

NEXUS-Neuro 2026–2056: A Thirty-Year Scientific Roadmap

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Document control

This is a forward-looking research proposal: every whole-brain and embodiment objective below sits at Technology Readiness Level (TRL) 1–2, and every performance figure is a projected target, not a validated result.

Field	Entry
Programme	NEXUS-Neuro (Neurovascular Ex Vivo Support and Monitoring Platform)
Horizon	2026–2056, six five-year phases
Version	1.0 — concept proposal
Author	Marie Seshat Landry, CEO and Founder, Landry Industries Inc.
Organisations	LandryIndustries.ca · MarieLandrySpyShop.com
ORCID	0009-0008-5027-3337
Location	Moncton, New Brunswick, Canada
Builds on	“What would a living brain need in a tube?”; “NeuroLife 2050”; “NEXUS-Neuro 2050: Proposed solutions”; “NEXUS-Neuro 2050 — Next-generation solutions”

Scope limits. Nothing here is medical advice or a claim that a living person can currently be sustained as an isolated brain. Any biological work described would run only in qualified laboratories under institutional animal-care, research-ethics and regulatory approval. The embodiment track (robots and drones) is a conditional long-term hypothesis gated behind every earlier phase.

Executive summary

NEXUS-Neuro is a 30-year, six-phase programme whose defensible core is a closed-loop neurovascular support platform; sustaining an intact conscious human brain, and letting that person fly or move through robots and drones, are conditional hypotheses unlocked only by passing evidence gates.

The programme keeps three outcomes separate, because success at one does not prove the next:

- 1. **Biological viability** — cells and tissue stay alive.
- 2. **Functional preservation** — neural circuits keep working, measured by electrophysiology and validated tasks.
- 3. **Consciousness and identity preservation** — a person persists, which no single biomarker can show today.

Track	Scope	Horizon	Starting point in 2026
A — Instrumentation and control	Perfusion loop, sensors, digital twin, independent safety controller	2026–2040	Builds on regulator-approved normothermic organ-perfusion devices
B — Neurovascular tissue models	Vascularised organoids, blood-brain-barrier models, tissue slices, approved animal work	2028–2045	Research stage; engineered vessels do not yet carry blood-like flow
C — Whole-brain functional preservation	Large-animal whole-brain support from hours to weeks, then months	2036–2056	Hours-scale pig-brain perfusion demonstrated (2019, 2023)
D — Embodiment	Neural link from a supported brain to ground robots and drones; onboard pods last	2030–2056	A paralysed participant flew a virtual quadcopter by implant (2025); onboard carriage is concept only

The central design decision: fly by link first, carry the brain last. A brain pod that stays in a protected ground facility and pilots robots and drones through a neural interface removes the hardest risks of flight — vibration, crash, power loss and thermal swings —

from the organ that holds the person. Onboard carriage is a final-phase option, entered only if remote embodiment works and the pod is proven fault-tolerant.

A legal reframing the programme must adopt. Canada's 2023 clinical guideline defines death as the permanent cessation of brain function. A person whose brain is sustained with function after the body fails is therefore not dead in that framework; the elective pathway in this document is described as *continuation after total bodily failure*, not resuscitation after death. This keeps the work inside existing law and the dead-donor rule rather than in conflict with them.

What this document does not claim. It does not claim that an isolated human brain has been, or can now be, kept conscious; that identity survives the transition; or that any date below is a forecast. Dates are planning targets, and each phase can end the programme at its gate.

Scientific baseline (verified October 2026)

As of October 2026, hours-scale whole-brain perfusion in pigs is proven, warm machine perfusion of livers and hearts is regulator-approved, and implanted brain-computer interfaces (BCIs) are entering pivotal trials; nothing yet sustains an isolated whole brain with function for days.

Date	Evidence	What it showed	What it did not show
Jun 2026	Paradromics Connect-One, first wireless implant (U. Michigan)	First-in-human implant under an FDA IDE granted Nov 2025; study targets long-term safety and synthesised speech	Results pending
Jan 2026	Neuralink “Two years of Telepathy” update (Reuters report)	21 participants enrolled; some above 10 bits/s; virtual-keyboard typing up to 40 words/min; no serious device-related adverse events reported by the company	Company-reported, not peer-reviewed long-term outcomes
Sep 2025	Wood et al., Patterns	Argues it is premature to dismiss consciousness in human brain organoids	Any test that settles the question

Date	Evidence	What it showed	What it did not show
Jun 2025	Kistemaker et al., <i>Trends in Biotechnology</i> 43(6)	Vascularised organoids partly reproduce neurovascular-unit structures	Vessel-like structures carry no blood-like flow and form no functional blood–brain barrier
Jan 2025	Willsey et al., <i>Nature Medicine</i> 31:96–104	A man with tetraplegia flew a virtual quadcopter through obstacle courses using decoded finger movements (4 degrees of freedom)	A physical drone; more than one participant
2024	Synchron <i>COMMAND</i> study (2026 pivotal plan)	Endovascular BCI in 6 participants with no serious device-related events at 12 months	Market approval; a pivotal trial is planned for 2026
Aug 2023	Shariff et al., <i>EPCC, Scientific Reports</i> 13:13942	Pig head circulation separated from the body and run by a computer-controlled pulsatile pump; electrocorticography stayed near-native for several hours	Days-scale support; a brain outside the skull
Apr 2023	Canadian death-determination guideline	One brain-based definition: permanent cessation of brain function , including consciousness, brainstem reflexes and independent breathing	Any provision for a sustained isolated brain
Aug 2022	OrganEx, <i>Nature</i> (summary)	Whole-body pig perfusion started 1 h after cardiac arrest restored cellular functions in heart, liver and kidney	Organised brain electrical activity, which was not observed

