THE COURSE COMPANION · ONLINE COURSE · MY360

Mastering Uncertainty

Decide well when you cannot know — the philosophy, the mathematics, and the method of the uncertain zone.

Magnus Penker
Founder & CEO, Innovation360

Based on Dancing with Uncertainty, the Innovation360 Uncertainty Model (Penker 2023), and Business Experiments L1–L4

Copyright Innovation 360, 2026 · Mastering Uncertainty™ · my360.global

BEFORE YOU BEGIN

The One-Page Version

If you read nothing else, read this page — then go take the course at app.my360.global.

Uncertainty is not missing information waiting for a bigger spreadsheet. It is a property of reality. Like infinity, it cannot be divided away: resolve a thousand unknowns tonight and tomorrow the unknown is undiminished — Hilbert's fully booked hotel always has room. Frank Knight drew the line in 1921: RISK has computable odds and can be pooled away; UNCERTAINTY has no odds and often no list of outcomes, and it is precisely where entrepreneurial profit lives, because whatever can be computed has already been competed away.

Leaders make two errors in front of this fact. Denial: pretend the unknown is divisible — the five-year forecast, the forty-page business case, the turkey's beautiful trend line. Paralysis: wait for a certainty that arrives only after someone else has captured the value. The third way is a disciplined relationship with not knowing: control the stake, the threshold, and the test; accept the space of futures; act small and learn fast. Three thousand years of thought about the unknowable — from "I will be what I will be" and the via negativa to Pascal's wager and Kierkegaard's leap — converge on exactly this stance. So do Gödel, Escher, Bach and the fractals: systems fold back on themselves, and you can only participate in them wisely, never manage them from outside.

The instruments: the binomial distribution prices every test you design (six sign-ups out of 100 against a pre-set 3% bar is decisive: a weak idea produces it once in two thousand runs, a strong one more than half the time). Guess-and-halve removes ~90% of decision-relevant uncertainty in three tests. But name the world before you reach for a tool — chaos, fractal scale, fat tails, vagueness, Jevons effects and missing data each break a different model, and most catastrophic decisions are made with a perfectly good instrument in the wrong world. Then decide: map the portfolio on impact × uncertainty, replace dates with thresholds ("we proceed if…"), hunt the killer assumption first, and lead so that uncertain work is small, cheap, reversible, logged — and celebrated.

THE COURSE IN NUMBERS

- 3 chapters · 9 sub-chapters · hands-on exercises on your own portfolio
- 9 quizzes · certificate add-on USD 29 · The Uncertainty Toolkit (5 templates) + Workbook (4 pages)
- Sister courses: Innovation Sandboxing (the moves) · Business Experiments L1–L4 (the library)

"You cannot know. You can still decide well."

Copyright Innovation 360, 2026 · my360.global

CHAPTER 1

The Unknowable

Risk, turkeys and the indivisible infinite · Three thousand years of the unknowable · Strange loops and the two errors

1.1 — A casino is risky: unknown roll, known odds — which is why casinos and insurers profit; pooled risk averages away. The future your business faces is uncertain in Knight's stronger sense: no odds, often no list of outcomes. David Spiegelhalter adds the modern refinement: uncertainty is a relationship — part aleatory (the die not yet thrown; no information removes it), part epistemic (the die under the cup; every test shrinks it). Hume's problem of induction, retold by Russell's chicken and Taleb's turkey, warns what data can never promise: a thousand generous mornings do not imply morning 1,001. And Cantor proved the deep reason no analysis closes the gap: the space of possible futures is not merely large but uncountable — it cannot even be listed, so it cannot be assigned complete probabilities. Cantor himself drew a second line, between the transfinite (which mathematics can work with) and the Absolute (which it cannot); he called the Absolute God, and refused to compute it. The greatest mathematician of the infinite drew, with his own hand, the boundary of his own method.

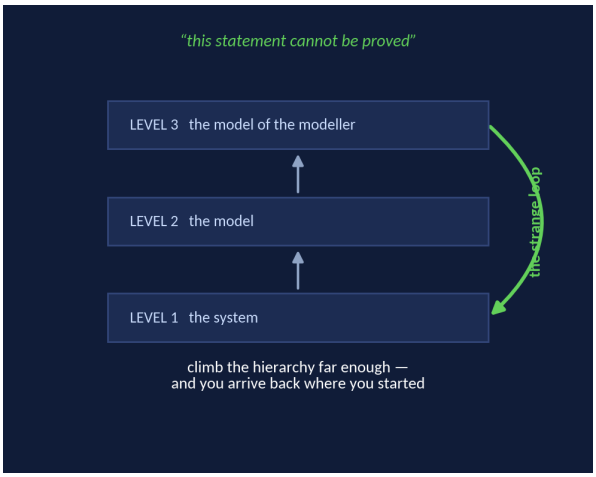
1.2 — Theology is the oldest discipline of the unknowable; the course takes its method and leaves its doctrine. Exodus 3:14 answers the request for a name — a category, a handle, something to plan with — with a verb in the imperfect: ehyeh asher ehyeh, I will be what I will be. Job demands a complete account and receives a whirlwind of questions instead. The via negativa (Pseudo-Dionysius, Maimonides) knows the infinite only by what it is NOT — falsification, fifteen centuries before Popper. Nicholas of Cusa's docta ignorantia makes precise knowledge of one's ignorance the highest knowledge, derived from the mathematics of infinity. The Cloud of Unknowing sends probes into what the intellect cannot pierce — an experiment, in Middle English. The Tao that can be named is not the eternal Tao; the Upanishads say neti, neti. Ecclesiastes says it plainest — "time and chance happen to them all" — the verse with which Spiegelhalter opens the sharpest statistics book of 2024. Pascal, co-founder of probability, meets an uncomputable question and prices the SHAPE of the bet instead of its odds: bounded stake, unbounded upside — the first asymmetric bet in history. Kierkegaard defines faith as "objective uncertainty held fast" — the exact anatomy of every serious strategic commitment; the course's contribution is to attach a threshold to the leap and cap the stake.

