Brainstorming Part 2
reassessing our progress

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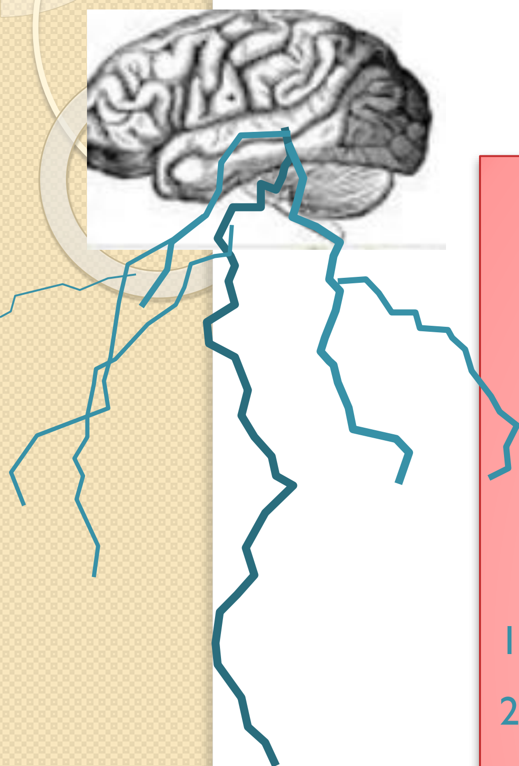
learned Objectives

- What Idea’s we discussed
- Follow up of your brainstorming
- Moment of force revision
- *Revision of first principals of Moment*
- Observations you need to make
- Learn about CNC Axis
- Information on Lead screws
- Determining what critical path testing is required



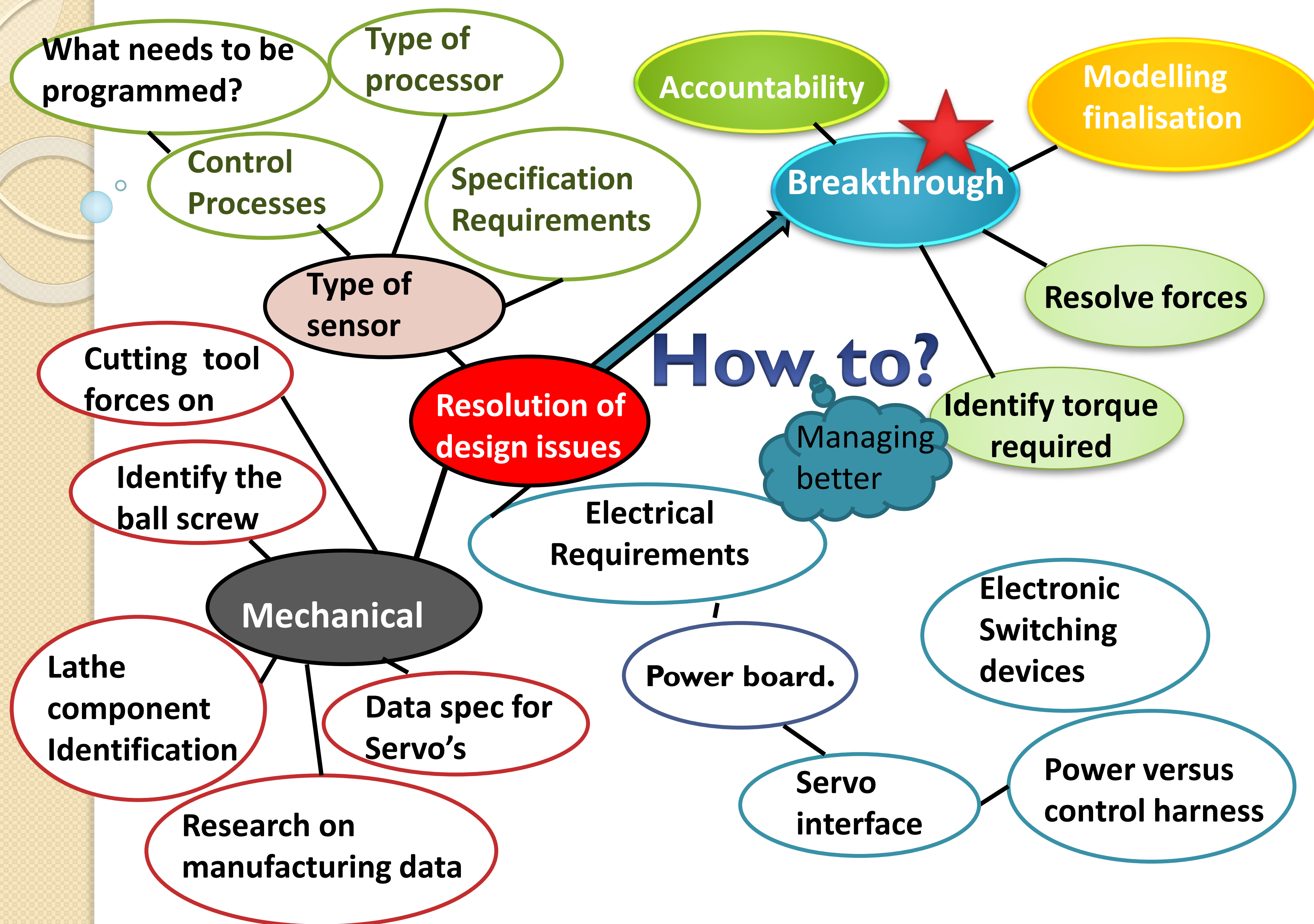
What Idea's we discussed

Key areas we discussed

- Control and technology. (Tran, Corey & Miguel)
- Electrical (Snehdeep , Sundeep & Nimesh)
- Mechanical (Alex, Rosani & Sean)

Common tasks were'

1. Research information and share on student drive.
2. Prepare input to produce a specification for key components such as ;
   - Lathe carriage lead screw (Y axis) .
   - Lathe tool (operate at (x axis).
3. Identify: Force, timing, speed, & direction.
4. Produce a illustration of the Lathe showing key parts.


What needs to be programmed?
Type of processor
Accountability
Modelling finalisation
Control Processes
Specification Requirements
Breakthrough
Resolve forces
Type of sensor
How to?
Cutting tool forces on
Resolution of design issues
Identify torque required
Managing better
Identify the ball screw
Electrical Requirements
Mechanical
Electronic Switching devices
Lathe component Identification
Power board.
Data spec for Servo's
Servo interface
Power versus control harness
Research on manufacturing data

Moment of force revision

- The moment of force about a point is defined as the product of force and the perpendicular distance of its line of action.

$$\boxed{M = Fd}$$

Revision of first principals of Moment

1. Define moment of force and calculate moments of non-concurrent forces about a chosen *reference point*;
2. Determine the resultant of non-concurrent forces and locate the resultant relative to a specified reference point;
3. Define a force acting on a body as an equivalent force-couple system acting elsewhere on the body

