

EE2066 Engineers in Society

工程師與社會

Lectures 1-4 精簡中英對照溫習筆記（黑白雙面打印版） | 每點：English 在上，中文縮排在下；【L1 p.15】 = 原講義頁碼；灰底粗體底線 = 關鍵字；★ 灰框 = 必記重點；▲ = 提示；細框 = 延伸。

Lecture 1 | 社會、倫理與科技導論

Introduction to Society, Ethics and Technology

Course info & assessment | 課程資料與評核【L1 p.1-7】

- EE2066 Engineers in Society; Prof. Rosa Chan + 3 TAs; Wed 15:00-17:50, YEUNG LT-4.
工程師與社會；陳教授 + 3 位助教；逢星期三，楊建文學術樓 LT-4。
- 10 topics: local industry; society & engineering; product engineering & innovation; business & entrepreneurship; professional ethics; health, safety & environment; sustainable engineering; career advising; emerging tech; global challenges.
十個課題：本地工業、社會與工程、產品工程與創新、商業與創業、專業倫理、健康安全環境、可持續工程、職涯指導、新興科技、全球挑戰。

Component 評核項目	Weight 比重
Final Exam 期末考	<u>30%</u>
Coursework 持續評估	<u>70%</u>
Test 1 / Test 2 測驗	5% / 15%
In-class / Individual 課堂／個人	10% / 10%
Group Project 小組專題	30%

- Must score $\geq 30/100$ on BOTH exam and coursework.
考試及課程作業兩者都要 ≥ 30 分才合格。
- Sick on test day: notify within 1 hour, medical certificate within 24 hours; other absences need prior approval. Missed in-class work = 0.
測驗病假：1 小時內通知、24 小時內交醫生證明；其他缺席須事先批准。缺席課堂作業即零分。

Why engineers need more than engineering | 工程師不只需要工程知識【L1 p.8-13】

Myth 迷思	Reality 現實
Engineers don't write much 不用寫	Extensive <u>report writing</u> 大量寫報告
Work alone 獨自工作	<u>Communication & negotiation</u> vital 溝通談判
Just follow orders 聽指令	High <u>responsibility & decision-making</u> 高度責任
Textbook answer exists 有標準答案	No book has all answers 沒有萬能答案
Only maths & physics 只是數理	<u>Imagination, innovation, aesthetics</u> 想像、創新、美學

- Engineering shapes daily life: coffee (supply chain, QC), smartphone (materials, telecoms, UI), commute (traffic systems), building (structure, A/C, fire safety), healthcare (devices, telemedicine).
工程塑造日常：咖啡（供應鏈、品控）、手機（物料、電訊、介面）、通勤（交通系統）、大廈（結構、空調、消防）、醫療（器材、遙距醫療）。
 - Many hats: Negotiator, Manager, Safety Expert, Treehugger (environment), Innovator, KOL (explains tech to the public).
多重角色：談判者、管理者、安全專家、環保者、創新者、意見領袖（向公眾解釋技術）。
 - 8 responsibilities: project mgmt, financial decisions, documentation, technical design, ethical judgement, collaboration, maths, troubleshooting - only 2 are purely technical.
八項責任：項目管理、財務決策、文件、技術設計、倫理判斷、協作、計算、解難——只有兩項是純技術。
- ★ Engineering = applying technical knowledge in a broader societal context.
工程 = 在社會脈絡中應用技術知識。

Can vs Should; technology is never neutral | 能否 vs 應否；科技從不中立【L1 p.14-18】

Can we? 技術可行性	Should we? 倫理正當性
Physical laws, computation, budget, performance 物理、運算、預算、性能	Social welfare, human rights, <u>systemic risk</u> , <u>intergenerational equity</u> 社會福祉、人權、系統性風險、跨代公平
Sound design? Specs on time? Reliable components? 設計穩妥？準時達標？零件可靠？	Who benefits / who is harmed? <u>Dual-use</u> misuse? <u>Informed consent</u> ? 誰得益誰受害？兩用濫用？知情同意？

- ★ Your job: answer BOTH questions.
工程師要同時回答兩個問題。
- Never neutral - same tech, two uses: facial recognition (find missing kids / mass surveillance); data analytics (predict outbreaks / manipulate elections); CRISPR (cure disease / designer babies, bioweapons); social-media algorithms (connect / misinformation, echo chambers).
科技不中立：人臉識別（尋人／監控）、數據分析（預測疫情／操控選舉）、基因編輯（治病／訂製嬰兒、生物武器）、社交演算法（連結／假資訊、迴音室）。設計選擇已嵌入價值。
 - Dilemmas (competing values): safety vs cost; environment vs development; transparency vs confidentiality; personal ethics vs company policy.
倫理兩難（價值互相競爭，slide 誤寫 Completing）：安全 vs 成本、環境 vs 發展、透明 vs 保密、個人倫理 vs 公司政策。
 - Why ethics: no formula; competing qualitative values; affects real lives; decisions must be quick.
為何重視：沒有公式、質性價值互相競爭、影響真實生命、要快速決定。

筆記 Notes

延伸 Extension 例：人臉識別——Can：準確率、延遲；Should：數據來源、對深膚色人士的偏見、會否用作監控、有否同意。C hallenger、737 MAX 都是只答了 Can。

Facial recognition: 'Can' = accuracy/latency; 'Should' = data, bias, surveillance, consent.

What ethics is / is not; moral reasons; micro vs macro | 倫理是甚麼／不是甚麼；道德理由；微觀與宏觀【L1 p.19-24】

- Definitions (Cambridge, Merriam-Webster, Britannica): a field of study of right/wrong, a set of principles, a code of conduct. 定義：研究對錯的學問、一套原則、一套行為守則。
- Ethics is NOT: feelings (right acts may feel uncomfortable), science (possible ≠ ethical), religion, cultural norms (cultures contain unethical practices), **law** (legal ≠ ethical). 倫理不是：感覺、科學（做得到≠應該做）、宗教、文化規範、**法律（合法≠合乎倫理）**。
- Moral reasons (fairness, justice, duty, rights) vs non-moral reasons (prudence, self-interest, efficiency, economy, lawsuits, PR). 道德理由（公平、公義、責任）vs 非道德理由（審慎、自利、效率、官司、公關）。

- ★ Both can reach the same decision, but only moral reasons reflect your values - non-moral reasons vanish when the cost vanishes.
- 兩者可得相同結論，但**只有道德理由反映價值**；非道德理由在成本消失時就消失。
- Decisions occur at three levels: personal, institutional, social. 倫理決策三層：個人、機構、社會。

Micro-ethics 微觀（個人操守）	Macro-ethics 宏觀（社會方向）
Bribery & kickbacks 賄賂回佣	Environmental justice 環境公義
Conflict of interest 利益衝突	AI governance, autonomous weapons, bias AI 治理
Data integrity 數據誠信	Sustainability, carbon lifecycle 可持續
Whistleblowing protocol 吹哨程序	Democratic control of tech 民主監督；technological lock-in 技術鎖定

延伸 Extension 非道德理由是「有條件」的：官司變便宜、負面新聞不曝光，理由就消失；道德理由無論有沒有人看見都成立。

Non-moral reasons are conditional; moral reasons hold even when no one is watching.

