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1. RATIONALE

The course aims to develop the creative imagination by encouraging pupils to reason in two and three-dimensions and by applying these abilities to the solution of graphical and spatial problems of an abstract and practical nature. The cognitive and practical skills developed will act as a stimulus in helping pupils to "see " their environment with a critical and analytical awareness and will enhance their aesthetic values

Proficiency at freehand drawing is seen as particularly desirable not just as a means of communication but also as an interactive element in imaging and spatial modelling. The body of knowledge and skills associated with graphicacy will allow the pupils to interpret and communicate information and ideas graphically, thereby encouraging competency in the universal language of design and technology.

The course is also seen as an ideal vehicle for developing computer graphics skills and introducing computer aided design graphics. Graphical design problems in two and three-dimensions will allow the pupils to experiment with shape and form, shade and colour. The modelling of solutions, in card or other materials, will contribute to an enjoyable and creative learning experience. Pupils interaction will be encouraged through group activity assignments in measuring and scaling and the production of graphical solutions either pictorially or through orthographic projection, (the geometry of representation).

The course provides a unique range of skills and techniques at junior cycle and is a foundation course for senior cycle Technical Drawing. The course will also act as a contributing discipline to all technology based subjects and to any subject which uses graphics and/or cognitive functions such as holistic reasoning and image manipulation.

2. COURSE STRUCTURE

Year one consists of a series of modular topics which together lay the foundation for the following two years. While some of the topics are discrete most will be inter-dependent. At the core of the course are plane and descriptive geometries and communication graphics. These expand to underpin a range of topics that increase in factor-of-difficulty over the three years. The course is so structured as to provide pupils with a stimulus for managing spatial problems mentally and communicating spatial ideas and solutions graphically. Shown in figure 1 is a schematic diagram of the course structure. Figure 2 represents the suggested modules contributing to basic graphicacy in the first year foundation course. Figure 3 is a schematic diagram showing the interrelationship of the topics in the course content.