Defining a moment of force

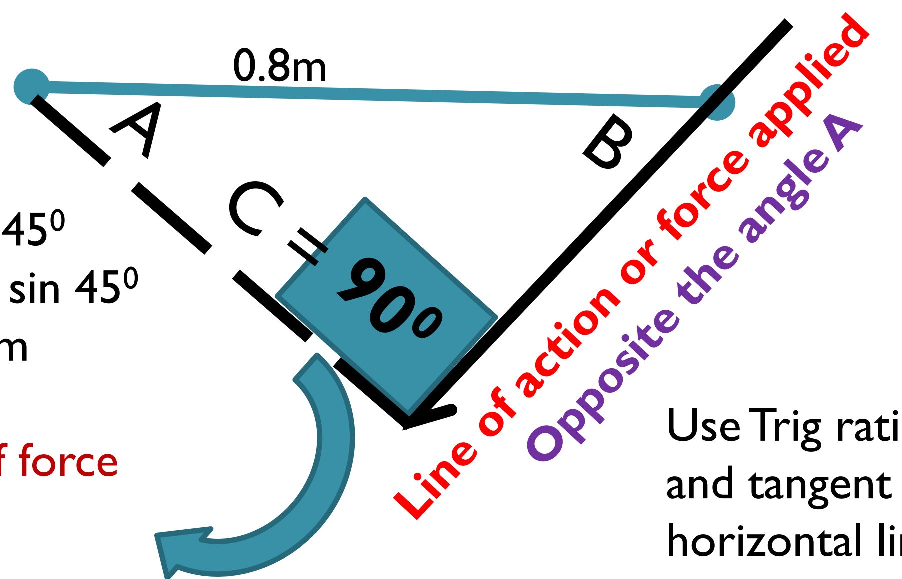
- The product of force and the perpendicular distance of its line of action from that point.
- Line of act is the direction *that the force is acting on*.
- The perpendicular distance must be at right angles to that force or line of action, otherwise losses will result and the actual force for a different line of action will not be realised.
- Using trigonometric equations will be necessary to correct the distance to calculate the correct moment force.

Observations you need to make

- Is the *acting force or line of action at right angle to the moment arm*? If not <u>you will</u> need to use trig ratios to produce a line of action that is at right angles to the moment arm (example).

For angle C to be 90^0 angle A&B = 45^0

F = 50 N



So Md = AB x sin 45^0

Md = 0.8m x sin 45^0

Md = 0.566.m

So the moment of force

M = Fd

50N x .556 m

0 **28.4** N.m clockwise

Use Trig ratios for sine, cosine, and tangent so view the horizontal line as the hypotenuse and a opposite side.

M d = AB sin 45^0

6.3 Example read the problem in the book p89

Determine the momentum of force ***F = 50N about a point A if the distance AB is 800 mm***

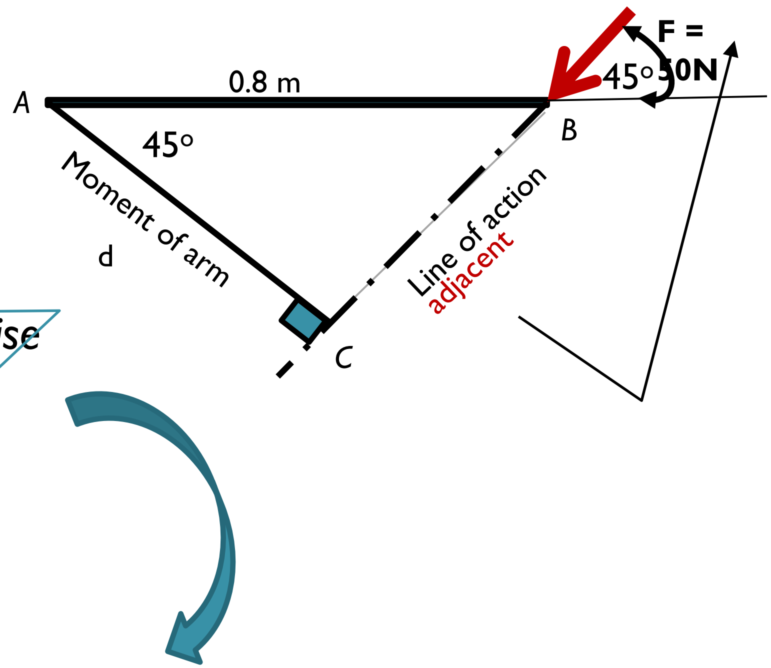
Solution

Try graphically

Momentum arm d = AB sin 45⁰

$= 0.8 \times 0.707$

$= 0.566$ m



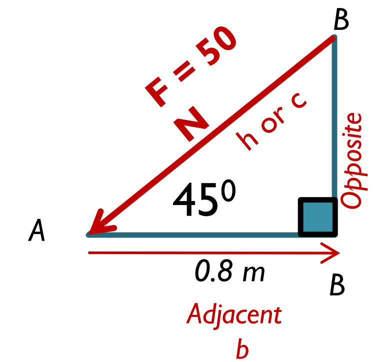
The moment of force is therefore

M = Fd

$= 50N \times 0.566$ m

$= 28.3$ Nm clockwise

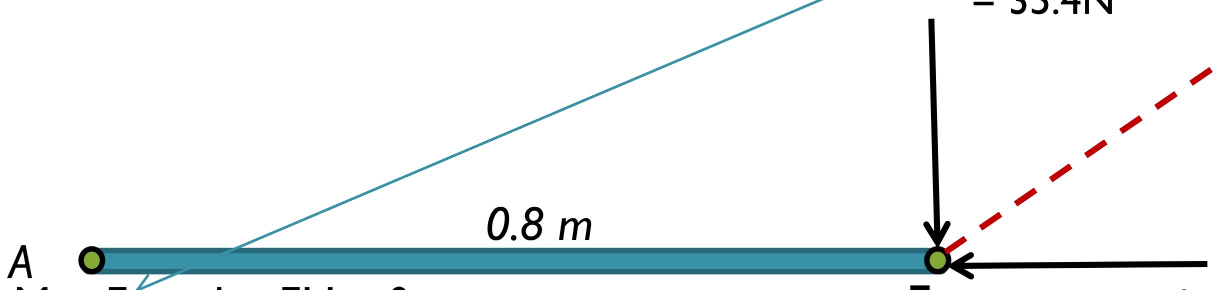
The Avignon theorem



Sates that the moment of force about an axis is equal to the sum of the moments of its components about that axis.

$F_v = 50 \sin 45^0$ (a/h)
$= 35.4\text{N}$

Given
F = 50 N
Solve for H and V.



$M = F_v \times d + F_H \times 0$
$= 35.4\ \text{N} \times 0.8\ \text{m} + 0$
$= 28.3\ \text{N.m}$

$F_H = 50 \cos 45^0 = 35.4\ \text{N}$ (b/h)

A moment *must* always be calculated with respect to a particular reference point.

Note: An actual moment may not occur only a tendency of forces.