Date	Evidence	What it showed	What it did not show
2021–2026	OrganOx metra and TransMedics OCS Liver	FDA approval of warm machine perfusion for donor livers (2021); metra used in more than 6,000 transplants and cleared for air transport	Any brain application
Apr 2019	Vrselja et al., BrainEx, Nature 568:336–343	32 pig brains perfused for 6 h starting 4 h after death, with a haemoglobin-based acellular perfusate: preserved structure, less cell death, spontaneous synaptic activity, active metabolism	Global electrocorticographic activity, which was absent

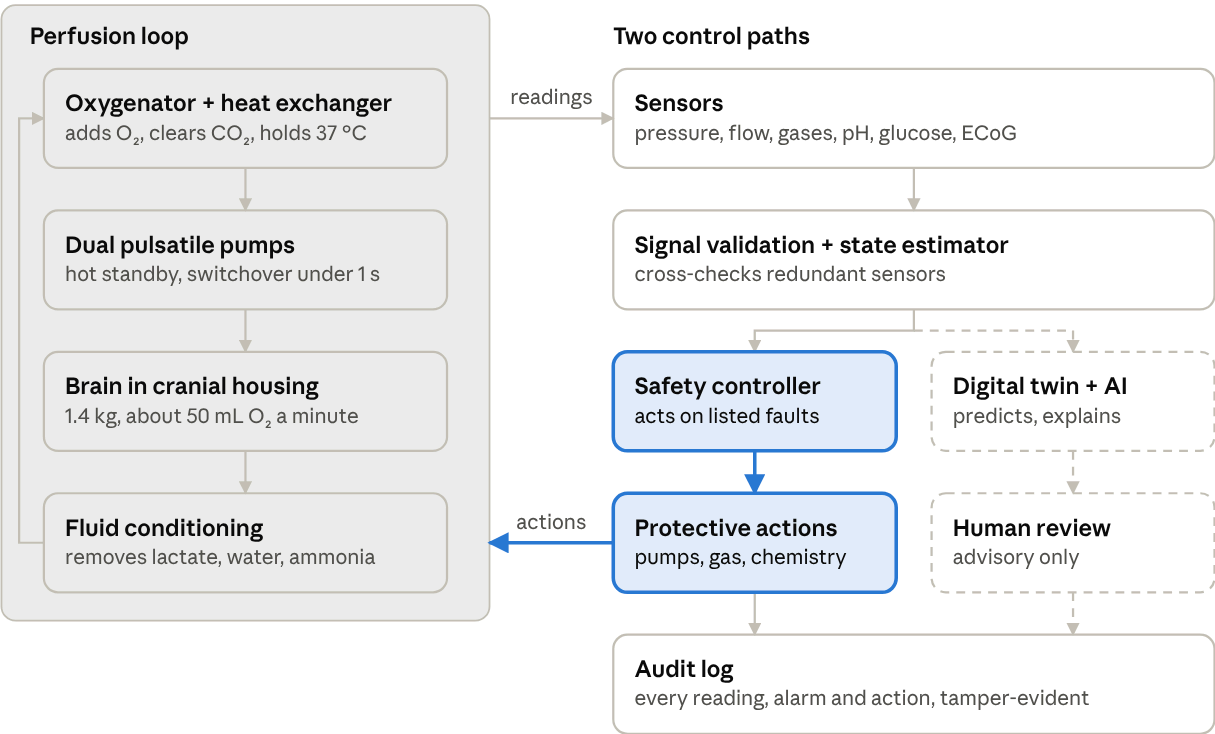
Oxygen carriers. A [2023 review](#) found most haemoglobin-based oxygen carriers discontinued; Hemopure remains in clinical use in South Africa and Russia, and HemO2life is approved in the EU for organ preservation. BrainEx used Hemopure supplied under a materials transfer agreement.

The gap this programme exists to close. No study has kept an isolated large-mammal brain functional for days, validated a blood–brain barrier in an engineered vessel network, or offered an accepted test of awareness in an isolated brain.

System architecture

NEXUS-Neuro is a perfusion loop wrapped in two control paths: an AI advisory path that predicts and explains, and a deterministic safety path that alone can act on critical faults.

Only the safety controller acts on the pod; the AI only advises



NEXUS-Neuro architecture · perfusion loop, safety path (solid) and advisory AI path (dashed)

Readings leave the loop once and split: the solid path acts automatically on listed faults, the dashed path only predicts and informs people, and both are logged.

The five layers carried forward from the NeuroLife 2050 concept are: (1) biological interface, (2) physiological support, (3) measurement, (4) autonomous control, and (5) research and ethics governance. A sixth layer, **embodiment** (neural input and output to robots and drones), is added for Track D and connects only through the governance layer.

Subsystem specification

#	Subsystem	Function	Candidate technology	Readiness for brain use, 2026 (assessed)
1	Perfusion circuit	Pulsatile flow at native pressure and waveform	Computer-controlled pulsatile pump, as in EPCC; hot-standby second pump	Hours in pigs (TRL 4)

#	Subsystem	Function	Candidate technology	Readiness for brain use, 2026 (assessed)
2	Gas exchange	Add O ₂ , remove CO ₂	Hollow-fibre membrane oxygenator, sweep-gas control	Mature in bypass and ECMO; brain-specific TRL 4
3	Perfusate	Carry O ₂ , buffer, protect cells	Haemoglobin-based acellular perfusate (BrainEx class) or red-cell perfusate	TRL 3–4
4	Thermal control	Hold tissue at 37 °C	Inline heat exchanger plus housing jacket	Mature
5	Fluid conditioning	Remove lactate, ammonia, excess water; replace nutrients	Ultrafiltration and dialysis side-loop with metered infusion	TRL 3 for brain
6	Neurovascular interface	Connect circuit to arteries and veins	Arterial cannulation (BrainEx kept internal carotids open); engineered grafts later	TRL 3–4
7	Cranial housing	Mechanical protection, cushioning, pressure control	Rigid shell with cerebrospinal-fluid-equivalent bath and intracranial-pressure sensing	TRL 2
8	Sensing	Physiology and neural state	Pressure, flow, temperature, blood gas, pH, glucose, lactate, near-infrared oximetry, electrocorticography	Components mature; integration TRL 3
9	Neural interface	Sensory input and motor output for a person in the pod	High-channel intracortical recording and stimulation (BCI class)	TRL 5–6 in living patients; TRL 1 in an isolated brain