Four philosophical pillars & ethical thinking 四大哲學支柱與倫理思維【L1 p.25-28】		
Pillar 支柱	Core idea 核心	In engineering 應用
Utilitarianism 效益主義	Max net good outcome 最大總體好處	Cost-benefit, quantitative risk analysis 成本效益
Deontology 義務論 (Kant)	Duties/rights never breached 義務不可違	Safety & rights non-negotiable 安全人權是底線
Virtue Ethics 德行倫理	Character: integrity, honesty, competence 品格	"What would an ethical engineer do?"

Pillar 支柱	Core idea 核心	In engineering 應用
Care Ethics 關懷倫理	Vulnerable groups, empathy 弱勢、同理	Infrastructure, assistive tech 基建、輔助科技

- ▲ 提示：電車難題：效益主義會拉桿（5>1），義務論不主動殺人；自動駕駛「撞誰」是現代版。答題用兩個以上支柱分析。
- Ethical thinking: **moral compass** (foundation) + decision framework + social responsibility + critical thinking + professional codes + cultural influence. 倫理思維：**道德指南針**（基礎）+ 決策框架 + 社會責任 + 批判思考 + 專業守則 + 文化影響。

Engineering ethics, RAEng principles, HKIE rules | 工程倫理、英國四原則、HKIE 守則【L1 p.29-36】

- Special because: scale of impact, technical complexity, safety-critical, limited resources, exponential tech change, interdisciplinary. (Uncle Ben: great power, great responsibility.) 工程倫理特別之處：影響規模大、技術複雜、安全攸關、資源有限、科技急變、跨學科——能力越大責任越大。

RAEng / Engineering Council 四原則	Key duties 重點
1 Accuracy & Rigour 準確嚴謹	Only work within competence ; keep skills updated; don't mislead; present evidence without bias; quantify risks. 只在能力範圍內工作、不誤導、量化風險
2 Honesty & Integrity 誠實誠信	No deception; declare conflicts of interest ; reject bribery; be trustworthy. 申報利益衝突、拒賄
3 Respect for Life, Law & Public Good 尊重生命法律公益	Lawful work; minimise harm for future generations; hold paramount health and safety . 安全凌駕一切
4 Responsible Leadership 負責任領導	Listen to public concerns; promote public understanding; be objective & truthful. 聆聽、告知、真實

HKIE Rules of Conduct 守則	中文
1 Profession: uphold dignity & reputation	對專業：維護尊嚴聲譽
2 Colleagues: don't injure others' reputation	對同業：不損他人聲譽
3 Employers/clients: integrity, business ethics	對僱主客戶：誠信
4 Public: overriding interest of public safety, health, environment	對公眾：公眾利益 凌駕 其他

- Safety & risk: prioritise public safety; unbiased risk assessment; go **beyond minimum standards**; communicate risks transparently; know when to whistleblow. 安全與風險：公眾安全優先、無偏見評估、**超越最低標準**、透明溝通風險、判斷何時吹哨。

延伸 Extension 記憶口訣「準、誠、命、領」。Hold paramount = 公眾安全凌駕僱主、成本、工期；HKIE 第 4 條 overriding 同一意思。

Mnemonic: Accuracy-Honesty-Life-Leadership; 'hold paramount' and 'overriding' both put public safety first.

筆記 Notes

Ethical decision-making | 倫理決策流程 【L1 p.37-40】

4-step pipeline 四步	Action 做法
1 Recognise issue 識別	Conflict beyond legality? Harm or unjust distribution? 超越合法與否
2 Gather facts 事實	Unknowns, uncertainties, hidden stakeholders 隱藏持份者
3 Multi-lens audit 多角度	Rights, Justice, Utility, Virtue (+Common Good, Care) 權利公義效益德行
4 Test & reflect 測試反思	Front-page headline test ; safeguards; monitor 頭版新聞測試

• Markkula (SCU) framework, 10 questions: identify issue (Q1-2) → get facts, stakeholders, options (Q3-5) → evaluate with 6 lenses (Q6) → choose & test: what would someone I respect say? (Q7-9) → implement & reflect (Q10).

聖塔克拉拉大學十問框架：識別 → 事實、持份者、選項 → 六角度評估（權利、公義、效益、共善、德行、關懷） → 選擇並測試 → 執行反思。

延伸 Extension 答情境題可直接以四步作答題骨架；「頭版新聞測試」：決定明天上頭版你是否坦然？

Use the 4 steps as your answer skeleton; front-page test = would you be comfortable if it made headlines?

Why good engineers fail; whistleblowing | 好工程師為何失敗；吹哨 【L1 p.41-45】

Trap 陷阱	Meaning 意思
Normalization of deviance 偏差正常化	Accept defects because past failures caused no disaster (Challenger O-rings) 之前沒事就當正常
Groupthink & silos 群體思維、孤島	Fear/conformity suppress doubts → false unanimity 壓下異議
Shift in burden of proof 舉證責任轉移	"Prove it's safe" → "Prove it will fail now" 由證明安全變證明危險

• Whistleblowing: reporting illegal/unethical/dangerous practice, internal or external; a **last resort**; public safety vs loyalty; personal risk.

吹哨：舉報違法、不道德或危險做法，可內部或外部；是**最後手段**；公眾安全 vs 忠誠；有個人風險。

• Escalation: 1 document thoroughly → 2 exhaust chain of command → 3 ombudsperson / legal advice → 4 public disclosure if imminent danger persists.

上報層級：①詳細記錄 → ②用盡內部渠道 →

③申訴專員／法律意見 → ④危險持續才公開。

★ Creative middle way: fail-safe redundancy, phased deployment with canary monitoring, independent audit - avoid the safety-vs-cost deadlock.

創意中間路線：失效安全冗餘、分階段金絲雀部署、獨立審核——避免安全 vs 成本二選一。

• 1980s disasters triggered global rethink: Bhopal 1984 (MIC gas, 3,700+ deaths, 558,000 injured); Chernobyl 1986 (reactor explosion, >4,000 cancer deaths).