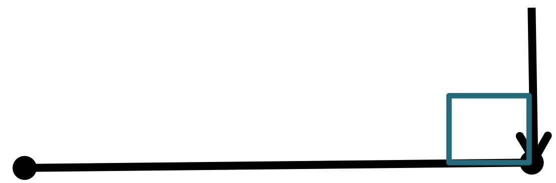
Defining non-concurrent forces

1. As is the case that *concurrent* (a structure that is at rest and to be in static equilibrium or balance) forces by definition when the line of action of all forces intersect at a common point of concurrency**.**
2. Non concurrent forces use a concept of moment of force about a reference point**.**

Where $M = Fd$ Moment = force x distance

Note: The moment of direction, refers to the direction of the force relevant to the distance acted upon.

If the angle is other than 90^0 then *trig equations* must apply to determine the moment of force.



6.1 moment of force

Non concurrent forces have *more than one point* of reference moment of force.

1. A moment is introduced here as an effect in a *non-current* system of forces.
2. Where a moment of force (M) about a point is the product of the force (F);
3. The perpendicular distance to (D) of its line of action from that point.

Archimedes is reputed to say 'Give me a place to stand, and I can move the earth"

The lever provides a means of magnifying a moment of force.

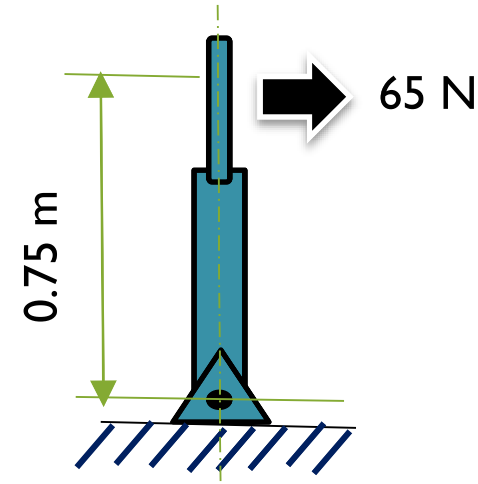
6.1 Example read the problem in the book p88

- The SI unit of momentum of force symbol N.m.
- Given: A figure with the required moment (M)
- Force = 65 N
- Distance = 0.75m

SOLUTION:

M = Fd = 65 N x 0.75 m

M = 48.75 N.m CLOCKWISE



Note: the answer also indicates the directional sense of the moment, clockwise .

Defining non-concurrent forces

1. A system of forces is called to be non-concurrent when it, ***<u>does not have a single point of concurrency.</u>***
2. **This illustration has three points of congruency applying moments of force.**

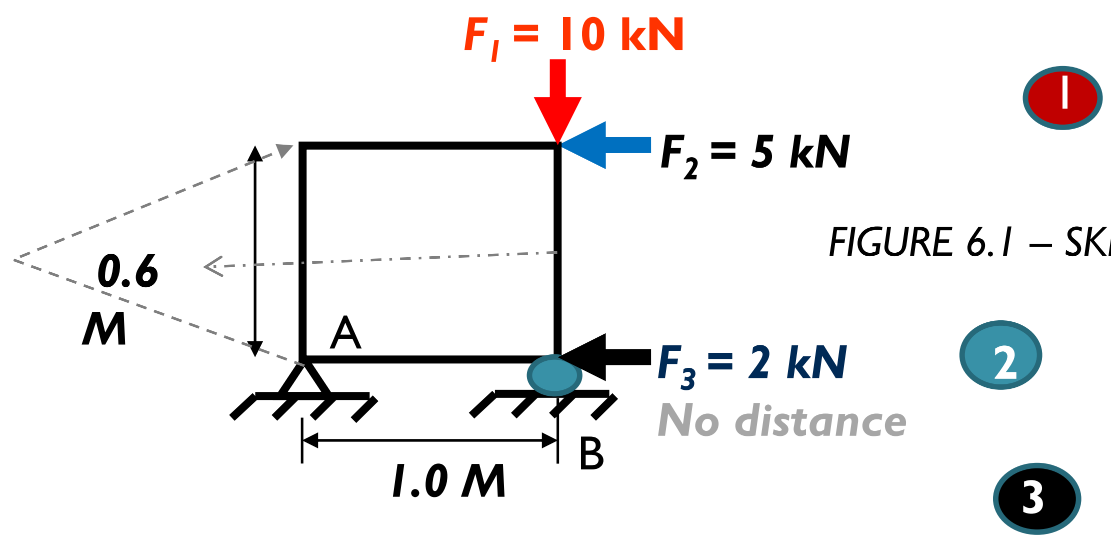
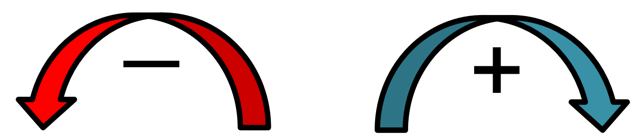


FIGURE 6.1 – SKETCH

Observations you need to recognise

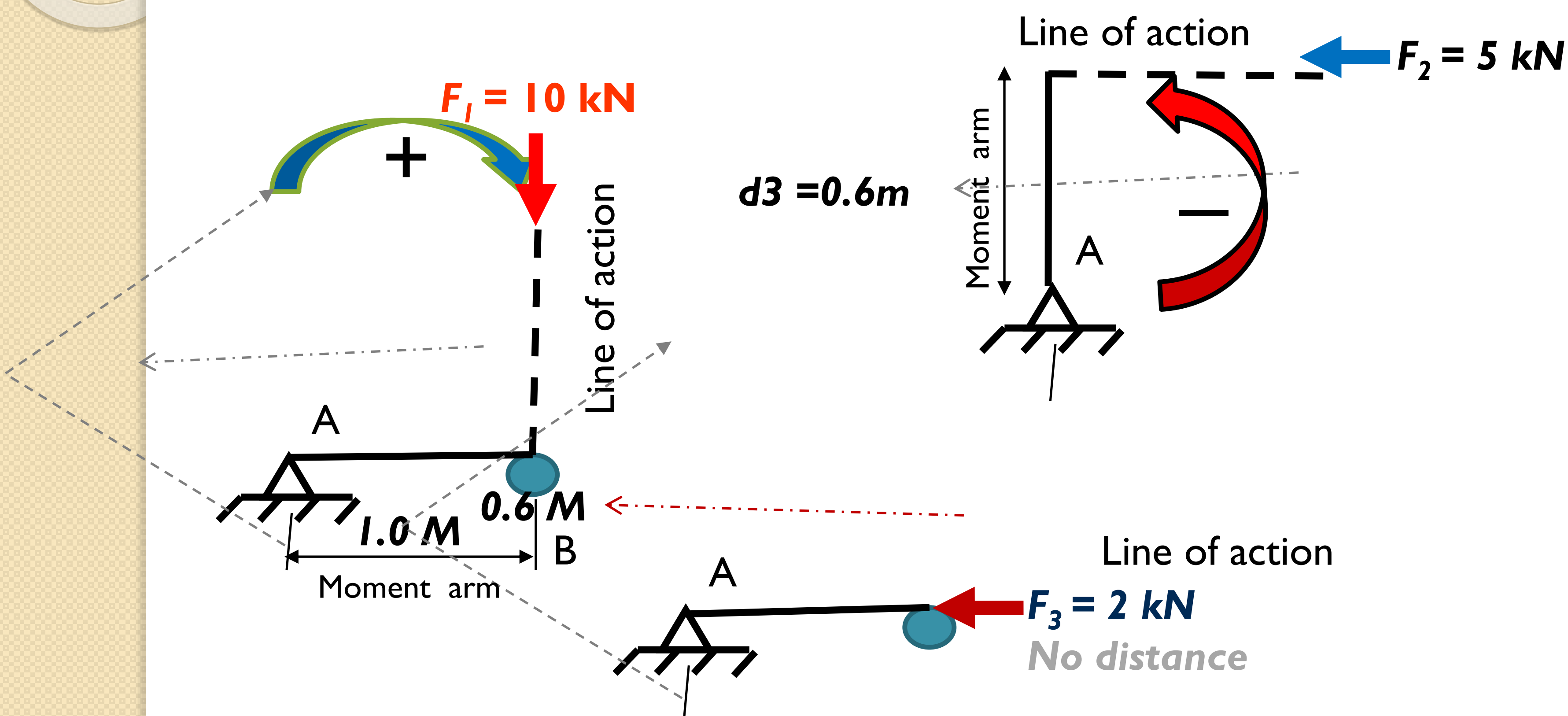
- Are there multiple forces with different line of action?
- In what direction is the moment of force about a point of rotation? You need to define the force about a point.
- Are all the acting line of action at right angles?
- Note *if there are more than one force acting on a body*, each tends to produce a turning effect about a point.
- The algebraic sum means that the moments of each

