Vibe Coding as a Reconfiguration of Intent Mediation in Software Development: Definition, Implications, and Research Agenda

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ABSTRACT Software development is undergoing a fundamental transformation as vibe coding becomes widespread, with large portions of contemporary codebases now being AI-generated. The disconnect between rapid adoption and limited conceptual understanding highlights the need for an inquiry into this emerging paradigm. Drawing on an intent perspective and historical analysis, we define vibe coding as a software development paradigm where humans and generative AI engage in collaborative flow to co- create software artifacts through natural language dialogue, shifting the mediation of developer intent from deterministic instruction to probabilistic inference. By intent mediation, we refer to the fundamental process through which developers translate their conceptual goals into representations that computational systems can execute. Our results show that vibe coding reconfigures cognitive work by redistributing epistemic labor between humans and machines, shifting the expertise in the software development process away from traditional areas such as design or technical implementation toward collaborative orchestration. We identify key opportunities, including democratization, acceleration, and systemic leverage, alongside risks, such as black box codebases, responsibility gaps, and ecosystem bias. We conclude with a research agenda spanning human-, technology-, and organization-centered directions to guide future investigations of this paradigm.

INDEX TERMS Vibe Coding, Generative Artificial Intelligence, Large Language Models (LLM), History of Software Development, Human-Computer Interaction, Intent Mediation, Cognitive Work

I. INTRODUCTION

THE software development landscape is undergoing a profound transformation. According to Y Combinator [1], a renowned Silicon Valley incubator, 25 % of startups in its Winter 2025 cohort reported codebases that were 95 % Algenerated. Such statistics reflect the rapid emergence of what Andrej Karpathy [2] has termed "vibe coding," a conversational way of creating artifacts where developers "see stuff, say stuff, run stuff" in a natural-language dialogue with AI systems, fundamentally altering how software is conceived and created. Rather than crafting an artifact through code line by line, developers are increasingly enabled to articulate higher-level intentionality through open-ended conversational loops, where AI not only generates code, but engages in problem framing and iterative sense-making [3].

This shift represents more than technological convenience; it marks a fundamental reconfiguration of intent mediation in software development. Intent mediation, the process of translating conceptual goals into representations that computational systems can execute has been central to software development [4], [5]. For instance, Norman [4] refers to the Gulf of Evaluation and the Gulf of Execution as gaps between user intent and system response, while Leveson [5] demonstrated how system purpose and design principles must be systematically translated into executable representations. Throughout computing history, major paradigm shifts have transformed how humans translate desired outcomes into machineexecutable instructions: from the physical manipulation of hardware circuits in systems like ENIAC and Zuse's Z3 [6], [7], through symbolic abstractions like assembly and highlevel languages such as Fortran and Algol [8], [9], to objectoriented paradigms and integrated development environments [10]. Each transition fundamentally altered the cognitive demands and epistemic requirements of software development. Especially Nygaard [11] was interested in democratizing the development process, making it more accessible to end-users.

On the one hand vibe coding can be seen in line with this development, but creates a different kind of shift: from deterministic instruction, where developers must explicitly encode intent through formal syntax, to probabilistic interpretation, where AI systems infer meaning from naturalistic expression and assume responsibility for translating human goals into executable code. This transformation extends far beyond productivity gains, fundamentally reshaping who can develop software [12]. Vibe coding reframes software development as interpretive co-creation, where humans and AI agents collaboratively construct solutions through iterative dialogue and mutual interpretation, rather than formal construction, where developers must explicitly design and execute all implementation details through predetermined syntax and logical structures, aligning with broader theories of distributed cognition [13] and hybrid intelligence, where cognitive work is dynamically shared between developer and AI agents [14]. The implications of the transformation span the reconfiguration of individual cognitive work, the evolution of professional expertise, and organizational structures, as software development shifts from a specialized craft requiring years of technical mastery to a more accessible, conversational approach, where domain knowledge and strategic thinking become more important as implementation skills, while simultaneously introducing risks of technical deskilling, responsibility gaps, and code quality concerns that challenge established software engineering practices.

While surveys show substantial integration of AI assistants into everyday workflows [15], [16], the conceptual understanding of vibe coding remains underdeveloped. Existing research has examined the integration of Large Language Models (LLMs) into software engineering tasks, highlighting practical benefits in code generation and productivity gains [16], [17]. But many of these approaches predominantly view LLMs as subordinate assistants within conventional development paradigms rather than as collaborative partners in a fundamentally new way of creating artifacts. For instance, Gao et al. [17] systematize technical architectures and performance metrics across LLM variants, while setting aside questions of how such models reconfigure the nature of programming in software development and intent mediation itself. This disconnect between widespread tool adoption and conceptual understanding reflects a broader pattern where practical use outpaces theoretical frameworks, creating urgent needs for systematic analysis of this emerging paradigm. We address this gap by providing the first systematic conceptualization of vibe coding as a distinct programming mode and analyzing its implications for software development practice. Our research is guided by two questions:

- 1) How can vibe coding be defined as a distinct software development paradigm, and how does it reconfigure the mediation of developer intent compared to traditional practices?
- What cognitive, epistemic, and organizational implications, both beneficial and problematic, arise from vibe

coding?

To investigate these questions, in Section II we begin by tracing the evolution of intent mediation in software development since the 1940s, identifying structural and epistemic shifts across the epochs. In Section III, we then define vibe coding in contrast to to traditional software development, articulating its key attributes and interaction patterns, which anchors our analysis of how vibe coding reconfigures cognitive work, expertise, and epistemic agency. Drawing on this conceptual groundwork, in Section IV we synthesize opportunities (e.g., accessibility, democratization, acceleration) and risks (e.g., deskilling, opacity, responsibility gaps) that emerge from the interpretive nature of vibe coding. In Section V, we critically reflect on the findings and outline future research directions. This paper ends with a conclusion and discussion of limitations in Section VI.

II. HISTORY OF INTENT MEDIATION IN SOFTWARE DEVELOPMENT

Intent mediation in software development has evolved significantly over the decades, reflecting changes in both how intent is expressed and how cognitive effort is distributed between human and machine. This section traces that evolution across nine decades, each marked by a significant evolution regarding the form of mediation and the nature of software development work. Each era concludes with a synthesis that reflects on the dominant patterns and implications for how intent was conveyed during that period. Together, these historical developments, summarized in Table 1 at the end of Section II, provide a basis for understanding how the mediation of intent has shaped and continues to shape the practice of software development.

A. MANUAL TRANSLATION: HARDWARE MANIPULATION TO ALGORITHMIC SPECIFICATION (1940S-1960S)

In the 1940s programmers mediated intent by physically manipulating machine components [18], [19]. On the ENIAC, one of the first general-purpose electronic computers, programs were "constructed" by manually setting switches and connecting patch cables to define the flow of computation [18]. Another early example is Konrad Zuse's Z3, often considered the first working digital computer, which used punched tape to feed instructions into fixed hardware circuits for sequential execution [6], [20], [21]. This was tightly coupled to the underlying hardware architecture [7], with no separation between logic and machine operation [22]. Each system required its own approach, making programming an inherently machine-specific task [6].

