Maths in Accounting

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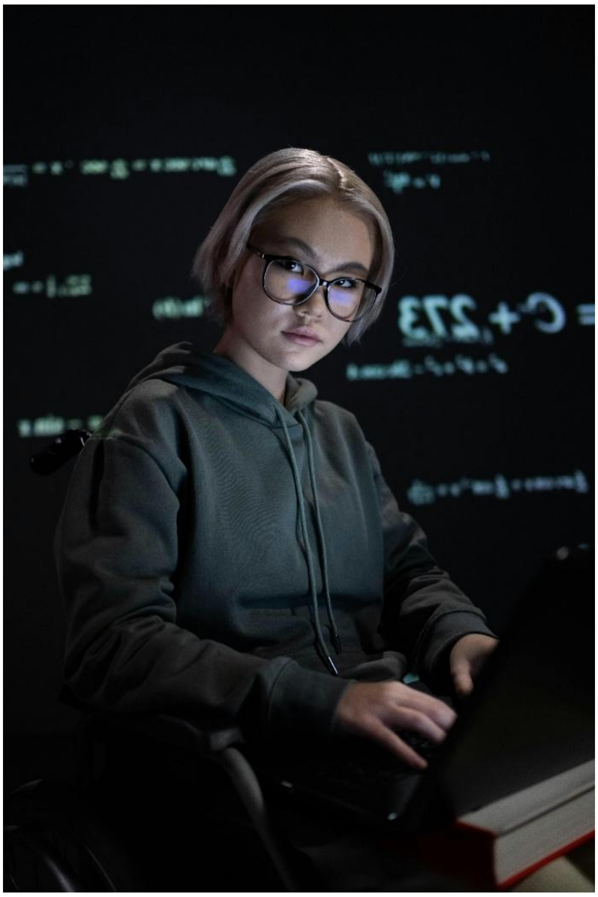
Can the subject of Accounting make greater use of mathematics to improve its own position? Here are some things to consider and some practical suggestions on how to upskill the finance team.

'Pure mathematics is, in its way, the poetry of logical ideas.' Albert Einstein

'The essence of mathematics is not to make simple things complicated, but to make complicated things simple.' S. Gudder

'Mathematics is not about numbers, equations, computations, or algorithms: it is about understanding.' William Paul Thurston

'Mathematics is the science of patterns, and we study it to learn how to reason about the world.' Keith Devlin



Accounting and Maths in the AI age

Accounting sometimes gets criticism that as a subject, it has relatively little theory in it. Just some principles, tax rules and human judgements.

A popular perception of accounting is that it's dull and mechanical. In need of a makeover even. Subjects like finance (investment appraisals, options valuations and credit assessments), engineering, actuarial science, operations research and econometrics, if not sexy, at least seem sophisticated. Possibly because they use advanced maths in them.

Both maths and accounting are about numbers. However, is there a sizeable opportunity, in the age of AI, to bring more maths into accounting, for greater economic benefit and more prestige as a subject, both?

Isn't there enough maths in accounting already?

Arguably no. The subject of accounting relies largely on basic math. For example, mathematical operations, supplemented by; basic statistics, trend, comparison and ratio analysis. The finance function also uses algebraic formulas drawn from the subject of finance, including for business case assessments (DCF), cost of capital and business valuation purposes.

The finance function does invite pension fund valuations from skilled actuaries, using probability calculations. It accounts for debt finance, based on lenders using the probability assessments of their credit analysts (as well as collateral assessments), to set the lending rates on loans issued to their customers.

Similarly, the finance function accounts for insurance premiums, based on insurance companies using the probability assessments of their risk adjusters (and recent claim histories), to set the annual insurance premiums charged to organisations.

Is advanced math necessary?

An extension of basic maths in accounting is necessary and still an improvement. As the external environment grows more turbulent and uncertain, aside from introducing more business flexibility to cope, finance teams using more advanced maths tools (and understanding them) is another good risk mitigator.

A great example is during WW2, where to crack the Axis (German, Italian and Japanese) cyphers (encrypted codes), Alan Turing turned not to advanced math (he was a respected Cambridge pure maths research fellow, completing his PHD at Princeton university at the time). Instead, Turing adapted basic pure math to apply to 'everyday situations' and also used 'applied logic' to bridge the gap between pure maths and engineering. Although at heart a pure mathematician, Turing came to be known as the father of modern computing and later, also posed 'the Turing test'[1], which is especially relevant in the age of AI.