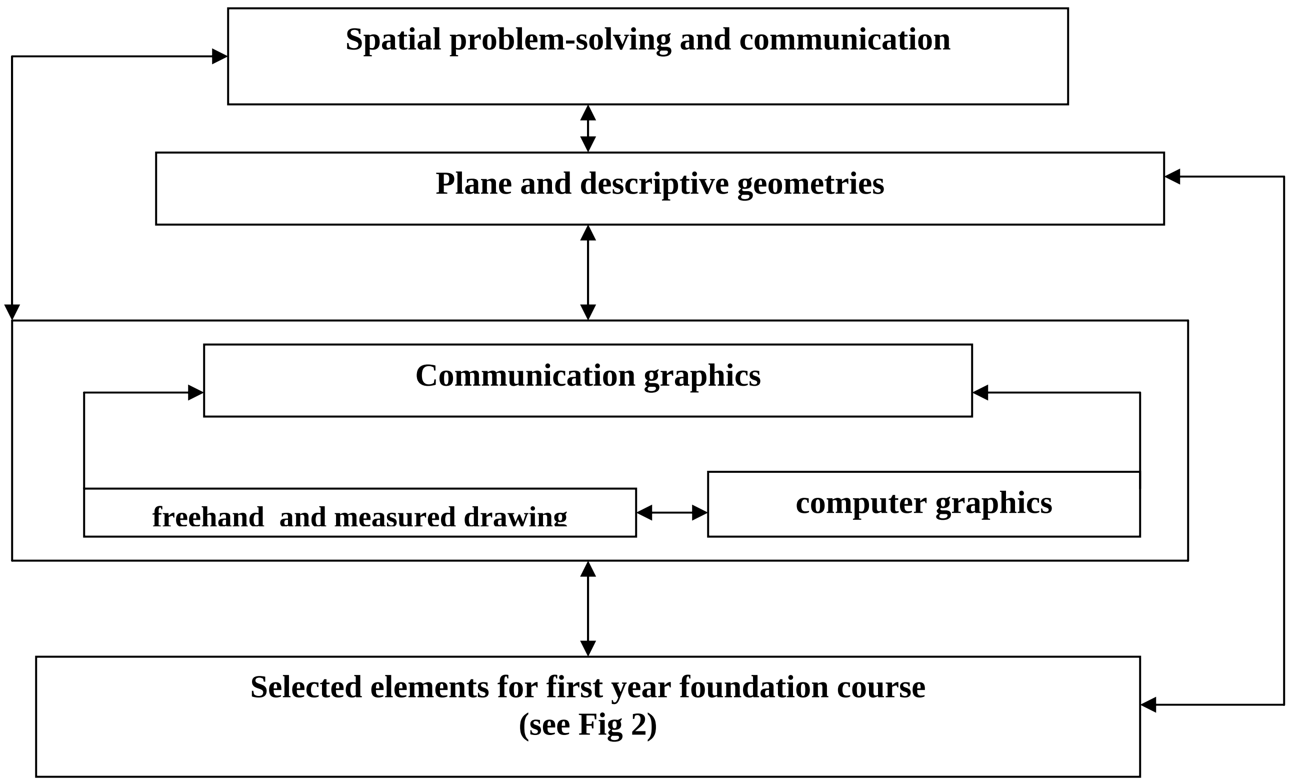