The advent of assembly languages in the 1950s marked the transition from physical manipulation of hardware to using symbolic expressions [18]. Rather than configuring cables or switches, developers were able to use instructions mimicking natural language. Short textual codes, such as 'ADD,' 'MOV,' or 'JMP' were directly mapped to the machine's binary operations [20], [22], [23]. The new layer of abstraction allowed to mediate intent in a language-like form that was more human-

readable, easily modifiable, and replicable compared to manual hardware reconfigurations [24]. Despite the use of textual mnemonics, the development process remained closely tied to machine architecture. Each symbolic instruction still corresponded one-to-one with specific hardware actions, still requiring developers to think in terms of memory addresses, CPU registers, and exact sequencing of low-level operations [25].

From the late 1950s through the 1960s, programming underwent a significant leap in abstraction, moving beyond the one-to-one symbolic mediation of assembly languages. New high-level programming languages like FORTRAN, ALGOL, COBOL and C moved away from hardware-specific encodings [20], [26], instead emphasizing machine-agnostic, higher-order constructs such as loops, conditionals, and functions. These constructs enabled the formal specification of complex procedural logic [20], [27]. Developers could now mediate intent through single high-level statements [20]. For example, a simple loop could be expressed in one concise line in a high-level language, whereas achieving the same in assembly would require manually managing memory addresses, loop counters, conditional jumps, and instruction flow control in multiples lines of code. Compilers provided the required software capabilities that translated these abstract algorithmic statements into the multitude of low-level instructions required for execution on a specific machine [22], [26], [8], [28]. Overall, this era was marked by efforts to formalize the nature and structure of programming languages, defining programming language grammar [9], establishing concepts such as lexical scoping and block-structured control constructs [9], [29], promoting separation of concerns, abstraction boundaries, and systematic decomposition [26].

The foundational era from the 1940s to the 1960s, thus, demonstrates a profound evolution in how developers mediate intent and engage cognitively with computational systems. From the physical manipulation of hardware circuits requiring intimate machine-specific knowledge, through assembly's symbolic mnemonics that maintained one-to-one hardware correspondence, development culminated in high-level languages that enabled abstract algorithmic intent mediation independent of underlying architecture. This progression fundamentally transformed cognitive work from hardware-focused mechanical controlling to conceptual algorithmic thinking, establishing the foundations for programming as an intellectual discipline.

B. CONCEPTUAL MODELING: STRUCTURED PROGRAMMING TO DESIGN PATTERNS (1970S-1990S)

By the 1970s, structured programming had become the dominant model of intent mediation. Developers employed procedural logic, writing how a task should be carried out, step by step. Writing how to reach a result however was increasingly tedious and error-prone [30], [31]. These circumstances motivated languages like SQL and Prolog, which follow the paradigm of declarative programming [32], [33]. The paradigm introduced an alternative form of intent media-

tion by shifting focus from defining procedures to conditions [34], [35]. Declarative programming inverted the programmer's relationship with the machine: instead of instructing how to compute a result, one specifies the desired outcome [36]. With SQL, for instance, a developer does not define the procedural steps for accessing and comparing data, instead, they write a single formal statement that describes the structure of the result, leaving the execution strategy to the machine [37]. Similarly, Prolog represented a distinct branch of declarative programming known as logic programming, allowing to define a set of logical facts. Computation then becomes a process of machine-automated resolution: the system searches for results that satisfy a query, automatically applying inference steps that were not not explicitly spelled out [38]. In parallel, functional programming offered another alternative to procedural expression of intent. Building on the foundations of early languages like Lisp, functional programming languages such as Scheme and Meta Language (ML) formalized computation around the concept of mathematical functions [39], allowing intent to be expressed without stepwise manipulation of state. Like declarative programming, it offered a model where developers could describe what should be computed, while abstracting away from how individual steps were executed [40].

By the 1980s, the growing complexity of software systems began to further strain the linear model of procedural code [20], [22]. The challenge was no longer just how to make the machine compute a result, but how to think about problems and effectively express intent in a way that was more intelligible to humans [18], [26]. These demands gave rise to object-oriented programming (OOP), which redefined intent mediation around the concept of objects, self-contained entities that combine data and behavior [41]. Rather than organizing logic into global procedures, developers now expressed intent by modeling real-world concepts as interacting objects [42]. Languages like Simula, Smalltalk and later C++ allowed developers to define classes, encapsulate state, and structure programs around message-passing between objects [42], [43]. While intent mediation still occurred through structured programming languages with defined syntax and semantics, developers increasingly approached problems not just through fixed sequences of steps, but by thinking in terms of distinct roles and responsibilities within code. Instead of focusing solely on controlling a singular flow of execution, they began to describe systems in terms of how different parts should interact, offering an alternative mental model to procedural logic.

This shift toward expressing intent through conceptual structures continued into the 1990s with the emergence of design patterns that provided reusable templates that structure software systems and communicate underlying intent consistently [44]. First formalized by Gamma [45], design patterns encapsulate proven solutions to recurring problems encountered in software development. They offer developers a shared vocabulary and a set of best practices that make the underlying design intent more explicit and communicable. Design

patterns thus mediate intent not only at the level of individual components but across whole system architectures, embedding requirements and domain logic into reusable forms [46], [47]. By formalizing these solutions, design patterns, by design, mediate the developer's intent, ensuring that underlying principles and requirements are consistently understood and implemented [48].

The 1970s to 1990s, thus, marked a turn from purely procedural control toward more expressive design and mediation of intent. As programming languages and paradigms matured, expressing intent became less about operational detail and more about developers shaping conceptual structures. The cognitive work of programming in software development shifted from managing stepwise execution to articulating coherent designs that reflect how developers understand and frame problems. Instead of translating intent into granular instructions, they began shaping code in forms that aligned with their mental models.

C. COLLABORATIVE SYNTHESIS: FROM PREDICTIVE ASSISTANCE TO AI CO-CREATION (2000S-2020S)

The 2000s saw the emergence of low-code and no-code platforms as an alternative approach to software development. Platforms like WordPress and Shopify enabled users without software development expertise to build systems by selecting templates, configuring modules, and customizing interfaces through graphical dashboards. Rather than writing logic, users expressed intent by assembling prebuilt components [49], [50] or code-blocks that enforce syntactic correctness [51], abstracting away boilerplate code [53], [54]. Software development became a matter of selecting features, adjusting settings, and orchestrating workflows through predefined options. Logic was embedded in the interface itself, constraining and guiding what could be expressed [53], [55], [50]. This approach did not replace traditional software development but introduced an alternative model of intent mediation, one where assembly and configuration took precedence over manual authoring and abstraction, shifting some of the responsibility to the machine to anticipate and interpret the developer's intent.