 Copyright Innovation 360, 2026 · my360.global

CHAPTER 1 · CONTINUED

Strange Loops — Seeing Systems Whole

Gödel · Escher · Bach · fractals — four arts, one lesson



1.3 — Hofstadter's Gödel, Escher, Bach (Pulitzer Prize, 1980) finds one pattern in three places: a proof that talks about itself, hands that draw each other, canons that return transformed one level up. He calls it the strange loop — climb the hierarchy far enough and you arrive where you began — and later argues the "I" itself is such a loop: a system modelling itself until a self appears. Add the fourth thread, self-similarity: Mandelbrot's fractals repeat the same shape at every zoom, in coastlines, markets and organizations.

Reference, containment, return, similarity: one insight from four directions. Systems fold back on themselves — and a system that folds back on itself cannot be managed from outside, because there is no outside. Your forecast moves the market it forecasts; your KPI rewrites the work it measures (Goodhart's law is a strange loop with a budget); Gödel proved in 1931 that even arithmetic contains truths it cannot prove from within. The complete, view-from-nowhere business case is therefore not hard — it is structurally impossible. What replaces the bigger map is disciplined participation: probe, threshold, shorter loop. The two errors — denial (fake certainty at full retail) and paralysis (Kodak held its own evidence for 37 years) — both refuse this participation; the third way practices it.

EXERCISE 1 · NAME YOUR TURKEY (WORKBOOK P. 1 · 10 MIN)

- Name your turkey: the untested trend line everybody "knows."
- Name your unnameable: the decision treated as risk that is really Knightian uncertainty.
- Which error is yours — denial or paralysis? Then name one strange loop you are inside.

Copyright Innovation 360, 2026 · my360.global

CHAPTER 2

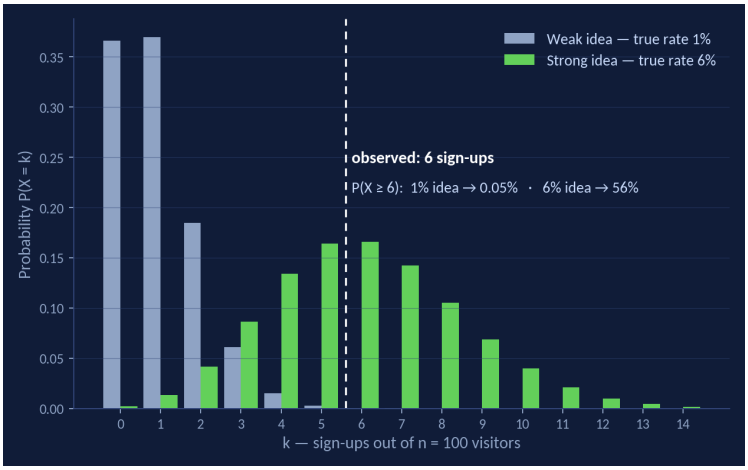
The Instruments — and Their Limits

The mathematics of the knowable · When the models break · Calibrate, then choose your instrument

2.1 — Mathematics divides the divisible; your job is to hand it something divisible. Carve one finite question out of the fog: a falsifiable claim ("we believe that…"), a designed trial of n independent yes/no observations, and a bar written before the data ("we are right if…" — set afterwards it is a rationalization in a lab coat). Then one formula prices every test you will ever run:

$$P(X = k) = C(n, k) \cdot p^k \cdot (1 - p)^{n-k}$$

$E[X] = n \cdot p$ $\quad \sigma = \sqrt{n \cdot p \cdot (1-p)}$ $\quad$ observed rate: $\sigma \approx \sqrt{p(1-p)/n}$



The worked example: the bar is ≥3% sign-ups; 100 visitors arrive; six sign up. If the true rate were a weak 1%, P(X≥6) ≈ 0.05% — once in two thousand runs. If it were a strong 6%, ≈ 56% — an ordinary Tuesday. That asymmetry IS the evidence. Rules of thumb: σ ≈ √(p(1−p)/n); decisive means the gap ≥ ~2σ; ten users with a "≥7 of 10" bar separate a coin-flip product (~17% pass) from a good one (~95%); and if no result would change your decision, the test is theater. Guess-and-halve: each decisive yes/no halves the DECISION-RELEVANT uncertainty — ~90% gone in three tests — while the ocean stays exactly as infinite as Cantor left it. You never needed certainty; you needed the remaining unknown to be smaller than the upside.