can be added together.



- $\Sigma M = M_1 + M_2 + M_3$ (the sign changes pending direction line of action)
- Note the illustration to determine the change in sign.

Evaluating a moment about a point for three examples



6.2 Example read the problem in the book p88

GIVEN: A FIGURE

REQUIRED: MOMENT (M)

SOLUTION: M @ POINT A

1. $M_1 = F_1 d$ = 10 kN x 1.0 m

M_1 = 10 kN.m clockwise

2. $M_2 = F_2 d$ = 5 N x 0.6 m

M_2 = 3 kN.m *counter clockwise*

Note anticlockwise direction changes the sign = -3 KN

3. ***$M_3 = F_3 d$ = 2 kN x 0 m = 0***

ΣM = +10kN.m – 3 kN.m + 0kN.m = <u>+7kN.m clockwise</u>

STUDY EXAMPLE 6.3

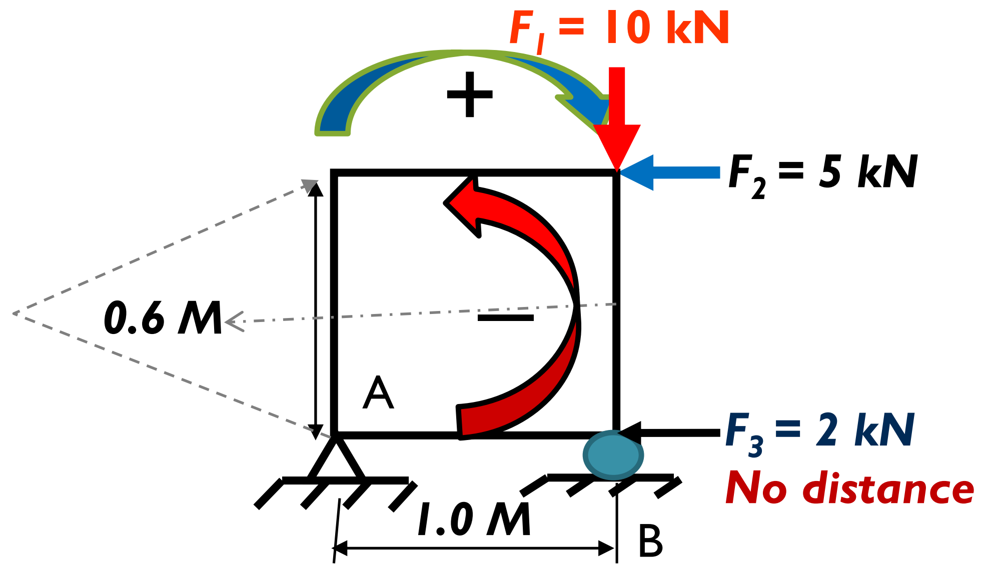


FIGURE 6.1 – SKETCH

6.2 Addition of Moments

If more than one force is acting a body, there is a corresponding number of force, each tending to produce a turning effect about the point..

The total turning effect, or resultant moment, is the algebraic sum of he moments of all the forces acting on the body.

Algebraic sum means that the different sense of the various moments must be taken into account when the moments are added.

Note; **+** values for the moment is a sign for are clockwise rotation

- values for the moment is a sign for are anti-clockwise rotation

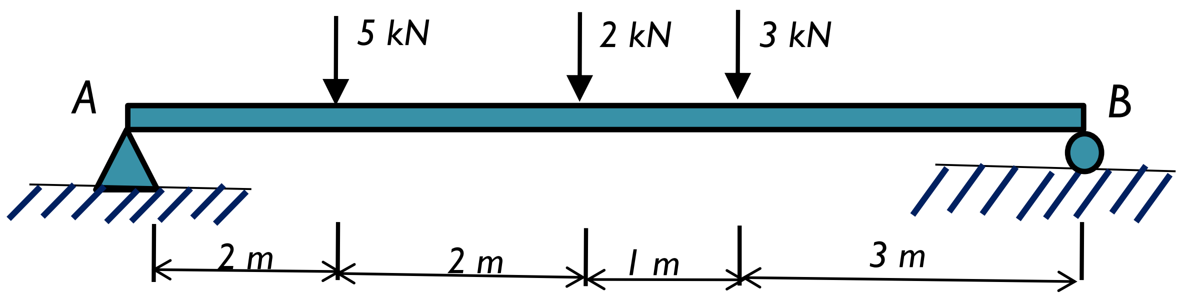
Returning to problem 6.2

$M = M_1 + M_2 + M_3$

$= +10\ kN.m - 3kN.m + 0$

$= kN.m$ *clockwise*

Example 6.6 p 91 (horizontal beam at rest)

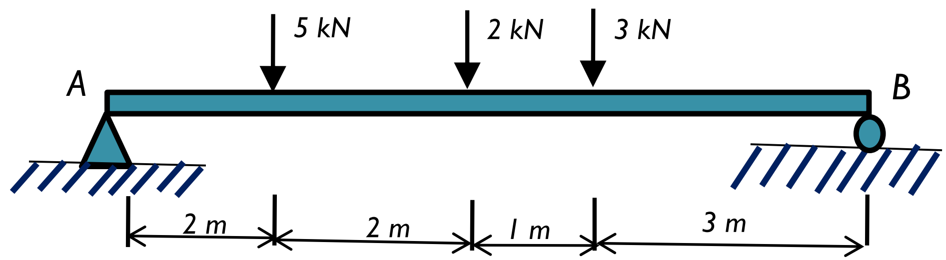


A horizontal beam rests on two supports A and B, and supports three forces as shown in Finger 6.6

a) About the left-hand support *A*
b) About the right-hand support *B*

Solution 6.6

p91



a) About the left-hand support *A*

$MA = \sum(F \times d)$

$= (5 \times 2) + (2 \times 4) + (3 \times 4)$

MA = 33 kN.m clockwise

b) About the right-hand support *B*

$MA = \sum(F \times d)$

$= (5 \times 6) + (2 \times 4) + (3 \times 3)$

MA = 47 kN.m anticlockwise

Approach to solve the problem

Information given

- Derive value for force derived from the max torque.
- Investigate dynamic force separate from static.
- The different of forces is a balance resultant force.
- The next task is to calculate the balance moment.
- Think laterally, clearly the dominant force which would clearly rotate towards the main drive shaft.
- If the ball screw remained was the dominant you must also review over a range of speeds required for different needs.
- Think about the bearing loads R/ LHS and the line of axis.

