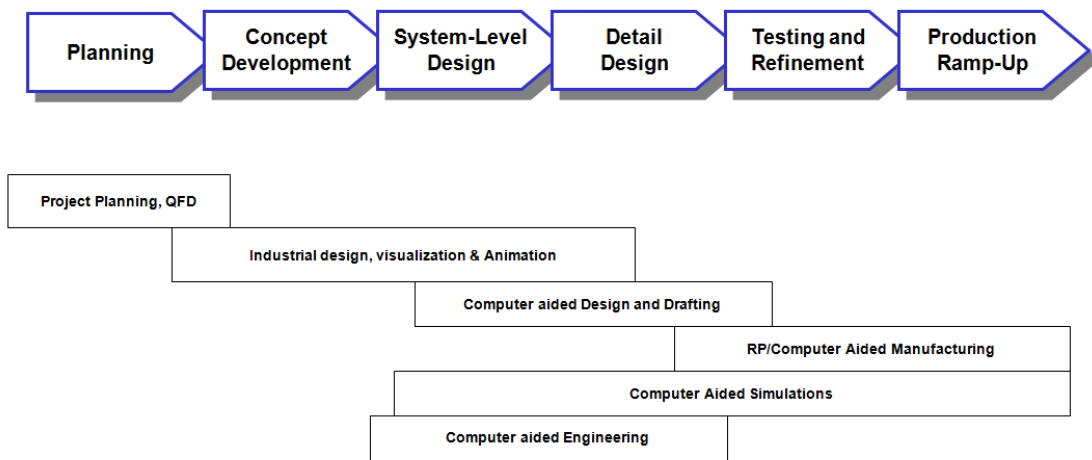


## MP3005 Computer Aided Design

1.a)



b) With help of NC, a machine tool or a robot can be numerically controlled with prepared programme to perform certain functions without handling of human. It's the foundation of Automation.

c) One model concept means to use one single solid model to perform a series of design activities. EG, use Solidworks to build one solid model, then the model can be used to do advertisement, finite element analysis, motion simulation, animation make. With one model concept, a lot of efforts can be saved, and it's quite easy to make changes, when change the model, all the following functions based on that changes.

d) To use mouse, we need to click, drag, rotate combined with left and right buttons to manipulate a 3D object. eg, for Solidworks, left click and drag to translate the object, right click and drag to rotate the object. For a data glove, it's quite easy, we just need to treat it as a real object to perform manipulation. However, data glove is much more expensive than a mouse, that's the problem.

e)  $y=mx+c$  only have two variables, so should not be used in 3D space, as it can only represent straight lines in x-y plane. To represent straight lines in 3D space, we need 3 variables, hence better use  $(x,y,z)=(x_0,y_0,z_0)+m(a,b,c)$ , this kind equation.

f) Quadric surfaces are simple surfaces defined by second order equations:

$$Ax^2+By^2+Cz^2+Dxy+Eyz+Fxz+Gx+Hy+Jz+K=0, \text{ such as sphere, cylinder, ellipsoid}$$

They are quite useful as they have simple equations and perfect symmetry, can be used to build functional mechanical parts in CAD, eg, joints.

g) Simple maths problem, just differentiate E with respect to  $\theta$  and  $\phi$ , then find the cross product of the two differentiations.

g) For a dynamic system, we must define the parts, and the constraints to link the parts, then the actuating forces applied to the system and also the physical laws governing motions.

2.a) Request mode: when you click "open files" button, a new window pops out, and hang there until you choose the file you want.

Sample mode: when you drag an object, it moves following the position of pointer, as it collects the position data with predetermined time interval, and samples the current value.

Event driven mode: when you open files one by one, the software will open them as your just follow your sequence, as all the command are saved in a input queue.

b) The computer has an invisible screen called bitmap besides the visible monitor screen, when you click the button, the menu appears, then the covered part is cut and pasted to the bitmap. And then, it will be placed back to the original position when the button is deactivated.

c) With keyboard, input the coordinates of points; input the length of edges.  
With mouse, click in the 3D space to create points; click and hold on to move to draw lines; choose functions to create objects, such as revolute, extrude.

3.a) Wireframe model, define only vertices and edges.

Surface model, define faces of the object.

