ANK 315 AIRCRAFT MAINTENANCE

LECTURE 2

Kamila Kustron, Ph. D.

1 INTRODUCTION TO AIRCRAFT MAINTENANCE
2 STUDENTS' PRESENTATIONS (INTRODUCING YOURSELF IN A PRESENTATION MAINTENANCE POLICIES
3 AVIATION ORGANIZATIONS, AUTHORITY REGULATIONS;
4 STUDENTS' PRESENTATIONS
5 DEPENDABILITY, RELIABILITY, AVAILABILITY, SAFETY, INTEGRITY, MAINTABILITY, RELIABILITY OF SYSTEMS, FMEA/FMECA, FTA, HOMEWORK 1
6 DEGRADATION PROCESSES, DAMAGES, RCM, MSG3 , HOMEWORK 2
7 INTRODUCTION TO DIAGNOSTICS, NDT, SHM, EHM, HUMS
8 MAINTENANCE PROGRAM,
9 OPTIMIZATION OF MAINTENANCE PROGRAM, HOMEWORK 3
10 HUMAN FACTOR AND FLIGHT SAFETY
11 PREPARING TO THE FINAL TEST
12 FINAL TEST I
13 SUMMARY and CONCLUSION of TEST
14 FINAL TEST II
15 FINAL SUMMARY AND CONCLUSIONS

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AGENDA

- Why We Have to Do Maintenance?
  - The Role of the Engineer
  - The Role of the Mechanic
- Failure Rate Patterns
- **MAINTENANCE POLICIES**

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Why We Have to Do Maintenance?

The Role of the Engineer

Perfect systems can be designed on paper but perfect systems cannot be built in the real world

A design engineer may be limited from making the perfect design by – imperfections in the natural world, technology, ability and economics

Very often there is just not enough money to build a (nearly) perfect system

However, the designer is obliged to build the best system possible within the constraints which exist

A project manager for a new aircraft will be responsible for the project budget

He will ask his design manager, “how much will it cost to build this ?”

The design manager might say $120M

The project manager, however, might be limited to a budget of $100M for the production cost of each of the new aircraft

In this case, the design manager must redesign the new aircraft so it can be built for $100M

That usually means – reduced tolerances, cheaper materials, and, consequently, more entropy

More entropy in the design will mean more maintenance is required

The design engineer's main problem is then to minimize (not eliminate) the entropy of the system he or she is designing while staying within the required constraints

The Role of the Mechanic

Entropy exists in every system and the entropy of a system is always increasing

This means not only that a real system which starts off being new will have some entropy already built into it, but that the entropy will increase with time

Some components or systems will deteriorate from use, or even lack of use

Misuse by an operator may cause some deterioration

Therefore, while the engineer's job is to minimize the entropy of a system during design, the mechanics job is to fight the continual increase in the entropy of a system during its lifetime