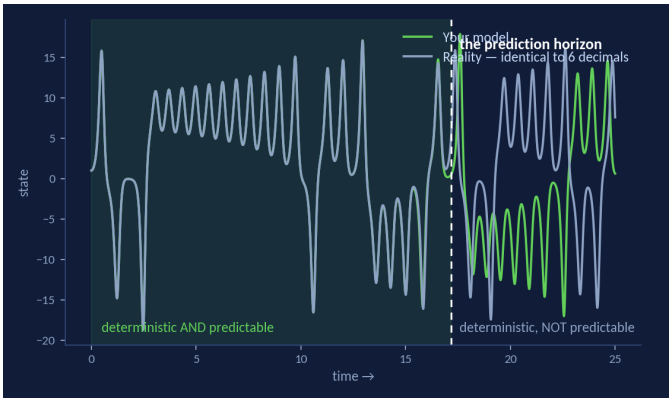
The boundary: the binomial and the law of large numbers presuppose a thin-tailed world where no single observation moves the average — true of your designed trial (because YOU capped it), false of startup returns, pandemics and crashes, where one observation dominates all others combined. Use the binomial where you designed the trials; use Chapter 1 everywhere else.

Copyright Innovation 360, 2026 · my360.global

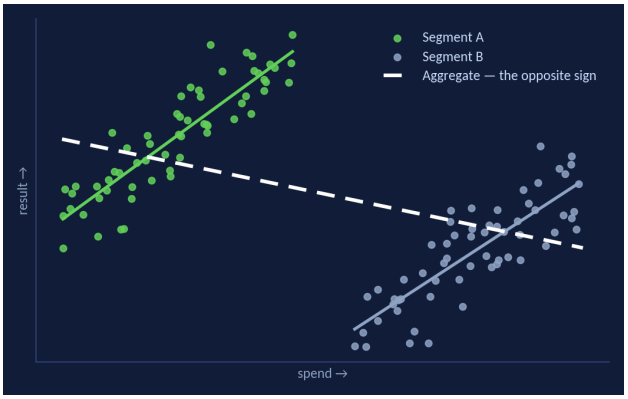
When the Models Break

Chaos · fractals · the flaw of averages · fuzzy logic · Jevons · point estimates · randomness

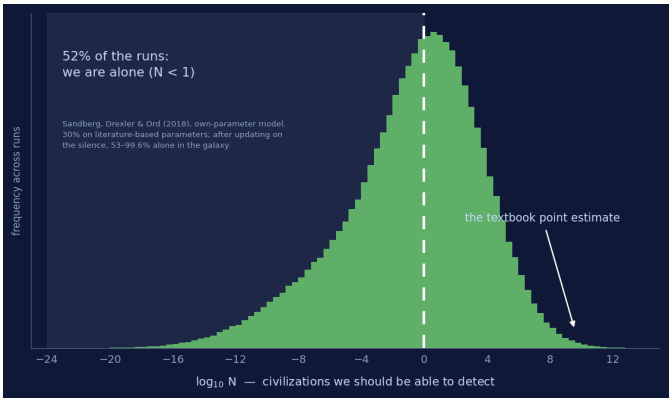
2.2 — We live on simplified models — the universe as machine, the mind as computation, the human as functions, the market as equilibrium — that served us magnificently and no longer suffice. Box: all models are wrong, but some are useful; the useful ones are the dangerous ones. Six failure modes, each with a countermeasure:



CHAOS (Lorenz 1963): two runs identical to six decimals diverge completely past the prediction horizon. Deterministic does not mean predictable; the weather's horizon is ~10 days at any budget, and the three-body problem has no closed-form solution — which is why trajectories are integrated and re-measured, never solved once. Countermeasure: don't buy a better model, buy a shorter loop. FRACTALS (Mandelbrot 1967): Britain's coast has no length, only a length per ruler (dimension ≈ 1.25); market size, churn and "the competition" change value with the resolution of the definition, and volatility repeats at every zoom. Agree on the ruler before arguing about the number.



AVERAGES: Simpson's paradox — every segment trends up while the aggregate trends down; both are arithmetically true, only one is a decision. The flaw of averages: plans built on the average customer fail on average. Challenger 1986: O-rings fine on average, launched 15°F outside the data; Feynman — nature cannot be fooled. FUZZY LOGIC (Zadeh 1965/-73): as complexity rises, precision and significance become mutually exclusive; real categories are slopes, dashboards render cliffs. Describe fuzzily, decide crisply — one deliberate bar, named as a choice. JEVONS (1865): efficiency lowers unit cost, new uses become viable, total consumption RISES — Watt's engines burned more coal; Nordhaus's light got ~1,000× cheaper and drenched the planet. AI is the purest Jevons machine ever built: cheap cognition means vastly more thinking, paid in energy, attention and complexity.



POINT ESTIMATES: the Drake equation multiplied seven guesses into "the galaxy teems"; the silent sky became the Fermi paradox. Sandberg, Drexler & Ord (Oxford, 2018) kept the equation and replaced point estimates with honest ranges: about half the runs say we are alone — the paradox was in the arithmetic, not the universe. Every business case is a Drake equation: market × share × price × conversion × retention. And randomness manufactures patterns for free — Spiegelhalter opens The Art of Uncertainty with a full box of double-yolk eggs ("one in a quintillion" — except eggs are size-graded and young flocks lay double yolks in clusters). Selection plus clustering makes miracles ordinary; the binomial is your null.