Torque turning effect applying relationships between displacement, P201 velocity and acceleration.

Two key considerations are the;

i. Start up torque
ii. Braking torque

Objective is to determine the moment of inertia at extreme winds.

In this case the Torque is ‘pure turning effort’ measured on Nm.

Torque is the sustaining effort applied to mechanical components.

Requiring a fixed distance from a pivotal geometrical point of axis.

A close relationship exits between torque and the acting forces such as gears and cams.

Torque *using angular velocity*

Torque = *Angular acceleration* $\alpha \times I$ *moment of inertia*

Where;

T =Torque = 0.6 x 95.16 = 57.1 N.m

r = radius of turbine 0.6 m

I = Force Resultant **95.16** Nm

Conversion from Torque to Power

- Conversion factor may be necessary when using different units of power, torque, or angular speed. In our case angular speed (radians per time) in our case it is given in seconds, it it were given in RPM we would need to multiply by a factor of 2π radians per revolution.

Power $W = T \times 2\pi Rps$

$W = 95.16 \times 2 \times 3.1429 \times 6.63$

$W = 3{,}965$

Mass of Inertia $kg.m^2$

$$I = \frac{mr^2}{2}$$

Where

$\boldsymbol{I}$ = kg/m^2

$\boldsymbol{m}$ = mass of the object in kg

r = radius in m

Angular velocity radians / s

$$\omega = G_{rpm} \times \frac{2\pi}{60}$$

Where

ω **= *Angular velocity rad / s***

T_{rpm} = *turbine rpm*

Turbine Torque N (kg.m^2)

$T = \omega \times I$

Where

ω **= *Angular velocity rad / s***

T = *Torque N/m^2*

I = *Inertia*

Turbine pulley Force in N.m

$$F_T = \frac{T}{r}$$

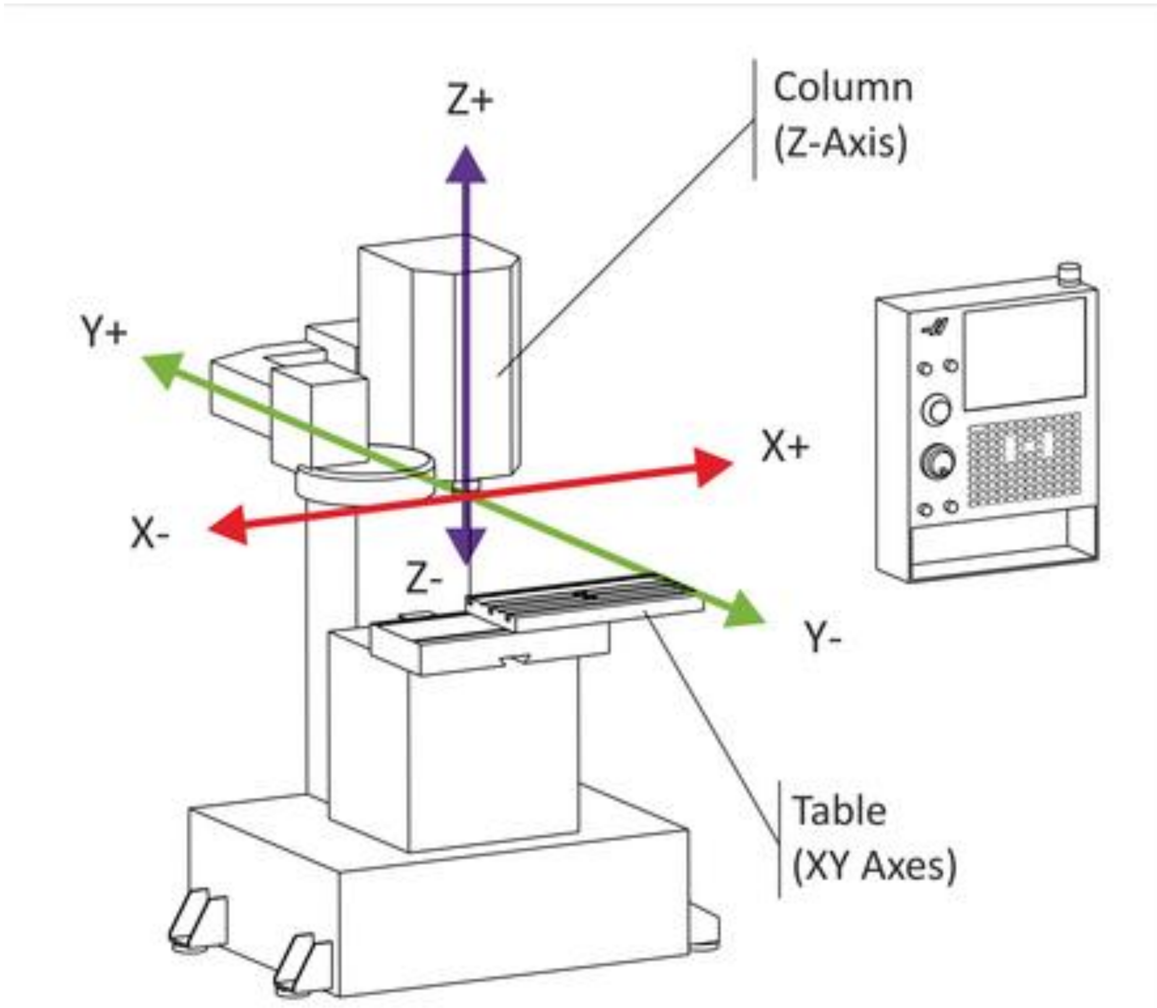
Where

$\boldsymbol{F_T}$ = *Force transferred by turbine pulley N.m*

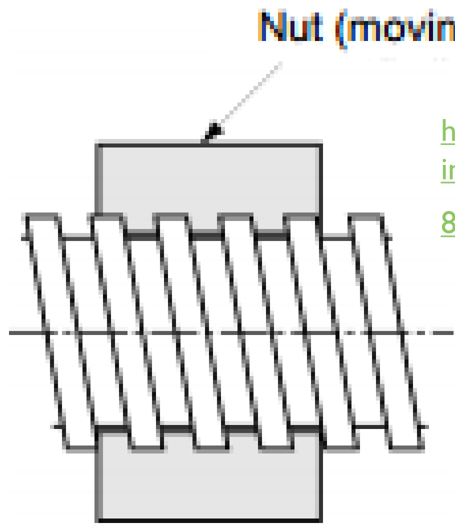
$\boldsymbol{T}$ = *Torque N/m²*

$\boldsymbol{r}$ = *Variable Speed Pulley PCD*

Lean about CNC Axis



Information on Lead screws



Acme thread lead screw

- Used to move things or to transfer forces.
- Screw portion of a jack, one of the tools furnished with a car, is a good example.