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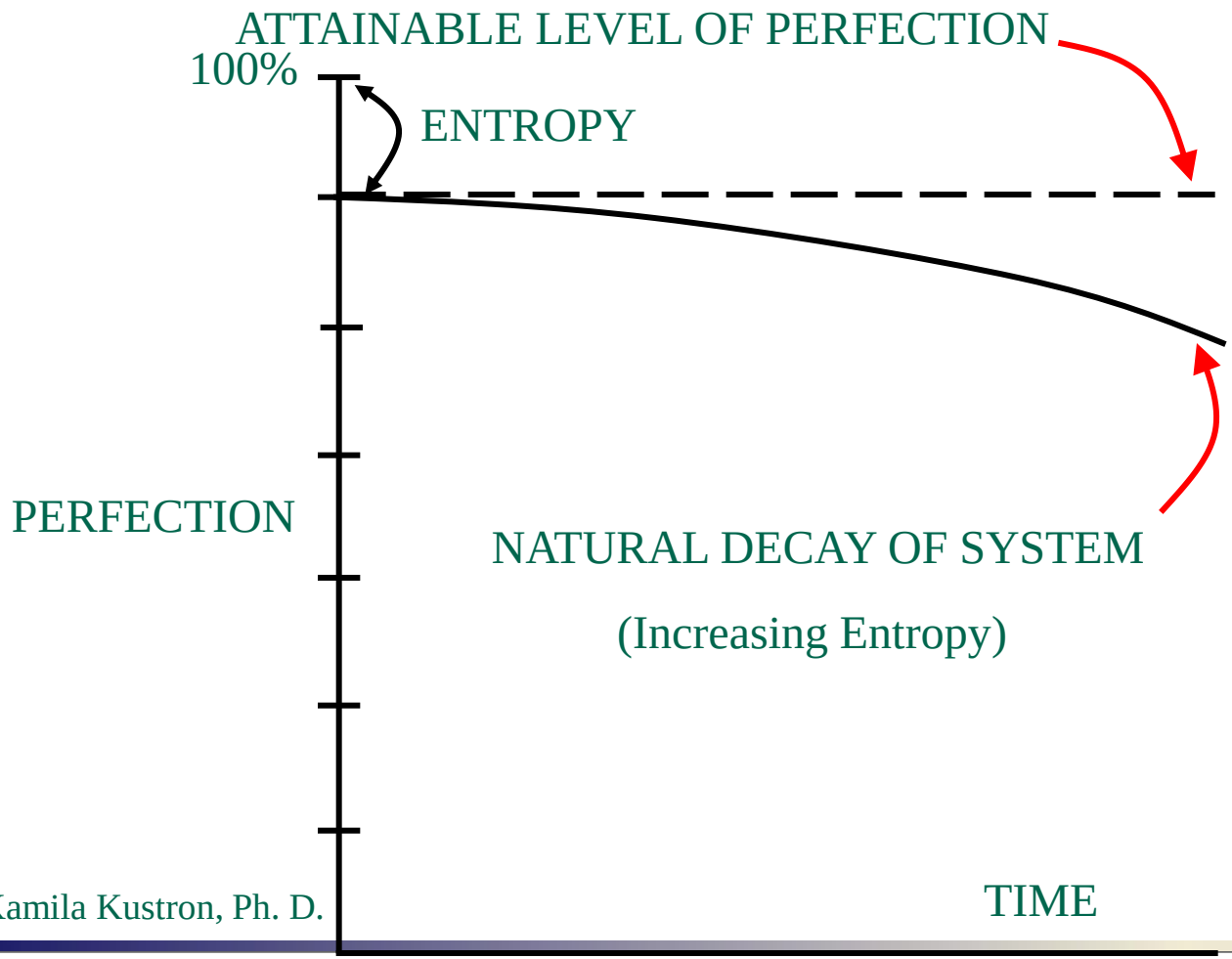
This graph shows the level of perfection of a typical system:



The solid curve shows the level of perfection of a real world system.

Note that the curve turns downwards with time.

