TRUE NORTH PAVILION

Supplementary Technical Notes

Companion Document to the Preliminary Project Proposal
Addressing Recommended Strengthening Measures

This document expands on five specific recommendations for strengthening the True North Pavilion proposal. It is intended as a working technical companion that can be published alongside the main proposal. The notes remain preliminary; they define measurement approaches, acceptance criteria, and design considerations that should be refined through student prototypes and professional review.

The five topics covered are: (1) early prototype measurements of magnetic torque versus friction and inertia; (2) magnetometer survey protocol and residual-magnetism acceptance criteria; (3) a hybrid mechanical-plus-electronic measurement architecture; (4) a prioritized cost framework for early sponsor conversations; and (5) interpretive signage and visitor experience design so the educational message remains clear even when the interactive disturbance mechanism is idle.

1. Early Prototype Plan: Magnetic Torque, Friction, and Inertia

Earth's horizontal magnetic field is relatively weak (typically 0.15–0.50 gauss / 15–50 µT at mid-latitudes). The restoring torque available to a free compass is therefore modest. As the diameter and mass of a compass card increase, both rotational inertia and bearing friction rise. If friction or damping exceeds the available magnetic torque, the card will not align reliably or will settle too slowly to be educationally useful.

The single most valuable early technical activity is therefore a systematic series of measurements that quantify available torque against friction and inertia at successive sizes. These data will quickly establish realistic upper bounds on diameter long before full-scale fabrication begins.

Recommended Prototype Sequence

- Stage A – 6–12 inch cards: Establish baseline methods for measuring period of oscillation, settling time, and static friction torque. Use simple pivot or low-friction bearing options.
- Stage B – 18–24 inch cards: Introduce more realistic card mass distribution and test at least two bearing types (e.g., precision ball bearing vs. low-friction polymer or jeweled pivot concepts). Measure response to controlled magnetic disturbance.
- Stage C – 30–36 inch cards: Confirm scaling behavior. Record torque margin, overshoot, and settling time under outdoor or simulated outdoor conditions. Introduce candidate passive damping methods (eddy-current plates or rings are preferred first candidates).

Key Measurements to Record at Each Stage

- Static friction torque (or equivalent break-away force) of the bearing assembly.
- Approximate magnetic moment of the magnet assembly (or measured deflection under a known field).
- Period of free oscillation and number of swings to settle within a defined angular window (e.g., ±2° of final heading).
- Settling time after a standardized angular displacement (e.g., 30° or 45°).
- Repeatability of final heading under quiet conditions (standard deviation over multiple trials).
- Qualitative notes on damping character (under-damped, critically damped, or over-damped).

A simple figure of merit can be defined as the ratio of available magnetic restoring torque to the sum of friction torque and the torque needed to accelerate the card's inertia through a representative angle in a useful time. When this ratio becomes marginal, further diameter increases should be approached with caution or accompanied by improved bearings and lighter card construction.

These measurements are deliberately low-cost and can be performed by students with ordinary shop tools, a stopwatch or video timing, a small reference magnet, and a basic electronic compass or smartphone magnetometer for independent heading checks. The resulting data set becomes both an engineering constraint document and a teaching resource for later classes.

2. Magnetometer Survey Protocol and Residual-Magnetism Criteria

Two distinct magnetic-cleanliness tasks must be addressed: (1) selecting and verifying a magnetically quiet site, and (2) ensuring that construction materials themselves do not introduce unacceptable residual magnetism near the compass chamber.

Site Survey Protocol (Recommended Minimum)

1. Perform a baseline survey of the candidate area with a calibrated three-axis magnetometer or a high-quality digital compass capable of recording field strength and direction. Record both total field and horizontal component if possible.
2. Map the area on a grid (suggested initial spacing 5–10 feet). Note all visible potential sources: light poles, fences, reinforced concrete, utility markers, vehicle parking areas, and nearby structures.
3. Measure diurnal variation over at least one full day at a fixed quiet reference point so that later differences can be distinguished from natural daily changes.
4. Identify any localized anomalies greater than a few hundred nanotesla that persist after known sources are accounted for. Such anomalies should be investigated further or the site rejected.
5. Document the survey with a simple map, raw data table, and a written recommendation for the preferred pavilion location within the surveyed zone.

