MAE386 — Week 1 Notebook Answers (GPT-5.2 rewrite)

Course: Ideation, Thought Media, and Mathematics
Week: 1
Reading: *Catching Unicorns* (CU), Introduction (pp. 3–12)
Answered by: GPT-5.2
Student: [Your Name]
Date: [Date]

1) Engrams and exograms (Merlin Donald)

a) Define both terms; explain advantages of exograms

In Donald's framing, **engrams** are *internal* memory traces (what your nervous system stores), while **exograms** are *external* memory traces (what you store outside the nervous system, in durable marks and symbols).

CU's Introduction doesn't use the words "engram/exogram" directly, but it does describe the same divide as **biological memory vs "non-biological memory"** (the Exographic Revolution) and the mechanism by which external marks change what we can think and discover (CU, Introduction; see also the "Exographic Revolution" paragraph).

The advantages of exograms (i.e., external symbolic records) follow from CU's core claim that exographics lets us do two things our unaided memory struggles with:

- **Reification (bringing abstractions into view):** CU argues we do our best ideation in the **visual field** and that abstract concepts (numbers, operators) have no "real-world referent." Exographics "brings representations of abstract concepts into our visual fields," making them workable objects of thought rather than fleeting mental states (CU, Preface/Intro section on visual field and abstract symbols).
- **Memory extension (supporting longer reasoning chains):** CU's "no-hands" arithmetic example shows that without an external record, many multi-step symbol manipulations are infeasible because intermediate results can't be held reliably. Writing lets you *offload* and *stabilize* intermediate states, enabling longer threads of reasoning (CU, Introduction; arithmetic examples).
- **Idea discovery, not just recording:** CU's central punchline is that writing is not merely a passive record of thoughts already formed; for many ideas it is *part of the thinking system*, enabling discovery that would otherwise be impossible (CU, Introduction; arithmetic + Einstein examples).

b) Other advantages of exograms

Beyond those two headline advantages, external records also:

- **Enable review and refinement:** You can iterate on an argument, revise, compare versions, and detect inconsistencies because the symbols remain available for inspection.
- **Enable division of cognitive labor:** Groups can coordinate around stable shared artifacts (notes, diagrams, checklists, proofs), rather than relying on transient oral memory.

- **Enable transmission across time:** Durable records allow later people to build on earlier work, which matters for cumulative culture (consistent with CU's emphasis on networked imaginations and cultural scaling).

c) Relative effort to form/store engrams vs exograms

- **Engrams:** Often require repetition, attention, and consolidation over time. Some engrams (skills, habits) form through practice rather than explicit memorization.
- **Exograms:** Require learning the symbolic system (literacy; math notation) *plus* the physical effort of producing the external mark (writing/typing/drawing). But once produced, the record persists and can be re-used without re-encoding it in biological memory each time.

CU highlights the social scale of this investment: children spend years learning literacy, and societies spend heavily to teach it—because it unlocks participation in techno-literate life and (for some) frontier ideation (CU, Introduction; literacy/education discussion).

d) Are there engrams that can't be stored as exograms?

Yes—at least not fully. Exograms excel at **symbolic, communicable** content. But some engrams are:

- **Procedural/tacit** (e.g., balance, timing, "feel" in a craft): you can describe them, but the skill itself still lives in embodied performance.
- **Richly experiential** (e.g., a smell memory, emotional nuance): you can label and narrate them, but the experience isn't reducible to the label.

So exograms can *index* or *prompt* many internal memories, but they don't automatically replace them.

e) Relative speed of recall: engrams vs exograms

- **Engrams:** When strong, can be retrieved quickly and applied fluidly (e.g., mental arithmetic facts, language comprehension).
- **Exograms:** Require access + reading/interpretation, so they can be slower moment-to-moment—but they are more reliable for long symbol chains and complex structures because they don't depend on short-term retention capacity.

f) In the age of Google/ChatGPT, do students still need engrams?

Yes—but the *target set* of engrams should be chosen strategically.

CU's argument implies a division:

- Students still need **engrams for primitives**: basic fluency (reading, arithmetic fundamentals), conceptual schemas, and judgment—otherwise they can't meaningfully interpret, evaluate, or use exographic tools.
- Students can rely more on **exograms for extended work**: long derivations, multi-step computations, large knowledge bases, and complex writing.