#	Subsystem	Function	Candidate technology	Readiness for brain use, 2026 (assessed)
10	Control	Estimate state, predict, protect	State estimator, digital twin, AI anomaly detection (advisory); deterministic safety controller (authoritative)	TRL 3
11	Power and redundancy	Uninterrupted operation	Dual supplies, battery ride-through, isolated safety power	Mature
12	Data and audit	Traceability and consent records	Tamper-evident logging of every reading, alarm and intervention	Mature

Rule of authority. The AI layer may alert, rank causes and propose actions; it may never change pump, gas or chemistry setpoints on its own. Only the deterministic safety controller, validated against a fixed fault list, acts automatically, and every action is logged for human review.

Technical requirements

The pod must deliver about 50 mL of oxygen a minute to roughly 1.4 kg of tissue without a single uninterrupted break of more than seconds, because the brain tolerates only about 4–5 minutes of absent flow before irreversible injury begins.

Physiological reference values (verified)

Parameter	Adult human value	Source
Brain mass	about 1,350–1,400 g, about 2% of body weight	SAJAA review ; Paediatric Anaesthesia review (PMC)
Share of resting cardiac output	about 15% (about 700–750 mL/min)	Veenith & Menon, Cambridge

Parameter	Adult human value	Source
Mean cerebral blood flow	about 50 mL/100 g/min; grey matter about 70, white matter about 20	Veenith & Menon
Oxygen consumption (CMRO ₂)	about 3.5 mL O ₂ /100 g/min, about 50 mL/min whole brain, about 20% of the body's resting total	PMC3868010
Energy equivalent	about 20 W	PMC3868010
Glucose use	about 31 μmol/100 g/min; CO ₂ produced at about the oxygen rate	PMC3868010
No-flow tolerance	about 4–5 min before irreversible injury begins	Scottish Intensive Care Society

Oxygen delivery check

Oxygen delivered by the perfusate is its oxygen content times flow. Content is set by the carrier concentration, its saturation and dissolved oxygen:

$$C_{aO_2} = 1.34 \cdot Hb \cdot S_{aO_2} + 0.003 \cdot P_{aO_2} \quad D_{O_2} = C_{aO_2} \cdot Q$$

At an equivalent haemoglobin of 13 g/dL, 98% saturation, 100 mmHg oxygen tension and 700 mL/min flow, delivery is about 122 mL O₂/min against about 49 mL/min consumed: a 40% extraction with a 2.5-fold margin. At about 6 g/dL equivalent carrier and the same flow, the margin shrinks to under 20%, so carrier concentration is a hard requirement, not a tuning parameter.

Daily consumables (computed from the values above)

Quantity	Per day
Oxygen consumed	about 70 L (about 100 g)
Glucose consumed	about 112 g

Quantity	Per day
CO ₂ to remove	about 70 L
Perfusate pumped	about 1,000 L (recirculated)

Design targets (projected, to be validated in Phases 1–3)

Requirement	Target	Basis
Temperature	37.0 °C ± 0.3 °C at the tissue	Normothermic operation as in BrainEx and EPCC
Flow	Pulsatile, matched to the subject's pre-isolation waveform	EPCC showed pulsatility matters for vascular and network signalling
Oxygen delivery margin	at least 2× consumption at all times	Computed above
Pump fault switchover	under 1 s to a hot-standby pump	Far inside the 4–5 min no-flow tolerance
Power ride-through	at least 4 h on battery for a stationary pod	Facility outage plus evacuation
Single-fault tolerance	No single component failure interrupts perfusion	Medical-device safety practice
Chemistry sampling	pH, gases, glucose, lactate, electrolytes at least every 5 min, oxygen and pressure continuous	Detect drift before injury
Sterility	Closed circuit, validated aseptic connections, continuous contamination monitoring	Weeks-to-months operation