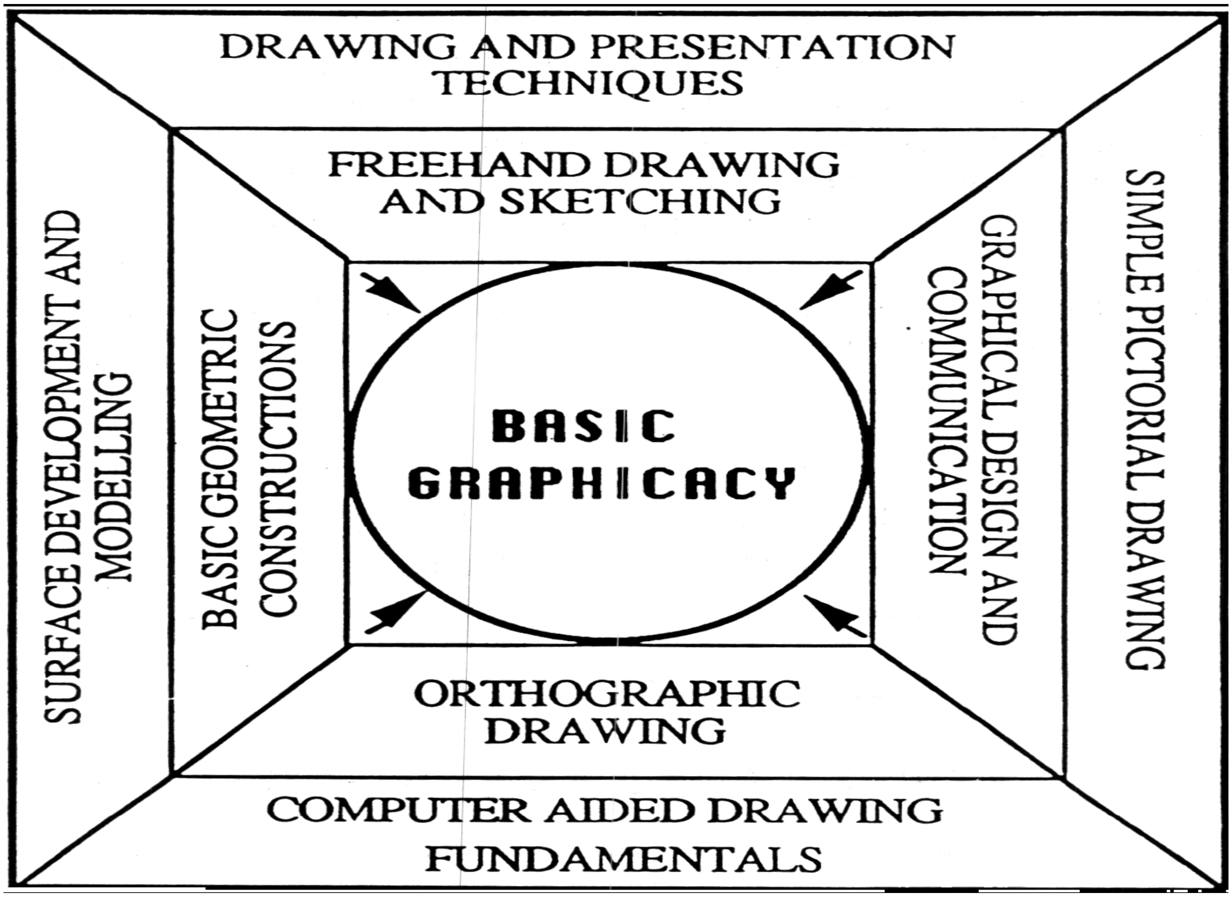