The exact exclusion distances from steel fences, reinforced concrete, or buried utilities should be determined empirically at each candidate site rather than taken from generic tables. A frisbee-golf fairway, open meadow, or similar park space is often a good starting candidate precisely because it tends to be farther from infrastructure.

Material Acceptance Criteria – Residual Magnetism

A practical working rule for the project is: nothing ferromagnetic should be placed near the compass chamber unless there is a demonstrated engineering necessity and its residual field has been measured and accepted.

Particular attention is required for stainless steel. Austenitic 300-series grades are often described as non-magnetic, yet cold working, welding, or certain manufacturing processes can introduce measurable magnetism. Finished components that will be located within several feet of the compass should therefore be tested rather than assumed clean.

Suggested simple acceptance test for candidate parts:

- Place a sensitive compass or magnetometer at a fixed distance that represents the closest approach the part will have to the finished compass card.
- Record the change in reading (heading or field strength) caused by introducing the part.
- Rotate the part through several orientations to check for directional residual fields.
- Accept the part only if the induced change remains well below the educational and measurement tolerance of the finished instrument (a conservative starting target might be a few tenths of a degree of heading error, to be refined by prototype experience).

Preferred structural materials remain wood, aluminum, brass/bronze, and suitable composites. Any stainless-steel fasteners or fittings near the chamber should be individually verified. A small “magnetic cleanliness log” kept by the student teams would be both good engineering practice and a useful educational artifact.

3. Hybrid Design: Mechanical Compass + Independent Electronic Magnetometer

The large mechanical compass card is the public centerpiece and the primary educational object. An independent, high-resolution electronic geomagnetic sensor can be added early in the project without waiting for the full-scale mechanical system to be completed. The two instruments then serve complementary roles.

Roles of Each System

• Mechanical compass card – Visible demonstration of Earth’s magnetic field acting on a free instrument. Provides the awe and the immediate question “Why does it point that way?”

• Electronic magnetometer – Higher resolution, continuous data logging, temperature and field-strength recording, and the ability to detect small long-term changes. Enables quantitative comparison and multi-year science.

Because the electronic sensor can be prototyped and installed on a temporary mast or simple enclosure long before the pavilion structure exists, students can begin collecting baseline heading and field-strength data in the first year of the project. Later classes can then compare the physical compass readings against the electronic record and ask concrete questions:

What does the physical compass say? What does the electronic sensor say? How close are they? Do both instruments show the same long-term trend? How do short-term disturbances (vehicles, nearby construction, solar events) appear in each data set?

Important design rule: the electronic system must observe the magnetic environment; it must never be allowed to control or bias the mechanical compass. Physical separation, careful wiring layout, and verification that the sensor and its power supply produce negligible local field at the compass location remain mandatory.

An early hybrid prototype also de-risks the long-term science goal. Even if the final mechanical compass is delayed or ultimately built at a smaller diameter than first hoped, the electronic station can continue operating and providing educational value.

4. Preliminary Cost Framework for Early Sponsor Conversations

A firm project budget cannot be established until prototype results, final diameter, site conditions, and professional engineering scope are known. Nevertheless, an order-of-magnitude framework organized by priority is useful for early discussions with potential sponsors, parks departments, and fabrication partners.

The table below groups major cost elements into tiers. Figures are intentionally broad ranges expressed in present-day relative terms; they should be replaced with local quotes as soon as the first working prototypes exist.

Priority Tier	Cost Category	Notes / Typical Scope
Tier 1 – Essential for any working instrument	Precision bearing & hub assembly Magnet set & mounting Basic damping system Compass card fabrication (prototype scale)	Must be solved for the instrument to function at all. Small prototype versions are low-cost; full-scale versions dominate early mechanical cost.
Tier 1 – Essential	Magnetic site survey Basic structural engineering review	Required before any permanent installation. Survey can often be performed with student help under professional oversight.