[1] Turing introduced this test in 1950. It is a test of a machine's ability to exhibit intelligent behaviour equivalent to that of a human. In the test, a human evaluator judges a text transcript of a natural-language

Audit

The external audit aspect of accounting is already moving from statistical sampling to census (full data) reviews and becoming more sophisticated in reviewing the probability of client going concern, to form an opinion. Forming an opinion of whether a set of accounts represents a true and fair view aligns with an approach Alan Turing used in the 1940s – to set a target in advance for how much evidence you need. Then, just keep making observations, until that target is reached. Auditors set a materiality level. They then sample evidence using statistics and determine how much sampling is needed, to see if the client's financial statements are materially true and fair. Or not.

Meanwhile, internal audit, informed by descriptive analytics and probability, is advising on controls and risk assessments in the annual audit plan agreed with the client.

Finally, another Turing cypher-breaking approach was to judge the value of an experiment by the amount of weight of evidence that it would, on average produce. Then look at volatility in that weight of evidence as well. For external audits of financial accounts, the Audit Committee can review the volume (weight of evidence) of audit findings and its variability (how many minor findings and how many major findings), to assess how valuable it believes the external or internal audit was.

Risk Assessment and Reporting

Within organisations, more work is needed on the probability component of risk assessments, for risk scores to be meaningful. For example, how many risk registers in organisations analyse how risk owners who alter (add or substitute) their risk mitigations, change the risk probability variable as a result and can some maths tools help with that?

Some risks are fast-moving threats (risk velocity) and broad (risk linking) in nature. How many organisations systematically modify probability variables (using data), as external environmental changes occur? Can some maths tools help with that?

Set theory, a branch of mathematics relating to sets of objects (including Venn diagrams) may be useful if applied to collections of risks (risk exposure and risk linking), with the goal of improving risk management. Perhaps set theory is worth exploring as a tool in business flexibility analysis (with types of flexibility as the objects) as well.

In summary, more maths may well be a key tool to improve risk management.

Pricing, Segmentation and Decay Rates

'You can't just ask customers what they want and then try to give that to them. By the time you get it built, they'll want something new.' Steve Jobs

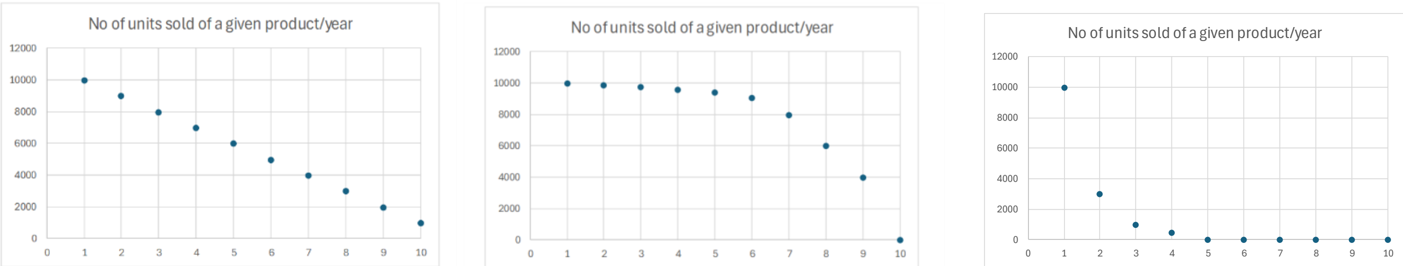
Dynamic pricing and customer demand forecasting is another area where maths (probability, adjusted for geographical cultural differences and elasticity of demand differences) can also

conversation between a human and a machine. The evaluator tries to identify the machine, and the machine passes, if the evaluator cannot reliably tell them apart.

enhance FBP pricing models and therefore forecasting accuracy for their budget holder and board clients.