Perfusate composition classes

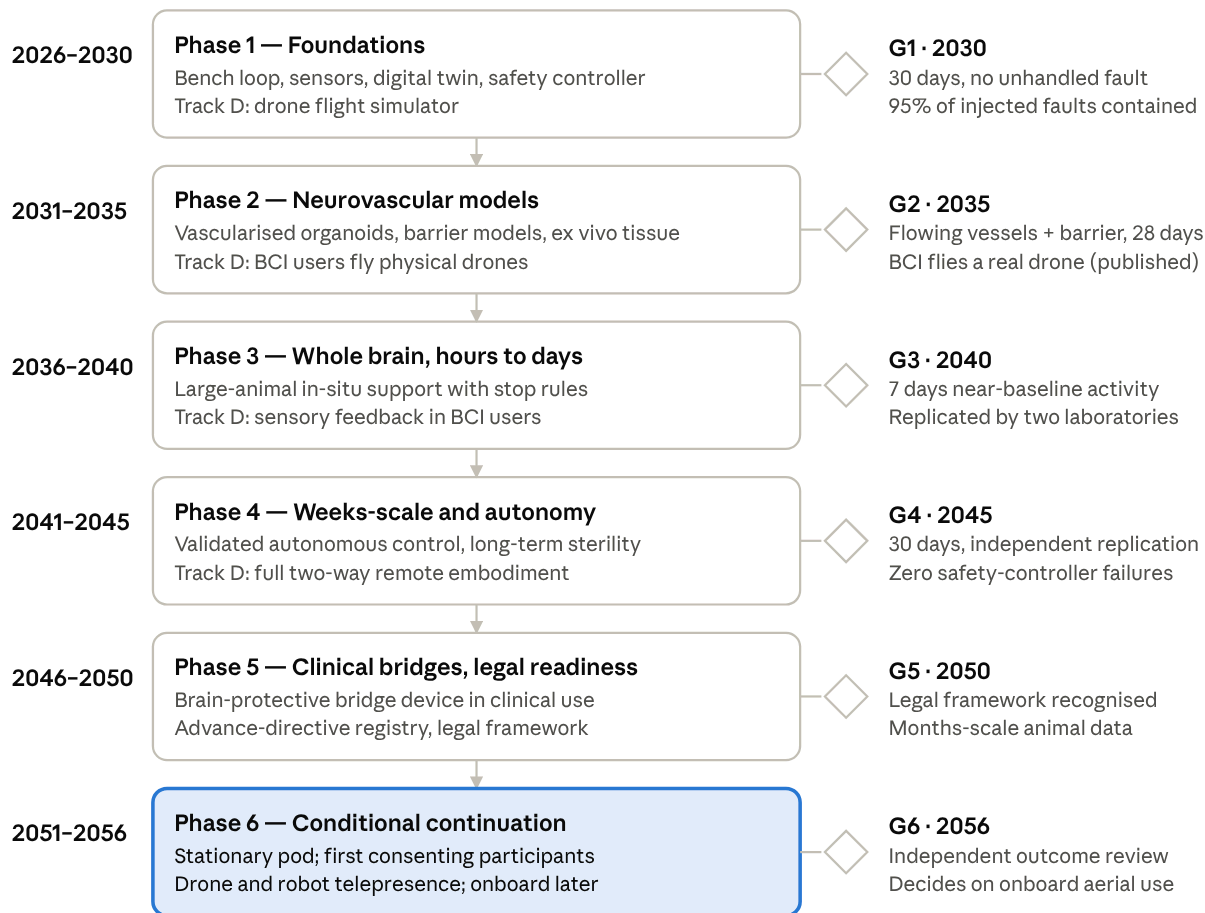
Class	Function	Design note
Oxygen carrier	Carries O ₂ to capillaries	Haemoglobin-based (as in BrainEx) or red cells; perfluorocarbons only if a specific advantage is shown
Electrolytes and buffers	Membrane potentials, pH	Na ⁺ , K ⁺ , Ca ²⁺ , Mg ²⁺ , Cl ⁻ , phosphate, bicarbonate held in narrow bands
Substrates	Energy	Glucose first; lactate and ketones studied as alternatives
Oncotic agents	Keep fluid in vessels	Prevent oedema
Cytoprotectants	Limit reperfusion injury and inflammation	Antioxidant and anti-inflammatory classes, dosed to measured need
Amino acids, lipids, vitamins, trace elements	Long-term maintenance	Matter on the weeks-to-months scale, not the hours scale
Signalling factors	Stand-ins for body-derived hormones	Added only after modelling shows which pathways matter

The 30-year roadmap, 2026–2056

Six five-year phases each end at a go/no-go gate; failing a gate stops Tracks C and D but leaves Tracks A and B as self-sustaining research and medical-device businesses.

Human continuation is reachable only after five gates, no earlier than 2051

Each gate can stop Tracks C and D; Tracks A and B continue regardless



NEXUS-Neuro roadmap · six phases and six go/no-go gates, 2026–2056

Read top to bottom: each phase ends at the diamond to its right, and no human continuation work starts before Gate G5 is passed in 2050.

Phase 1 — Foundations (2026–2030)

Objective: a validated, instrumented perfusion bench with no biology in it.

- Non-biological fluid loop with pressure, flow, temperature, gas exchange and simulated faults
- Sensor-validation rig, fault-injection library, digital twin v1, deterministic safety controller v1
- Ethics charter, independent advisory board, consent and data-governance templates
- Track D: software simulator in which recorded or synthetic neural control signals fly simulated drones

Gate G1 (2030): 30 days of continuous bench operation with no unhandled fault; at least 95% of injected faults detected and contained; ethics charter externally reviewed.

Phase 2 — Neurovascular models (2031–2035)

Objective: perfused neural tissue with flowing vessels and a measurable barrier.

- Vascularised organoid-on-chip and tissue-slice perfusion with partner laboratories under approved protocols
- Barrier metrics (permeability, transendothelial resistance), oxygen mapping, cell-type viability panels
- Approved small-animal ex vivo brain perfusion to benchmark the circuit against BrainEx-class results
- Track D: physical (not virtual) drone and ground-robot control by consenting BCI participants in partner clinical studies

Gate G2 (2035): engineered vessels carrying flow with measured barrier function for at least 28 days; physical drone control by a living BCI participant published.

Phase 3 — Whole-brain support, hours to days (2036–2040)

Objective: extend in-situ, anaesthetised large-animal brain support (EPCC class) from hours to days.

- Days-scale perfusion with network activity tracked against the animal's own baseline
- Mandatory awareness-suppression protocol and stop rules for any emergent organised activity
- Body-signalling layer v1: model the endocrine and immune inputs that matter most
- Track D: sensory feedback (intracortical stimulation) in living BCI participants

Gate G3 (2040): at least 7 days of whole-brain viability with network activity near baseline, replicated by two independent laboratories.

Phase 4 — Weeks-scale support and autonomy (2041–2045)

Objective: weeks of stable support under validated autonomous control.

- Predictive control and fault handling validated against the Phase 1 fault library on live preparations
- Long-term materials, sterility and perfusate-replacement protocols

- Consciousness-assessment framework adopted by an independent body, not by the programme itself
- Track D: full bidirectional remote embodiment (motor out, touch and vision in) in living participants

Gate G4 (2045): at least 30 days of support in a large-animal model with independent replication and no safety-controller failure.

Phase 5 — Clinical bridges and legal readiness (2046–2050)

Objective: first human benefit from the platform, without isolation.

- Short-term brain-protective perfusion as a bridge during cardiac arrest, surgery or transplant (clinical spin-off)
- Engagement with Health Canada, research ethics boards and provincial legislators on continuation after total bodily failure
- Advance-directive registry and consent model for the elective pathway

Gate G5 (2050): a recognised legal and ethical framework for elective continuation; months-scale animal data; a clinical bridge device in approved use.

