Linear and Lateral Thinking

THINKING: logical, floppy, investigative

TO KNOW and to reason are characteristic of man. By his five bodily senses and his spiritual mind he learns about God's creation. He reasons from this knowledge to new knowledge, always checking that his thinking is never contradictory.

The lower animals have instinct, whereas man has reason. Animals get knowledge through their senses, but it is limited to particular things or processes, never rising to abstract truths, 'universals' principles.

Man has understanding, i.e. the capacity to mentally 'stand under', to perceive 'the reasons why', to think, to comprehend, as well as to apprehend by the senses.

LINEAR THINKING — strict logical proof

LINEAR thinking works FROM GENERAL TO PARTICULAR, and is ruthlessly LOGICAL. It works by **deduction**. It 'descends' in a straight line from beginnings, from principles, from something 'higher' to something lower' — 'linear', from Latin *linea,* -œ, *f* = aline

It PROVES things and proves them conclusively. (See overl for *Liberal Arts,* on maths). This is the way philosophers *try* to think. Often they have gone, and still do, go wrong, and make the most awful "howlers", and alas, often refuse to budge from their absurdities.

Abstraction — insight, understanding

Abstraction is the intellectual process for arriving at the principles or general truths on which linear thinking depends. **It is much more than the generalizations** of experimental thinking; e.g. man abstracts the idea of 'tree' from particular trees, and begins to make and use definitions from his abstract idea of "tree".

Abstraction "understands": it 'stands under', sees within the particular knowledge from the five senses.

Example of LINEAR THINKING

Prove that (1) an eclipse of the sun must be in daylight and (2) an eclipse of the moon must be at night

1. An eclipse of the sun is when the moon blocks our view of it. The sun must be visible before and after, so it is daylight.
2. An eclipse of the moon is the earth's shadow cast by the sun on die moon, to hide it. First, for us to see it, the moon must be above the horizon. For the sun to cast the earth's shadow on it, the sun must be on the opposite side of the earth, so the sun must be below the horizon, and that is night.

LATERAL THINKING — "floppy* logic

Lateral thinking works sideways, FROM PARTICULAR TO PARTICULAR. It **PERSUADES** by plausibility, like a lawyer getting you off or convicting you. (Lateral, adjective from *latus,-eris,* n, Latin for side).

Lateral thinking is not proof. Over the last 40 years, Edward de Bono has popularized it as a new method of solving practical problems. Yet it always was and still is **the way many people *think* most of the time**. They compare one thing with another, and apply ideas about one thing to another thing.

It uses similes and metaphors, stories and parables, as illustrations. It often claims a transfer of training from specialities like Latin and maths to other difficult studies. The outcomes of lateral thinking are often true and often false: it all depends...

It is very useful in teaching. It helps people grasp the abstractions and deductions of linear thinking, by giving examples or parallel cases to make it clear.

Models

Models are an important **form of lateral thinking.** They are handy for many abstract matters in linear and experimental thinking.

If the abstract proof of the eclipses (above) is too difficult, set up a **model** of the heavenly bodies in a darkened room: a small torch as the sun, a tennis ball as the earth, a ping-pong ball as the moon.

In science teaching, we can explain the volts, coulombs, amps and ohms of electricity using water as a **model:** its pressure, volume, rate of flow, and the resistance offered by height or friction, are parallel concepts.

Again, a chain is as strong as its weakest link. Even a linear logical deduction is only as true as its starting points, which are the major and minor premises of its syllogism.

Beware of words like 'only' and 'always'. They apply to precise truths, but not to the more usual approximations to truth.

EXPERIMENTAL THINKING — induction

EXPERIMENTAL thinking works FROM PARTICULAR TO GENERAL, from individual instances to universal principles, not by abstraction but by generalizations using inductive methods.

It starts with careful observations checked by their **repeatability** and users both linear and lateral thinking, and preferably precise measurements. Like lateral thinking, it often assume that, if one thing follows another, it is because of it. **But CASUAL connections are not always CAUSAL** — see a dictionary to check that *post hoc* is not necessarily *propter hoc.*

Experimental thinking/procedure is the **powerful tool of the physical sciences**, and persuasive if not totally convincing by (1) its **consistency**, (2) **usefulness**, (3) capacity to lead on to **further knowledge.**

Yet its conclusions are only more or less certain. They depend on many factors and can be inconclusive, tentative, and even at their best, only highly probable.