Fig 1

SCHEMATIC DIAGRAM OF COURSE STRUCTURE



<u>Fig 2</u>

SUGGESTED ELEMENTS FOR YEAR ONE FOUNDATION COURSE

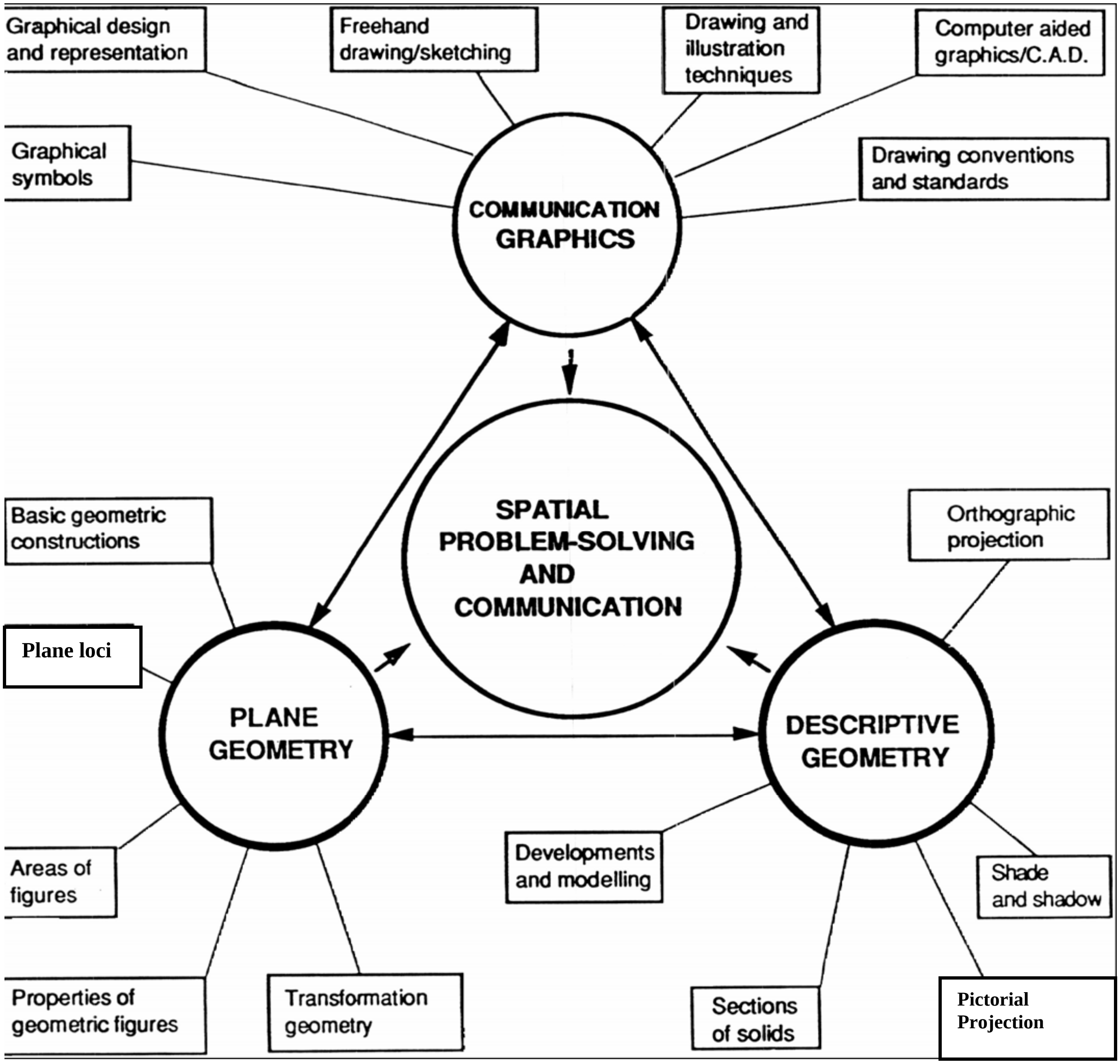


Fig 3

FLOW DIAGRAM OF COURSE CONTENT

2.1 AIMS OF THE COURSE

(a) To stimulate the pupils creative imagination through developing their visuo-spatial abilities.

(b) To encourage the development of the cognitive and practical manipulative skills associated with graphicacy.

(c) To provide pupils with a body of knowledge appropriate to interpreting and communicating spatial information and ideas.

(d) To sharpen the pupils visual perception of their environment and its elements and encourage the exercising of aesthetic value judgments.

(e) To develop basic competency in computer graphics in the context of graphical problem-solving and computer aided design.

(f) To encourage the development of logical and progressive reasoning and enquiry/investigative skills, and the ability to spatialise and visualise two and three dimensional configurations and their elements in the solution of graphical problems.

(g) To help pupils understand the importance of communicating information graphically.

2.2 COURSE OBJECTIVES

The pupils will be able to:-

- Use graphics in the development of ideas and in the communication of information.
- Interpret drawings and diagrams including freehand sketches, plans, numerical data (expressed graphically), flow charts and formal working drawings.
- Solve two and three-dimensional space problems graphically using appropriate geometries and their underlying principles and theorems.
- Demonstrate dexterity in the use of drawing instruments, templates etc. as reflected in neatness and accuracy.
- Display an understanding of the projection systems associated with descriptive geometry.

- Select appropriate methods of graphic representation in expressing spatial ideas and concepts.
- Show a basic understanding of input, processing and output systems associated with computers.
- Produce computer generated drawings and graphical solutions using appropriate computer graphics and computer aided design software.
- Produce neat and accurate drawings according to recognised standards, conventions and illustration techniques.
- Co-operate in the assimilation of data necessary for scaled representation.
- Produce freehand drawings in two and three-dimensions as graphical communication and as an aid to spatial reasoning and refinement.
- Recognise the importance of graphics in the process of designing and produce graphical solutions to appropriate design problems.
- Use shade and colour with discretion and model appropriate solutions in card or other materials.
- Apply ergonomic and other appropriate data in the consideration and solution of design problems.

3. COURSE CONTENT

PREAMBLE

The course content is arranged under the headings of topics and sub-topics, many of which are directly interrelated. The following are seen as the main areas of study; plane geometry, descriptive geometry and communication graphics (including design presentation and computer aided design/graphics). Freehand drawing is seen as an integral skill in all these areas as well as a stimulus to spatial reasoning.

The first year of the course will consist of basic modules taken from a variety of topics and will be a foundation course for the following two years. While the material content of the first year modules will in the main be common to both higher and ordinary levels, this will be structured so as to allow pupils to work at their own level of ability. The emphasis in the first year should be on material of an applied nature based on appropriate geometric principles and be such as to stimulate pupils interest and curiosity.