While such systems expanded who could participate in software development, the vast majority still took place through traditional programming. In such contexts, Integrated Development Environments (IDEs) provided static code completion based on simple lexical rules, offering basic assistance during the development process. Entering the 2010s however, it became increasingly recognized that source code exhibited statistical regularities similar to natural language [56], [57]. This realization opened up new opportunities to support developers through machine learning [58]. Early experimental approaches used nearest-neighbor models to suggest method calls based on past code examples [59]. Later, Bayesian networks were used to model the likelihood of specific completions in context [60]. These tools moved code completion beyond static completion to actively interpreting the developers intent in a given context. By the late 2010s, neural

models further advanced this approach, learning to predict more context sensitive completions like fitting variable names [61], [62]. These models offered completions that were not only syntactically valid but semantically plausible. While intent was still mediated through traditional code, the nature of interaction changed. Developers engaged in a new kind of dialogue with their tools, assisted by systems that could anticipate intent, transforming the development process into a more assisted activity.

In the 2020s, this development ultimately culminated in the plug-and-play integration of large language models directly into the developer's workflow. This integration manifests most prominently through GenAI [63], [64] that reliably and user-friendly anticipates the developer's intent and proposes syntactically correct and contextually relevant code.

This mediation takes two primary forms. The first is inline assistance, exemplified by tools like GitHub Copilot, which extends the concept of autocomplete from a single keyword to entire multi-line function blocks [63], [65]. As the developer types a comment or a function signature, GenAI offers a complete implementation as "ghost text", which can be accepted, rejected, or modified [66]. The second form is conversational snippet generation. Here, the developer might temporarily leave the IDE to engage in a dialogue with a LLM like ChatGPT, e.g., asking it to "write a function that generates prime numbers" or "generate ideas how to build an app for image filteres" [64]. The developer then acts as a curator of ideas and generated code [64].

This symbiotic interaction profoundly reallocates cognitive work. The primary burden is no longer the meticulous authoring of every aspect of a artifacts logic. Instead, it shifts to more high-level tasks like prompt articulation, expert supervision, and careful integration. The developer's core cognitive work becomes formulating a clear request (prompt) [67], critically evaluating the AI's output for correctness, security, and efficiency, and then weaving that generated output into the larger fabric of the application. The result ceases to be a self-authored artifact and becomes a collaborative piece that was co-created with the GenAI. While this level introduces a form of natural language interaction, it remains firmly grounded in the production of discrete, syntactically-bound code snippets, a crucial distinction from the more holistic, goal-oriented mediation that would follow with vibe coding.

The 2000s to 2020s thus marked a decisive shift toward assisted and collaborative forms of intent mediation. Beginning with low-code platforms that allowed users to configure systems through graphical assembly rather than manual coding, intent mediation expanded to include new user groups and interaction models. As statistical patterns in code were recognized and exploited, development environments evolved from passive editors into predictive, context-aware assistants. This trajectory culminated in the integration of LLMs that engage developers in a form of co-creation, where intent is expressed not just through code but through natural language prompts and ongoing dialog. Across these developments, the cognitive work of developers transitioned once again: from

authoring and structuring logic manually, to orchestrating, curating, and supervising machine-generated contributions. Software development became a mediated activity not just through tools, but through shared agency between human and machine.

III. VIBE CODING: FROM DETERMINISTIC TO PROBABILISTIC INTENT MEDIATION

Building on the historical trajectory outlined in Section II, this section introduces vibe coding as a new software development paradigm that reconfigures how intent is mediated and how cognitive work is shared between humans and machines. Unlike traditional approaches, where developers explicitly encode goals into formal structures, vibe coding centers on interpretive collaboration, using generative AI in free-flowing, improvisational dialogue to infer, adapt, and implement intent conveyed in natural language. The discussion is divided into two parts. Section III-A defines vibe coding as a conversational, multimodal software development paradigm, marked by interactive dialogue, co-creative timing, and semantic-level abstraction. Section III-B examines how this model reshapes cognitive demands and redistributes development expertise, proposing a new configuration of epistemic agency.

A. DEFINITION AND CONCEPTUALIZATION OF VIBE CODING

"Vibe coding" is an emerging way of developing artifacts coined by Andrej Karpathy [2] in early 2025, which has quickly gained traction in both developer communities and industry media [2], [68]. LLM-powered IDEs such as GitHub Copilot, Amazon CodeWhisperer, Tabnine, and specialized agents (e.g., Replit's Agent, Devin, Claude Code) are central to the vibe coding workflow. Unlike traditional programming workflows, vibe coding minimizes direct code authoring, allowing users to "see stuff, say stuff, run stuff" [2] in a conversational flow [69] that prioritizes intuitive expression of intent over technical specification [70]. This transition builds upon the paradigm of what we termed probabilistic generative programming that took root in the early 2020s. Notably, Y Combinator [1], renowned startup incubator and venture capitalist from Silicon Valley, reported that 25% of startup companies in its Winter 2025 batch had codebases that were 95% AI-generated, reflecting a move toward AI-assisted development. To understand the significance of this paradigm shift, we must first examine the term itself.

"Vibe" in contemporary discourse refers not only to an ambient emotional atmosphere, but also to a state of resonant interaction: Merriam-Webster [71] defines it as "a distinctive feeling or quality capable of being sensed", highlighting its subjective and relational nature. Colloquially, to "vibe" refers to aligning and harmonizing with another entity, where interaction feels effortless and flow emerges naturally. This phenomenon parallels the concept of networked flow, where creative collaboration flourishes when participants experience strong social presence and collective immersion, enabling seamless idea generation and shared understanding

[72]. Similarly, effective teamwork depends on establishing harmony and rhythm across learning modes, which enhances cohesion and drives innovation [73]. These insights suggest that "vibing" is more than a colloquialism: it describes a critical collaborative dynamic in which resonance and synchronization foster successful outcomes. This cultural context illuminates why "vibe coding" aptly captures the essence of this new approach: it emphasizes a synchronous co-creative dialogue where developer and AI find a collaborative rhythm, developing solutions through iterative conversation rather than precise technical specification. These transformations mark a transition from deterministic to probabilistic intent mediation, where the AI assumes responsibility for interpreting meaning from naturalistic expressions instead of requiring developers to translate goals into formal structures through technical expertise. Accordingly, we define vice coding as follows

Vibe coding is a software development paradigm where humans and generative AI engage in collaborative flow to co-create software artifacts through natural language dialogue, shifting the mediation of developer intent from deterministic instruction to probabilistic inference.

Vibe coding manifests through five key attributes: (1) goaloriented intent expression, where developers describe the shape of a goal rather than its technical implementation; (2) rapid dialogic interaction, enabling quick adjustments through conversational feedback, replacing traditional writecompile-test loops with a more fluid process; (3) implementation abstraction, where developers may deploy solutions that work without fully understanding implementation detail; (4) dynamic semantic refinement, where the developer's conception of requirements evolves through the Al's further interpretations; and (5) co-creative flow states, where developers and AI establish a productive rhythm of both ideation and implementation. Figure 1 represents a simplified example.