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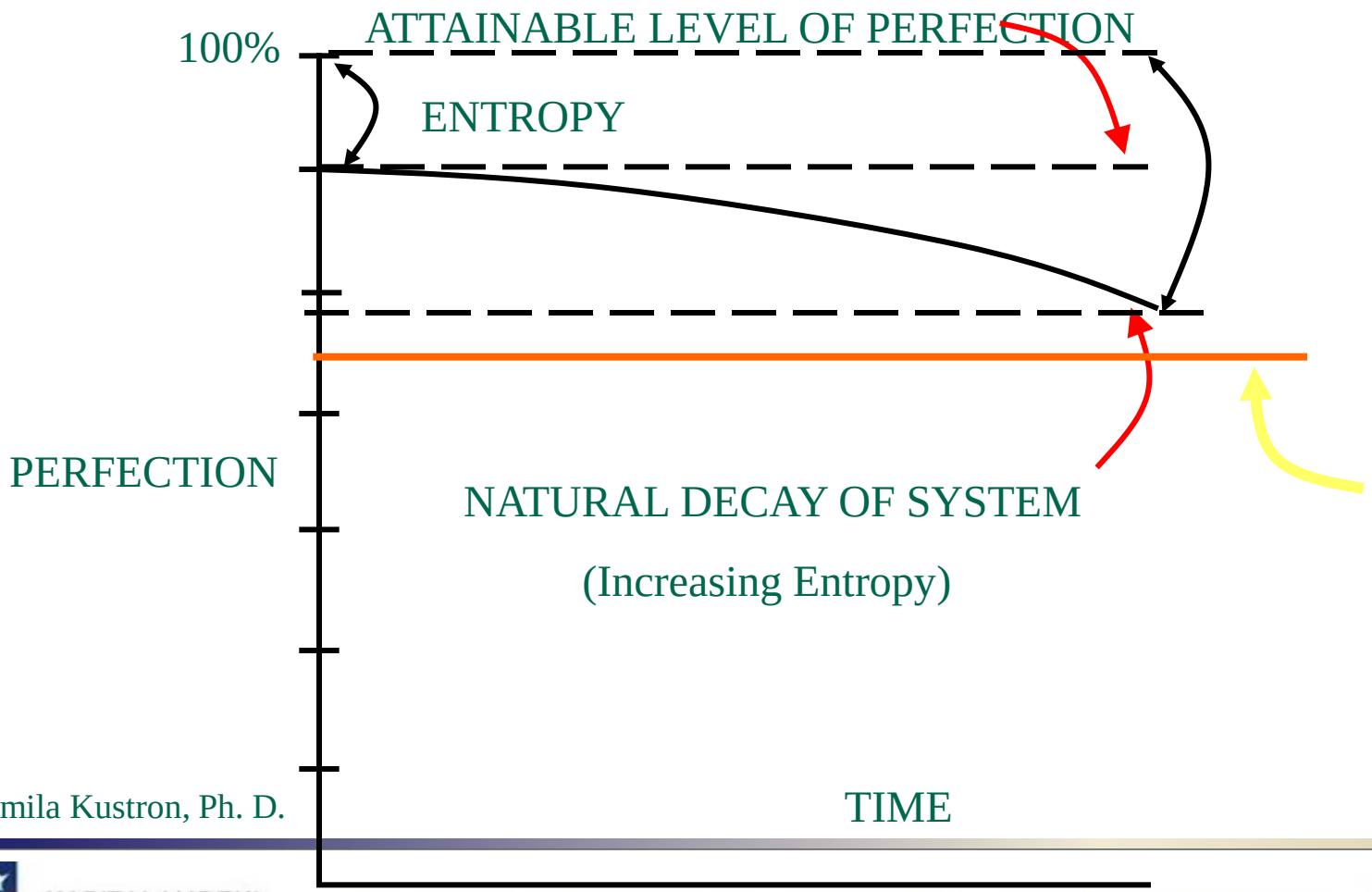
When the system deteriorates to some lower level of perfection, it is necessary to perform some corrective action - adjusting, servicing, etc.



System needs to be corrected when it reaches some lower level

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In other words, at some point, we have to perform some maintenance to restore the system to its designed-in level of perfection.

We need to reduce the entropy to its original level.

This is called *preventative maintenance* and is usually performed at regular intervals.

This is done to prevent deterioration of the system to an unusable level.

Preventative maintenance is also sometimes referred to as *scheduled maintenance*.

This schedule could be daily, every flight, every 200 flight , hours, or every 100 cycles (a cycle is a takeoff and landing).

Considering the number of components on a modern aircraft, maintenance is a complex, on-going process

For this reason, we will see that aircraft maintenance must be approached *systematically*

Definition

⇒***systematic***

⇒*adjective*

done using a fixed and organized plan

e.g. "the systematic collection and analysis of information" ***systematically*** *adverb*

Failure Rate Patterns

Not all systems or components fail at the same rate nor do they all exhibit the same pattern of wear out and failure

This is important because the nature of the maintenance to be performed on these systems and components is related to their failure rates and failure patterns

United Airlines did some studies on lifetime failure rates and found six basic patterns

six basic patterns

Note : The vertical axes show failure rates, not reliability! The higher the vertical position, the worse the failure rate. The horizontal axes show time

A. Infant mortality; constant or slightly rising failure rate; definite wear out period (4 %).

B. No infant mortality; slightly rising failure rate; definite wear out period (2 %).

C. No infant mortality; slightly rising failure rate; no definite wear out period (5 %).

D. Increasing failure rate at outset; constant or slightly rising failure rate; no definite wear out period (7 %).

E. No infant mortality; constant failure rate throughout life; no definite wear out period (14 %).

F. Infant mortality; constant failure rate throughout life; no definite wear out period (68 %).

The United Airlines study showed that only about 11 % of the items included in the experiment (curves A, B and C) would benefit from setting operating limits, or from applying a repeated check of wear conditions. The other 89 % would not.