 Copyright Innovation 360, 2026 · my360.global

CHAPTER 2 · CONTINUED

Calibrate, Then Choose Your Instrument

Cooke's Classical Model (TU Delft) · the IPCC scale · the Instrument Panel

2.3 — When there is no data, don't ban judgment — score it. Cooke's Classical Model (TU Delft; 30+ years across nuclear safety, volcanology, climate): experts give 5th/50th/95th-percentile ranges on seed questions whose answers are known but not to them; they are scored on calibration (does truth land inside your ranges as often as you claimed?) and informativeness (are the ranges tight enough to matter?); the panel is weighted by performance. Measured calibration does not track seniority, confidence or volume — loud is not accurate, scored is. Speak on a calibrated scale (IPCC): virtually certain >99% · very likely >90% · about as likely as not 33–66% · very unlikely <10% — and note Spiegelhalter's warning that different agencies put different numbers behind the same word "likely," which is why you publish your scale. When you communicate a forecast, show the fan, not the line — the Bank of England's fan charts put the uncertainty in the picture itself.

THE INSTRUMENT PANEL — name the world, then pick the instrument

Designed trial · thin tails	Binomial · pre-set threshold · the 2σ rule
Chaotic · nonlinear	Shorten the loop — re-measure inside the horizon
Scale-free · fractal	Fix the ruler · never average · study the structure
Fat-tailed	Cap exposure · buy options · build convexity
Vague · linguistic	Describe fuzzily, decide crisply — one deliberate bar
Efficiency case	Jevons check: what becomes viable at the new price?
No data · high stakes	Calibrated expert judgment — seed questions (Cooke)
Knightian · genuinely novel	Small asymmetric bets · capped stakes · thresholds · probes

Most catastrophic decisions are not made with a broken instrument. They are made with a perfectly good instrument — in the wrong world. Naming the world is the skill.

EXERCISE 2 · NAME THE WORLD (WORKBOOK P. 2 · 10 MIN)

- Three live decisions — one confident, one dreaded, one postponed. Name the world of each.
- Pick the instrument and the null: what would chance plus selection have produced?
- Run the Jevons check: where is a saving booked with demand held constant?

Copyright Innovation 360, 2026 · my360.global

CHAPTER 3

Deciding in the Fog

The Uncertainty Map · Roadmapping under uncertainty · Leading in the fog — and your sprint

3.1 — The Innovation360 Uncertainty Model (Penker 2023) locates every initiative on two axes — business impact × uncertainty — with bubble size as the position you could win; a PESTLED scan (political, economic, social, technological, legal, environmental, demographic) feeds the candidates. Portfolios crowd the safe corner (Horizon 1), where everyone holds the same data and margins compress every quarter; the prize sits diagonally opposite — high impact, high uncertainty, winnable position — unowned precisely because it cannot be business-cased. It becomes affordable through the shape of the bet: cap the downside (one experiment at sandbox prices), free the upside (options with pre-written scale triggers), and let convexity work — a portfolio of capped-downside probes profits from surprise, where the fully-committed turkey is ruined by it. Pascal got here in 1670; Ecclesiastes 11:2 got here two thousand years ago: “divide your portion into seven, or even eight — for you do not know what disaster may come.” And the map is a film, not a photo: evidence moves bubbles, opinions don’t; a bubble unchanged for two quarters is a zombie. Fund movement, not positions.

3.2 — The classic roadmap is a forecast in disguise: a Gantt chart of the unknown, milestones as dates, slips punished, truth hidden. Flip one variable — milestones become evidence bars — and the physics reverses: “we proceed if ≥3% convert”; commitment extends only to the next rung; a missed bar is information; a decisive kill saved a launch. Anatomy of a threshold milestone: the claim (falsifiable), the bar (written before data; the 2σ rule sizes the sample), the stake (only the next tranche), the pre-committed exits (persevere / pivot / kill). Backcast from the destination — what would have to be TRUE? — rank must-be-trues by lethality × uncertainty, and test the killer assumption FIRST, at Level 1–2 prices; most roadmaps test the easy assumptions first and die of the hard one in year three (Kierkegaard: life is lived forwards and understood backwards — backcasting borrows the backward view in advance). Scenarios are stress tests, not predictions: sort every move into robust (do now), bet (stake small, gate with thresholds) and option (cheap now, valuable if scenario X arrives) — Shell had rehearsed the 1973 embargo and moved quarters before its peers. The option ladder is Business Experiments L1–L4 read as an options trader would: each rung buys information that reprices the next; never buy rung-four certainty at rung one; ROI lives after the ladder.

 Copyright Innovation 360, 2026 · my360.global

CHAPTER 3 · CONTINUED

Leading in the Fog

The Ellsberg effect · the leader's checklist · your 25-minute sprint

3.3 — Ellsberg, 1961: offered a known 50/50 urn and an unknown one, people bet on the known urn — and keep doing so even when it is the objectively worse deal. Ambiguity aversion is human hardware; organizations amplify it into policy: the safe-corner portfolio, business cases demanded at Level 1, the punished pioneer and the promoted caretaker. The leader's move is not to preach courage but to change the PRICE of the unknown urn: make uncertain work small, cheap, reversible, logged and celebrated. The checklist: (1) change the question — "what's the cheapest test, and what's the threshold?" replaces "what's the business case?"; (2) budget for movement, not positions; (3) celebrate decisive kills — or people will only bring you survivors; (4) review maps and logs, not decks; (5) protect the fragile — shield L1–2 work from certain-zone metrics until it has earned L3. Remember the Cloud of Unknowing: you cannot think your way through the cloud — you hand every person a probe, a threshold, and company.