80 年代災難促使反思：博帕爾 1984（毒氣，逾 3,700 死）；切爾諾貝爾 1986（核反應堆爆炸，逾 4,000 癌症死亡）。

延伸 Extension 失敗多數源於系統與文化，不是壞人——所以需要匿名渠道、安全否決權、鼓勵異議。金絲雀部署 = 先向少量用戶推出並監察，有事即回滾。

Failures come from culture, not bad people; canary release = small rollout with monitoring and rollback.

Challenger; Boeing 737 MAX; environmental ethics | 挑戰者號；波音 737 MAX；環境倫理 【L1 p.46-50】

• Challenger (28 Jan 1986): exploded 73 s after launch, 7 dead; O-ring in right booster failed in unusually cold weather.

挑戰者號：升空 73 秒爆炸，7 死；低溫令右推進器 O 形環失效。

• Issues: engineers overruled by management; schedule pressure; normalisation of deviance; reversed burden of proof; poor risk communication.

問題：工程師意見被推翻、進度壓力、偏差正常化、舉證倒轉、風險溝通不清。

• 737 MAX: design flaws → crashes; internal pressure discouraged risk reporting; **profit over safety** → systemic failure. (MCAS software relied on a single sensor.) Q: how should regulators enforce safety?

737 MAX：設計缺陷致空難；內部壓力阻止上報；**利潤凌駕安全**（MCAS 依賴單一感應器）。思考：監管如何執法？

• Environmental ethics tools: life-cycle assessment, pollution control, ecosystem modelling, renewables, waste/recycling, water treatment, sustainable materials, carbon footprint. 環境倫理工具：生命週期評估、污染控制、生態建模、可再生能源、回收、水處理、可持續物料、碳足跡。

延伸 Extension Challenger

三大陷阱齊全：偏差正常化（之前已見 O 形環侵蝕）、群體思維（會議壓力）、舉證倒轉（要工程師證明不安全）。737 MAX：軟件修補硬件問題時，軟件本身就是安全攸關系統，要有冗餘。

Challenger shows all three traps; in 737 MAX, software compensating hardware became safety-critical and needed redundancy.

Flint water crisis; HK bottled water | 弗林特水危機；香港樽裝水事件 【L1 p.51-57】

• Flint (~100,000 people), Apr 2014: water switched from Detroit/Lake Huron to Flint River **to save cost**; no corrosion control → lead leached from old pipes.

弗林特：2014

年為**省錢**改用弗林特河水，沒有防腐處理，舊鉛管釋出鉛。

• Timeline: complaints Aug 2014 → Detroit reconnection declined Jan 2015 → high lead Feb 2015 → Virginia Tech: 40% homes elevated lead; pediatrician: child blood lead up (Sep 2015) → switch back Oct 2015 → emergency Dec 2015/Jan 2016.

時序：居民投訴 → 拒絕重接 → 驗出高鉛 → 40%

住戶鉛超標、兒童血鉛上升 → 改回水源 → 宣布緊急狀態。

筆記 Notes

• Ethical issues: safety vs cost; MDEQ engineers' due diligence; delayed public notice; **environmental justice** (poor, African-American city); whistleblower (Miguel Del Toral, EPA); long-term harm to children.

倫理問題：安全 vs 成本、工程師應有審慎、延遲通知公眾、**環境公義**、吹哨者、兒童長期傷害。

• HK bottled water (2025, background): HK\$52.9m government contract to a supplier that misrepresented the water's source; terminated, audited, officials disciplined. Lesson: due diligence beyond paperwork; procedural compliance is only a floor; public trust.

香港樽裝水事件（2025，補充資料）：約 5,290 萬合約供應商虛報水源，合約終止、審計、官員受紀律調查。啟示：盡職審查不止紙上程序、合規只是底線、公眾信任。

延伸 Extension 工程師最遲應在 2014 年 8-9 月居民投訴時檢測並要求防腐；最好在轉水源前做腐蝕評估。問題由外部研究者及醫生揭發，說明獨立數據與跨專業合作（避免 silo）的重要。

Engineers should have tested and required corrosion control by Aug-Sep 2014; outsiders exposed it - silos failed.

Computing ethics: VW, Cambridge Analytica, HK data leak | 電腦倫理：福士、劍橋分析、香港資料外洩【L1 p.58-69】

• Computing challenges: rapid evolution, global impact, interdisciplinary, unintended consequences.

電腦科技挑戰：變化快、全球影響、跨學科、意外後果。

• VW (2015): software **defeat device** turned on emission controls only in lab tests; real driving NOx up to **40X** legal limit; sold as 'clean diesel'. Engineers knew in 2008 they couldn't meet both performance and emissions; CEO resigned 23 Sep 2015.

福士：軟件**作弊裝置**只在測試時啟動排放控制，實際 NOx 達上限 **40 倍**，卻宣傳「清潔柴油」；2008 年已知無法兩全；CEO 辭職。

★ VW obeyed the letter of the law but violated its spirit - legal ≠ ethical.

福士**符合條文、違反精神**——合法不等於合乎倫理。

• Cambridge Analytica: Kogan's quiz app (2013-14) got ~300,000 users **plus their friends** → ~87 million profiles; Facebook knew 2015 but didn't verify deletion or disclose; exposed by whistleblower Wylie (Mar 2018); fines £500k (ICO) and US\$5bn (FTC).

劍橋分析：性格測驗 app 約 30 萬人**連同朋友**→ 約 8,700 萬帳戶；Facebook 2015 年已知但沒核實刪除、沒公開；吹哨揭發；罰款 50 萬英鎊及 50 億美元。

• Issues: privacy & consent, data protection, trust, transparency, algorithmic influence on elections → **privacy by design**, data minimisation.

問題：私隱同意、數據保護、信任、透明、演算法影響選舉 → **私隱設計**、數據最少化。

• HK Companies Registry (2024, background): portal sent extra personal data (full ID numbers, addresses) to the browser - hidden but visible via F12; ~110,000 people.

公司註冊處（2024，補充）：網頁暗中傳送額外個人資料（按 F12 可見），約 11 萬人受影響——「沒顯示」≠「沒外洩」。

延伸 Extension VW 工程師應在 2008 年如實報告技術限制、拒絕編寫作弊軟件、按吹哨層級上報。劍橋分析：API 容許讀取朋友資料，30 萬同意被放大成 8,700 萬——API 設計本身就是倫理決定。

VW engineers should have reported limits and refused; CA shows an API design choice is an ethical choice.

Governance and your role | 治理與你的角色【L1 p.70-74】

• Red lines: AI autonomy (who dies in crashes?), brain-computer interfaces (therapy vs mind reading), genetic enhancement, digital addiction (engaging vs manipulative UX), smart cities (efficiency vs surveillance).