Consequently, time of failure, or deterioration beyond useful levels could be predicted on only 11 % of the items.

Only components with definite life time limits and/or wear out periods will benefit from scheduled maintenance !

The required maintenance activity for these items can be spread out over the available time to even out the work load.

For the other 89 %, these items will have to be operated to failure before replacement or repair is done.

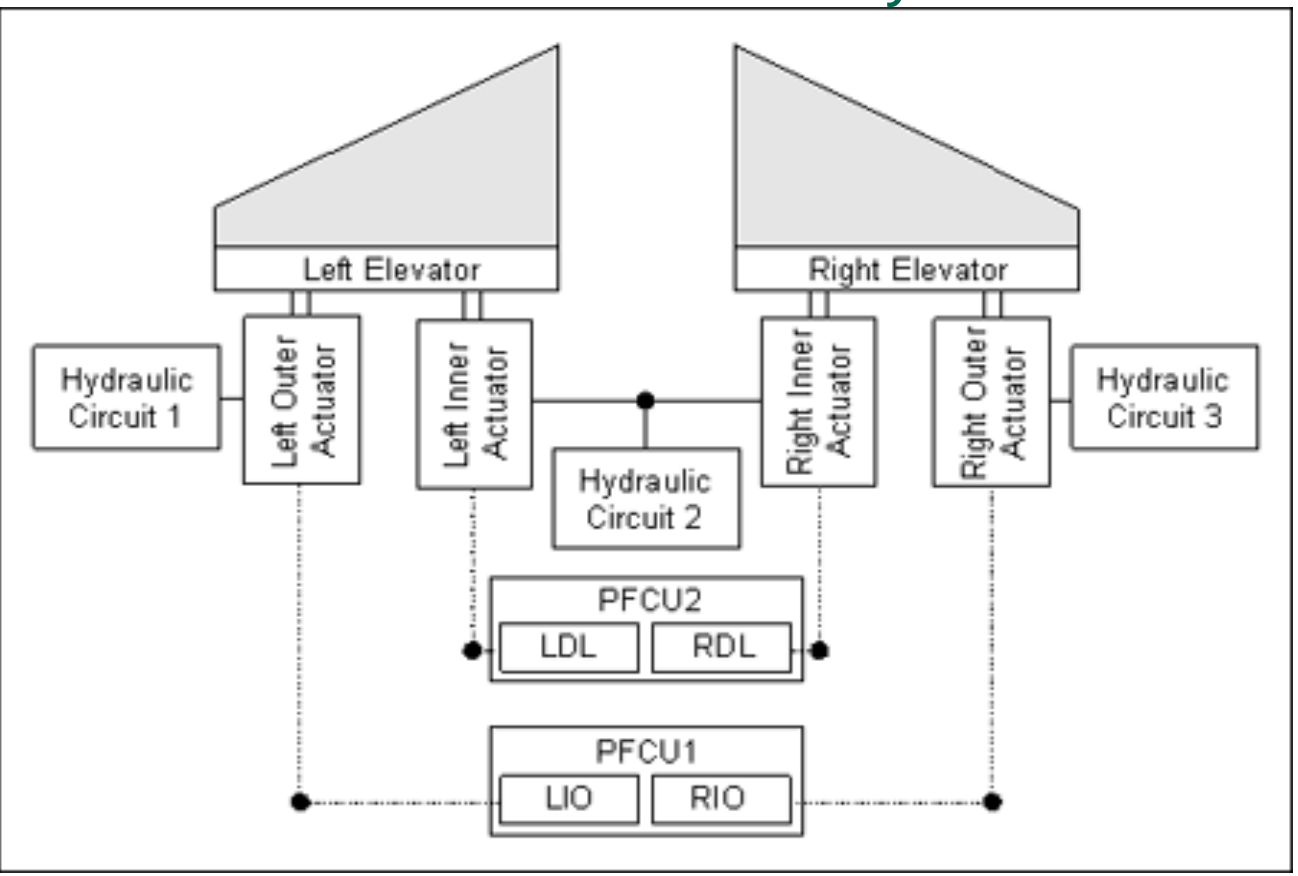
This is unpredictable and would result in a need for maintenance at odd times – i.e. unscheduled maintenance.