While traditional development environments passively expected explicit commands, vibe coding introduces AI as an epistemic agent that, in response to human intention and interaction, actively participates in knowledge construction, interpretation of requirements, and collaborative sensemaking. Rather than merely executing predefined instructions, it participates in the interpretation of the developer's explicit or implicit goals based on inference, predicting potential needs, and offering output informed by patterns learned across vast code repositories. This epistemic dimension fundamentally reshapes the developer-machine relationship. The AI becomes capable of contributing solutions that may exceed the developer's technical knowledge, identifying ambiguities in requirements that need clarification, and recommending alternative implementation strategies based on its extensive pattern recognition capabilities. These dynamics set the stage for our next section, which examines concrete examples of vibe coding and explores the resulting changes in cognitive work and technical expertise.

TABLE 1. Intent Mediation in Software Development (1940s-2020s)

Era	Anchor	Form of Intent Mediation	Cognitive Work
1940s	Hardware Control	Physical manipulation of switches, plugboards, and wires.	Translating logic directly into a physical machine configuration.
1950s	Symbolic Code	Textual mnemonics representing machine opcodes.	Meticulously managing CPU registers and memory addresses.
1960s	High Level Languages	Structured, high-level textual syntax with formal grammar.	Designing step-by-step logic and managing the state of variables.
1970s	Declarative Paradigm	Domain-specific, descriptive statements that define desired results.	Specifying the "what" and delegating the "how."
1980s	Object Oriented Programming	Mapping of real-world entities that embody roles and responsibilities.	Conceptual modelling of real-world entities.
1990s	Design Patterns	Usage of templates that carry underlying intent.	Identifying common problems and applying proven solutions.
2000s	Component Configuration	Assembling and configuring pre-built visual components.	Orchestrating systems by shaping behavior through interface constraints.
2010s	ML Predictive Assistance	Partial single code lines interpreted by ML.	Reviewing, editing, and integrating context-sensitive completions.
2020s	LLM Code Generation	Single code lines, code-contexts, and natural language prompts interpreted by LLMs.	Prompting, reviewing, and correcting contextually generated code snippets.

Figure 2 illustrates the paradigm shift from deterministic intent mediation in traditional software development to probabilistic intent mediation in vibe coding. In both scenarios, the human actor begins with a specific intent. In our example, the developer carries the intent "I want to sort the list [3, 1, 2] from smallest to largest." (1). To enable computer execution, the developer must first overcome the intend mediation gap between the human and the computational system. Traditionally, this mediation requires the adherence to a rigid and narrow specification space. The developer must produce code that conforms exactly to predetermined syntactic and semantic rules for deterministic, instructional execution (2). In contrast, vibe coding allows developers to bridge this gap through natural language communication, which operates on probabilistic-interpretive principles. The developer mediates intent through interaction with a LLM (3), which assumes responsibility for interpreting the natural language specification and producing executable code outputs (4). Regardless of the mediation pathway, whether through direct deterministic coding (2) or LLM-interpreted probabilistic communication (3), the resulting code output undergoes deterministic processing (e.g., compilation) before execution by the processor, maintaining the same final computational determinism in both paradigms (5).

B. RECONFIGURING COGNITIVE WORK AND EXPERTISE

Building upon the exploration of vibe coding as a collaborative, natural language, dialogic co-creation flow, that shifts from deterministic to probabilistic intent mediation, this section examines how this emerging approach fundamentally reconfigures cognitive demands and expertise in the software development practice. The foundation begins with "cognitive alignment," where mental models and artifacts emerge

through natural language, which enables a new "cognitive work division" as tasks redistribute between human and AI partners. This redistribution naturally alters the "cognitive rhythm" of development work, so we argue, creating more fluid patterns of engagement. These changes in turn reshape the "nature of expertise" from technical mastery toward collaborative orchestration. As expertise evolves, "knowledge boundaries" become more permeable, with AI compensating for human knowledge gaps. Finally, these shifting boundaries necessitate reconsideration of "epistemic agency and responsibility" when artifact creation becomes a shared human-AI endeavor. By examining these dimensions, we reveal how vibe coding creates a fundamentally different cognitive landscape for developers. Table 2 at the end summarizes Section III-A and Section III-B by systematically contrasting traditional programming with vibe coding.

In examining cognitive alignment, traditional programming in software development often forces developers to infer, adept and translate high-level goals into low-level code, creating a disconnect between mental models and formal structures [74]. Vibe coding's conversational flow and interpretive interface allows intent expression in natural language, better aligning cognitive representation with emerging solutions and reducing extraneous cognitive load [74], [75], [76]. In vibe coding, alignment becomes mutual attunement as developers express goals fluidly while AI infers and refines code. These systems support emergent semantics: as AI iteratively refines code, the developer's mental model updates continuously. This tight coupling mirrors design principles favoring matched mental models, improving comprehension and efficiency [77] and that has the chance to create a kind of a talk-back of the artifact created, that is fundamental to many other professions [78], but that was lacking in software

I want to build an app in which I can save and rate coffees that I have tried. Do you have a suggestion for this?

Yes, that sounds perfect! I would also like to be able to describe the coffee notes and add the coffee roaster. That sounds like a great idea! To get started, let's break down the features to include in the app:

- 1. View all the coffee ratings
- Add new coffees with ratings
 Store everything in a database
- Does that sound about right?

Great! Let's add those features to the list. For the initial design, we can start with a simple layout:



That looks great! I think this is a good starting point.

Do you have a suggestion for a design? I want to incorporate the colors of coffee in the design.

Absolutely! Incorporating the colors of coffee can give the app a warm and inviting feel. I suggest a coffee-themed design using warm browns, creams, and complementary colors:



FIGURE 1. Dialogue between human user (green) and AI (blue) illustrating a vibe coding process.

development. The alignment task moves from API memorization to orchestrating a collaborative flow, with adaptive understanding reducing the gap between intent and code structure, making cognition fundamentally interactive [79].

Building on this transformed alignment between mind and code, the configuration of cognitive work demonstrates how, in traditional coding, developers bear the full cognitive burden while work remains siloed. Vibe coding converts this into a conversational co-creation. This shift exemplifies distributed cognition, spreading intelligence across human and machine agents [13]. With vibe coding, humans articulate intentions in natural language rather than merely delegating routine coding while focusing on higher reasoning. This creates a dynamic where developers express goals and concepts rather than

just offloading repetitive implementation tasks to AI, freeing cognitive resources for architectural decisions and problem conceptualization. By combining human creativity and strategic thinking with AI's recall and pattern implementation, the complementary strengths of both agents form a more efficient cognitive system than either could achieve alone, a concept referred to as "Hybrid Intelligence" [14]. Also, we argue that Vibe coding creates co-creative flow states with alternating leadership. Developers set goals and interpret results rather than writing every line of code. This resembles cognitive apprenticeship [80], where system feedback partially reveals the AI's "thought process" and enables collaborative learning. Cognitive roles thus shift from a single expert to a human-AI team, with humans as 'vibe directors' and semantic curators while AI serves as a dynamic problem-solver.