紅線：AI 自主、腦機介面、基因增強、數碼成癮（操控式設計）、智慧城市（效率 vs 監控）。

• Who controls tech: companies (fast, profit), governments (slow, control), international (different values), users (don't see risks), engineers (knowledge, little power). Tech outpaces regulation.

誰控制科技：企業求快求利、政府慢、國際難協調、用戶不懂風險、工程師有知識沒權力；科技快過規管。

• Your role: advocate ethical design, communicate risks to non-experts, join professional societies, shape standards.

你的角色：倡議倫理設計、向非專家解釋風險、參與專業學會、制定標準。

★ Ask: Purpose, Stakeholders, Unintended consequences, Red lines, Safeguards, Transparency (PSURST).

開發科技六問（**PSURST**）：目的、持份者、意外後果、紅線、保障、透明。

• Reflection: our duty to poorer countries and to future generations.

反思：對貧窮國家及下一代的責任。

Lecture 2 | 技術溝通 — 嚴謹、承擔與專業責任

Technical Communication - Rigor, Ownership, Professional Responsibility

Types of technical writing | 技術寫作類型【L2 p.1-3】

• Opening video: Lisa Su (AMD CEO) to MIT Class of 2026. 開場：AMD CEO 蘇姿丰 MIT 畢業演說。

• Product docs (manuals, datasheets, specs); software docs (API, code, release notes, requirements, **AI model cards, system cards, prompt schemas, agent SOPs**); reports (technical, feasibility, test, **bias audits, AI safety assessments**); process docs (SOPs, workflows, troubleshooting); legal/business (patents, proposals); communication (white papers, presentations, blogs).

產品文件、軟件文件（含 AI 模型卡、系統卡、提示結構）、報告（含偏見審計、AI 安全評估）、流程文件、法律商業（專利、建議書）、傳播（白皮書、簡報、網誌）。

★ AI-era skills: curate, prompt, verify, edit.

AI 時代技能：**策劃、提示、核實、編輯**。

Plagiarism, AI accountability, copyright | 抄襲、AI 責任與版權【L2 p.4-12】

- Plagiarism: not acknowledging sources; over-using sources; buying/copying work; letting others copy you; **submitting unverified or undeclared AI output**; using AI for analytical work without your own thinking.
抄襲：沒註明來源、過度依賴來源、買或抄功課、借人抄、**提交未核實或未申報的 AI 內容**、用 AI 代替自己思考。
- Problems: cognitive atrophy; **hallucination** risk in engineering pipelines; professional liability - you sign off, you can't sue the AI.
問題：認知萎縮、AI **幻覺**進入工程流程、專業責任——你簽名，不能告 AI。
- Acknowledge: paraphrase → in-text citation + reference list; direct quote → quotation marks too; AI → **AI usage statement** (tool, version, purpose).
註明：轉述要文內引用 + 參考列表；直接引用另加引號；用 AI 要寫 **AI 使用聲明**（工具、版本、用途）。

★ No excuse (fake AI refs, 'only for grammar', passed AI detector). The engineer is 100% accountable for every character.
沒有藉口。工程師對提交的**每一個字元 100% 負責**。

- AI vs plagiarism debate - for: not original, misrepresents ability, copyright, hinders learning; against: a tool like a calculator, a starting point, boosts productivity, hard to detect. Appropriate: brainstorming, debugging, formatting. Unethical: hallucinated facts, bypassing learning, unverified bulk writing.
正方：非原創、誤導能力、侵權、妨礙學習；反方：只是工具、起點、提升效率、難分辨。適當：構思、除錯、排版；不道德：幻覺事實、繞過學習、大量未核實寫作。
- IEEE: putting a manuscript under review into a public AI = **breach of confidentiality** (AI learns from input). Lawsuits: Getty vs Stability AI, NYT vs OpenAI, publishers vs Anthropic; authors' settlement ~US\$3,000 per book.
IEEE：把審稿論文放入公共 AI = **違反保密**。訴訟：Getty、紐約時報、音樂出版商；作家和解每本 3,000 美元。

延伸 Extension AI 使用聲明例子：「本報告使用 Claude（版本 X）協助構思大綱及修飾文法；所有技術內容、數據及引用由作者核實。」關鍵：AI 是幫你思考還是代你思考？
AI statement: tool, version, purpose, and what you verified. Is AI helping you think or thinking for you?

Working with AI: prompts and loops | 與 AI 協作：提示與迴圈【L2 p.13-19】

- Old: programming language → computer executes. New: natural language → AI interprets, proposes, executes. Coding still matters; **defining goals, context, constraints, quality** matters more.
以前用程式語言，現在用自然語言；寫程式仍重要，但**定義目標、背景、限制、質素**更重要。

Prompt = work spec 提示五元素 (CGCDV)	
Context 背景	Audience & situation 受眾情境
Goal 目標	Problem to solve 要解決的問題
Constraints 限制	Scope, data, limits 範圍數據

Prompt = work spec 提示五元素 (CGCDV)	
Deliverable 交付物	Expected output 預期輸出
Verification 核實	Quality & acceptance criteria 驗收標準

★ Engineering loop: Plan → Execute → Verify → Correct (fix the smallest gap first). AI drifts when context is incomplete; you stay responsible.
工程迴圈：**計劃 → 執行 → 核實 → 修正**（先修最小缺口）。背景不全 AI 會偏離，責任在你。

- Literature search: question → keywords/Boolean strings → screen candidates → **read and verify originals**; 'do not invent papers'. Tools: Elicit, Semantic Scholar, IEEE Xplore, ACM DL.
文獻搜尋：問題 → 關鍵詞 → 篩選 → **親自讀原文核實**；不准捏造論文。
- Figures: message → figure type → draft → check (no data = concept sketch only). Slides: audience → outline → draft → review facts. Other roles: explain, examiner questions, rubric review, debug.
圖表：先訊息後類型，沒數據只畫概念圖。投影片：受眾 → 大綱 → 初稿 → 審閱。其他：解釋、出題、審閱、除錯。

Research, bias, Feynman, first principles | 研究、偏誤、費曼法、第一性原理【L2 p.20-23】

- Credible sources: author credentials, recent date, publisher reputation, **cross-reference**; synthesise; understand history, interdisciplinary links, state of field, future.
可信來源：作者資歷、日期、出版商、**交叉核對**；綜合整理；了解歷史、跨學科、現況、未來。
- Information overload: easy to know of many things, understand few deeply. Biases: **confirmation** (core), memory, interpretation, selection, correlation-causation neglect; system-level echo chamber.
資訊過載：知道很多、理解很少。偏誤：**確認偏誤**（核心）、記憶、詮釋、選擇、混淆相關與因果；系統層迴音室。

Feynman (what is) 費曼法	First principles (what if) 第一性原理
1 Choose concept 2 Teach a child (no jargon) 3 Find gaps, revisit sources 4 Refine & simplify 選概念、教小朋友、找缺口、簡化	Battery: analogy says ~\$600/kWh, aim 5-10% cut; first principles: materials only ~\$80/kWh → cost is manufacturing & supply chain = solvable 電池原料只值約 80 美元，成本在製造及供應鏈

延伸 Extension Feynman 建立「現況是甚麼」的深厚理解，第一性原理挑戰「本來就是這樣」的假設。費曼亦曾在 Challenger 聽證會用冰水示範 O 形環低溫失效。
Feynman builds 'what is'; first principles challenges assumptions for 'what if'.