These characteristics of failure make it necessary to approach maintenance in a systematic manner, to reduce periods of unscheduled maintenance.

The aviation industry has developed three management techniques for handling in-service interruptions which occur where items must be operated to failure before maintenance can be done.

1. Redundant Systems

In redundant systems, if one unit fails, one or more backups are available to immediately take over the function :



Example 1

Aircraft elevator hydraulic actuator

2. Line Replaceable Unit (LRU)

An LRU is a component or system that has been designed in such a manner that the parts that most commonly fail can be quickly removed and replaced on the vehicle.

The vehicle can then continue in without any significant interruption in service.

The failed part can be discarded or repaired later.

3. Minimum Equipment List (MEL)

This list allows a vehicle to be dispatched into service with certain items inoperative – provided that the loss of the function does not affect the safety and operation of the flight.

These items are carefully determined by the aircraft manufacturer and must also be sanctioned by the appropriate regulatory authority during the early stages of vehicle design and test.

The manufacturer issues a master minimum equipment list (MMEL) which indicates all equipment and accessories available for a particular aircraft model.

The airline then customizes this document to produce its own MEL

What you need to know for the final test!

1.Explain what entropy is and its relationship to the need for maintenance.
2.What is the role of an engineer in the context of entropy ?
3.What is the role of a mechanic in the context of entropy ?
4.With the aid of a sketch diagram, explain the relationship between entropy or perfection and time.
5.With the aid of a sketch diagram illustrating the relationship between reliability and time, explain what is meant by the “designed-in level of perfection” and the “point at which scheduled maintenance is done”
6.With the aid of a sketch diagram, explain the relationship between perfection and cost.
7. Give some examples of failure rate patterns. What is the “bath tub” curve ?
8. Explain each of the three management techniques which have been developed by the aviation industry for handling in-service interruptions due to equipment failures. What failure rate curves characterize these types of failures ?

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MAINTENANCE THINKING

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MAINTENANCE THINKING

Concept of Aircraft Maintenance

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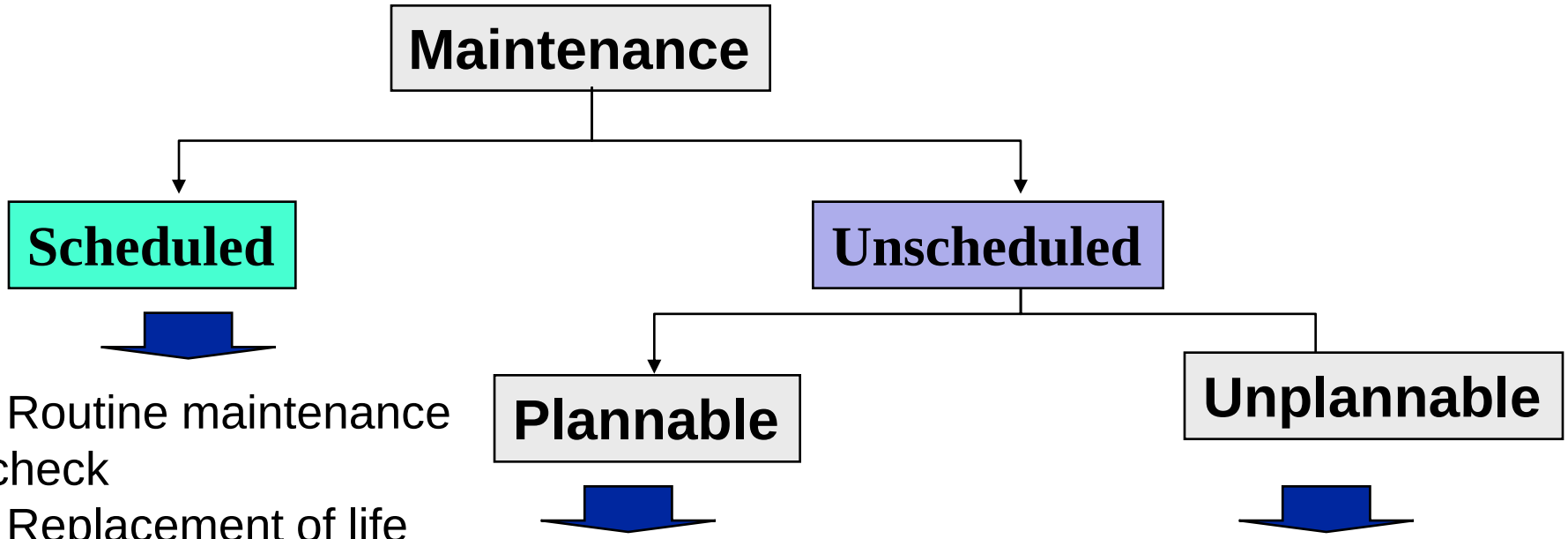
- Types of Aircraft Maintenance