Assume that customer demand (for products & services) depends on affordability (a function of value perception and credit availability) and utility (usefulness) perception.   Then, as utility on the existing products & services diminishes, FBPs can expect customer demand patterns to follow utility patterns. The rate of decline might resemble any of the following linear or exponential patterns, with time (years on the axis – refer Figure 1 below. The FBP working with the sales budget holders can make a broad assessment of the 'decay rate'.

Figure 1



Forecasting

'Emergent properties in complex systems are almost always a function of scaling.' Guru Madhavan

'Structure influences behaviour. More often than we realise, systems cause their own crises, not external forces or individual's mistakes.' Peter Senge

'Systems display characteristics that are properties of the system as a whole and are not characteristics of any of the individual component parts. Since these special properties exist only at the level of the system, no amount of study of the component parts will even identify their existence.' Dennis Sherwood

More use needs to be made of probability & statistics in forecasting. Arguably, it is much easier to forecast impact than probability. For the FBP function, aside from using or partnering with AI-enhanced systems, more use of maths tools may also have the biggest impact on the quality of FBP support.

Case study: The Fibonacci sequence is present in nature – in the structure of plans, sea shells and even animal breeding patterns. Starting simply with 0 and 1, each number in the Fibonacci sequence is the sum of the two preceding ones (0, 1, 1, 2, 3, 5, 8, 13, 21 etc). Refer www.internetsearchinc.com/why-does-the-fibonacci-sequence-appear-so-often-in-nature/#
In following the Fibonacci sequence, growth is achieved in an optimal (efficient) way. Control comes from adhering to the sequence. In your organisation, are there systems (ones that don't have 'emergent properties' as they scale) that can be made more efficient, if they grow by following the Fibonacci sequence?

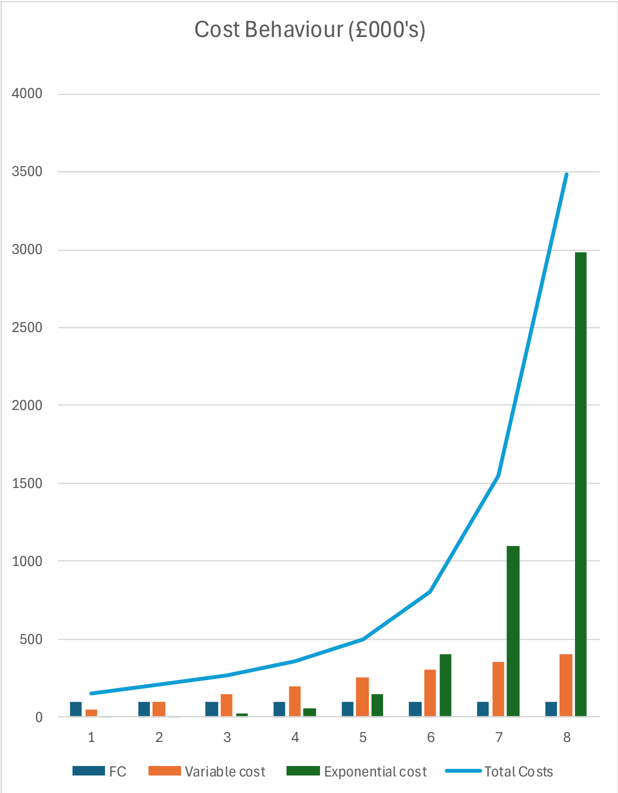
Using the example shown in Table 1 below, long run total costs can be forecast if (using legacy data analysis and other input), the cost pool for exponential growth is identified and a separate cost pool for variable linear growth is also identified, using a maths formula of:

$y=100+50x+e^X$ where y is total costs – refer Table 1 and Figure 2 below.

Table 1

£k's x	£k's FC	£k's Variable cost	£k's Exponential cost	£k's Total Costs
1	100	50	3	153
2	100	100	7	207
3	100	150	20	270
4	100	200	55	355
5	100	250	148	498
6	100	300	403	803
7	100	350	1,097	1,547
8	100	400	2,981	3,481

Figure 2



Another view of cost behaviour over the long run is to consider the following series of sigmoidal curves, joined up to produce steady long run linear growth. Refer Figures 3 and 4 below. The implications are that:

- there needs to be a dynamic tension between the twin forces of efficiency (the consolidation phase – in yellow in Figure 4 below) and innovation (the step change phase – in green in Figure 4 below).
- cashflow planning will be very uneven,

- stakeholders need to recognise that progress is uneven in the short to medium term, but to 'stay the course' and not lose their nerve.