In practice: requiring students to internalize *every* procedural detail may be less justified when exographic tools are ubiquitous; but requiring them to internalize the **conceptual core** remains necessary to avoid "outsourcing thinking" without understanding.

2) Is a spoken word also a symbol?

Yes. CU explicitly draws the analogy: if written words are arbitrary signs agreed upon by a community, then **speech is also symbolic** (CU, Introduction: after the "apple/elppa" example).

The reasoning:

- The sound pattern for a word has no natural connection to the thing (we could have named it differently).
- The meaning arises from shared cultural convention.

So spoken words are symbols; exographics is a special case of symbol use that adds persistence and visual availability.

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3) The four characteristics of a techno-literate culture (and the CAF)

CU defines techno-literate culture using four characteristics (CU, Introduction):

1. **Broad basic literacy** (reading, writing, arithmetic) in most of the population.
2. **A smaller set of innovators** who can push the Ideasphere forward.
3. **Large-scale social/economic structures** that allow many strangers to coexist (cities, laws, markets, institutions).
4. **A substantial education system** to teach basic literacy and advanced knowledge for frontier work.

Is the CAF a techno-literate culture?

If "CAF" means the **Canadian Armed Forces**, it is best described as a **techno-literate institution inside a techno-literate society**, rather than a full stand-alone culture.

Still, it strongly exhibits the four characteristics operationally:

- It requires literacy and technical competence.
- It contains innovators/specialists (doctrine, engineering, R&D).
- It relies on bureaucracy, formal rules, and large-scale coordination structures.
- It runs extensive education and training pipelines.

So: **CAF is techno-literate in function**, but it's nested within Canada's broader techno-literate culture.

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4) Why is cooperation so important to Homo sapiens?

CU emphasizes that modern techno-literate life depends on large numbers of people coordinating with minimal central direction, and that humans are unusually capable of collaboration at scale (CU, Introduction; Tokyo example; "networked imaginations").

Cooperation matters because it enables:

- **Large, anonymous groups** to function (cities, institutions, markets).
- **Massive collective projects** (CU cites the Apollo program and complex industrial products as examples of large-scale collaboration).

- **High-fidelity social learning:** culture is not genetically "wired" like in bees; humans must learn and transmit norms, skills, and knowledge socially.

On the self-domestication story: if humans selected for reduced reactive aggression and increased prosociality, then cooperation becomes a core advantage for building complex institutions and cumulative culture.

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5) Counter-example: show "All ideas discoverable by the human mind can be discovered without exographics" is false

CU provides a direct counter-example: attempt **8,497 × 8,672** with "hands neatly folded." The text argues that for most people this is effectively impossible without an external record, but straightforward with exographics (CU, Introduction; "no-hands" multiplication example).

This is a valid counter-example because it exhibits:

- A definite idea (the product) that is discoverable by humans **with** exographics.
- The same idea is not practically discoverable by humans **without** exographics (under the no-hands constraint).

CU adds a second, high-stakes illustration: Einstein's relativity work required falling back to mathematics worked through with pen and paper (CU, Preface/Intro; Einstein example). Together, these show that exographics can be constitutive of discovery, not merely a recording medium.

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6) Why multiplication is an abstract object

CU's distinction is that abstract objects are concepts without a direct real-world referent. CU uses **numbers** as the canonical example: "Numbers exist only in our minds," and exographics makes them workable by placing their symbols in the visual field, "as real as a hammer" for the purposes of ideation (CU, Introduction; "23" passage).

Multiplication is abstract in the same way:

- You can see *groups of things* (e.g., 3 groups of 4 apples), but the **operation** "×" is not a physical object.
- The operation is a rule/relationship that lives in a symbolic system.
- Exographics supplies the stable symbol ("×", juxtaposition, notation) that lets us treat that operation as a manipulable object in reasoning—especially when building long chains of computation.

Source

Hurley, Bill, and David Hurley. *Catching Unicorns: The Exographic Revolution and the Rise of Techno-Literate Culture.* Wild Road Books, 2026. (CU Introduction, pp. 3–12)