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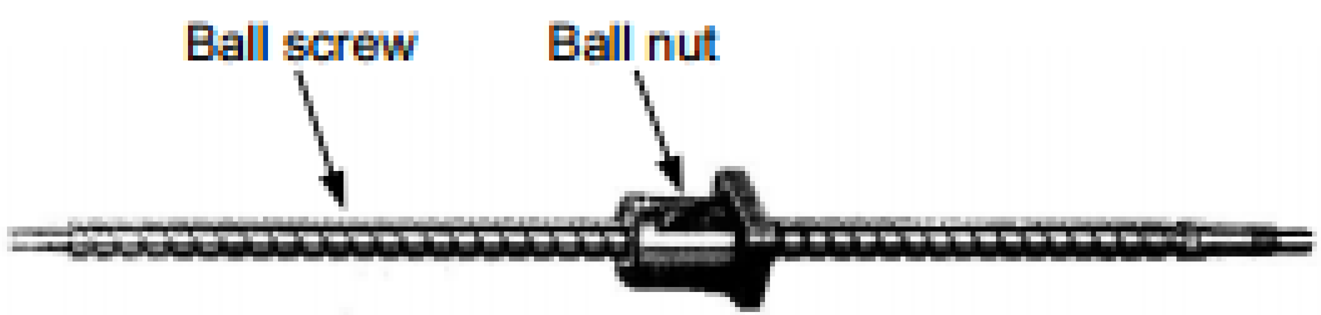
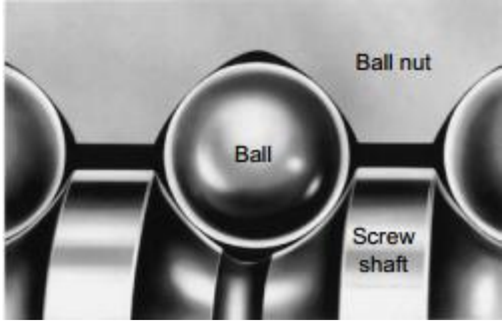
What is a Lead screw?
source
information NSK



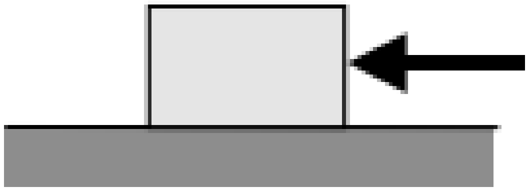
Sliding friction



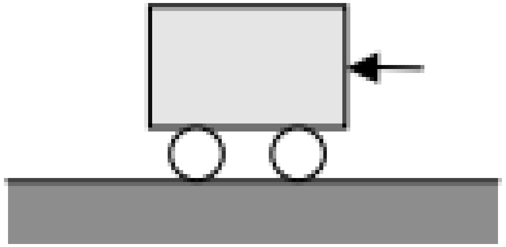
■ *Note* ■ What is friction force? (Sliding and rolling friction)

◊When you want to slide a box sitting on a floor, it does not move while your pushing force is yet too small (static frictional force). But, it starts moving when the pushing force has reached a certain level. In order to keep the box moving on, you need to maintain your pushing force at its dynamic frictional force, which is far less than the static friction force.
As described above, the **friction force** is the force that two objects exert upon each other through their contact surface and hinder each other's relative movement when they are in contact.

◊The intensity of frictional force varies with the state of contact. A friction force of rolling contact is usually smaller than that of sliding contact.



Sliding friction ↔ Acme thread screw
(Requires larger force)

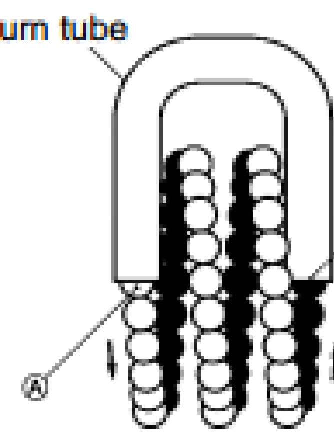


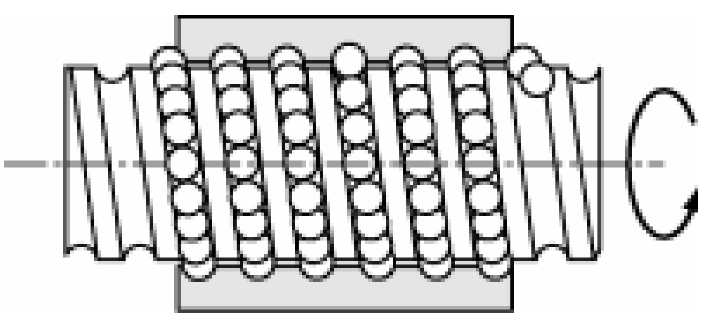
Rolling friction ↔ Ball screw
(Requires far less force)

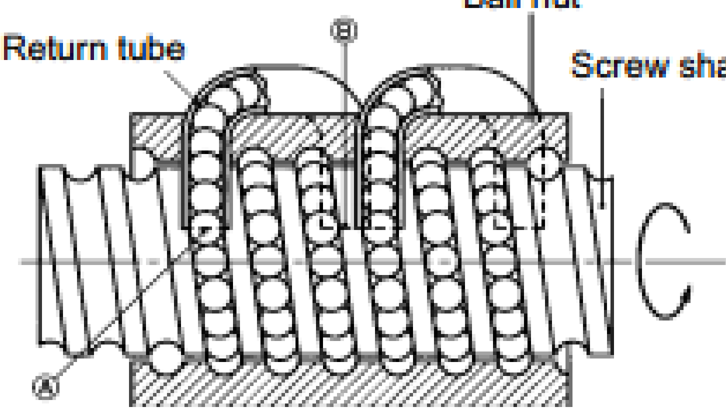
How ball screw feed back into the ball race.

The way the steel balls recirculate endlessly (in the case of return-tube type)

When the screw shaft is rotating, as shown in the illustration, a steel ball at point (A) travels 2.5 turns of screw groove, rolling along the grooves of the screw shaft and the ball nut, and eventually reaches point (B). Then, the ball is forced to change its pathway at the tip of the tube, passing back through the tube, until it finally returns to point (A). Whenever the nut strokes on the screw shaft, the balls repeat the same recirculation inside the return tube.







Key technology challenges

- Robust design that stands up to the riggers of;
  1. Environment
  2. Ease of assembly.
  3. Has excellent display on performance issues.
  4. Has back up capabilities in the case of partial system failure.
  5. Complies to standards.
  6. Meets the Scope requirements.

Strategy

- Identify what you do know
- Share information.
- Develop strategies on how you might work together to meet the challenge.
- Consider technologies that could achieve desired outcomes.
- Identify the unknowns ask questions .
- Experts are working in the background to help guide you but not do the work for you.
- Identify the critical path develop ideas on cost, time and resources.