This redistribution of cognitive work naturally alters the temporal patterns of development. The design and management of these human-AI interactions becomes critical as developers navigate new forms of collaborative engagement [81]. Analyzing the cognitive rhythm of engagement, the temporal rhythm of coding has evolved throughout programming history. While traditional development imposed discrete write-compile-test-debug cycles that fragmented attention, vibe coding creates a fluid, conversational cadence. Vibe coding often enables faster feedback through dialogue-based iteration, where developers can receive AI responses to queries during the ideation and design phases, potentially accelerating parts of the refinement process. While compile and execution cycles remain necessary for many applications, the conversational nature of the interaction can reduce cognitive fragmentation. Developers can make conceptual pivots more fluidly, keeping their focus on problem-solving rather than implementation details [82]. Developers can make conceptual pivots more fluidly, keeping their focus on problem-solving rather than implementation details. This iterative engagement aligns with agile principles [83], while vibe coding's emergent semantic alignment and acceptance of partial comprehension allow work to progress even when details aren't fully specified. Cognitive work thus becomes more conversational and mutually adaptive, with constant dialogue blurring the boundary between ideation and implementation.

As cognitive alignment, labor, and rhythms transform, so too must our understanding of software development expertise. The nature of expertise evolves considerably, as traditional expertise is largely procedural: experts internalize idioms, mentally simulate execution, and possess rich tacit knowledge [84], [85]. Traditional experts excel in domain decomposition with brains encoding technical program structures [86]. With AI assistance, tacit knowledge shifts to the tool. Each paradigm creates new expertise: OOP experts think in objects, web developers master frameworks. Vibe coding redefines expertise as adaptive collaboration, valuing problem framing, output validation, and design thinking. The expert becomes an orchestrator of vibes, steering co-creation. They elicit appropriate AI behavior and embrace evolving code. This connects to Polanyi's tacit knowing: developers

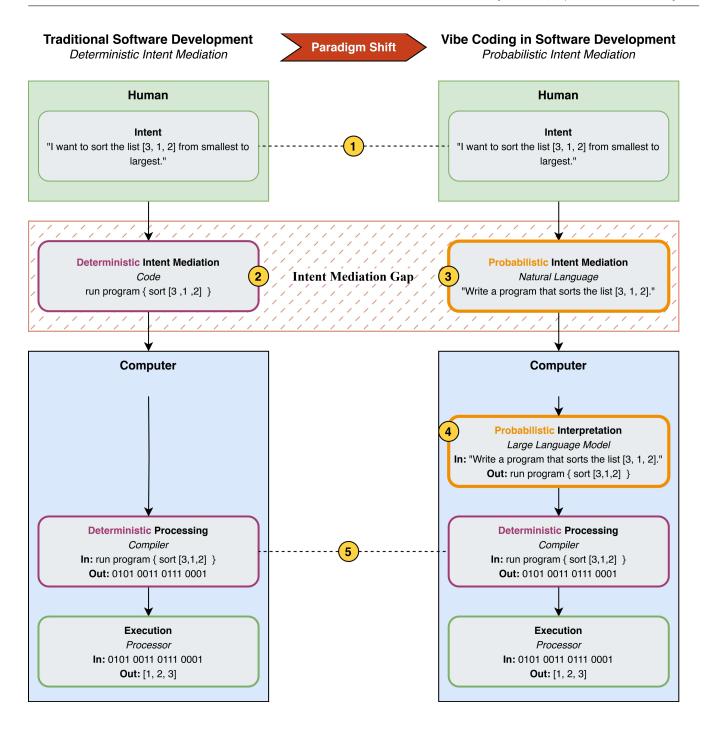


FIGURE 2. Paradigm shift from deterministic to probabilistic intent mediation in software development.

"know more than they can tell" while AI generates code [85]. Expertise becomes metacognitive: asking right questions and interpreting answers. This favors technical knowledge blended with conversational skill. In vibe-oriented flow, developers navigate solutions through intuition, resembling jazz improvisation [82], [85]. Development expertise shifts from craftsmanship to synergistic problem-solving. The artifacts talk-back of the artifacts become more instant [78].

This redefinition of expertise directly impacts what knowl-

edge is required for successful software development. In terms of knowledge boundaries, traditional programming established rigid parameters requiring comprehensive expertise in syntax, algorithms, and frameworks developed through years of practice [87]. Vibe coding fundamentally transforms these boundaries by creating a conversational ecosystem where AI compensates for human knowledge gaps. While expert developers traditionally develop rich mental schemas through extensive practice [86], vibe coding creates a flexible

boundary where AI capabilities offset limited technical understanding. This complementary relationship allows novices to produce functional code despite knowledge deficits, as AI interprets intentions and reduces cognitive load through natural dialogue rather than formal specification. The boundary in vibe coding changes from non-negotiable technical mastery to a permeable threshold where even partial understanding becomes acceptable. While Ericsson et al. emphasize how deliberate practice builds expertise within fixed domains [84], vibe coding expertise involves effectively guiding AI tools across flexible boundaries. The boundary's focus moves futher and further away from deep syntax knowledge toward problem decomposition, domain reasoning, and prompt engineering skills. Developers operating within the vibe coding paradigm still benefit from domain knowledge but face less rigid boundaries around language mastery. Critical thinking and effective AI collaboration become more crucial than memorizing syntactic details, as the complementary AI system handles boilerplate logic and compensates for technical knowledge gaps.

Finally, as knowledge boundaries become more permeable and expertise redistributes, questions of agency and responsibility emerge as critical considerations. Hence, aspects of epistemic agency and responsibility become central as vibe coding transforms knowledge ownership in software development. While traditionally developers were sole epistemic agents, vibe coding creates shared knowledge production. This resulting diffusion of authorship creates potential responsibility gaps [88]: when bugs arise, is the developer or tool at fault? The relational nature of agency in human-AI systems [89] complicates traditional notions of responsibility, as agency emerges from the interaction rather than residing in either the human or AI alone. Human developers retain ultimate agency but work with AI. Studies show humans tend to either over-rely on or under-utilize automated aids [90]. Despite accepting partial comprehension, developers must maintain skepticism by questioning AI suggestions. As Naeem & Hauser [91] note, users can integrate AI while maintaining responsibility. The dialogue-based workflow supports this by making AI "reasoning" partially explicit and editable. While knowledge creation becomes shared, developers transition toward orchestrator roles, remaining gatekeepers responsible for ensuring correctness, security, and goal alignment [88] [90].

The transformations in epistemic agency and responsibility highlighted above represent the culmination of vibe coding's reconfiguration of software development practice across multiple cognitive dimensions. These shifts, from sole to shared knowledge production, from complete comprehension to accepted partial understanding, and from individual to distributed responsibility, fundamentally alter how developers engage with code creation. Table 2 synthesizes these cognitive reconfigurations alongside the intent mediation transformations explored in Section III-A, providing a systematic comparison between traditional software development and the emerging vibe coding paradigm.