Writing: story, structure, references, style | 寫作：故事、結構、引用、風格 【L2 p.24-42】

- Writing tells a story: engage; stand-alone complete picture; each paragraph builds on the last; use linking statements. Structure: introduction → details → conclusion. 寫作是講故事：吸引讀者、獨立完整、段段相連、用連接語。結構：引言 → 細節 → 結論。
- Introduction: don't start with facts; say what and why; personal encounter (Ex.1 grandmother & health info systems) or a question (Ex.2 'Why reverse-engineer the brain?'). 引言：不要先堆事實；說明寫甚麼、為何重要；用個人故事或問題開頭。
- Details: past vs new technologies, pros and cons, a few clear points. Conclusion: wrap up, opinion, future, **ethical issues - think wider**. 細節：新舊技術比較、優缺點、少而精。結論：總結、意見、未來、**倫理問題**。
- IEEE refs: [13] in square brackets before the period; '[3, 4, 15, 22]'; full details; links for online; cite AI. Common errors: inconsistent author initials, journal abbreviations, vol/no format, capitalisation. IEEE：方括號編號放句號前；資料齊全；網上附連結；引用 AI。常見錯：作者縮寫、期刊名、卷期格式、大小楷不一致。
- Style: correct grammar; careful; logical. Use UK or US spelling **consistently** (behaviour/behavior, analyse/analyze). Precision: 'the **presence of** stray capacitance causes EMI', 'sum of **the number of** capacitors and inductors', '**high** compression rate'. 風格：文法、細心、邏輯；英美拼法**統一**；比較要精確（電容的「存在」、元件的「數目」、「高」壓縮率）。
- Avoid mismatch ('The apple is a book' → 'the subject of a book'). Don't start a sentence with a symbol: write 'Voltage vo is...'. 避免主謂錯配；不要用符號開句，寫「Voltage vo...」。

★ Your writing reflects your attitude: if you can't format a reference list consistently, why trust your measurements?
文字反映態度：參考列表都做不好，別人怎信你的數據？

延伸 Extension 結論四句範本：總結 → 個人意見 → 未來發展 → 倫理考慮。小心 invaluable = 「非常寶貴」、inflammable = 「易燃」。

Conclusion template: summary, opinion, future, ethics. 'Invaluable' = very valuable; 'inflammable' = flammable.

Mission statements | 使命宣言 【L2 p.43-46】

- Mission = short statement of an organisation's purpose; guides decisions at every level and what to measure. **If it can't help choose between two technical options, it is failing**. Link proposals to it. 使命宣言：機構存在目的；指導決策及量度甚麼；**不能幫你在技術選項中抉擇就是失敗**；建議書要連結使命。
- Examples: LEGO (builders of tomorrow), Tesla (sustainable energy), IKEA (affordable design), Google (organise world's information), Meta (human connection); universities; Starbucks changed 1990→2008→2023→2025 with user needs. 例子：LEGO、Tesla、IKEA、Google、Meta、大學；星巴克使命隨用戶需要多次改變。

Data visualisation (Tufte) | 數據可視化 (Tufte) 【L2 p.47-64】

- Technical writing = subject expertise + clear writing + data visualisation. Graphical excellence: greatest ideas, shortest time, **least ink, smallest space**; multivariate; tell the truth. 技術寫作 = 專業 + 清晰寫作 + 可視化。圖像卓越：最短時間、**最少墨水**、最多意念；多變數；說真話。
- Good graphics: show data, focus on substance, don't distort, many numbers in small space, encourage comparison, multiple levels of detail, clear purpose, integrated with text. 好圖表：展示數據、聚焦內容、不扭曲、小空間多數字、方便比較、多層細節、目的清晰、與文字結合。
- **Anscombe's quartet** (1973): 4 datasets, identical mean (x 9, y 7.5), regression $y = 3 + 0.5x$, $R^2 0.667$ - but plots differ (linear, curve, outlier, single point). Always plot data. **安斯庫姆四重奏**：四組統計完全相同，圖形卻截然不同——一定要畫圖。
- Classics: John Snow's 1854 cholera map (deaths cluster at Broad St pump); Minard's 1812 Russia campaign (army size, route, direction, temperature, time). 經典：John Snow 霍亂地圖（找出污染水泵）；Minard 拿破崙圖（人數、路線、方向、氣溫、時間）。

Formula 公式	Meaning 意思
Lie Factor = effect shown in graphic ÷ effect in data	>1.05 overstate 誇大; <0.95 understate 低估; e.g. 783% ÷ 53% ≈ 14.8
Data-ink ratio = data-ink ÷ total ink	= 1 - erasable non-data ink 刪去不損數據的墨水; remove chartjunk

- Integrity: drawn size ∝ data; clear labels; annotate events. Bad examples: shrinking-dollar picture (WP 1978), Pravda 1982 circles. Prefer **bar over pie**; **avoid 3D**. 誠信：大小與數據成正比、清楚標示。壞例：縮小美元圖、真理報圓圈。**柱狀圖勝圓餅圖、避免 3D**。

★ AI can assist editing but must complement, not replace, human expertise - always verify.

AI 可輔助但**不能取代**專業，必須核實。

延伸 Extension

人眼感知面積：數值加倍而把圖示長闊都加倍，面積變 4 倍（Lie Factor 偏大）。柱狀圖比較長度最準；3D 會遮擋及透視失真。

Eyes read area: doubling both sides quadruples area. Bars compare length best; 3D hides and distorts.