Like other forms of thinking and abstraction, it is prone to go wrong. Nor is it science at all if a scientist claims infallibility for his hypothesis/theory and won't admit it might be falsifiable by further experiments.

Further reading

***Reasoning Things Out, Tracts for the Times* n. 7, John Young,** an introduction to the Church's perennial philosophy (in 72pp), then his detailed ***The Scope of Philosophy* (339pp).**

Handouts* n. 3, *"Between you and me, "p. 2 on Grammar andits importance for Philosophy.

Handouts* n. 27, *God and the Soul, p. 1 on Sherlock Holmes and on the Farmeras Philosopher. SherlockHolmes used the inductive method, in which parts of his procedure were deductions dependent on the premises.

Handouts* n. 57, *No Errors in the Bible, section on syllogisms on p. 1.

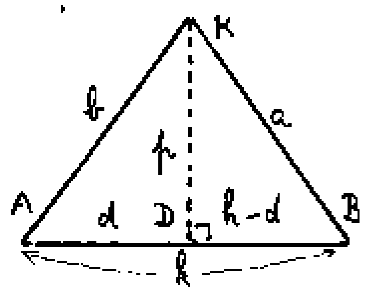
***Handouts n.* 78, *Development of Doctrine,* on misuse of the mind in** philosophy and theology.

Science is a Sacred Cow, Anthony Standen, 1950 and reprints, available by internet sales (Amazon etc). "A brilliantly amazing, highly informative, debunking of Science — by a Scientist."

Arithmetic & Geometry ***Liberal Arts,*** *lead to Algebra & Trigonometry*

THE SINE RULE

For a ΔABK lacking a *L*90 (we draw a perp. KD to AB and so we get two 90°Δs.
(We use K, lest C get muddled with a handwritten c, and we label lines and lengths with lower case letters)



(1)

In Δ AKD: p/b = sin A
$\therefore$ p = b sin A .... (1)
In Δ BKD: p/a - sin B
$\therefore$ p = a sin B (2)
From (1) and (2): b sin A = a sin b

$$\frac{\sin A}{a} = \frac{\sin B}{b} \qquad (3)$$

Similarly, with a perpendicular from B to AK:

$$\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin K}{k} \qquad \textbf{Q.E.D.}$$

Sides are proportional to the sines of the *L*'s opposite them.

THE COSINE RULE

which extends Pythagoras' Theorem to Δs without *L* 9O^0, using the figure on the left:

In ΔBKD: $a^2 = p^2 + (k-d)^2$ . . . . . . (1)
In ΔAKD: $b^2 = p^2 + d^2$ . . . . (2)
(1) - (2): $a^2 - b^2 = (k-d)^2 - d^2$
Simplify RHS: $k^2 - 2kd + d^2 - d^2 - k^2 - 2kd$
$\therefore a^2 - b^2 = k^2 - 2kd$ (3)
We need to eliminate d:
in **ΔAKD:** cos A - d/b, so d - b cos A . (4)
Substitute (4) into (3): $a^2 - b^2 - k^2 - 2bk \cos A$.'.
$\therefore$ **$a^2 = b^2 + k^2 - 2bk \cos A$, *cosine rule 1,*** and

$$\cos A = \frac{b^2 + k^2 — a^2}{2bk} \quad \textit{cosine rule 2,} \qquad \textbf{Q.E.D.}$$