❒ Routine maintenance check
❒ Replacement of life limited items
❒ Cleaning

❒ Performance of modification originated work
❒ Rectification of deferred defects

Activities originated from:
❒ Cabin log book
❒ Technical log book
❒ Ground findings

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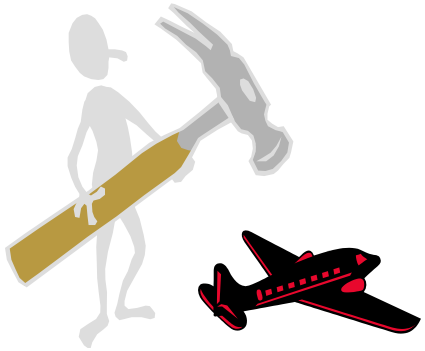
.General



MAINTENANCE DEFINITION

Those actions required for restoring or maintaining an item in serviceable condition

TYPES

- Unscheduled
- Scheduled
- Servicing

LEVELS

(Line (Ramp)

(Hangar or Main base

(Workshop

Mainly unscheduled maintenance limited to the replacement of faulty components that will have immediate or short term influence on aircraft operations (MMEL).

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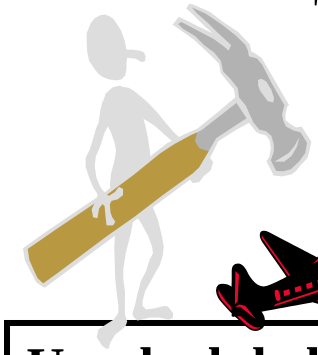
TYPES OF MAINTENANCE



Unscheduled (or corrective):
Maintenance performed to restore an item to a satisfactory condition by providing correction of a known or suspected malfunction and/or defect.
Unscheduled maintenance action is performed if there is a pilot report or a complaint from the scheduled maintenance

Scheduled:

Maintenance performed at defined intervals to retain an item in a serviceable condition (availability, safety and reliability to their inherent levels)

Scheduled maintenance action is performed according to the Maintenance Program requirements

Servicing:
Any act of replenishment for the purpose of maintaining the inherent design operating capabilities of an item