At the end of the first year pupils will have acquired basic graphic communication skills and techniques. They should also appreciate the significance of graphics in 'ordering' space, their unique value in communicating information and ideas as well as their intrinsic beauty, particularly in graphical design.
NOTE: <u>underlined elements applv to higher level only</u>

3.1 CONVENTIONS AND STANDARDS

Pupils are expected to adhere to current standards, conventions and practices associated with drawing and illustration. (B.S. schools and colleges versions or I S.O. equivalents would be appropriate) However, bearing in mind the creative-problem solving nature of the subject, these should not be applied so rigidly as to stifle individual flair.
Pupils should be familiar with the following:

- Line types
- Projection standards
- Symbols
- Scales
- Dimensioning
- Lettering

3.2 PLANE GEOMETRY

Apart from its discrete value in problem solving this area will serve to support all other areas of the syllabus. The geometry and constructions should where possible be taught in the context of concrete applications. All constructions should be supported by the appropriate axiom or theorem as listed in the appendix.

3.2.1 CONSTRUCTIONS

Basic geometric constructions.

Construction of plane and diagonal scales.

The mean proportional

3.2.2 PLANE FIGURES

Construction and geometric properties of:

Triangles

Quadrilaterals

Polygons

The Circle (incl. tangency).

Construction, basic properties and applications of the ellipse and parabola (excluding reference to eccentricity).

3.2.3 LOCI

To include the plotting of loci under specified constraints in relation to fixed points, curves and lines in one plane

The plotting and identification of ellipse and parabola as plane loci in problem solving

3.2.4 TRANSFORMATION GEOMETRY

This area deals with geometric transformations, either singly or combined, as applied to problem solving.

Parallel projection

Translations

Reflections (central and axial symmetry)

Rotations

Enlargements and reductions

Examples of above in nature and design

3.2.5 AREAS OF FIGURES

This should be dealt with by applying appropriate Euclidian theorems and/or transformation geometry theorems.

Determination and division of polygonal areas by triangulation

Conversion of rectilinear figures to equivalent areas

Approximate determination of areas with curved perimeters

3.3 DESCRIPTIVE GEOMETRY

This area is of particular importance in developing pupils ability in visual imagery and representation. Projections should initially be dealt with in a deductive manner without reference to projection systems, but with a knowledge of planes of reference. The sequencing of the material and teaching techniques should gradually develop spatial abilities relating to imagery, orientation, and visualisation. Pupils should as a result be able to build clear images of objects in space and accurately represent these in two-dimensions. The complexity of image and representation will vary according to level and ability. Although the final solution to problems in this area will normally be represented in measured drawings, pupils should be competent in representing these through freehand drawings and sketches.

3.3.1 ORTHOGRAPHIC PROJECTION

Considering that orthographic projection is an abstraction which allows accurate representation of objects in three-dimensional space, teaching strategies should aim at bridging the gap between concrete and abstract spatial reasoning. Therefore to assist visualisation the 'objects' represented in the projection should where possible relate to pupil interest and experience. For the purpose of this syllabus the axes of geometric forms should generally not be inclined to more than one plane of reference and solids with oblique axes are not considered.

Planes of reference.

Projections in 1st and/or 3rd angle. (H.L. pupils conversant with both)

Interpretation of given data.

Sectional views.

Inclined solids.

Exploded views

Working and design drawings.

First auxiliary projections.

Rotation of solid objects.

Rebatment of surfaces.

Traces, true lengths and inclinations of lines and edges.

True shape of surfaces.

Solids in contact.

Intersection of surfaces (see also developments).

Elementary treatment of shadow and shade with parallel light rays

3.3.2 PICTORIAL DRAWING AND PROJECTION

This area should be covered in two modules, (a) pictorial views of objects on given axes and without reference to projection systems and axonometric planes, and (b) projections within the classification of projection systems and the framework of axonometric planes.

(a) Oblique and planometric views.
Isometric views.
Simple perspective with arbitrary vanishing points (one and two point).
Orthographic from pictorial and visa-versa.

(b) Axonometric projections to include:
Isometric proiection with reference to axonometric plane
(include use of isometric scale).