Structuring a Project

- The project team must determine *every major process* and create a sub directory list of objectives and resources to support that project.
- You must also determine the linkage *cross functional processes.*
- Analyse and understand the scope determine acceptable method for translating project objectives to deliverables.
- Produce a *work breakdown* structure (top down) under each major sub group.
- Produce the *work breakdown structure*.
- Measure and monitor project status
- Analysis and *identify potential risks*.

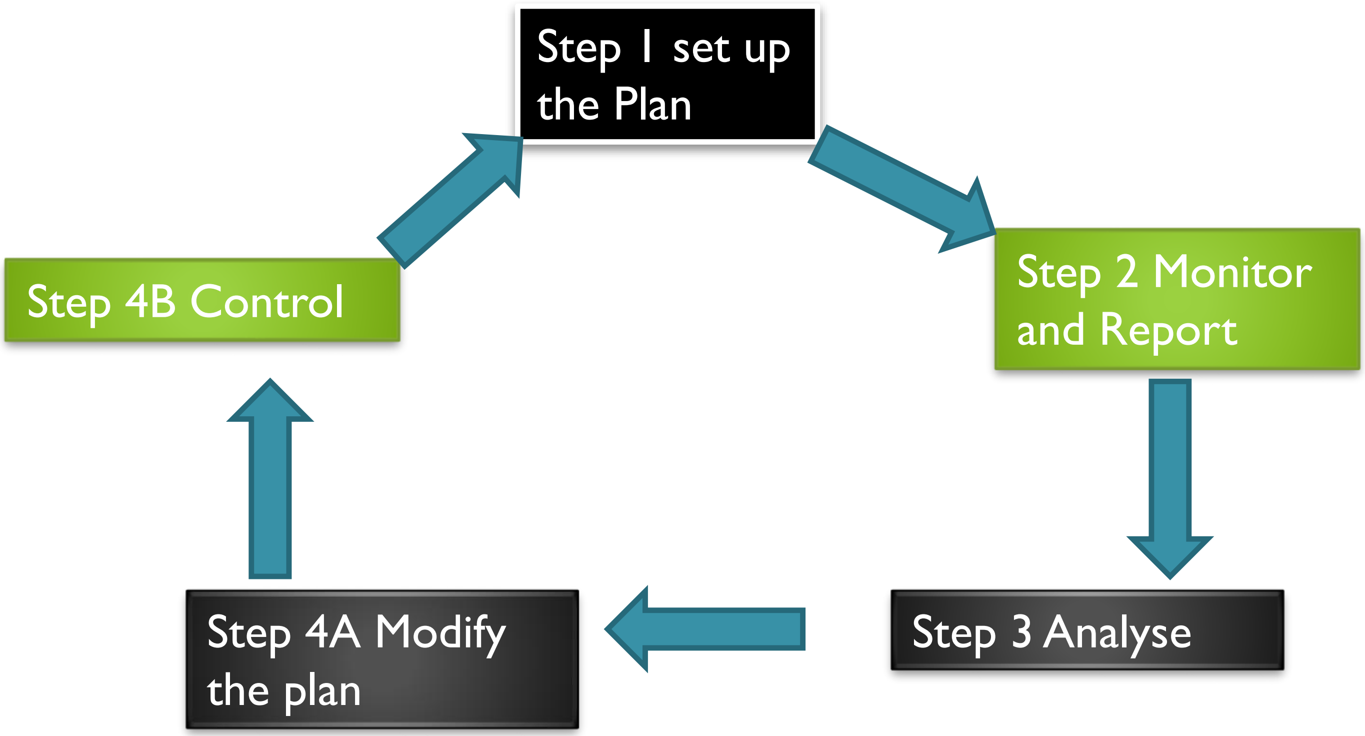
Idea's

- Review the expertise you have in your group
- Expertise needed
  - Who is innovative & researching the internet for answers
  - Persons with electronics / programing skills
  - Who is a team mentor / leader in your team
  - Who is the go to mechanically make things
  - The pragmatist (focused on reaching a goal) that can construct a report?
  - Who is good a excel and word?
  - All round team person?

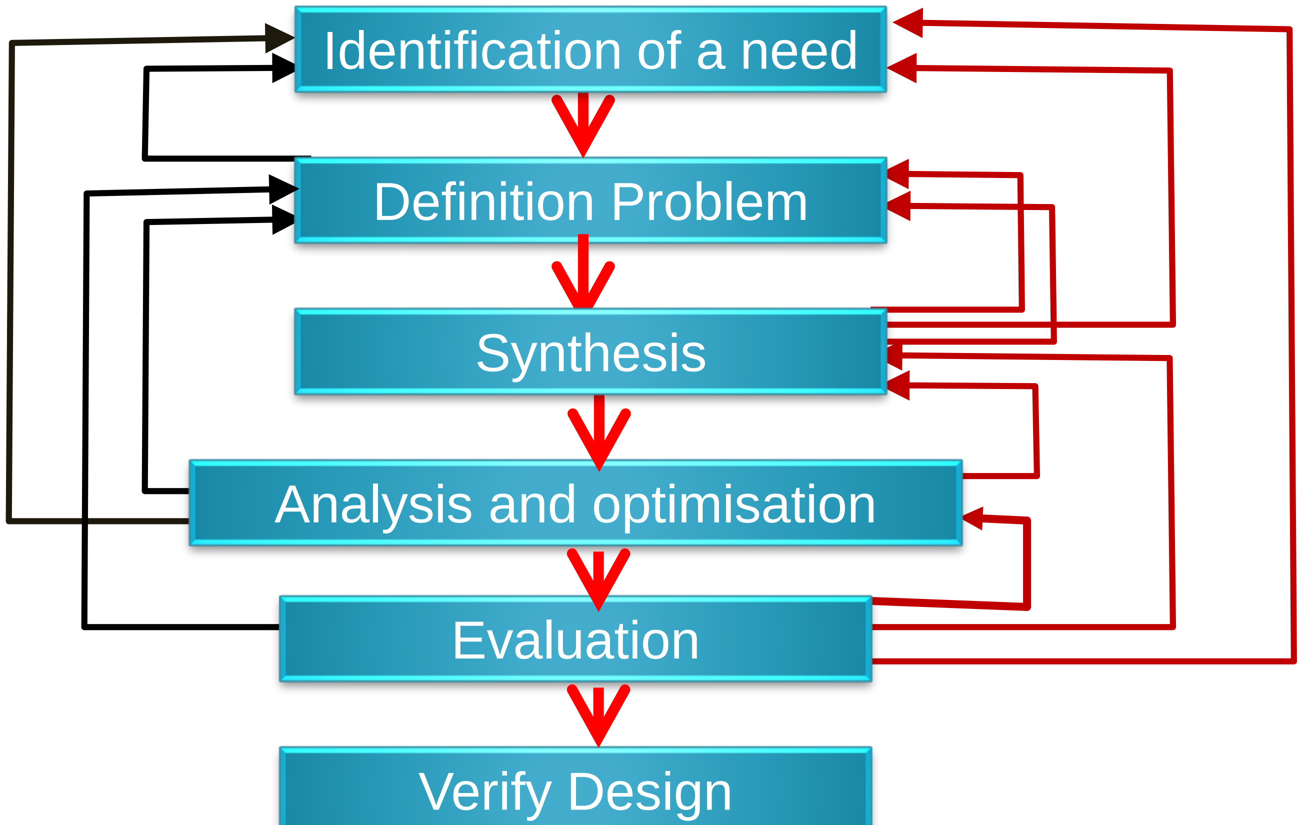
Plan to achieve

- You agreed to do certain tasks, did you do them?
- Have you identified what critical information you need to get the next part of the task completed?
- Record exactly what each of you has agreed to complete by next week!
- Project Management training is coming your way but you must get up to speed with the project first.