Phase 6 — Conditional continuation and embodiment (2051–2056)

Objective: only if G5 is passed, a first-in-human feasibility study of elective continuation after total bodily failure.

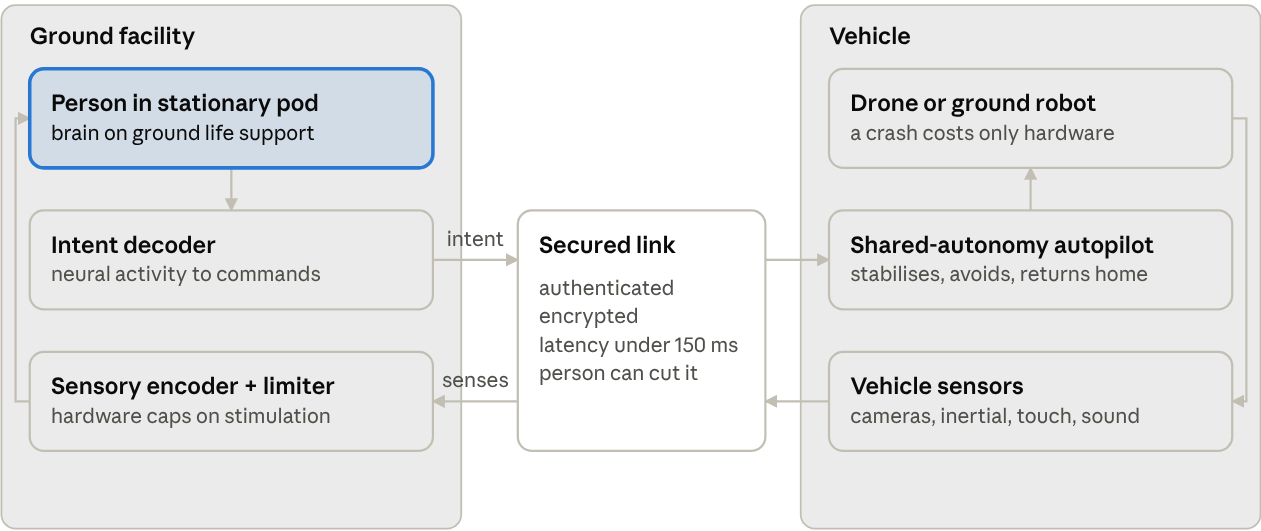
- Stationary pod in a hardened clinical facility; remote embodiment through ground robots and drones
- Onboard carriage evaluated first on ground robots; aerial onboard carriage only after ground data

Gate G6 (2056): independent review of participant outcomes, including the participant's own reported experience, before any expansion or onboard aerial use.

Track D — Embodiment: robots, drones and elective flight

The safest way for a sustained person to fly is to keep the brain on the ground and send its commands to the aircraft; carrying the brain aloft adds crash, vibration, power and thermal risk to the one component that can never be replaced.

The brain stays on the ground; only intent and senses travel the link



Track D, architecture D1 · remote telepresence through a secured neural link

In D1 the person flies by intent while the autopilot keeps the vehicle stable; if the link drops, the vehicle returns home and the person is unharmed.

Four embodiment architectures

Architecture	Where the brain is	What a fault costs	Earliest use in this plan
D1 — Remote telepresence	Stationary pod in a hardened facility; neural link over a secured network to any robot or drone	A lost robot or drone; the person is unharmed	Phase 6, built from Phase 2–4 work with living BCI users
D2 — Tethered ground robot	Pod on a mobile base with an umbilical to facility power and perfusate service	Limited range; umbilical damage triggers onboard ride-through	Phase 6
D3 — Autonomous ground robot	Pod with full life support carried by a legged or wheeled robot	Falls and power loss threaten the person	After Gate G6

Architecture	Where the brain is	What a fault costs	Earliest use in this plan
D4 — Onboard aerial	Pod carried by a heavy-lift multirotor	A crash can end the person's life	After G6 and D3 ground data; likely beyond 2056

The neural link

- **Motor output.** Decoded intent becomes high-level commands. The closest evidence is the 2025 *Nature Medicine* study in which a participant flew a virtual quadcopter with four degrees of freedom from decoded finger movements. Neuralink reports some participants above 10 bits/s; Paradromics [claims more than 200 bits/s](#) on its own benchmark (company preprint, not independently confirmed).
- **Sensory input.** Camera, inertial and touch data rendered as stimulation patterns. This is less mature than motor output and is scheduled for Phases 3–4 in living participants.
- **Shared autonomy.** The vehicle’s autopilot always owns stabilisation, obstacle avoidance, geofencing and return-to-home; the person flies by intent. This keeps link latency from becoming a crash.
- **Latency target (projected):** under 150 ms end-to-end for direct piloting; above that, the vehicle drops to supervisory mode automatically.
- **Neuro-security.** A hijacked link could crash a vehicle or feed false sensations into a person’s brain. Commands and sensory streams are authenticated and encrypted, sensory input is rate- and intensity-limited in hardware, and the person can sever any link at will.

Flight engineering for onboard carriage (D4)

Lift is not the binding constraint: today’s heavy-lift delivery drones such as the [DJI FlyCart 100](#) carry up to 85 kg in dual-battery mode and up to 100 kg on a single battery, with an [integrated parachute](#). Endurance, reliability and survivability are.