EXERCISE 3 · YOUR PORTFOLIO IN 25 MINUTES (WORKBOOK P. 3)

- 10 MAP — top 10 initiatives on the Uncertainty Map; bubble = the position you could win.
- 7 THRESHOLD — "we proceed if…" for your three biggest bubbles.
- 5 HUNT — backcast the boldest bet; name the killer assumption.
- 3 COMMIT — book the cheapest decisive test. Innovation Sandboxing shows you how.

Then claim the credential: pass all nine quizzes and add the Mastering Uncertainty Certified Micro-Credential for USD 29 — built to be worn on LinkedIn beside Innovation Sandboxing: the map and the moves, side by side.

"Uncertainty is not divisible. It is danceable. — What's your threshold?"

Copyright Innovation 360, 2026 · my360.global

THE MATHEMATICS, EXPLAINED · I

The Binomial, From Zero

No prior statistics assumed. Ten minutes here and the formula on the Binomial Card becomes obvious rather than intimidating.

Start with one visitor. She either signs up (probability p) or she does not (probability 1 − p). That is the whole atom of the theory. Now send n independent visitors and ask: what is the probability that EXACTLY k of them sign up? Two things must happen: some particular set of k visitors converts — that has probability p·p·… (k times) = p^k — while the remaining n − k do not, which has probability $(1 - p)^{n-k}$. Multiply, because the visitors are independent.

But "some particular set" undercounts: the k converters could be the first k visitors, the last k, or any mixture. The number of ways to choose which k of the n convert is the binomial coefficient C(n, k) = n! / (k!·(n−k)!). Multiply in that count, and the formula assembles itself:

$$P(X = k) = C(n, k) \cdot p^k \cdot (1 - p)^{n-k}$$

how many ways it can happen × the chance of the successes × the chance of the failures

Two summary numbers follow directly. The EXPECTED count is E[X] = n·p — send 100 visitors at a true rate of 3% and you expect 3 sign-ups. The SPREAD around that expectation is the standard deviation σ = √(n·p·(1−p)); for rates, divide by n: $\sigma_{rate} \approx \sqrt{p(1-p)/n}$. This one line quietly replaces a statistics course, because almost every question you will ever ask a test reduces to: is the gap I care about large compared to σ?

WHY "INDEPENDENT, DESIGNED, CAPPED" IS NOT SMALL PRINT

- Independence: if visitor 2 copies visitor 1 (referrals, virality), $p^k \cdot (1-p)^{n-k}$ is the wrong multiplication.
- Designed: YOU chose n before looking. Peeking until it "works" silently multiplies your false-positive rate.
- Capped: one trial can never dominate the rest — that is what makes the world thin-tailed and the average honest.

Copyright Innovation 360, 2026 · my360.global

THE MATHEMATICS, EXPLAINED · II

The Worked Example — Every Number Shown

Six sign-ups out of 100 against a 3% bar. The course states the verdict; here is the full calculation.

The claim to test: “at least 3% of cold visitors will join the waitlist.” The design: n = 100 visitors, bar pre-set at ≥6 sign-ups. Result: k = 6. Was that luck?

STEP 1 — the null (the skeptic’s world, p = 1%): expected count E = 100 × 0.01 = 1.0, spread σ = √(100·0.01·0.99) = 0.99 ≈ 1. Six successes sits (6 − 1)/1 = five standard deviations above a weak idea’s expectation. Exactly: $P(X \geq 6 \mid p = 1\%) = 1 - \Sigma_{=0}^{5}\, C(100,k)\cdot 0.01^{k}\cdot 0.99^{100-k} \approx 0.0005$ — one run in two thousand. A weak idea essentially cannot produce your result.

STEP 2 — the alternative (the believer’s world, p = 6%): E = 6, σ = √(100·0.06·0.94) ≈ 2.4. Six is exactly typical: $P(X \geq 6 \mid p = 6\%) \approx 0.56$ — a genuinely good idea clears your bar more often than not. The two worlds give the SAME observation wildly different probabilities (0.0005 vs 0.56); that thousand-fold likelihood ratio is what “decisive” means.

STEP 3 — the false-kill guard, computed: at a true p = 5%, $P(X \leq 2) = \Sigma_{=0}^{2}\, C(100,k)\cdot 0.05^{k}\cdot 0.95^{100-k} \approx 0.12$. Twelve percent of the time a GOOD idea lands at two or fewer — which is why the exit is pre-committed as “pivot the test, one more cohort,” never an instant axe on a near-miss.