The Plan structure



Phase and Integrations of the Design Process

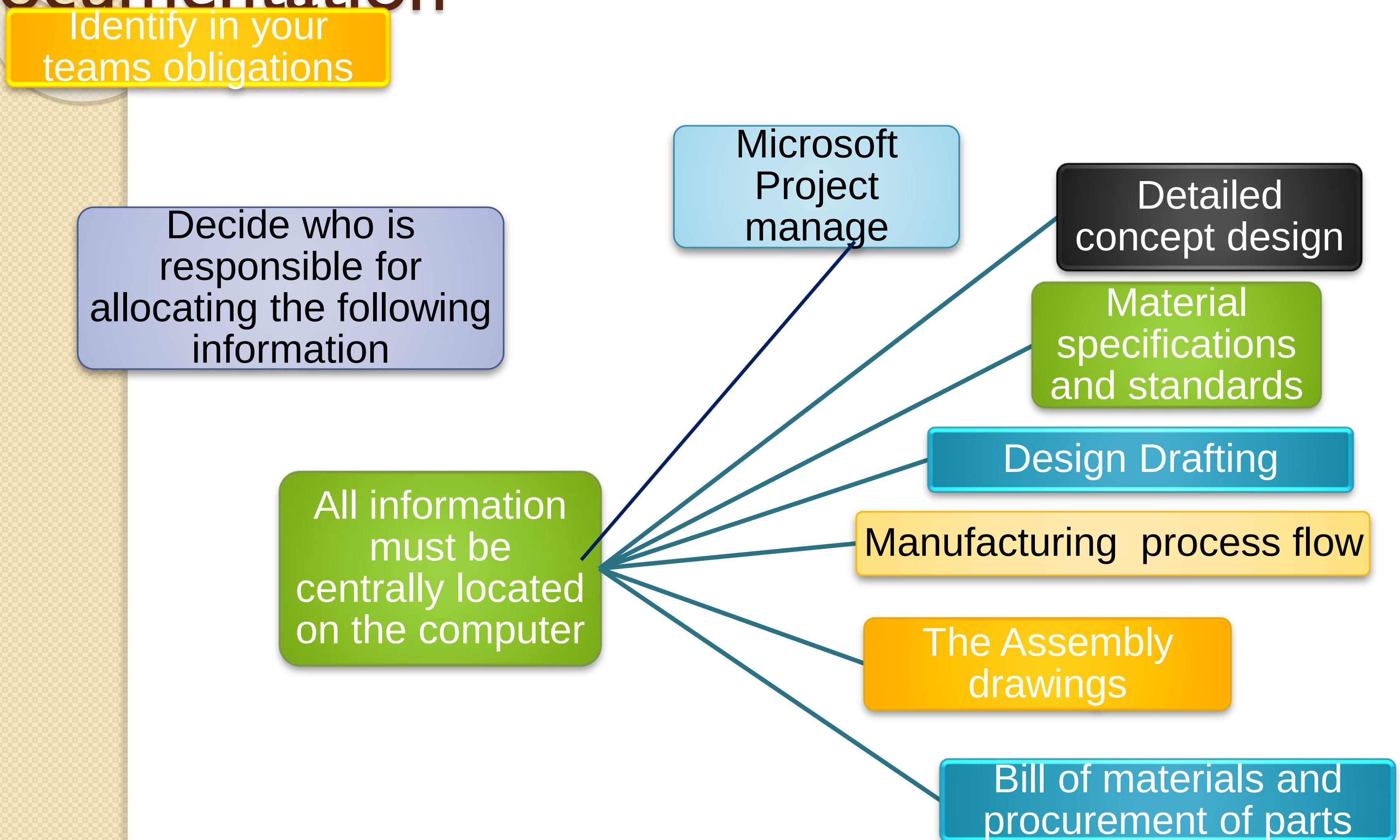


Synthesis is to combine two or more things to produce a new more complex product

Team activity

- Use your critical path analysis based around the headings listed.
- Then add your potential cause and ***Ishikawa Diagram***
- Next view the mind diagram with a view to see how your group may;
  - Form strategic thinking on how to resolve key issues
  - Formulate a team management strategy
  - Develop a implementation plan in terms of resolving the Big issues
  - Agree on your individual involvement and the time to deliver.

Documentation Information and documentation



Developing a control strategy and a test station system for critical issues before final design.

Strategy

Undergo some Microsoft training for project management top down process.

The key objective is to define the correct sequence of events necessary to formulate a program sequence.

Then to set up controlled experiments to validate design fundamentals.

Model the sequence using spread sheet to verify the algorithms and assigned range of operating parameters are correct.

Before we buy in major items questions need to be answered.

1. How robust is the design?
2. Have you cross matched the operational specifications to our design application?
3. How do you intend to mount it to the existing design?
4. How easy will it be to service?
5. Is there other equipment that could interfere, thus causing misleading readings?
6. How do you plan to interface with the microprocessor?

Determining what critical path testing is required

1. Utilise an algorithm that will cause the pressure and filtered water volume to identify its position ‘0’ and then correlate reverse flushing process of the operating envelope.
2. Remember we were intending to reduce water wastage by using post filtered water from the upstream sand filter.
3. After the first stage of the process is met, a second algoritium is needed to detect the optimisation of the timing of this sequence. In other words has the prediction of maximum efficiency needs to be been met, based on the quality of the post filtered sand filtration and the membrane clogging up in the osmotic filter.
4. By allowing this to happen will minimise the losses of having to use the clean water that has undergone the Osmotic process for the purpose of final flushing.

Preparation for inputting information

- Have a draft of the scheduled events
- Complete a bill of materials (BOM) with
  - Part descriptions
  - Required delivery date
  - Cost
  - Suppliers name and contact details.
- Project information
  - Reports scheduling for special times
  - Some scenarios may be evaluated
  - Special information on hourly rates and duration
  - Contingency plans for events that may emerge.
  - Calender time frame for resources

Class activity

- Use your critical path analysis to update you individual time management planning.
- Discuss with other groups how key areas concerning interface of events can be most effectively managed. Finalise your Microsoft Project Management Gaunt chart.
- Ensure you have developed areas where data collection is to occur.
- You must also ensure you develop electronic flow logic and relevant information for Jean each week that will precede mechanical implementation
- Identify testing processes that must be set up for resolving interface issues.