Presentations & storytelling | 簡報與說故事 【L2 p.65-81】

- Slides are posters, not documents; you are the main event; if they read, they don't listen. Example: Jobs iPhone 2007. 投影片是海報不是文件；你是主角；觀眾在讀就沒在聽。例：喬布斯 iPhone 發布。
- 'The human mind is a story processor, not a logic processor' (Haidt). Know audience, interest, prior knowledge, desired outcome. 人腦是故事處理器（Haidt）。了解受眾、興趣、背景、期望結果。

筆記 Notes

- Pixar's 22 rules - key ones: #4 story spine (Once upon a time... Every day... One day... Because of that... Until finally...); #5 simplify; #7 ending first; #13 have opinions; #16 stakes; #19 no lucky escapes; #22 essence first.
- Pixar 規則重點：#4 故事骨架、#5 簡化、#7 先想結尾、#13 要有立場、#16 風險、#19 不靠巧合脫困、#22 先抓精髓。

Story stage 階段	Pitch deck slides 投影片
Once upon a time 從前	Title, agenda, hook/vision, team 標題、願景、團隊
Every day 每天	Problem - 'searing pain' 痛點
One day 有一天	Solution, value proposition 方案
Because of that 因此	Market, business model, KPIs (CAC, LTV, CAC:LTV, churn, AOV/ACV); competition, go-to-market
Until finally 最後	Financing: raised, asking, use of funds, runway 融資

- Hooks: provocative question, surprising statistic, punchy statement, vivid image, start mid-action, contradiction, humour.
 - 開場：挑釁問題、驚人數據、短句、畫面、從中段開始、矛盾觀點、幽默。
- ★ Communication stack: research → knowledge → strategy → writing → visuals → presenting.
溝通堆疊：研究 → 知識 → 策略 → 寫作 → 視覺 → 簡報。

延伸 Extension CAC 獲客成本、LTV 客戶終身價值（健康比例約 1:3）、churn 流失率、runway 資金可撐多少個月。Pitch deck 的 Problem 對應 Week 4 同理心地圖的痛點。

CAC, LTV (healthy ~1:3), churn, runway. The deck's Problem slide maps to Wk4 empathy-map pains.

Lecture 3 | 項目管理與專業職涯發展

Project Management and Professional Career Development

Career goals, SMART, strengths & weaknesses | 職涯目標、SMART、強弱 【L3 p.1-9】

- Three parts: career advising + PM skills (planning, risk, execution, monitoring, closure) + applying PM to resume, networking, interviews.
- 三部分：職涯指導 + 項目管理 + 把項目管理用於履歷、人脈、面試。
- Videos: Will a robot take my job? / AI will take all jobs? - AI automates tasks more than whole jobs; judgement and communication stay human.
- 影片：AI 會搶工作嗎？——AI 取代任務多於整份工作，判斷及溝通仍靠人。

SMART	Meaning 意思
Specific 具體	Clearly define goals
Measurable 可量度	Can be tracked
Achievable 可達成	Realistic
Relevant 相關	Aligned with aspirations
Time-bound 有時限	Set a timeframe

- Align goals with values and interests; aim for personal and professional satisfaction. Assess skills (technical & soft), experience, personality (+ SWOT).
- 目標配合價值觀及興趣；評估技能（硬／軟）、經驗、性格（SWOT）。
- Career advising = Goals, Strengths/Weaknesses, industry Clusters (type of workforce), career Plan (goals + roadmap).
- 職涯指導：目標、強弱、行業群組、計劃（G-S/W-C-P）。

延伸 Extension SMART 例：畢業後 18 個月內（T）取得 AI 系統整合相關（R）工程師職位，並完成 HKIE Graduate 會籍及一個雲端證書（M），每週申請 5 份工作（A、S）。
Full SMART example must make all five letters explicit.

Railway disciplines & professional institutions | 鐵路專業範疇與專業學會 【L3 p.10-15】

- Technical: permanent way (track), overhead line, rolling stock, signalling, communications, power distribution, civil, building services. Functional: design, construction, **PM & system integration**, safety & QA, technical support, maintenance.
- 技術範疇：路軌、架空線、列車、信號、通訊、供電、土木、屋宇設備。職能：設計、建造、**項目管理及系統整合**、安全品質、技術支援、維修。
- Institutions: HKIE, IET, HKCS, IEEE.
- 專業學會：香港工程師學會、IET、香港電腦學會、IEEE。

HKIE route 途徑	Path 路徑	Min 最少
Formal Training (Scheme A) 正式培訓	Degree → training 2-3 y → responsible exp 1-2 y → assessment	4 years
General Experience 一般經驗	Degree → experience 5 y → responsible exp 1 y → assessment	6 years
Mature (35+) 資深	Recognised + 6 y, or non-recognised + 15 y → paper + interview	6 / 15 y

- IRSE (railway signal engineers): degree → ~3 y practical training → IRSE exam / equivalent / ~7 y senior experience → **current 'senior responsibility'** → Member.
- IRSE：學位 → 約 3 年培訓 → 考試／同等資格／約 7 年經驗 → **現職高級責任** → 會員。
- GBA professional titles: Trainee → Assistant → Engineer → Senior → Chief Senior Engineer (HKIE disciplines mapped to mainland categories).
- 大灣區職稱：見習 → 助理 → 工程師 → 高級 → 正高級工程師。

延伸 Extension 職涯是「範疇 × 職能」矩陣，例如「信號 × 系統整合」。A 計劃最快（4 年），所以要找有 Scheme 'A' 的僱主。

Career = discipline x function matrix; Scheme 'A' is the fastest route.

筆記 Notes

PM essentials, planning, methodologies | 項目管理要素、規劃、方法【L3 p.16-21】

- Essentials: planning (scope, objectives, timeline, budget); risk; execution; monitoring & control; **hybrid delivery** - railway brownfield uses control points for safety, software/simulation iterates.
要素：規劃、風險、執行、監控；**混合交付**——鐵路棕地項目用控制點保安全，軟件模擬用迭代。
- Planning: scope (objectives, deliverables, constraints); stakeholders (needs, expectations); schedule (dependencies, durations); budget (people, materials, equipment).
規劃：範圍、持份者、時間表（依賴關係、工期）、預算。

Waterfall 瀑布式	Agile (Scrum) 敏捷
Sequential: analysis → design → implement → test → maintain 順序	Iterative 1-4 week sprints 迭代衝刺
Fixed requirements, one final delivery	Changing requirements, working increments
Safety-critical, regulated 安全攸關	Software, uncertain needs 軟件

- Scrum: product owner → product backlog → sprint planning → sprint backlog → sprint (daily 24-h cycle) → review, retrospective, finished work; scrum master facilitates.
Scrum：產品負責人、待辦清單、衝刺規劃、每日循環、評審回顧；Scrum Master 促進流程。
- Kanban** (agile): columns, cards, **WIP limit** (e.g. 3/4), swimlanes (expedite). **Flow efficiency = active time ÷ lead time** (e.g. 2 of 10 days = 20%).
看板：欄、卡、**在製品上限**、泳道。**流程效率 = 實際工作時間 ÷ 前置時間**。
- Railway project team: external (offshore design & safety team, contractor T&C) and internal (designers, implementers, train crews); tasks: cost mgmt & funding, in-house design, stakeholder liaison, technical support.
鐵路團隊：外部（海外設計安全、承辦商測試調試）、內部（設計、實施、列車人員）。

延伸 Extension 棕地 = 在運作中系統上改造（限制多）；綠地 = 全新。安全攸關（信號）用瀑布式控制點；乘客資訊 App 用敏捷 → 混合交付。鐵三角：範圍、時間、成本互相牽制。
Brownfield vs greenfield; safety-critical = waterfall gates, apps = agile -> hybrid. Iron triangle: scope, time, cost.