THE 2σ RULE — WHY 100 CLICKS SEPARATES 1% FROM 6% BUT NEVER 3.0% FROM 3.5%

- At p ≈ 3%, n = 100: $\sigma_{rae} = \sqrt{(0.03\cdot 0.97/100)} \approx 1.7$ points. Decisive gap ≈ 2σ ≈ 3.4 points.
- 1% vs 6% is a 5-point gap — comfortably beyond 2σ: one hundred visitors settle it.
- 3.0% vs 3.5% is 0.5 points — you would need $n \approx 4\cdot p(1-p)/\text{gap}^2 \approx 4\cdot 0.029/0.000025 \approx 4{,}600$ visitors.
- Sandbox rule: widen the QUESTION until 2σ fits inside it, or move on — don’t buy precision you don’t need.

TEN USERS, SAME LOGIC: bar “≥7 of 10 complete the task.” A coin-flip product (p = 0.5): $P(X \geq 7) = [C(10,7)+C(10,8)+C(10,9)+C(10,10)] / 2^{10} = (120+45+10+1)/1024 \approx 17\%$. A genuinely good one (p = 0.85): $P(X \geq 7) \approx 95\%$. Small samples are decisive when the bar — not the sample — does the work.

Copyright Innovation 360, 2026 · my360.global

THE MATHEMATICS, EXPLAINED · III

Halving, Bits — and Where the Math Ends

Guess-and-halve is information theory in disguise; thin vs fat tails is the honest boundary of everything above.

GUESS-AND-HALVE, FORMALLY. A decisive yes/no question carries one bit of information — it splits the space of decision-relevant possibilities in half. Three decisive tests: ½ × ½ × ½ = ⅛ of the original uncertainty remains ≈ 90% resolved. Choosing among N comparable options therefore needs about $\log_2 N$ decisive tests (8 options → 3 tests), which is why the course insists each test be a genuine binary against a pre-set bar: a test whose every outcome leads to the same decision carries zero bits — the acid test, restated in information theory. Meanwhile the TOTAL space of futures stays exactly as infinite as Cantor left it; what halves is only the uncertainty inside the finite question you carved. Both statements are true at once, and the whole art lives in the difference.

THIN VS FAT TAILS — THE BOUNDARY. Everything above leans on the law of large numbers: averages of many small, independent, capped contributions settle down, and σ shrinks like $1/\sqrt{n}$. Add the tallest person on Earth to a thousand-person sample and the mean height barely twitches — heights are thin-tailed. Add one Google to a portfolio of startups and the average return IS that one company — startup returns, pandemics, blockbusters and crashes are fat-tailed: a single observation can dominate all others combined, the historical average actively misleads, and σ itself may not exist to converge to. The turkey's feeding log was a thin-tailed model living in a fat-tailed world.

HOW TO TELL THE WORLDS APART IN PRACTICE: ask whether the biggest observation in your history changes the average materially when you drop it. If removing one row barely moves the mean — thin tails, the binomial toolkit applies where you designed the trials. If one row IS the story — fat tails: stop averaging, cap exposure, buy options, and read chapter 3.1 again. The fractal chart on page 6 is the visual signature: scale-free structure (straight lines on log-log plots, volatility clustering) is fat-tail country.

THE DRAKE MISTAKE — WHY MULTIPLYING POINT ESTIMATES MANUFACTURES CONFIDENCE

- Multiply seven "reasonable" point estimates and errors compound multiplicatively — the product is dominated by the tails you ignored.
- In log-space multiplication becomes addition: uncertainty ≥ several orders of magnitude per factor → the honest answer is a DISTRIBUTION.
- Sandberg, Drexler & Ord (2018): same equation, honest ranges → about half the runs say N < 1. The paradox was arithmetic.
- Your business case: market × share × price × conversion × retention — five factors, same disease. Report ranges, or state yours.

 Copyright Innovation 360, 2026 · my360.global

THE MATHEMATICS, EXPLAINED · IV

The Failure Modes, Quantified

The numbers behind chapter 2.2–2.3 — enough to reproduce every chart in this book.

CHAOS & THE HORIZON. Lorenz's system is three innocent-looking equations (dx/dt = σ(y−x), dy/dt = x(ρ−z)−y, dz/dt = xy−βz). Two starts differing by δ_0 diverge like $\delta(t) \approx \delta_0 \cdot e^{\lambda t}$, where λ is the Lyapunov exponent. The prediction horizon — the time until the error reaches tolerance Δ — is $t \approx (1/\lambda)\cdot\ln(\Delta/\delta_0)$: because δ_0 sits inside a LOGARITHM, measuring a million times more precisely buys only $\approx \ln(10^6)/\lambda \approx 14/\lambda$ extra time units. That is why the ten-day weather wall stands at any budget — and why the countermeasure is a shorter loop, not a better model.

FRACTAL DIMENSION. Measure a coast with ruler length r and count N(r) segments: for fractals $N(r) \sim r^{-D}$, so measured length $L(r) = N \cdot r \sim r^{1-D}$ — with D ≈ 1.25 for Britain's west coast, halving the ruler multiplies the "length" by $2^{0.25} \approx 1.19$, forever. D is read as the slope of log N against log(1/r). Business translation: any quantity whose value keeps changing as you refine the measurement (market size, churn, "the competition") has no true value — only a value per ruler. Agree on the ruler before you argue about the number.