Figure 3

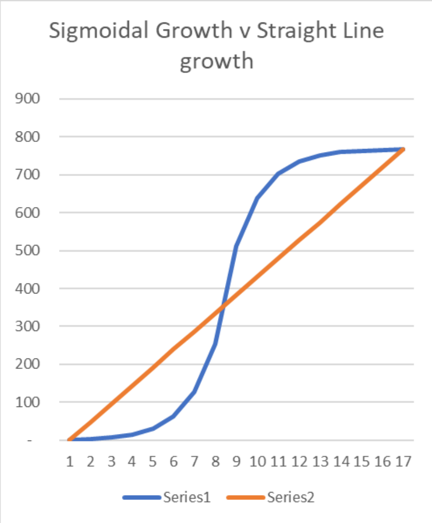
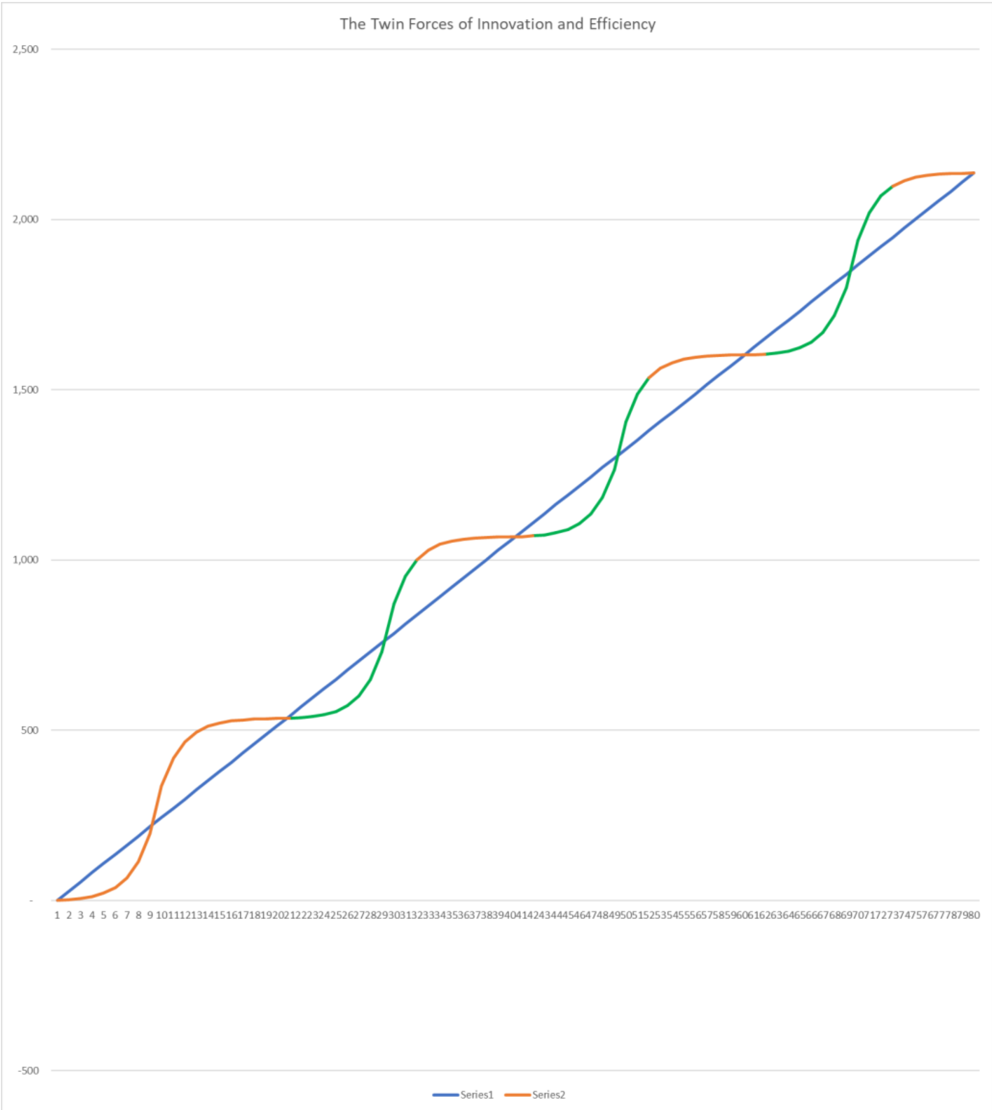