Risk, execution, monitoring, closure | 風險、執行、監控、結束【L3 p.22-28】

- Risk: identify internal & external risks, keep a **risk register**; plan mitigation/avoidance + **contingency**; review regularly and adjust.
風險：識別內外風險、**風險登記冊**；緩解／避免 + **應變計劃**；定期檢討。

P \ S	Catastrophic 4	Critical 3	Marginal 2	Negligible 1
Frequent 4	High 16	High 12	Serious 8	Medium 4
Probable 3	High 12	Serious 9	Serious 6	Medium 3
Remote 2	Serious 8	Serious 6	Medium 4	Low 2

P \ S	Catastrophic 4	Critical 3	Marginal 2	Negligible 1
Improbable 1	Medium 4	Medium 3	Low 2	Low 1

- ▲ 提示：風險分數 = 可能性 × 嚴重性。低機率但災難性仍屬 Serious，不可忽視。
- Execution: put plan into action, manage budget/tasks/schedules, keep stakeholders informed, feedback, collaboration.
執行：落實計劃、管理資源、通知持份者、回饋協作。
 - Railway limitations: **manpower** (extra staff, parallel sites); **skills** (structured training); **materials/interface** (upcycle, life-cycle cost); **method** (follow practice, T&C, site survey e.g. work at height); **other** (limited track access, agree interface demarcation early).
鐵路限制：人手、技能培訓、物料／介面（升級再用、生命周期成本）、方法（測試調試、實地勘察）、其他（封路時段有限、及早劃分介面）。
 - Monitoring & control: update status, find issues, corrective action; measure KPIs (cost, schedule, quality); adjust plan when off-track or scope changes.
監控：更新狀態、糾正；量度成本進度質素；偏離或範圍改變時調整。
 - Closure: project review, **lessons learned**, hand over deliverables. Examples: MTR 'Q-Train' on Island Line (2024); Light Rail 5G radio won ICCA 2025 award.
結束：檢討、**記錄教訓**、移交。例：港島綫 Q-Train、輕鐵 5G 無線電獲國際大獎。

延伸 Extension
風險應對：避免、緩解、轉移（保險）、接受。分數是序數：4 分（經常 × 可忽略）與 4 分（不大可能 × 災難性）性質完全不同。監控是閉環：量度 → 比較 → 糾正 → 再量度。
Responses: avoid, mitigate, transfer, accept. Equal scores can hide different risks; monitoring is a closed loop.

PM for your career: plan, resume, network, interview | 以項目管理發展職涯【L3 p.29-41】

- Career plan = project plan: assess skills/interests/values, research paths, set goals, actions, timelines: short 6-12 m → medium 12-24 m → long 2-5 y → lifelong.
職涯計劃 = 項目計劃：短期 6-12 月 → 中期 12-24 月 → 長期 2-5 年 → 終身目標。
- Resume = project deliverable: plan, execute, monitor; highlight key skills and **quantified accomplishments**.
履歷 = 交付物：突出關鍵技能及**量化成就**。
- Industry aspirations: energy-saving design (low-E glass, daylight); eco materials (upcycled waste, tyres); zero effluent discharge; innovation (video analytics, MiC, MiMEP, BIM). Smart city opportunities.
行業方向：節能設計、環保物料、零污水排放、創新科技（影像分析、組裝合成、BIM）；智慧城市。
- Networking: identify key stakeholders, a networking plan, social media (LinkedIn).
人脈：找關鍵人物、制定計劃、善用社交媒體。

筆記 Notes

• Interview: plan (goals, tasks, timeline); research company & hiring manager; active listening, good questions. Assessed on technical competence, problem-solving, explaining to non-experts, **cultural fit**. Signal-aspect images = observation test.

面試：計劃、研究公司、積極聆聽；評估技術、解難、向非專家解釋、**文化契合**；信號燈圖是觀察測試。

• Be prepared (EMSD, Cyberport, Science Park, MTR); global mindset (virtual coupling of trains).
做好準備（機電署、數碼港、科學園、港鐵）；全球視野（列車虛擬連掛）。

★ Conclusion: ESTABLISH a clear career plan, FOSTER a strong network, ANTICIPATE future opportunities and challenges.

總結（EFA）：**建立**職涯計劃、**培養**人脈、**預見**機遇與挑戰。

延伸 Extension 履歷要量化：×「負責測試軟件」→√「設計40個自動測試，回歸測試時間減60%」。面試答行為題用STAR：情境、任務、行動、結果。
Quantify resume bullets; answer behavioural questions with STAR.

Lecture 4 | 由外而內的設計（客席講者 Clarence Cheung）

Outsider In Design (Guest: Clarence Cheung)

Speaker journey; what is design | 講者經歷；甚麼是設計【L4 p.1-11】

• Global Head of Business Risk Analytics, HSBC; 20+ years in data governance, AI, data science; fraud & anti-money laundering; HKUST research on LLM safety, deepfakes, accessibility; ex-EY/Accenture, startups, family business; CMU, PolyU, HKUST PhD.
滙豐環球業務風險分析主管；20多年數據及AI經驗；反詐騙反洗錢；科大研究LLM安全、深偽、無障礙；曾任顧問、創業。

• Journey: CMU → certainty of uncertainty → leaving corporate (fashion, factory) → PolyU → startups → corporate 2.0 → HKUST (silver-age digital banking, social-VR lie detection). **Non-linear careers are normal.**

經歷：美國讀書 → 不確定 → 離開企業 → 理大 → 創業 → 重返企業 → 科大研究。**非線性職涯很正常**。

• p.10: AI asked for 5 designer pictures produced 6 - designers stereotyped as visual; AI didn't follow the spec.
AI被要求畫5張卻畫6張——設計師被定型為視覺工作，AI亦沒跟指示。

★ Design = building bridges between human intent and the complex systems around us.

