

Article

Enriching Idealized Design: A Multimethod Framework Integrating Systems Thinking Tools

Ali Hamidi *, Fisnik Dalipi  and Sadaf Salavati 

Informatics Department, Linnaeus University, 352 52 Växjö, Sweden; fisnik.dalipi@lnu.se (F.D.); sadaf.salavati@lnu.se (S.S.)

* Correspondence: ali.hamidi@lnu.se

Abstract

Complex and wicked problems characterized by high levels of uncertainty motivate the use of multimethodology (or methodological pluralism) in which different methodologies and methods are combined to better approach problems and develop solutions. This methodological pluralism has been applied across disciplines, including the systems thinking field, where scholars employed complementary methodologies and methods. Idealized design and interactive planning represent one such systems methodology that offers a structured action-oriented approach to redesigning a system toward an idealized state rather than attempting to predict it. Although conceptually well-established, idealized design has been noted for its limited practical guidance, particularly in identifying where and how to intervene in a system. The present paper addresses this gap by proposing an enriched idealized design framework that integrates rich pictures from soft systems methodology and causal loop diagrams, system archetypes, and the leverage points framework from system dynamics. Each tool is integrated at a specific phase of the idealized design process, forming a progressive cascade while preserving the original sequence of the idealized design approach. A retrospective empirical demonstration drawing on a longitudinal study on computational thinking (CT) education is presented to illustrate the conceptual coherence of the framework, and potential directions for future work, including prospective validation, are discussed.

Keywords: systems thinking; idealized design; interactive planning; computational thinking; rich pictures; CLDs; system archetypes; leverage points



Academic Editors: Rea Lavi and Oleg Pavlov

Received: 31 March 2026

Revised: 14 July 2026

Accepted: 15 July 2026

Published: 18 July 2026

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1. Introduction

Complex, ill-structured “wicked” problems, characterized by uncertainty, stakeholder divergence, and counterintuitive dynamics, demand methodological approaches that transcend single-paradigm limitations. Traditional problem-solving often fragments such messes into tractable parts, yielding suboptimal solutions that generate new problems elsewhere [1]. Systems thinking offers a compelling antidote through multimethodology, strategically combining complementary methods to illuminate different facets of complexity: interpretive divergence (Soft Systems Methodology—SSM), structural dynamics (System Dynamics—SD), and intervention leverage (critical heuristics). Yet, although individual systems tools excel within their paradigm, their orchestrated integration within an established framework remains underexplored, limiting practical applicability.

Idealized design, Ackoff’s cornerstone of interactive planning, exemplifies this opportunity. Rather than engaging in futile prediction, it invites stakeholders to design their

desired future system as if it existed today, operationally feasible, technologically possible, and motivationally compelling [2]. The process sequences mess formulation to diagnose the current system's obstructions, ends planning to envision the ideal future state, and means planning to chart viable implementation pathways. However, the research community notes its practical limitations: vulnerability to subjective bias in the absence of structured diagnostics, difficulty surfacing the endogenous feedback driving decline, and the absence of leverage prioritization for intervention [3,4]. These gaps motivate enriching idealized design with established systems tools while preserving its participatory nature.

This paper proposes an idealized design framework that systematically integrates:

1. Rich pictures for developing an understanding of the system during mess formulation, particularly in systems analysis and obstruction analysis;
2. Causal loop diagrams (CLDs) and system archetypes for reference projections and reference scenario construction;
3. Leverage points for prioritizing high-impact interventions in ends planning.

The framework maintains the sequencing of idealized design by incorporating multi-method structure through a progressive cascade: from interpretative divergence to structural dynamics and, finally, interventional prioritization. Theoretical compatibility is anchored in shared commitments, including evolutionary learning [5], applicability to complicated-pluralist problem context [6], and participatory futures orientation, while achieving pragmatic complementarity by compensating for each method's inherent limitations.