Pod component (projected mass)	kg
Brain	1.4
Cranial housing and fluid bath	2.5
Perfusate in circuit	2.0

Pod component (projected mass)	kg
Dual pumps	1.5
Oxygenator and oxygen supply	3.0
Fluid-conditioning side-loop	2.0
Thermal control and insulation	1.0
Sensors, electronics and neural interface	1.5
Independent life-support battery (about 600 Wh, 4 h at about 150 W)	3.0
Crash structure and vibration isolation	3.0
Pod total	20.9

Hover power from momentum theory, where m is all-up mass, ρ air density, A total rotor disc area and FM rotor figure of merit:

$$P_{\text{hover}} = \frac{(m g)^{3/2}}{FM \sqrt{2 \rho A}}$$

For a 60 kg all-up aircraft on eight 1.2 m rotors (FM 0.65, sea level) this gives about 4.7 kW, against about 150 W for life support. Life support therefore runs on its own battery and bus, never on the flight battery.

Onboard design requirements (projected):

- Survive a parachute-descent impact and keep perfusing for at least 4 h on the internal battery until recovery
- Isolate rotor blade-pass vibration from the cranial housing with tuned elastomer mounts, verified on a shaker table
- Hold 37 °C from –30 °C to +35 °C outside air (New Brunswick conditions), with insulation sized to the heater budget
- Cap altitude or pressurise the oxygenator, because ambient pressure changes gas exchange
- Treat an aircraft carrying a sustained person as a crewed aircraft until Transport Canada rules otherwise; this is an open regulatory question

The elective continuation pathway

The pathway is opt-in, decided years in advance, and reversible by the person at every step.

1. Advance directive made with confirmed capacity, independent legal advice and a cooling-off period
2. Medical eligibility review and independent ethics review
3. Total bodily failure with the brain still functioning (not death by neurologic criteria)
4. Emergency brain-protective bridge perfusion, then transfer to a stationary pod
5. Neural-interface activation and re-orientation with family and clinicians
6. Stepped embodiment: screen and virtual reality, then ground robot, then drone telepresence
7. Scheduled consent checkpoints with an independent advocate; the person may end support at any time

Non-negotiable safeguards. Continuation is never a default, never a condition of care and never paid for by surrendering data or rights. The person keeps legal personhood, property and privacy, and a pre-agreed protocol governs what happens if they lose the ability to communicate.

Consciousness, personhood and consent

The programme treats signs of awareness in an animal preparation as a reason to stop and review, never as a target to chase; in a consenting human participant, the person’s own communicated report becomes the primary evidence.

Evidence ladder and stop rules

Level	Evidence	Programme response
0	Cellular viability: histology, metabolism, cell-death markers	Continue
1	Local synaptic activity in tissue	Continue
2	Organised network activity near the animal’s baseline	Continue only under the approved suppression or anaesthesia protocol

Level	Evidence	Programme response
3	Stimulus-specific evoked responses	Independent review before the next session
4	Complexity markers associated with awareness in clinical practice	Pause; independent board decides whether and how to continue
5	A communicated report through a neural interface (human participants only)	The participant's report governs, within the consent protocol

No single marker establishes consciousness, and researchers still dispute whether it can arise in engineered neural tissue at all; the 2025 [Patterns review](#) argues that dismissing the possibility is premature. The ladder therefore errs toward caution at every level.

Legal status of a sustained person

- Canada's 2023 guideline defines death as the permanent cessation of brain function. A person whose brain is sustained with function is alive under that definition, and every right of a living patient applies.
- [Statutory definitions of death vary by province and territory](#), with common law filling gaps. The programme will seek legal opinions in New Brunswick and each partner jurisdiction before Phase 5.
- The dead-donor rule is unaffected: no part of this programme takes organs from, or ends support for, a person to supply the pathway.

Research ethics framework

- Landry Industries adopts [TCPS 2 \(2022\)](#) voluntarily, as the policy invites organisations outside the Tri-Agency agreement to do, and runs human work only through partner institutions with a research ethics board.
- Animal work runs only through partner institutions' animal-care committees, under national standards.
- An independent Data and Safety Monitoring Board reviews every adverse event and every Level 3+ finding.

Consent requirements for the elective pathway

- Capacity confirmed by two independent clinicians; no substitute decision-maker can opt someone in

- Disclosure of every known unknown: identity continuity, sensory deprivation, chronic distress, dependence on operators and infrastructure, and the possibility that no meaningful experience survives
- Cooling-off period and repeat consent at least 12 months apart
- Right to end support at any time, expressible through any consistent channel, honoured within a defined time
- Scheduled re-consent checkpoints after continuation, each witnessed by an independent advocate

Wellbeing risks and mitigations

Risk to the person	Mitigation
Sensory deprivation and isolation	Sensory input from day one; scheduled contact with family; telepresence access
Distress or pain the person cannot express	Multiple output channels; distress decoders monitored continuously; analgesic protocols
Loss of autonomy to operators	Charter of participant rights; operator actions logged and reviewable by the participant
Infrastructure dependence	Long-term funding escrow and transfer agreements so support never depends on one company’s survival
Exploitation of data or capability	The person owns their neural data; no commercial use without separate consent

Risk register

Seven of the fourteen tracked risks are rated critical; four of them (R1, R2, R4, R5) are biological or sensing failures that the Phase 1 fault library and the Phase 2–4 gates are built to expose before any person depends on the system.

ID	Risk	Likelihood	Severity	Mitigation	Phases
R1	Microvascular no-reflow and uneven oxygen delivery	High	Critical	Pulsatile control, distributed oxygen mapping, perfusion modelling, anticoagulation strategy	2–4
R2	Oedema and rising intracranial pressure	High	Critical	Oncotic agents, fluid-balance control, continuous intracranial-pressure sensing	2–4
R3	Crash of an aircraft carrying an onboard pod	High	Critical	Remote telepresence first; onboard aerial deferred past G6; parachute, crash structure, 4 h internal ride-through	6+
R4	Loss of sterility over weeks of operation	Medium	Critical	Closed circuit, validated aseptic connections, continuous contamination monitoring	3–6
R5	Sensor drift or common-mode sensor failure	Medium	Critical	Redundant sensors of different types, cross-checks, scheduled calibration	1–6
R6	Hijacked neural or vehicle link	Medium	Critical	Authenticated encryption, hardware limits on stimulation, person-controlled link cut-off	2–6
R7	Emergent awareness in an animal preparation	Low	Critical	Evidence-ladder stop rules, suppression protocol, independent review	2–5
R8	Reperfusion injury	High	Serious	Cytoprotective perfusate, staged reperfusion, inflammation monitoring	2–4
R9	Funding gaps over 30 years	High	Serious	Revenue from Tracks A and B, staged grants, funding escrow for any human participant	1–6
R10	Oxygen-carrier toxicity or discontinued supply	Medium	Serious	Two qualified carriers plus a red-cell fallback	2–6
R11	AI gives false reassurance	Medium	Serious	AI advisory only; deterministic safety controller holds authority	1–6

