### **Technical Research Report: A Four-Agent, Autonomous R&D Pipeline**

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**1. Abstract** This document formalizes the complete architectural vision for a fully autonomous, multi-agent research and development pipeline. The system is composed of four distinct, specialized agents: a **Master Project Manager**, a **Research Agent**, a **Design Agent**, and a **Coding Agent**. This architecture solves the "manual scaffolding" problem of prompt engineering by creating a closed, autonomous loop where the system can reason about its own state and define its next evolutionary step. The agents communicate via a sequence of structured artifacts (research\_synthesis.json, design\_spec.md), ensuring a robust, traceable, and verifiable workflow from high-level concept to code implementation. This design aligns with state-of-the-art research in autonomous software engineering agents and represents a concrete path toward a system capable of self-improvement and self-generation.

**2. The Four-Agent Roles and Artifact Flow** The pipeline operates on a principle of sequential specialization, with each agent consuming the output of the previous one.

* **Master Project Manager (PM) Agent:** The orchestrator. Its primary role is to perceive the holistic state of the project by analyzing the latest generated artifacts. It reasons about the next logical goal and initiates the entire workflow by generating a high-level prompt for the Research Agent.
* **Research Agent (Current System):** Consumes the high-level goal from the PM Agent. Its purpose is to explore the knowledge base and produce two key artifacts: a human-readable report.md and a machine-readable research\_synthesis.json.
* **Design Agent (Future Implementation):** Consumes the research\_synthesis.json. Its purpose is to act as a systems architect, translating the conceptual blueprint from the research phase into a formal design\_spec.md. This specification details the precise changes needed for the code and prompts.
* **Coding Agent (Future Implementation):** Consumes the design\_spec.md. Its purpose is to act as an expert programmer, executing the design by making the specified modifications to the system's .py and .yaml files.

**3. The Autonomous Loop: Solving the Maintenance Problem** This architecture's key innovation is the autonomous loop enabled by the Master PM Agent. The system moves from being human-driven to self-driven. The research\_synthesis.json artifact is the critical enabler, providing the structured data necessary for the PM Agent to perceive the system's state without needing to parse unstructured text. This allows the system to set its own subsequent goals, effectively automating the "who updates the prompts" problem and enabling true self-evolution.