Priority Tier	Cost Category	Notes / Typical Scope
Tier 2 – Core pavilion & power	Pavilion structure (wood/aluminum frame, roof) Foundations / site work Solar panels, charge controller, battery Weather-protected compass chamber	Largest single cost block. Scales with footprint and local construction rates. Many components are candidates for in-kind donation.
Tier 2 – Core	Electronics, sensors, display, lighting Basic interpretive signage	Can begin with modest off-the-shelf modules. Display and lighting loads determine solar/battery sizing.
Tier 3 – Visitor experience & durability	Interactive disturbance mechanism Enhanced vandal-resistant details Accessibility improvements Expanded educational graphics	Important for public success but can be staged or refined after the basic instrument is operating.
Tier 4 – Long-term science & polish	High-resolution magnetometer station Data logging & remote access Professional fabrication of final card Long-term maintenance endowment	These items raise scientific and community value but are not required for the first public opening.

Sponsorship strategy suggestion: invite partners to underwrite a specific Tier 1 or Tier 2 item (bearing, solar system, structural frame, site survey) rather than asking for an undifferentiated total. Named sponsorship of a visible element (solar array, educational panels, or the compass itself) often proves more attractive than a general contribution.

Student and in-kind contributions can substantially reduce cash outlay for prototyping, signage design, basic fabrication, and data-system software. Professional structural, electrical, and accessibility reviews should remain budgeted as paid services.

5. Interpretive Signage and the Visitor Disturbance Experience

The physical compass overhead is the primary attraction. Interpretive materials and the optional disturbance mechanism must support that instrument rather than compete with it. The educational message should remain clear and inviting even when no one is operating the interactive pedestal.

Core Messages That Should Always Be Visible

- You are looking at a real magnetic compass driven by Earth’s magnetic field.
- The card points toward magnetic north, which is not the same as geographic (true) north.
- The difference between the two is called magnetic declination and changes slowly over time.
- This instrument was designed and prototyped with student involvement and continues to collect data for future classes.

A concise primary tagline already proposed in the main document works well: “LOOK UP. DISCOVER NORTH. EXPLORE OUR WORLD.” Secondary statements such as “You are watching Earth’s magnetic field in action” reinforce the same idea without requiring the visitor to activate anything.

Signage Hierarchy Recommendation

1. Large, simple overhead or entry statement that needs no reading time – the tagline itself.
2. One primary panel visible from the viewing area that answers the immediate question “Why does it point that way?” in three or four short sentences plus a clear diagram of magnetic versus true north.
3. Secondary panels or a small digital display for deeper content: current heading and declination, solar/battery status, short explanation of damping, and an invitation to try the disturbance experiment if it is available.

4. QR code or small link to a project website or student-built data page for visitors who want the full technical story or the long-term data record.

Designing the Disturbance Experience

When the interactive mechanism is present, the sequence itself should be self-explanatory:

Visitor applies force → energy is stored and then released in a controlled way → the compass is briefly disturbed → the disturbance is removed → the card swings and settles back toward magnetic north under Earth's field alone.

A short instructional panel at the pedestal can state the design principle in plain language: "You provide the disturbance. Earth's magnetic field provides the return." If quantitative feedback is displayed (peak displacement angle, settling time), keep the numbers secondary to the physical motion the visitor is watching.

Importantly, the pavilion must still feel complete and educational when the disturbance mechanism is offline for maintenance or has not yet been installed. The overhead compass and the core interpretive panels should carry the experience on their own. The interactive element is an enhancement, not the sole reason to visit.

Final design of both signage and the pedestal should be reviewed for accessibility (reach ranges, contrast, font size, tactile or multi-language options if appropriate) and for resistance to ordinary public use and weather.

Closing Note

These five notes are offered as practical next steps rather than final specifications. Each can be turned into student investigations, early prototypes, or short technical memos that feed back into the main proposal. Together they strengthen the project's scientific rigor, reduce later risk, improve sponsor conversations, and keep the visitor experience focused on the central wonder of a free magnetic instrument responding to the Earth itself.

As with the main proposal, all dimensions, acceptance thresholds, and cost figures remain starting points. Prototype testing, site measurements, and professional review will determine the final values.

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