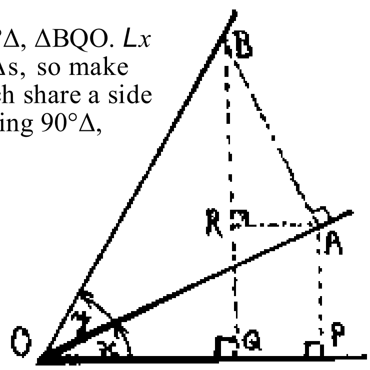
"Solving" Triangles

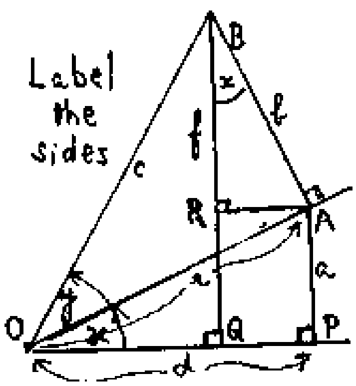
Every Δ has 3 angles and 3 sides, and usually three of these items are enough to find the missing items:

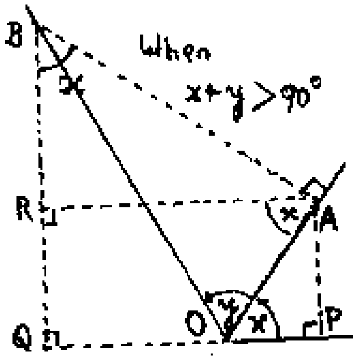
- **3 sides**(3S): use cosine rule 2 (CR2), then sine rule (SR) and supplementary angle (SA) [note the abbreviations]
- **2 S & included *L* :** use CR1, then SR and SA.
- 2 S & non-included *L*: ambiguous! can have two solutions.
- **1 S & 2 corresponding *Ls*** : use SA, then SR twice.
- 2 *L*s: third is SA; such Δs are similar, not congruent

Finding sin (x + y), the sine of the sum of the angles x and y

Reasoning things out
Sin (*x* + *y*) needs a 90°Δ, ΔBQO. *Lx* & *Ly* also need 90°Δs, so make Δs BAO & APO which share a side OA. Lastly, add a linking 90°Δ, BAR.







Preliminaries
Complement of *L* RBA is vertically opposite the complement of x, so *L* RBA » x.
In rectangle RQRA: QR = PA = a (1)
In Δ PAO: a/e = sin x (2)
In Δ ABR: f/b = cos x (3)
in Δ ABO: b/c= sin y (4)
and e/c = cos y (5)

Proof
in ΔBQO: sin (x + y) = QB/OB = (QR + f)/c
= (a + t)/c from (1)

$$= \frac{e \sin x + b \cos x}{b \sin y} \qquad \text{from (2) \& (3) \& (4)}$$

= (*e*/*b*) sin *x* sin *y* + cos *x* sin *y*

$$= \frac{c \cos y \sin x \sin y}{c \sin y} + \cos x \sin y \qquad \text{from (5) \& (4)}$$

$\therefore$ **sin (*x* + *y*) = sin *x* cos *y* + cos *x* sin *y***

Q.E.D

Corollaries
1. Put -*y* for *y*: $\therefore$ **sin *(x - y)* = sin x cos *y* - cos *x* sin *y*.**
2. To expand cos (x + y), use same diagram & preliminaries and adapt the proof, using OQ - g, RA = QP = d-g. Thus: **cos *(x + y)* = cos *x* cos *y* - sin *x* sin *y***
3. To expand cos (*x* – *y*) again put –*y* for *y*. Thus: **cos (*x* - *y*) = cos *x* cos *y* + sin *x* sin *y***
4. For sin 2*x* put *y* = *x*. Thus: **sin 2*x* = 2sin *x* cos *x*.**
5. For cos 2*x* put *y* = *x*. Thus: **cos 2*x* = $\cos^2 x - \sin^2 x$.**
6. To change a sum of two sines (and kindred expressions) such as **sin A + sin B** into a product, work thus:
sin (*x* + *y*) + sin (*x* - *y*)
= (sin *x* cos *y* + cos *x* sin *y* + (sin *x* cos *y* - cos *x* sin *y*)
= 2 sin *x* cos *y*.
Let *x* + *y* = A; *x* - *y* = B: so *x* = (A+B)/2 and y - (A-B)/2;
$\therefore$ **sin A + sin B = 2 sin [(A+B)/2] cos [(A-B)/2],**
which is expressed in words,
The sum of the sines of two angles is twice the sine of half the sum times the cosine of half the difference.