Solid model, 3D shapes which are closed, bounded, unambiguous, valid solid, and partitions the space into solid part and air part.

b) Solid model would be the best, as it's closed, valid solid, hence it has internal features, and solid properties, which are quite useful in mechanical applications. While wireframe model is too ambiguous, and surface model can only represent the external shape, does not have internal shape and solid properties, eg, mass, volume.

c) Perform mass calculation. Only solid model can finish the task.

NC machining simulation. Only solid model has internal shape to handle it.

Finite element analysis. Only solid model has volume, can be divided into finite small parts.

d) The neutral file. Neutral file type is developed by all the joint companies together, hence can support all of the software developed by them. When we need to use two different software, we just save the model as the neutral file, then open it in another software.

4.a) Feature addresses a functional groups of faces as a whole unit, instead of a loose collection, hence enhance the users to interact with the system in a more natural way- holes as holes, slots as slots. Feature provide a new level of interactions in modeling.

Faces-----solid, with help of feature based design, faces---features----solid.

b) Constraints specify the relationships between different parts in a component, and also the way two components are assembled together. With help of constraints, entities are specified relative to their parents and carried long when the parents change. If entity is changed, only the dependents will follow the change, and the relationships between them are reserved.

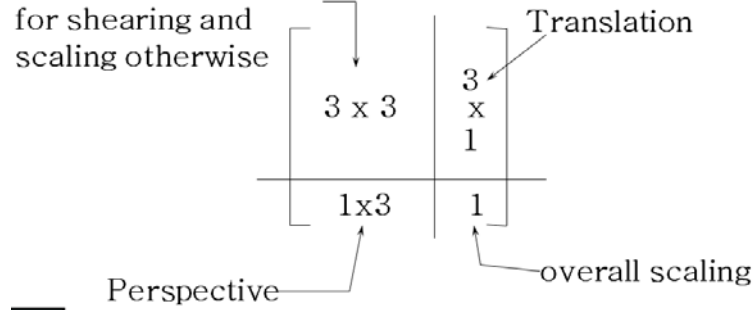
c) They can provide the user with power and flexibility, able to support downstream application more effectively, as all information is transparent to the users.

d) For this kind of question, just assume you are building a solid model according to this

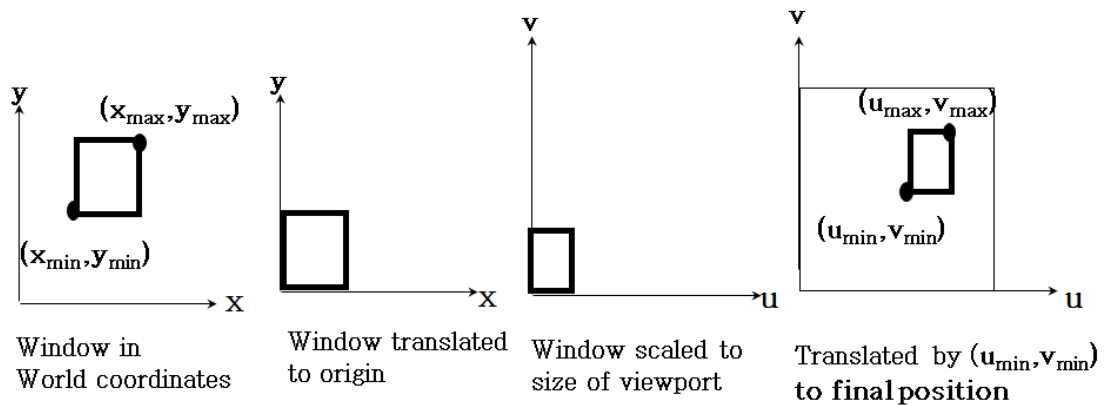
picture, think about what information you need to finish it. Then all the information required would be the constraints. Eg, diameter of holes, central distance in between two holes, thickness of the walls.....

5.a)

For Rotation if  $\text{Det} = 1$ ,  
for shearing and  
scaling otherwise



b) translation in the world---scaling---translation in viewprot



c) Sorry, in the softcopy, there's no figure 2.

But I think you can answer it, just bear in mind that:

The processing matrices starts from right to left. And perform all the inverse process after translation and rotation.

$$[P'] = [T]' [Rx]' [Ry]' [Rz] [Ry] [Rx] [T]$$

And also notice the rotation angle, whether it's positive or negative, make it right.