Figure 4

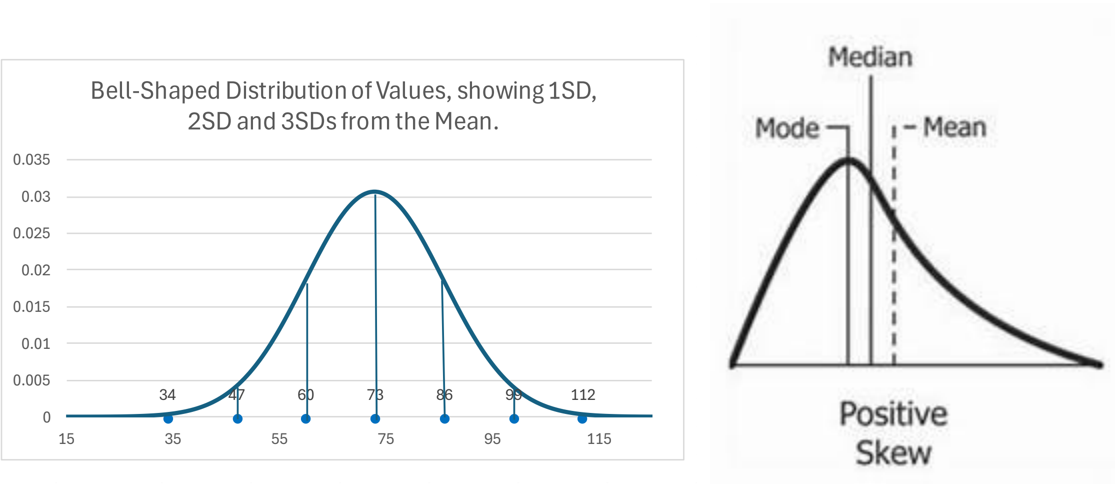


Bell-shaped curves

W. Edward's Deming pioneered some work on manufacturing defect rates, expressed in statistical terms. What are the other bell-shaped curves in business? Hint: actual staff performance (graded on a curve) might be one. Using maths to relate the shape of the curve to future resource allocation decisions (bonus pool allocation) can then follow. Refer Figure 5 below.

Other graphs may show positive or negative skew from a normal bell-shaped curve. For example, where market research and design solutions are strong, customer adoption rates and beneficiary impact may both show positive skew – most impact for most of the group, then a long tail of additional benefit for the few that value the impact the most (reinforced by rapidly diminishing returns, as progressively more benefit is added?).

Figure 5



Data on project delivery rates (whether a project is on time and on budget) may also be worth examining, to see if they can be summarised as a bell-shaped curve. Or if there is positive or negative skew. Given the under-whelming success for many projects (building projects or technology projects), then, if the x axis represents fast time and low spend, the profile is likely to be negatively skewed.

On a practical level, what's a fast way to bolster the strength of the finance team with general maths skills?

Retired secondary school maths teachers, because of their general maths training, are a potential inexpensive, but skilled resource. CFO's could engage them (part time), specifically to apply more maths to the finance service and upskill other members of the finance team in their use.

An alternative is for the finance function to deliberately hire graduates, who are double majors - in maths and accounting.

What are some areas ripe for improvement?

- Rate changes in organisations probably need to draw more on (differential) calculus.

- Based on correlation & causation studies, new algebraic formulas can be invented within organisations, to improve on accuracy - what patterns fit this data? What formulas might represent observed 'rules of thumb'?
- Simultaneous equations can be developed to optimise and solve for multiple unknowns.

Can maths improvements be left to AI instead?

The author would advise not really. To elaborate, if over the next 5-10 years, the optimal productivity results in organisations will involve AI and human partnerships, then finance staff will need to upskill in the use of maths to review and refine AI-generated algorithms and maths branch insights. Perhaps, the sooner, the better.

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