SIMPSON'S PARADOX, MECHANICALLY. Segment A: spend and results both high; segment B: both low; WITHIN each, more spend → better results. Pool them and the mix effect dominates: the pooled slope weights each segment by size and position, and can flip sign — correlation within ≠ correlation between. The pooled number answers a DIFFERENT question ("what happens if I move budget between segments?"), not the one you asked. Rule: never act on an aggregate before seeing the segment-level slopes.

FUZZY MEMBERSHIP. Zadeh replaces the yes/no indicator with a membership function $\mu(x) \in [0,1]$ — e.g. $\mu(\text{engaged}) = 1/(1+e^{-a(x-x_0)})$. His 1973 incompatibility principle: as complexity rises, precision and significance become mutually exclusive. The course's resolution: model the slope μ honestly, then place ONE crisp decision bar on it, and say aloud that the bar is a choice.

JEVONS, IN ONE INEQUALITY. If demand has price elasticity ε and efficiency cuts effective price by fraction f, consumption changes by roughly $(1-f)^{1-\varepsilon}$: whenever ε > 1 (elastic demand — computing, light, and very plausibly cognition), total consumption RISES after the efficiency gain. Nordhaus: light became ≈ 1,000× cheaper per lumen; we flooded the planet with it. Put ε in your efficiency case or admit you assumed ε = 0.

COOKE'S SCORE, CONCRETELY. Each expert gives 5–50–95% ranges on seed questions with known answers. Calibration: with honest ranges, ≈ 5% of truths should land below the 5th percentile, ≈ 45% in each middle band — the score is a χ^2-style distance between claimed and realized coverage. Informativeness: how concentrated the ranges are relative to a background range. Final weight ∝ calibration × informativeness — you cannot win by vagueness (kills informativeness) nor by confident narrowness (kills calibration). Ten seed questions from your own industry suffice to rank a leadership team.

 Copyright Innovation 360, 2026 · my360.global

SOURCES & FURTHER READING

The Library of the Unknowable

Every author named in the course — and where to go deeper. All works are cited as inspiration; interpretations are the course's own.

FOUNDATIONS OF UNCERTAINTY

Knight, F. (1921). Risk, Uncertainty and Profit. Houghton Mifflin — the risk/uncertainty distinction; profit as the reward for bearing the uninsurable.

Spiegelhalter, D. (2024). The Art of Uncertainty: How to Navigate Chance, Ignorance, Risk and Luck. Pelican — aleatory vs. epistemic; double-yolk eggs; verbal probability scales; fan charts. The course's recommended companion.

Kay, J. & King, M. (2020). Radical Uncertainty. Bridge Street Press — "what is going on here?" against misplaced probability.

Taleb, N. N. (2007/2012). The Black Swan; Antifragile. Random House — the turkey, fat tails, convexity and optionality.

Hume, D. (1748). An Enquiry Concerning Human Understanding — the problem of induction.

Ellsberg, D. (1961). "Risk, Ambiguity, and the Savage Axioms." QJE 75(4) — ambiguity aversion.

Kahneman, D. (2011). Thinking, Fast and Slow. FSG — the psychology under all of the above.

MATHEMATICS, STATISTICS & FORECASTING

Bernoulli, J. (1713). Ars Conjectandi — the binomial distribution.

Savage, S. (2009). The Flaw of Averages. Wiley — why plans built on averages fail on average.

Pearl, J. & Mackenzie, D. (2018). The Book of Why. Basic Books — Simpson's paradox and causal reading of data.

Tetlock, P. & Gardner, D. (2015). Superforecasting. Crown — calibration in practice.

Cooke, R. M. (1991). Experts in Uncertainty. OUP — the Classical Model of structured expert judgment (TU Delft).

TU Delft OpenCourseWare: Decision Making Under Uncertainty — Structured Expert Judgment (CC BY-NC-SA).

Sandberg, A., Drexler, K. E. & Ord, T. (2018). "Dissolving the Fermi Paradox." arXiv:1806.02404 — distributions, not point estimates.

IPCC (2010–). Guidance Note on Consistent Treatment of Uncertainties — the calibrated language scale.

 Copyright Innovation 360, 2026 · my360.global

SOURCES & FURTHER READING

The Library of the Unknowable · II

Systems, chaos and the braid · The philosophy and theology of the unknowable · Strategy and method

SYSTEMS, CHAOS, FRACTALS & THE BRAID

Hofstadter, D. (1979). Gödel, Escher, Bach: An Eternal Golden Braid. Basic Books — strange loops; and (2007) I Am a Strange Loop.

Nagel, E. & Newman, J. (1958). Gödel's Proof. NYU Press — the incompleteness theorems, readable.

Gleick, J. (1987). Chaos: Making a New Science. Viking — Lorenz and the prediction horizon.

Mandelbrot, B. (1967). "How Long Is the Coast of Britain?" Science 156; and (1982) The Fractal Geometry of Nature. Freeman.

Mandelbrot, B. & Hudson, R. (2004). The (Mis)Behavior of Markets. Basic Books — fractals and fat tails in finance.

Zadeh, L. (1965). "Fuzzy Sets." Information and Control 8; (1973) the principle of incompatibility, IEEE Trans. SMC-3.

Jevons, W. S. (1865). The Coal Question. Macmillan — the paradox; Nordhaus, W. (1996) on the price of light.

Meadows, D. (2008). Thinking in Systems. Chelsea Green — the gentlest door into systems thinking.