設計 = 在**人的意圖與複雜系統之間搭橋**。

Theme 主題	Quote 名言	Framework
Unspoken need 未說出的需要	Eames: recognising the need is the primary condition	HCD / Product-market fit

Theme 主題	Quote 名言	Framework
Right problem 對的問題	Jobs: design is how it works	Design Thinking
Design for tomorrow 為明天設計	Kay: best way to predict the future is to invent it	Future Thinking

Design thinking toolkit | 設計思維工具【L4 p.12-18】

★ Design thinking (IDEO): balance human needs, technical feasibility, economic viability.

設計思維：平衡**人的需要、技術可行、經濟可持續**。

Double Diamond 雙鑽石	Mode	Output
Discover 探索 (research)	Diverge: rip the brief, primary & secondary research	Unstructured findings
Define 定義 (synthesis)	Converge: insights → themes → opportunities → HMW	Final brief / HMW question
Develop 發展 (ideation)	Diverge: many ideas, evaluate	Ideas
Deliver 交付 (implementation)	Converge: build, test, iterate	Product / solution

▲ 提示：第一個鑽石 = 設計對的東西（Don't know → Do know）；第二個 = 把東西設計好。HMW = How Might We「我們可以如何…」。p.14 便利貼牆 = 親和圖歸類。

- Human-Centred Design: Desirability (people) ∩ Feasibility (technology) ∩ Viability (business).
以人為本設計：可取性（人）∩ 可行性（技術）∩ 可持續性（商業）。
- Empathy Map: WHO, what they need to DO (goal), SEE, SAY, DO, HEAR, THINK & FEEL (pains | gains). The gap between SAY and DO reveals unspoken needs.
同理心地圖：誰、目標、看到、說、做、聽到、想與感受（痛點 | 收穫）；**說與做的落差**揭示真正需要。
- Product-Market Fit: Product (desirability) + Market (viability) + Price (feasibility) = FIT.
產品市場契合：產品 + 市場 + 價格 = 契合。
- Business Model Canvas (9 blocks): key partners, key activities, key resources, value proposition, customer relationships, channels, customer segments, cost structure, revenue streams.
商業模式畫布九格：夥伴、活動、資源、價值主張、客戶關係、渠道、客戶群、成本、收入。

延伸 Extension 三圈例子：只技術可行沒人要 = 失敗產品；人人想要但不能賺錢 = 無法持續；有市場但做不到 = 空想。長者網上銀行：Say「唔識用」、Do 排隊去分行、Pain 怕被騙 → 真需要是安全感。

Feasible but unwanted fails; wanted but unviable can't last. Older-adult banking: the real need is safety.

筆記 Notes

Future thinking; design in practice;
lessons | 未來思維；設計實踐；教訓【L4 p.19-33】

• Future thinking: imagine **multiple plausible futures** to improve present decisions, resilience, long-term outcomes (previs design futuring for HCI).
未來思維：想像**多個合理未來**以改善當下決策、增強韌性。

Future Cone 未來錐 (Voros)	Basis
Preposterous 荒謬	"Won't ever happen"
Possible 可能	Future knowledge - might
Plausible 合理	Current knowledge - could
Probable 很可能	Current trends - likely
Projected 基線	Business as usual
Preferable 理想	Value judgement - should

• Practice: co-design workshops with users; design for social good (Rohingya camp 24-h clinic, public toilet research, 3D-printed assistive aids); UI/UX (TV predictive search); fashion label; coffee-bean subscription (PMF); Designing Your Life; objects of desire (3D-printed lamp, violin); VR design.
實踐：與用戶共創；設計造福社會（難民營診所、公廁研究、3D 打印輔助工具）；UI/UX；時裝品牌；咖啡訂閱尋找契合；設計人生；3D 打印；VR。

Service design in corporate - lessons 企業服務設計教訓	
1 Don't call it 'service design' - use the team's language	用團隊聽得明的語言
2 Plan ahead - curate the experience, keep it moving	提前計劃、保持節奏
3 Communicate user research insights to get buy-in	以研究洞見爭取支持
4 Put together an experienced team	組建有經驗團隊

• Learning journey: IDEO / Stanford d.school starter kits (Design Thinking Bootleg), conferences (DTIA, SDHK), helping as TA, LUMA Institute (Looking, Understanding, Making - 36 methods), **practice doing**.
學習途徑：IDEO／d.school
工具包、設計會議、擔任助教、LUMA（觀察、理解、製作 36 方法）、**實踐**。

延伸 Extension 由內到外：Projected → Probable → Plausible → Possible → Preposterous；Preferable
屬價值判斷（Should），設計就是把 probable 推向 preferable。
Inner to outer cone; design moves us from probable to preferable futures.

Review | 一頁總複習
One-page review

Formula / mnemonic 公式口訣	Content 內容
Lie Factor 謊言因子	graphic effect ÷ data effect (0.95-1.05 OK)
Data-ink 數據墨水比	data-ink ÷ total ink

Formula / mnemonic 公式口訣	Content 內容
Flow efficiency 流程效率	active time ÷ lead time
Risk 風險	P × S; High 12-16, Serious 6-9, Medium 3-4, Low 1-2
CGCDV	Context, Goal, Constraints, Deliverable, Verification
AI loop	Plan, Execute, Verify, Correct
SMART	Specific, Measurable, Achievable, Relevant, Time-bound
4 principles 四原則	Accuracy & Rigour; Honesty & Integrity; Life, Law & Public Good; Responsible Leadership
PSURST	Purpose, Stakeholders, Unintended, Red lines, Safeguards, Transparency
EFA	Establish, Foster, Anticipate
Key numbers 數字	Challenger 73 s/7; Flint 40% homes; VW 40× NOx; CA 300k → 87m; HKIE 4/6 years

• Answer templates - ethics scenario: dilemma → facts & stakeholders → 2+ lenses → codes (hold paramount safety, HKIE Rule 4) → action & escalation / middle way → front-page test.
答題：倫理題 = 兩難 → 事實持份者 → 兩個以上角度 → 守則 → 行動及上報／中間路線 → 頭版測試。
• Case: background → technical failure → ethical issues → traps → what engineers should have done → lessons. PM: scope → method → risk matrix → limitations → KPIs → closure.
Design: empathy map → HMW → double diamond → 3 circles → future cone.
案例題：背景 → 技術 → 倫理 → 陷阱 → 應做 → 教訓。項目題：範圍 → 方法 → 風險 → 限制 → KPI → 結束。設計題：同理心 → HMW → 雙鑽石 → 三圈 → 未來錐。

筆記 Notes