3.3.3 SCALED DRAWING

Pupils will learn to solve problems associated with representing on paper or monitor items of small and large dimensions. In the main concrete examples should be used such as room or garden layout, record stylus, etc. The area also provides opportunity for group activity and co-operation through measuring and recording data, design of scales etc. in connection with buildings, classroom layout, location maps and so on.

Design of scales.
Scale rules. (Standard metric scales)
Scaled representation including working and design drawings

3.3.4 SURFACE DEVELOPMENT

Orthographic projection including true length of lines and edges and true shape of surface will contribute to this. In the initial module however complex shapes requiring rotation or rebatment should be avoided. Any of these solutions may be modelled. (see also modelling)
Right solids and their frusta.
Composite solids (see also intersection of surfaces).

3.4 COMMUNICATION GRAPHICS

Material from this area of study will permeate all other elements. The sub-topics should provide a stimulus for creative thought and provide a basis for expression of ideas and information through the application of the illustration/communication skills and techniques acquired. It will also help the pupils to relate to the graphic environment they are constantly exposed to.

3.4.1 FREEHAND DRAWING AND SKETCHING

It is intended that this area should contribute to the development of the pupils intra and extra-personal communication skills and techniques and encourages sketching as a stimulus in the thinking process. The use of a variety of media is recommended. These should include squared, isometric grid and other suitable papers.

Sketching skills and techniques

Two and Three dimensional graphic representation

Procedural diagrams

Design sketching

Shading and texturing

Colour as an enhancement

*(*See also graphical design *).*

3.4.2 GRAPHICS IN DESIGNING

Sketching and drawing are at the core of the process of designing and so these visual images are of particular importance in developing and refining ideas. The pupils creativity will be encouraged through appreciating the problems associated with designing, proposing solutions on paper and modelling these where appropriate.

3.4.2.1 THE PROCESS OF DESIGNING

The pupils will acquire an overview of the design process with particular emphasis on associated graphics. Pupils will be helped to appreciate the visual qualities of objects with particular reference to shape/form and proportion. Examples should include the geometry of form and proportion in nature and in man-made objects.

Design appraisal

Analysis and evaluation of design problems

Acquiring and using data (shape, volume, ergonomics, etc)

Presentation of solution

3.4.2.2 MODELLING OF SOLUTIONS

This activity will contribute to the development of the pupils spatial abilities through interplay between the drawing and the visuo-tactile stimuli. Pupils will be encouraged to model appropriate solutions using card or other materials. Design and execution of packaging solutions is seen as making a significant contribution. Surface development is a prerequisite and integral part of this activity.

The following are examples of solutions appropriate to modelling:

Regular and semi-regular polyhedra.
Packaging problems including appraisal and reproduction.
Development and execution of packaging solutions.
Projection planes and systems.
Loci and simple linkages as models.

3.4.2.3 GRAPHICAL DESIGN AND REPRESENTATION

This element will contribute to the pupils ability to graphically symbolise information and ideas; and will facilitate clear communication as well as rapid interpretation of comparative data and statistics. While the main focus will be on design and representation in two-dimensions, working in three-dimensions is to be encouraged.

Geometric pattern drawing.
Graphical symbols including: Pictograms, Monograms, and Logograms.
Graphical representation of numerical data including: Graphs, Histographs, Pictographs, Bar and Pie-charts etc.

3.4.3 COMPUTER GRAPHICS

It is intended that this area of the programme will give pupils an understanding of the computer as a tool in graphical communication and design. The pupils should get 'hands-on' experience in using the computer to solve real problems of graphic representation, communication and design. A basic understanding of 'input', processing' and 'output' devices is expected as well as some knowledge of contemporary hardware and appropriate software. While a knowledge of a programming language would be desirable this is seen as discretionary. The following should be included:

Input, output and processing hardware.

Loading and saving programs.

Graphics and C.A.D. programs.

Generation of graphics and drawings.

Printing and plotting.

4. ASSESSMENT

4.1 ASSESSMENT OBJECTIVES

Pupils should be able to:

(a) Solve problems in two and three dimensional space using appropriate geometries and principles.