ID	Risk	Likelihood	Severity	Mitigation	Phases
R12	Legal prohibition or unresolved legal status	Medium	Serious	Early legal opinions, legislator engagement, Phase 5 gate	4–6
R13	Results fail to replicate	Medium	Serious	Two-laboratory replication built into gates G3 and G4	3–4
R14	Loss of public trust	Medium	Moderate	Open publication, independent oversight, plain-language reporting	1–6

Resourcing and staged budget

Phase 1 can start lean in Moncton as an engineering and software effort; every phase after it needs academic and clinical partners, because the biological work must run inside institutions with ethics boards and animal-care committees.

Staged budget (planning estimates, CAD, not quotes)

Phase	Years	Core team (FTE)	Budget range	Main funding route
1 — Foundations	2026–2030	3–8	\$2M–\$4M	Provincial and federal SME innovation funding; Track A service revenue
2 — Neurovascular models	2031–2035	10–25 plus partner labs	\$10M–\$20M	Partner-led national research grants; industry contracts
3 — Whole brain, hours to days	2036–2040	25–60	\$40M–\$80M	Consortium funding; strategic investors
4 — Weeks-scale and autonomy	2041–2045	60–120	\$80M–\$150M	Consortium plus device revenue
5 — Clinical bridges	2046–2050	100–200	\$100M–\$200M	Clinical-trial financing; device sales

Phase	Years	Core team (FTE)	Budget range	Main funding route
6 — Conditional continuation	2051–2056	150–300	\$150M–\$300M, plus a funding escrow per participant	Clinical partners; long-term care trust

Disciplines required

Perfusion engineering, critical-care medicine, neurosurgery, neurophysiology, vascular and tissue bioengineering, biomaterials, control and safety engineering, machine learning, cybersecurity, robotics and aerospace engineering, bioethics, health law and regulatory affairs.

Funding instruments to approach in Phase 1

Instrument	What it fits	Phase
NRC IRAP	Advisory support and R&D funding for Canadian small businesses: bench loop, digital twin, safety controller	1
New Brunswick Innovation Foundation (incl. its Emerging Concepts and Technologies program)	Provincial seed funding for early research and development	1
New Frontiers in Research Fund — Transformation	Large interdisciplinary, high-risk research led by an academic partner	2–3

Track A products that can earn revenue early

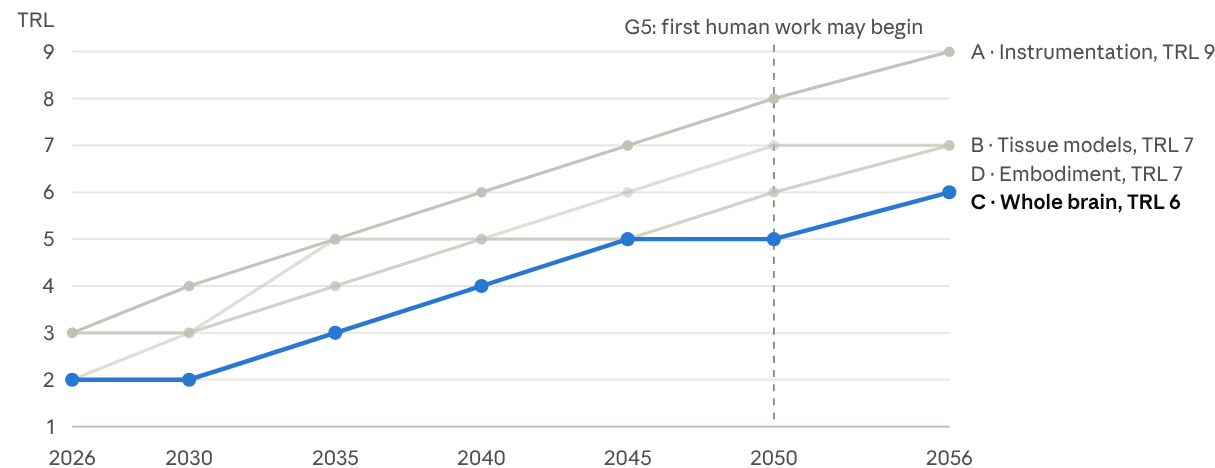
- Perfusion-circuit fault simulator and sensor-validation rig for device makers and transplant programmes
- Digital-twin and anomaly-detection software for existing normothermic organ-perfusion systems
- Audit-grade data logging for perfusion research laboratories

KPIs and verification plan

The programme succeeds by measurable steps, not by a brain that looks intact in a container: each gate is passed only on pre-registered metrics, blinded analysis and, from Phase 3, independent replication.

Whole-brain preservation stays the laggard, reaching only TRL 6 by 2056

Projected Technology Readiness Level at each gate year, by track; planning targets, not forecasts



Projected TRL by track at each gate year · planning targets set in this proposal, not measured values

Instrumentation and embodiment can mature on today’s medical-device and BCI foundations; whole-brain preservation is the pacing item, which is why it carries the strictest gates.