Feynman, R. (1986). Appendix F, Report of the Presidential Commission on the Challenger Accident — "nature cannot be fooled."

THE PHILOSOPHY & THEOLOGY OF THE UNKNOWABLE

Exodus 3:14; Job 38; Ecclesiastes 9:11 & 11:2 — the name that refuses definition; the refused account; time and chance; the oldest portfolio advice.

Pseudo-Dionysius (5th–6th c.). The Mystical Theology — the via negativa; Maimonides (12th c.), Guide for the Perplexed.

Nicholas of Cusa (1440). De Docta Ignorantia — learned ignorance, from the mathematics of infinity.

Anonymous (14th c.). The Cloud of Unknowing — probes into what the intellect cannot pierce.

Lao Tzu, Tao Te Ching, ch. 1; the Upanishads — neti, neti.

Pascal, B. (1670). Pensées — the wager: pricing the shape when the odds are unknowable.

Kierkegaard, S. (1846). Concluding Unscientific Postscript — "objective uncertainty held fast"; the leap.

Dauben, J. (1979). Georg Cantor: His Mathematics and Philosophy of the Infinite. Harvard UP — the transfinite and the Absolute.

STRATEGY & METHOD

Penker, M. (2023). The Innovation360 Uncertainty Model; Dancing with Uncertainty (masterclass); Play Bold (2021, WSJ & USA Today bestseller).

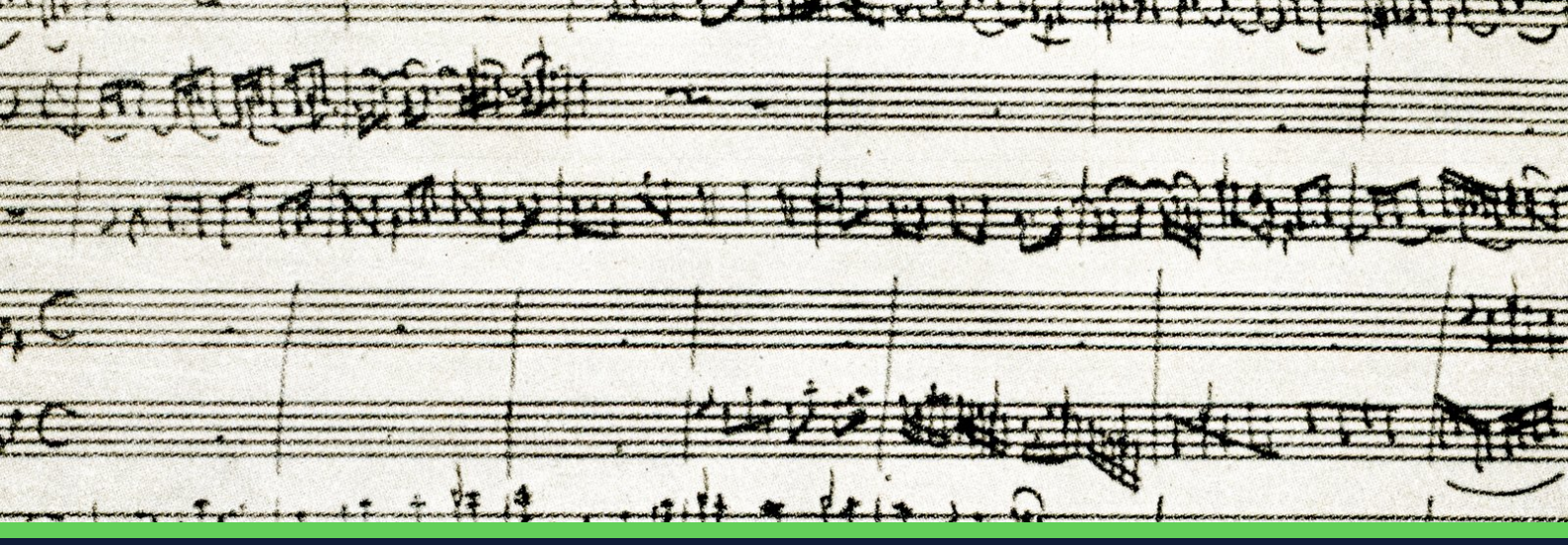
Innovation360. Business Experiments Level 1–4 (44 experiment cards); Innovation Sandboxing (my360.global) — the tactical sister course.

Wack, P. (1985). "Scenarios: Uncharted Waters Ahead." Harvard Business Review — Shell and the 1973 oil shock.

Ries, E. (2011). The Lean Startup. Crown — build-measure-learn as the shortest loop.

McGrath, R. G. (2019). Seeing Around Corners. HMH — inflection points and staged commitment.

 Copyright Innovation 360, 2026 · my360.global



TAKE THE COURSE

Decide well when you cannot know.

3 chapters · 9 quizzes · hands-on exercises on your own portfolio.

The Uncertainty Toolkit (5 templates) and Workbook included. Certificate add-on: USD 29.

Enroll: app.my360.global — course: Mastering Uncertainty. Sister course: Innovation Sandboxing.

“You cannot know. You can still decide well.”

Pictures licensed under Adobe Stock by Innovation 360. Mastering Uncertainty™ and InnoSurvey® are trademarks of Innovation 360 Group AB.
Copyright Innovation 360, 2026 · my360.global