IV. OPPORTUNITIES AND RISKS

As our analysis illustrates, vibe coding represents a paradigmatic change in how humans interact with systems to create software, fundamentally reconfiguring the relationship between human intent and machine execution through probabilistic rather than deterministic mediation. This transformation extends beyond productivity gains, reshaping who can develop, how programming tasks are approached, and the organizational structures that result. Drawing on the dimensions of intent mediation, cognitive work, and expertise outlined in Table 2, we identify significant opportunities and risks arising from this evolution, reflecting a complex interplay that likely only hints at the broader implications.

A. OPPORTUNITIES OF VIBE CODING

The shift toward probabilistic intent mediation in software development creates opportunities ranging from individual empowerment to organizational transformation. By democratizing development, enabling cognitive liberation, accelerating feedback loops, and providing systemic leverage, vibe coding changes not only how software artifacts are produced but also who can participate in digital creation. These opportunities span multiple dimensions of development practice, suggesting that the conversational paradigm will profoundly impact both the social and technical fabric of software development, with many consequences still emerging.

1) Cognitive Accessibility and Inclusion

The transition toward intent expressed through natural language and multimodal conversational interfaces is fundamentally transforming the nature of software development. No longer confined to the realm of a specialized craft practiced by a select group of experts, it is rapidly evolving into an expressive medium that is accessible to a much broader and more diverse range of participants. By enabling individuals to communicate their ideas, goals, and creative visions through everyday language and intuitive interactions, these new paradigms lower traditional barriers to entry and foster a more inclusive environment for innovation. This reconfiguration of the landscape opens several pathways for inclusion:

- Empowerment of Domain Expertise: By enabling AI to infer intent from natural language, domain specialists can directly translate their expertise into functional software, reducing reliance on formal programming skills and rebalancing traditional technical hierarchies.
- Lowered Entry Threshold: Programming that aligns with intuitive reasoning allows individuals without technical backgrounds to participate meaningfully in software development, broadening access and democratizing technological creation.
- Cognitive Scaffolding: AI's ability to complement human knowledge enables users to make progress even with incomplete technical understanding, supporting productive work without requiring full mastery of implementation details.

TABLE 2. Traditional Software Development vs. Vibe Coding

Category	Dimension	Traditional Software Development	Vibe Coding
Intent Mediation	Intent Layers	Intent expressed in formal programming languages; limited to text mode via code editors.	Intent expressed through natural language, voice, visual cues; supports multimodal interaction across chat, speech, or graphical interfaces.
	Intent Translation	Human decomposes intent into semantics and syntax; compiler handles syntax-to-execution.	AI infers semantics from naturalistic input and generates syntax; developer guides through prompt iteration and review.
	Intent Fidelity	High fidelity through explicit specification and manual control.	Variable fidelity; AI interpretation introduces ambiguity, requiring testing and refinement.
Cognitive Work	Cognitive Alignment	Requires structured, abstract reasoning aligned with machine logic and formal languages.	Aligns with intuitive, expressive reasoning; supports informal articulation of goals.
	Configuration of Cognitive Work	Developer as sole constructor and debugger; responsible for all formalization.	Developer as articulator, critic, and tester; shares generative and interpretive labor with AI.
	Cognitive Rhythm of Engagement	Linear and staged: plan \rightarrow implement \rightarrow test; feedback is delayed and tool-mediated.	Dialogic and iterative: prompt → interpret → revise in near real time; continuous co-adaptation.
Expertise	Nature of Expertise	Emphasizes formal implementation and optimization.	Emphasizes articulation, prompting, validation, and strategic steering of generative systems.
	Knowledge Boundary	Fixed and comprehensive; requires mastery of syntax, algorithms, architecture, and system interaction with minimal external compensation.	Fluid and complementary; AI capabilities offset human knowledge gaps through iterative dialogue, reducing need for technical mastery.
	Epistemic Agency and Responsibility	Human holds full authorship and explanatory authority over code behavior.	Epistemic agency is shared; AI proposes logic, human accepts, tests, and assumes partial accountability.

2) Cognitive Liberation

Vibe coding's shared epistemic agency and dialogic engagement reframe software development from technical execution to strategic orchestration. In this approach, it is not simply about conceptualizing and writing code to achieve a specific outcome, but about engaging in ongoing, collaborative dialogue that shapes both the problem and its solution. This method privileges iterative dialogue, where participants continuously refine their ideas and approaches through discussion and feedback. It also encourages higher-order thinking, as individuals are required to analyze, evaluate, and synthesize information rather than follow predetermined steps. As a result, vibe coding supports a more reflective and adaptive form of problem-solving, where knowledge is constructed collectively and solutions emerge through interaction and negotiation:

- Rapid Prototyping and Iteration: AI's ability to infer intent from naturalistic input accelerates the creation and exploration of initial solutions, enabling rapid testing and refinement of alternative approaches before committing to a final implementation.
- Human-AI Co-Creation: By shifting cognitive work from individuals to collaborative human—AI configurations, developers act as articulators, critics, and testers. This partnership frees human resources for strategic and creative tasks while AI manages implementation complexity.
- New Forms of Expertise: As programming emphasizes

- articulation, prompting, and strategic steering over implementation, evaluative and dialogic skills gain prominence over low-level mastery. This expertise evolution creates space for differently skilled individuals to contribute meaningfully to software development.
- Emergent Problem Understanding: Within the dialogic and iterative development rhythm, requirements evolve through AI interaction rather than upfront specification. This emergent approach encourages exploratory design thinking and reduces cognitive overhead in early development stages.
- Expanded Creative Horizons: Freed from the constraints of formal syntax and implementation details, developers can pursue conceptual and domain-specific innovation, focusing on user-centered solutions rather than technical feasibility.

3) Accelerated Development Cycles

Traditional software development typically progresses through a series of linear stages, such as requirements gathering, design, implementation, testing, and deployment. Each stage is often separated by formal handoffs, where responsibility shifts from one group to another. This process can create bottlenecks, slow down progress, and limit opportunities for feedback and revision. In contrast, the continuous co-adaptation inherent in vibe coding enables more fluid approaches to system construction:

• Rapid Prototyping and Iteration: AI's ability to infer

intent from naturalistic input accelerates the creation and exploration of initial solutions, enabling rapid testing and refinement of alternative approaches before committing to a final implementation.

- Reduced Translation Overhead: By automating the translation from abstract requirements to executable code, AI minimizes manual mapping and cognitive load for engineers, expediting development and reducing error rates.
- Conversational and Iterative Flow: Real-time, dialogic engagement with AI fosters a seamless development rhythm, promoting creative flow and minimizing friction between ideation and realization.
- Flexible, Evolving Specifications: Development proceeds through cycles of prompting, interpretation, and revision, allowing solutions to emerge organically without the need for fully specified requirements at the outset.

