Report — Estimarmine

1) Company Information

- Company Name: Estimarmine

- Contact Person: Cédric Aymeric Niango

- Email Address:

- Website: https://www.linkedin.com/company/estimarmine/?viewAsMember=true

- Location: Canada

2) Recommended Team & Required Skill Sets

Ideal team size: 4–7 students

Core skills:

- C++17/20 (RBF, meshing, voxel modelling): Numerical core, implicit Radial Basis Functions, marching cubes/dual contouring, voxel/block processing. Use Eigen, optionally CGAL.

- C#/.NET 6 (WPF/WinUI) or Qt/C++ (UI, workflows): UI for data import, visualization controls, legend management, AR integration.

- VTK (BSD) / OpenGL (OpenTK): Rendering pipeline for 3D views, clipping planes, color mapping, camera handling, annotations.

- AR/VR & Immersive Visualization:

  • Desktop AR: OpenCV + ArUco marker tracking, overlays, calibration.

  • Immersive AR/VR: Unreal Engine 5 (OpenXR) integration, asset prep (glTF/FBX/OBJ/VTK), performance profiling.

- Interoperability & code translation: Convert Python/Matlab scripts into C++/C#.

- Geoscience data handling: Import/export drillholes, meshes, and block models (CSV, VTK, VTP, VTU, STL).

- DevOps: GitHub Actions CI, testing with GoogleTest/CTest.

Optional skills: GPU acceleration (CUDA/OpenCL), UX testing, technical writing.

3) Project Title & Acronym

- Title: Estimarmine — Geological Mineral Resource Modelling, Visualization & Desktop AR/VR

- Acronym: EM-AR

4) Project Overview & Problem Statement

Exploration teams and mining engineers need unified, cost-effective tools for:

- Modelling lithologies/domains

- Visualizing 3D geological data

- Validating mineral quantities in deposits

- Reducing environmental impact

Challenge: Existing solutions are costly and fragmented.

Objective: Deliver a desktop application combining implicit/explicit 3D modelling, real-time visualization, and AR/VR overlays.

Target users: Resource geologists, modelers, mine planning engineers, project leads.

5) Solution Approach & Core System Components

- Architecture:

  • Core (C++): RBF solver, data structures, meshing, block models.

  • UI (C#/.NET or Qt): Workflow-driven interface with legends, AR tools.

  • Interop: C++/CLI or P/Invoke for bridging core & UI.

- Implicit Modelling: RBF interpolation with regularization, KD-tree queries, iso-surfaces (marching cubes/dual contouring).

- Explicit Tools: Sketch/brush, triangulation, manual overrides.

- Block Model Integration: Voxel grid sampling, per-block attributes (lithology, grade), CSV/VTK export.

- 3D Visualization: VTK/OpenGL rendering, clipping/sectioning, color mapping, legends, measurement tools.

- Desktop AR: Webcam overlays with OpenCV + ArUco; clipping & annotations.

- Immersive AR/VR: UE5 (OpenXR) viewer with geological models (glTF/FBX/OBJ/VTK).

6) Technical Considerations

Stack (open-source/free):

- Languages: C++17/20, C#/.NET 6 (WPF/WinUI), Qt 6/C++

- Visualization: VTK (BSD), OpenGL (OpenTK), Qt + VTK, HelixToolkit (optional)

- Math/Geometry: Eigen, optional CGAL

- AR/VR: OpenCV (BSD) + ArUco; optional Unreal Engine 5 (OpenXR)

- Data: CSV, Parquet, SQLite, VTK/PLY/OBJ/FBX/glTF

- Build/QA: CMake, GoogleTest/CTest, GitHub Actions CI, Doxygen/Sphinx

Constraints:

- Performance: Optimize C++ kernels; async compute; LOD rendering.

- Numerical Stability: Regularization (λ), scaling, thinning, cross-validation.

- Packaging: Bundle dependencies (VTK, OpenCV, .NET/Qt); MSIX/WiX installer.

7) Innovation & Competitive Advantage

- Unified workflow: implicit + explicit + viz + AR/VR in one app.

- Optional immersive demos with UE5 for stakeholders.

- Fully open-source, reproducible stack (VTK, OpenGL, Eigen, OpenCV).

- UX designed for geological interpretation speed (fast slicing, legend editing, measurement).

8) Proposed Implementation Timeline (2 Months)

- Week 1–2 (Foundations): Repo setup, CI/CD, C++ core skeleton, UI shell (WPF/Qt), VTK viewport, wireframes.

  Deliverable: Design doc, dataset checklist, UI mockups.

- Week 3–4 (Core Modelling & Viz MVP): RBF prototype, iso-surfaces, basic clipping/sectioning, legend editor.

  Deliverable: Prototype (import → model → slice → export).

- Week 5–6 (AR & Explicit Tools): Desktop AR (OpenCV/ArUco), annotations, clipping; sketch/brush surface editing.

Deliverable: MVP with AR demo video.

- Week 7 (Immersive AR/VR Spike): UE5 (OpenXR) viewer, asset export pipeline (glTF/FBX/VTK).

Deliverable: VR demo (stretch goal).

- Week 8 (Optimization & Docs): Performance tuning, usability test, installer, manuals.

Deliverable: Packaged MVP release + documentation.

9) Deployment & Support Expectations
- Platform: Windows 10/11 (primary), optional Linux (Qt build)

- Packaging: MSIX/WiX installer with dependencies

- Hardware: Mid-range GPU, webcam for AR, VR headset optional

- Support: Partner provides datasets, legend specs, UX feedback

10) Confidentiality & Intellectual Property Considerations
- Academic use allowed: Students may reference outcomes (methods, goals, learnings) for school reports or portfolios.

- No disclosure: Code, models, or data may not be shared, published, open-sourced, or distributed.

- No commercialization: Students may not reproduce, license, or sell deliverables.

- IP ownership: All IP (source code, models, docs) belongs to Estimarmine.

- Confidentiality: Non-public datasets/specs are confidential and only for project tasks.

11) Proposed Success Metrics
- Performance: Viewer at 45–60 FPS; RBF solver <30s; memory <2 GB; I/O <10s for 100k intervals.

- Accuracy: RBF RMSE validated via cross-validation; compared with IDW/kriging.

- Usability: SUS ≥ 75; workflow completed in ≤10 min by a new user.

- Reliability & Docs: All tests pass in CI; installer works on Win10/11; full user & developer docs.

- Optional AR/VR (UE5): ≥60 FPS in VR viewer; geological assets load correctly (glTF/FBX/VTK).

12) Mentorship & Communication Plan
- Kickoff: Week 1 (60–90 min)

- Check-ins: Bi-weekly (30–45 min) + Slack/Teams async Q&A

- Mentorship focus: RBF modelling, visualization, UI/UX, AR/VR integration

- Resources: Partner provides datasets, legends, wireframes, references

13) Additional Notes

- Deliver a robust, well-documented MVP over breadth.

- Modular design (core, viz, AR/VR) for future extensions.

- Include a Geologist Mode (simple UI preset for quick reviews).