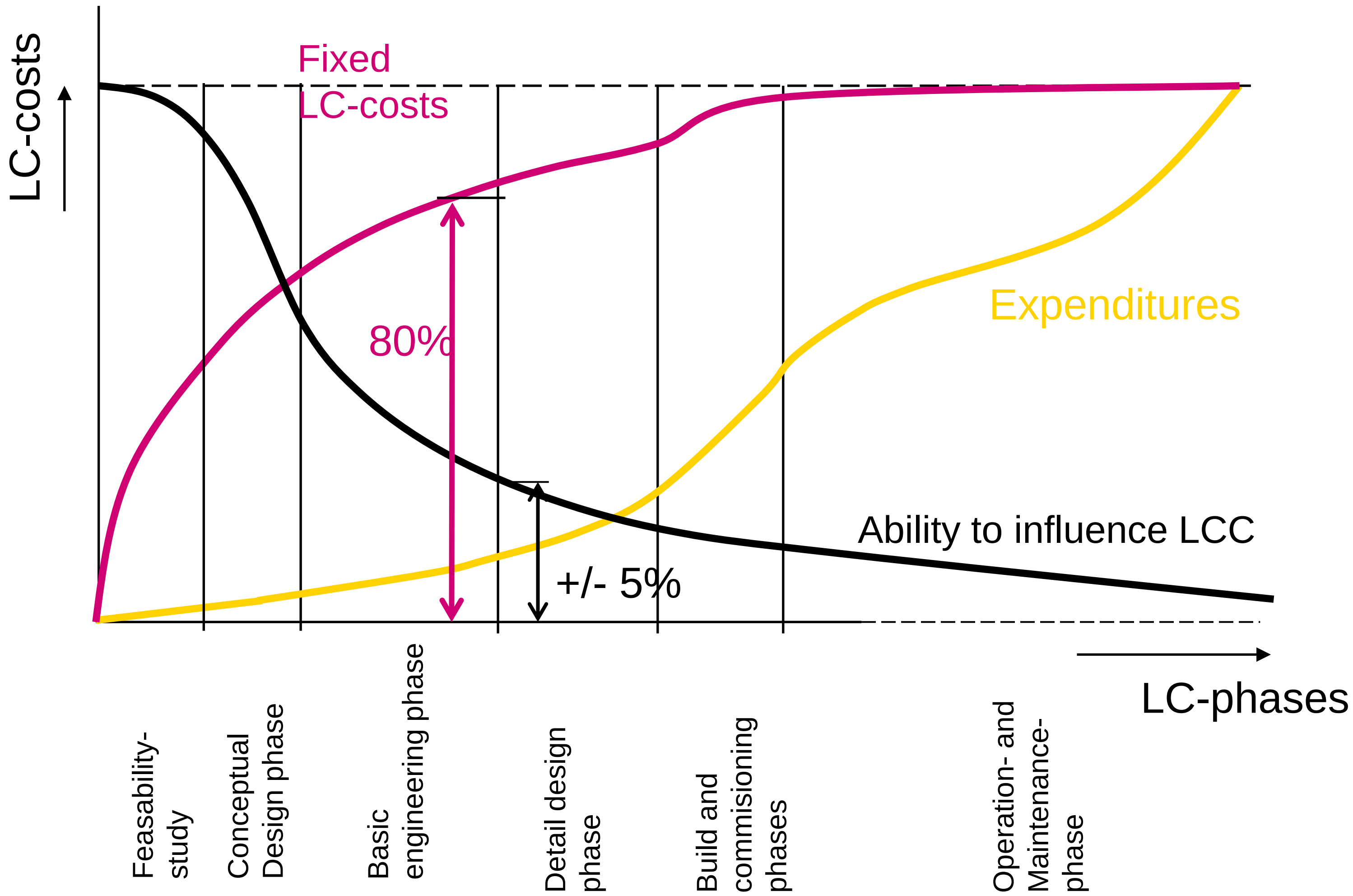
RAMS
RELATIONSHIP WITHIN RAMS

- What is the relationship or connection within RAMS?

- Reliability, Maintainability and Supportability are very similar to each other:

- Reliability is the probability to function properly
- Maintainability is the probability to be maintained or repaired properly
- Supportability is the probability to supporting maintenance action properly

ECONOMICS
LIFE CYCLE COSTS



ECONOMICS
INVESTMENT DECISON MAKING: BUYING A CELLL PHONE

- **CHARACTERISTICS**
- What were the **main** characteristics influencing your investment decision?

- **RATIONALITY**
- How **rational** was your decision-making?

- **OBJECTIVITY**
- How **objective** was your decision-making?

ECONOMICS
FEASABILITY STUDY (BUSINESS CASE)

“Feasibility studies aim to **objectively** and **rationally** uncover the **strengths and weaknesses** of an existing business or proposed venture, opportunities and threats present in the environment, the resources required to carry through, and ultimately the prospects for success.”

In its simplest terms, the two criteria to judge feasibility are:
cost required and **value to be attained**.

ECONOMICS
FEASABILITY STUDY (BUSINESS CASE)

- **FINANCIAL AND NON-FINANCIAL**
  - Financial: e.g: Net present value, return on investment, Payback time, sum of OPEX and CAPEX over life-cycle
  - Non-financial, e.g: alignment with strategic goals, safety, stakeholder value, circular value
- **STRATEGIC ALIGNMENT**
  - Determine to what extent the investment is aligned with the short and long term vision of a company
- **STAKEHOLDERS**
  - Identifiy, assess and manage stakeholders in the investment decision making process
- **RISK MANAGEMENT**
  - Identify and manage (technical) risks related to the execution of the investment
- **MULTIPLE SCENARIO'S**
  - Compare various scenario's (e.g. null-scenario)
- **INVESTMENT PROCESS**
  - Structure the investment decision making process (inform stakeholders at the right moment and information)

ECONOMICS
LIFE CYCLE COSTS (LCC)

DEFINITION LCC

- Costs over the whole life cycle: considered include the financial cost which is relatively simple to calculate and also the environmental and social costs which are more difficult to quantify and assign numerical values
- LCC, also called: “Cradle to grave” "Whole Life Cost" of "Cost of Ownership“
- From “Cradle to Grave” to“Cradle to Cradle”

GOALS LCC

- Minimal LCC, optimal investment versus exploitation cost
- Comparison of design alternatives
- Identification of “LCC Drivers"
- Sensibility and risk-analysis
- LCC goals for performance based contracts, cost allocation
- Optimizing preventive maintenance concept
- Replacement timing, Modification (MLU), life time extension

HEALTH ENVIRONMENT AND POLITICS

- Compliancy with regulation and legislation
- Safe Operation and Maintenance
- Reduction/ prevention emissions (e.g. CO_2)
- Short and long term impacts on society
- Re-use of materials (circularity)