(b) Interpret drawings, diagrams and other graphical data and 'spatialize' written or oral information.

(c) Select appropriate methods of graphical communication to represent artifacts, solutions and ideas.

(d) Demonstrate neatness and accuracy in drafting skills and techniques.

(e) Display a knowledge of recognised drawing standards, conventions and terminology.

(f) Use freehand sketches in developing ideas and solutions, and in representing information.

(g) Make working drawings of artifacts from given data.

(h) Demonstrate an understanding of graphical design through appropriate representation of ideas.

(i) Display an understanding of projection systems

(j) Display a knowledge of basic ergonomics and other design related data.

(k) Produce solutions on paper to appropriate design problems.

(I) Model solutions to appropriate problems (in card etc).

(m) Display a knowledge of computer input, processing and output systems through the production of hardcopy of appropriate graphics.

(n) Use the computer to solve space/design problems.

(o) Represent numerical and other data graphically.

(p) Use shade and colour appropriately to enhance drawing and as an aid in clarity and in presentation.

APPENDIX

Axioms and Theorems supporting the content of syllabus

Intersecting Lines:

1. If two straight lines intersect, then vertically opposite angles are equal.
2. When a transversal cuts two parallel lines, then corresponding angles are equal, and alternate angles are equal.

Triangles:

1. Sum of the interior angles in a triangle is 180o
2. The exterior angle at any vertex in a triangle equals the sum of the two opposite interior angles.
3. In an isosceles triangle the angles opposite the equal sides, are themselves equal in measure.
4. Bisectors of the angles of a triangle are concurrent at the *incentre "*.
5. Mediators of the sides of a triangle are concurrent at the *"circumcentre"*.
6. Perpendiculars from the vertices of a triangle to their opposite sides are concurrent at the *"orthocentre"*.
7. The medians of a triangle are concurrent at the 'centroid'.
8. The area of triangles on the same (or equal) base and between the same two parallels are equal.
9. The areas of triangles of equal bases are proportionate to their heights, and the areas of triangles of equal height are proportionate to the length of their bases.
10. In similar triangles, the lengths of corresponding sides are proportional.
11. Theorem of Pythagoras:
    In any right-angled triangle, the area of the square on the hypotenuse equals the sum of the areas of the squares on the other two sides.

Parallelograms:

1, Opposite sides and opposite angles in a parallelogram are equal in measure.
2. The diagonals of a parallelogram bisect each other.

3. The diagonals of a rhombus bisect each other perpendicularly.
4. The diagonal of a parallelogram bisects its area.

The **Circle:**

1. The mediator of any chord in a circle is a diameter line of the circle.

2. The measure of the angle at the centre of a circle is twice the measure of the angle at the circumference, standing on the same arc (chord).

   and its corollaries:

   (i) The angle in a semi-circle is a right angle.
   (ii) The sum of opposite angles in a cyclic quadrilateral is 180°
   (iii) Angles in the same segment of a circle are equal.
   (iv) The angle between a chord and tangent at the point of contact equals the angle at any point in the opposite segment, subtended by the same chord.

3. The angle between the diameter of a circle and a tangent, at the point-of-contact is 90°

Theorems in Transformation Geometry:

1. Parallel projection conserves equality and proportion of length.
2. Translation maps a line onto a parallel line.
3. Central symmetry maps a line onto a parallel line.
4. The composition of two central symmetries (point reflections) is equivalent to a translation.
5. The composition of two axial symmetries (line reflections), in intersecting axes, is equivalent to a rotation.
6. The composition of two axial symmetries in perpendicular axes is a central symmetry in their point of intersection.
7. The composition of two axial symmetries in parallel axes is a translation.
8. An enlargement maps a line onto a parallel line.

9. Axial symmetry, central symmetry, translations and their composite mappings are isometries (conserving measure of length, angle and area).
10. The composition of translations is both commutative and associative.
11. The composition of reflections is neither commutative nor associative.