4) Systemic Leverage

Beyond its advantages for individuals, vibe coding generates transformational impacts at both the organizational and ecosystem levels. These changes help organizations become more agile and responsive to emerging challenges and opportunities. In this way, the opportunities previously identified, such as increased inclusion, enhanced problem-solving, and more flexible system development, are elevated from isolated benefits to strategic outcomes that shape the direction and success of entire organizations and broader communities:

- Scalable Team Efficiency: By amplifying the capabilities of small teams, vibe coding enables organizations to achieve outputs that once required much larger technical departments. This democratizes innovation, empowering startups and smaller units to compete with established players.
- Strategic Talent Reallocation: As cognitive work transforms from implementation to orchestration, organizations can prioritize hiring domain experts and creative thinkers over traditional technical specialists, optimizing talent deployment and fostering interdisciplinary collaboration.
- Lowered Organizational Barriers: The combination of accessible interfaces and conversational workflows allows organizations to pursue projects previously constrained by technical or resource limitations, broadening the scope of feasible innovation.
- Accelerated Innovation and Market Responsiveness:
 The synergy of rapid prototyping, reduced translation overhead, and iterative refinement compresses development cycles and aligns solutions more closely with market needs, enabling faster, more relevant innovation and a stronger competitive edge.

B. RISKS OF VIBE CODING

Despite its promising opportunities, vibe coding introduces significant challenges that warrant critical examination as the paradigm shift toward probabilistic intent mediation reshapes software development practice. The risks span from potential erosion of technical expertise and degradation of code quality to the emergence of responsibility gaps and organizational vulnerabilities that threaten long-term sustainability. Addressing these challenges requires proactive strategies for knowledge preservation, quality assurance, governance, and strategic planning. Only by anticipating and managing these risks can we ensure that the benefits of vibe coding are realized without compromising fundamental software engineering principles or introducing unforeseen negative consequences.

1) Erosion of Programming Expertise

As AI infers semantics from naturalistic input and increasingly mediates programming activity, the embodied and cognitive practices that once defined technical fluency are being bypassed. In traditional software development, expertise was closely linked to the ability to manipulate code, understand complex syntax, and apply established procedures. However, as programming shifts toward a predominantly conversational activity, these forms of expertise may become less central. This development raises important questions about how expertise in software development is now formed, maintained, and passed on to others:

- Technical Deskilling and Design Competence: With developers acting more as articulators than implementers, core skills, such as algorithmic thinking, debugging, and architectural planning, may atrophy. Reliance on AI to fill knowledge gaps can weaken developers' capacity for systematic solution design and independent problemsolving.
- Illusory Mastery and Overconfidence: The ability to generate functional code and artifacts without deep understanding fosters a false sense of competence, increasing the risk of overlooking critical issues like security and performance.
- Disrupted Knowledge Transfer: As development evolves toward prompt engineering, traditional avenues for transmitting tacit knowledge, such as mentoring and code reviews, are diminished, impeding the professional growth of less experienced developers.

2) Code Quality and Maintainability

The integration of generative AI into software development risks undermining the collective practices and engineering rigor that ensure code stability and long-term viability. In established development environments, teams rely on shared standards, thorough review processes, and systematic testing to maintain the quality and reliability of software systems. These collective practices help to identify errors, enforce best practices, and support ongoing maintenance. However, as generative AI takes on a larger role in producing code, there is a danger that these collaborative routines may be weakened or overlooked:

- Instability, Debugging Challenges, and Technical Debt: Iterative prompting can lead to unpredictable code rewrites, making local debugging less effective and introducing instability and unanticipated side effects. The prioritization of immediate functionality over sound architecture accelerates technical debt and creates longterm maintenance burdens.
- Opaque Verification and Inconsistent Patterns: As traditional reviews and testing protocols are replaced by AI-driven judgments, quality assurance becomes less transparent and reliable. Additionally, code generated through conversational flows often lacks cohesive structure, consistent patterns, and proper documentation, complicating future maintenance.

3) Epistemic and Responsibility Gaps

The integration of shared epistemic agency in code production introduces new challenges by distancing developers from the underlying logic and intent of the systems they help create. When responsibility for decision-making is distributed among multiple participants, including AI systems, it becomes more difficult for any single individual to fully understand or explain how and why certain outcomes are produced. This separation can complicate efforts to assign accountability when problems arise, as it may not be clear who is responsible for specific design choices or errors. Additionally, ethical oversight becomes more complex, since the intentions and values guiding the development process may be less transparent or consistent:

- Ambiguity of Authorship and Accountability: Dialogic, iterative engagement blurs ownership boundaries between human and AI, making it difficult to assign responsibility for errors or unethical outcomes and creating governance challenges.
- Black Box Codebases: As developers increasingly rely on AI-generated code, they become detached from the internal logic of their systems. This partial comprehension makes it harder to understand, intervene, or recover during critical failures when deep system knowledge is essential.
- Loss of Intent Traceability: The continuous coadaptation workflow obscures the connection between original requirements and implemented solutions. Without transparent mapping between prompts, revisions, and code, future maintainers cannot reconstruct the rationale behind key decisions.
- Ethical and Data Protection Blind Spots: AI's limited explanation capabilities and reliance on probabilistic mediation increase the risk of undetected ethical breaches and data protection violations, which may only become apparent in edge cases or production environments.

4) Strategic and Organizational Vulnerabilities

Vibe coding introduces systemic challenges that extend beyond individual risks, affecting both organizational structures

and broader ecosystems. At the organizational level, the collaborative and adaptive nature of vibe coding can make it harder to maintain consistent processes, enforce standards, and ensure clear lines of responsibility. At the ecosystem level, the interconnectedness fostered by vibe coding can amplify the impact of local issues, allowing problems to spread more quickly across teams, departments, or even partner organizations:

- Compliance and Regulatory Challenges: Black box codebases, ethical and data protection blind spots, and inconsistent documentation undermine auditability and verifiability, posing significant barriers to compliance in regulated sectors such as healthcare and finance.
- Ecosystem Bias and Tool Dependency: AI inference capabilities are stronger for mainstream programming languages, granting strategic advantage to some organizations while disadvantaging those using specialized languages. At the same time, reliance on proprietary AI tools and probabilistic mediation introduces economic and infrastructural dependencies, reducing organizational autonomy and exposing organizations to risks from pricing changes, service discontinuations, or shifting external priorities. Together, these factors create hidden competitive distortions and long-term strategic vulnerabilities.
- Talent Misalignment: As expertise shifts toward prompt engineering and strategic steering, organizations may undervalue traditional software development skills, leading to capability gaps in authoring code, debugging, maintenance, and scaling. This misalignment threatens system continuity when deep technical knowledge is required.

V. DISCUSSION

A. VIBE CODING AND THE RECONFIGURATION OF INTENT MEDIATION

Section II detailed the significant shift that vibe coding represents in software development, moving from deterministic processes to a more interpretive and collaborative model in which human intent is probabilistically mediated by generative AI. This transition introduces a dialogic and iterative engagement process, capturing both the explicit and implicit intentions of human collaborators.

The nature of software development expertise is fundamentally transformed. As discussed in Section III, traditional skills such as implementation-specific fluency and syntactic mastery are increasingly supplanted by new competencies, including problem articulation, prompt engineering, and evaluative judgment. Research on live programming environments highlights the importance of immediate feedback on Algenerated code in fostering these emerging skills [92]. Moreover, recent studies emphasize that the widespread adoption of large language models in software engineering amplifies these challenges, raising critical concerns about code quality, explainability, and the urgent need for updated educational and professional practices [93]. This evolution reflects a

redistribution of expertise across a collaborative human-AI system.