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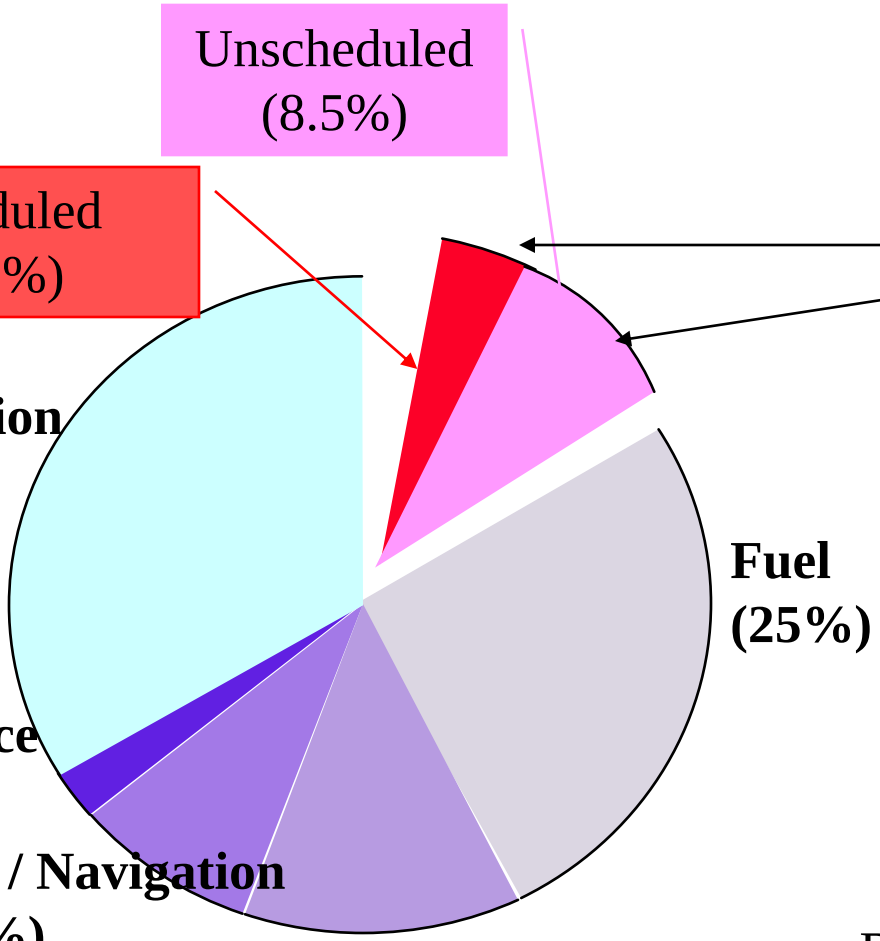
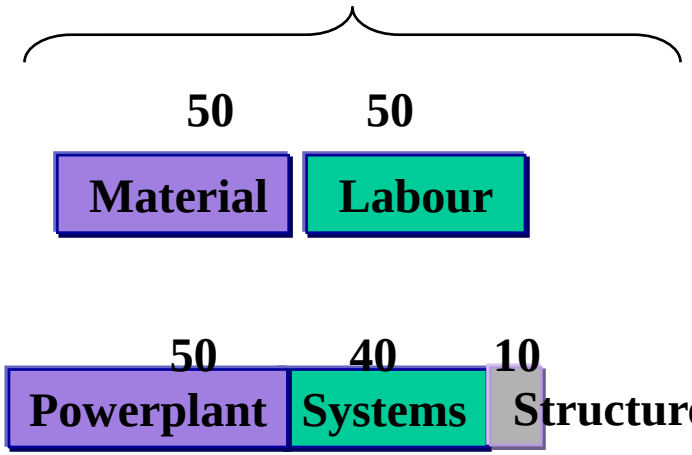
DIRECT OPERATING COST BREAKDOWN





DMC = 700 $/FH (???)

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Aircraft maintenance checks are periodic inspections that have to be done on all commercial/civil aircraft after a certain amount of time or usage; military aircraft normally follow specific maintenance programmes which may be or not similar to the commercial/civil operators.

Airlines and other commercial operators of large or turbine-powered aircraft follow a continuous inspection program approved by National Aviation

Each operator prepares a continuous airworthiness maintenance exposition/program (CAME, CAMP) under its Operations Specifications

The CAME/CAMP includes both routine and detailed inspections

Airlines and airworthiness authorities casually refer to the detailed inspections as "checks"

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.Types of Scheduled Maintenance

- **Light or Line Maintenance:**
  - Preflight Check
  - Daily Check
  - Weekly Checks
  - A (Multiple A) and B Checks
- **Base or Heavy Maintenance:**
  - C (Multiple C) and D Checks
- **Shop or Component Maintenance:**
  - Maintenance on components when removed from aircraft

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Introduction

Operational Aspects

Operational interruption or disturbances have repercussions on the following areas:

- Passengers Comfort
- Corporate Image Of The Operator
- Operating Cost

WHAT KIND OF SCHEDULED MAINTENANCE ARE WE PREPARED TO TOLERATE IN ORDER TO OPTIMISE THE ABOVE CRITERIA ?

COST OF SCHEDULED MAINTENANCE < **COST OF FAILURE CONSEQUENCES**

(SCHEDULED) Maintenance Program (MP) !!!

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NEXT LECTURE

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2 STUDENTS' PRESENTATIONS (INTRODUCING YOURSELF IN A PRESENTATION) MAINTENANCE POLICIES

3 AVIATION ORGANIZATIONS, AUTHORITY REGULATIONS

4 STUDENTS' PRESENTATIONS

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