KPI	Metric	Target (projected)	Verification
Fault containment	Share of injected faults detected and contained	95% at G1; 99% at G4	Blinded fault-injection campaigns on bench and live preparations
Warning lead time	Time from first detectable anomaly to measurable tissue injury	At least 30 min at G3	Retrospective and prospective analysis against histology
False alarms	Nuisance alarms per operating day	At most 1/day at G2; at most 1/week at G4	Alarm log audit

KPI	Metric	Target (projected)	Verification
Model agreement	Digital-twin prediction vs independent measurement of oxygen and pressure	Within $\pm 10\%$ at G2	Held-out validation runs
Barrier function	Permeability and barrier-integrity assays in perfused tissue	In physiological range for 28 days at G2	Partner-lab assays, blinded
Supported duration	Days with network activity near the animal's own baseline	7 days at G3; 30 days at G4; months at G5	Two independent laboratories
Safety controller	Failures to act on a listed critical fault	Zero in qualifying runs	Independent safety assessment
Embodiment	Task success and latency for living BCI users flying physical drones	At least 90% course completion; under 150 ms end-to-end by G4	Partner clinical studies, pre-registered tasks
Ethics response	Level 3+ findings reviewed by the independent board	100% within 48 h	Board minutes and audit log

Verification principles. Pre-register endpoints before each campaign; blind histology and electrophysiology scoring; publish negative results; share data openly where consent allows; and never let the team that builds a subsystem be the only team that tests it.

Conclusion and the first 12 months

The 30-year vision of a person who outlives their body and flies through drones is worth stating plainly, but the programme earns the right to pursue it only by building, in Year 1, a perfusion bench that fails safely and proves it.

Months 1–3: define

- ☐ Write the Phase 1 requirements, hazard analysis and fault list
- ☐ Draft the ethics charter and recruit an independent advisory board

- ☐ Review published perfusion circuits (BrainEx, EPCC, approved organ-perfusion devices) and their stated limits
- ☐ Approach NRC IRAP and NBIF; identify one academic perfusion partner

Months 4–6: build

- ☐ Assemble the non-biological fluid loop with pressure, flow, temperature and gas-exchange sensing
- ☐ Implement fault injection: blocked flow, leaks, pump stall, sensor drift, gas-exchange loss, power loss

Months 7–9: control

- ☐ Build the data pipeline, state estimator and digital twin v1
- ☐ Implement the deterministic safety controller and its audit log
- ☐ Build the Track D flight simulator driven by recorded or synthetic control signals

Months 10–12: prove

- ☐ Run a 30-day continuous bench campaign with blinded fault injection
- ☐ Commission an external review of results and the ethics charter
- ☐ Publish the bench design and results as a citable preprint and decide whether to proceed toward Gate G1

Bottom line. Keeping cells alive is solved for hours; keeping a brain working is unsolved for days; keeping a person is unsolved and may prove impossible. This roadmap makes each of those a testable step, and lets a sustained person fly first through a link, with the brain kept safe on the ground.

References

Every source below was retrieved and checked on 13 October 2026; figures marked projected, planning estimate or computed in the text are this proposal's own and are not drawn from these sources.

1. Vrselja Z., Daniele S.G., et al. Restoration of brain circulation and cellular functions hours post-mortem. *Nature* 568, 336–343 (2019). [doi:10.1038/s41586-019-1099-1](https://doi.org/10.1038/s41586-019-1099-1)
2. Andrijevic D., Vrselja Z., et al. Cellular recovery after prolonged warm ischaemia of the whole body. *Nature* (2022). [doi:10.1038/s41586-022-05016-1](https://doi.org/10.1038/s41586-022-05016-1); [ScienceDaily summary](#)

3. Shariff M., Dobariya A., et al. Maintenance of pig brain function under extracorporeal pulsatile circulatory control (EPCC). *Scientific Reports* 13, 13942 (2023). [Article](#); [abstract \(DOAJ\)](#)
4. Kistemaker L., van Bodegraven E., de Vries H.E., Hol E.M. Vascularized human brain organoids: current possibilities and prospects. *Trends in Biotechnology* 43(6), 1275–1285 (2025). [Record](#)
5. Wood C., Wang H., Yang W.-J., Xi Y. Facing the possibility of consciousness in human brain organoids. *Patterns* (2025). [PMC12485551](#)
6. Willsey M.S., Shah N.P., Avansino D.T., et al. A high-performance brain–computer interface for finger decoding and quadcopter game control in an individual with paralysis. *Nature Medicine* 31, 96–104 (2025). [PMC11750708](#)
7. Shemie S.D., et al. A brain-based definition of death and criteria for its determination after arrest of circulation or neurologic function in Canada: a 2023 clinical practice guideline. *Canadian Journal of Anesthesia* (2023). [doi:10.1007/s12630-023-02431-4](#); [CDTRP FAQ](#); [Canadian Blood Services summary](#)
8. Chen L., Yang Z., Liu H. Hemoglobin-based oxygen carriers: where are we now in 2023? *Medicina* (2023). [Record](#)
9. Brain oxygen consumption and cerebral blood-flow physiology. [PMC3868010](#); [SAJAA cerebral physiology review](#); Veenith T., Menon D.K. [The cerebral circulation](#), Cambridge University Press (2011); [Scottish Intensive Care Society module](#)
10. Normothermic machine perfusion approvals: [OrganOx metra FDA PMA](#); [metra air-transport approval](#); [TransMedics OCS coverage policy](#)
11. BCI clinical status: [Neuralink two-year update](#); [Reuters via GV Wire](#); [Synchron COMMAND 12-month results](#); [Synchron 2026 pivotal plan](#); [Paradromics first implant](#); [Paradromics trial clearance](#)
12. Heavy-lift drones: [DJI FlyCart 100 overview](#); [FlyCart 100 specifications](#)
13. Research ethics and funding: [TCPS 2 \(2022\)](#); [NRC IRAP guide](#); [NBIF](#); [NFRF Transformation 2026](#)
14. Source concept documents (Landry Industries, 2026): “What would a living brain need in a tube?”; “NeuroLife 2050”; “NEXUS-Neuro 2050: Proposed solutions”; “NEXUS-Neuro 2050 — Next-generation solutions”.