As outlined in Sections III and Section IV, vibe coding presents opportunities for democratization, acceleration, and enhanced cognitive accessibility in software development. However, it also introduces risks, including technical deskilling, code quality issues, and responsibility gaps. Empirical studies indicate that programming with large language models can yield significant productivity gains [16], but may also introduce new forms of systemic fragility. Addressing these challenges will require innovative approaches to software development, as well as revised educational and professional practices. For instance, research has shown that the quality of identifier construction directly affects a developer's ability to comprehend and debug code, suggesting that Algenerated code with ambiguous or poorly chosen names may exacerbate these difficulties [94].

Current institutional frameworks, which rely on explicit control and procedural transparency, are destabilized by vibe coding's shared epistemic agency and fluid knowledge boundaries. This misalignment calls for coordinated adaptation across educational, regulatory, and organizational domains to establish coherent frameworks for this new programming paradigm. Furthermore, the digital environments in which software development now occurs may subtly nudge practitioners toward certain approaches, creating choice architectures that institutional frameworks have yet to recognize or address. Regulatory systems, which assume clear lines of accountability, are challenged by the blurred responsibilities inherent in collaborative human-AI development. The opacity of AI decision-making processes further complicates accountability, making explainable artificial intelligence essential for maintaining institutional oversight and compliance.

B. FUTURE RESEARCH DIRECTIONS

The transformation from deterministic to probabilistic intent mediation reveals fundamental gaps in our understanding of how software development practice, expertise, and organizational structures are being reconfigured through generative AI use. While vibe coding offers unprecedented opportunities for democratization and acceleration, it simultaneously introduces profound uncertainties that require systematic investigation before developing appropriate governance frameworks. The urgency of establishing such frameworks is underscored by rapid AI adoption in business contexts, where organizations must navigate complex governance challenges. Drawing from a sociotechnical perspective, we organize this research agenda around three interconnected domains: the human actors whose cognitive work and professional identities are being reconfigured, the technological systems whose interpretive capabilities shape what can be expressed and built, and the organizational structures that must evolve to accommodate shared epistemic agency.

C. HUMAN-CENTERED RESEARCH DIRECTIONS

Vibe coding may not only transform the tasks developers perform but also how they think, learn, and define themselves. These shifts necessitate rethinking cognitive models of software development, the nature of programming expertise, and the pedagogical frameworks used to train future practitioners. Vibe coding also opens new possibilities for inclusion, potentially altering who participates in software development and under what conditions. The current professional development has a potential to swap over to the field of End-User-Development (EUD). As natural language becomes a primary interface to create artifacts, traditional forms of mastery may be replaced, or complemented, by new types of articulation and collaborative fluency.

- How can the new environment be used for software development education and what are appropriate didactical approaches for teaching software development?
- How must software development education be restructured to develop competencies in prompt articulation, semantic validation, and co-creative orchestration?
- What forms of expertise are emerging in vibe coding, and how should these be systematically recognized, assessed, and certified?
- How does vibe coding reconfigure the identity of developers, and what are the implications for professional development and recruitment?
- Does vibe coding measurably lower participation thresholds for underrepresented groups in software development, and how can this potential be institutionalized?

1) Technology-Centered Research Directions

At the core of vibe coding lies a generative model whose probabilistic processes remain largely opaque. This raises urgent questions around intent fidelity, semantic alignment, and AI explainability. While multimodal prompts and natural language allow expressive flexibility, they also introduce ambiguity and model-specific variability that complicate reproducibility. Technical research must focus on making these systems more transparent, accountable, and certifiable, particularly as they are integrated into workflows with legal, ethical, or safety-critical implications.

- How do different LLMs vary in their interpretation of identical prompts, and what are the systemic implications for reliability, reproducibility, and control?
- What linguistic and modal features ensure high-fidelity intent expression across LLMs, and can these be codified into standardized prompt design guidelines?
- How can explainability be operationalized in vibe coding environments to render AI inferences interpretable and critique-ready?
- What technical and procedural standards are required to certify AI-generated code for use in critical domains with legal, ethical, or safety implications?

2) Organization-Centered Research Directions

The uptake of vibe coding reshapes not just individual work, but institutional logic, team composition, and accountability structures. Organizations must adapt their development methodologies, redefine roles, and implement new governance protocols that account for shared human-AI authorship. At the same time, operational resilience requires maintaining critical technical capabilities even as routine implementation is increasingly offloaded to generative systems. Strategic alignment, compliance, and knowledge retention emerge as key concerns in managing this transition.

- What new roles must organizations establish to manage prompt engineering, semantic design, and AI oversight in software teams?
- How should software development processes be restructured to support dialogic iteration, emergent requirements, and epistemic ambiguity?
- How can accountability and legal liability be operationalized in systems where authorship and agency are shared between humans and AI?
- How can organizations preserve deep programming expertise for system resilience while scaling vibe coding practices operationally?

These research directions reflect the complex reconfiguration of software development as both a technical and social practice. Vibe coding challenges longstanding assumptions about intent, authorship, expertise, and responsibility in software creation. Addressing these challenges will require interdisciplinary collaboration across computing, design, education, organizational science, and ethics. A robust sociotechnical research agenda is therefore essential not only for understanding vibe coding, but for shaping its institutional, technical, and cognitive future.

VI. CONCLUSION

In conclusion, this paper has introduced and defined vibe coding as a novel software development paradigm, characterized by natural language dialogue and collaborative flow between humans and AI. By situating vibe coding within the historical evolution of intent mediation in software development, from early machine languages to high-level abstractions and now to conversational, collaborative approaches, this work highlights how each shift in modality has reconfigured the mediation of intent and the relationship between humans and mashine. Addressing the first research question, the paper has articulated how vibe coding distinguishes itself from traditional software development by shifting intent mediation from explicit instruction to probabilistic, goal-oriented dialogue, as reflected in its five key attributes: goal-oriented intent expression, rapid dialogic interaction, implementation abstraction, dynamic semantic refinement, and co-creative flow states.

In response to the second research question, the analysis has explored the cognitive, epistemic, and organizational implications of vibe coding. The opportunities identified in-

clude enhanced cognitive accessibility and inclusion, cognitive liberation, accelerated development cycles, and systemic leverage. However, these benefits are accompanied by significant risks, such as the erosion of programming expertise, challenges to code quality and maintainability, epistemic and responsibility gaps, and strategic and organizational vulnerabilities. While the definition and implications outlined in this paper offer a foundation for understanding vibe coding, they remain open to refinement as the field develops.

Looking ahead, the future research questions proposed here point toward human-centered, technology-centered, and organization-centered research directions. Continued investigation along these lines will be essential for establishing a nuanced understanding of vibe coding, enabling the field to harness its benefits while addressing its inherent risks as this development modality matures.

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