We demonstrate the conceptual coherence of the enriched framework through a retrospective empirical demonstration drawn from a five-year study on CT education across the K-9 context, where teacher capacity gaps, curriculum ambiguity, and policy inertia create a classic mess [7]. Rich pictures supported systems analysis by identifying the components, relationships, and interdependencies of the messy situation, capturing both objective elements and subjective stakeholder perspectives. CLDs revealed the causal relations and feedback loops through which CT education variables influence each other over time, showing reinforcing and balancing dynamics. System archetypes further translated these dynamics into recurring patterns to support reference scenarios. Finally, leverage points guided prioritized interventions by providing a structured means for envisioning the ideal state, moving from shallow to deep intervention areas. Overall, this retrospective empirical demonstration exemplifies how the integration of these complementary systems tools and approaches can collectively support mess formulation, reference projections, and ends planning within an idealized design framework.

Contributions of this paper are twofold:

1. Theoretical—formal orchestration of systems thinking tools drawn from different traditions within Ackoff's idealized design framework, demonstrating how targeted tool integration can enrich an established methodology without replacing its core structure;
2. Methodological and practical—a structured enriched idealized design framework with clear steps and a visual cascade, illustrated through an application to CT education, supporting practitioners from mess formulation to ends planning across different problem domains.

The remainder of the paper is structured as follows: Section 2 surveys methodology in systems thinking, whereas Section 3 introduces and explicates idealized design. Section 4 describes the complementary systems tools. Section 5 develops the integrated framework. Section 6 elaborates on practical considerations. Section 7 illustrates its use in the context of CT education. Section 8 discusses the study's limitations and directions for future research, and Section 9 presents the conclusions.

2. Multimethodology and Methodological Pluralism in Systems Thinking

The combination of methodologies, potentially from different paradigms and methods, within a single intervention is the core idea of methodological pluralism, or multimethodology [8,9], as an approach to problem-solving. The main reasons for such combinations are theorized by different scholars and summarized into five main points by Jackson [10]. First, different paradigms emphasize certain aspects of a problem while giving less attention to others, often leading to conflicting interpretations. Because complex situations have multiple dimensions, relying on a single perspective can result in an incomplete understanding. Using several paradigms and a range of methods allows for a more comprehensive analysis and more effective intervention. Second, research and interventions typically proceed through multiple phases, each with different tasks and challenges from understanding the problem to testing solutions. Using a variety of methodologies enables researchers and practitioners to handle these demands effectively. Third, using different methods enables a more comprehensive understanding of problems, while also noticing differences and accepting aspects that cannot be easily compared. Fourth, this combination addresses the shortcomings of any single method in practice, challenges traditional approaches, and helps develop new ones that integrate both old and new methods. Fifth, this multimethodology approach is a form of triangulation to increase the precision of the analysis and enhance the overall validity of the findings.

This idea of combining methodologies is reflected in systems approaches research. Early examples can be found in the work of scholars such as Jackson and Keys [6] and Jackson [11], who developed different combinations of systems methodologies and methods, so-called System of Systems Methodologies, depending on the problem context. Such a view would advance the practice of researchers in terms of localizing the choice of methods in space and time, such that a method or combination of methods can be applied, for example, in a novel and unintended way [12]. In a more dynamic and flexible way, Midgley [5] motivated the creative design of methods, or even parts of a method, emphasizing the role of intuition. This implies that in any specific situation, the researcher (also called the intervener) needs to draw upon their knowledge and experience and regard their intuition as an important resource. Consequently, the selected combination of methods is the product of choices made by the researcher, whether through conscious deliberation, intuitive judgment, or a combination of both.

Together with theoretical and conceptual combinations, multimethodological systems approaches have been applied in practice by different scholars. For example, Hanger-Kopp et al. [13] proposed a qualitative systems mapping framework that integrates three systems approaches of CLDs, concept mapping, and cognitive mapping, applied in a transdisciplinary case study on water stress in Austria. CLDs capture system dynamics and feedback loops, concept maps organize and explain knowledge hierarchically, and cognitive maps represent stakeholders' mental models and perspectives. The paper explores how these approaches intersect and can be used in combination to address complex problems involving high stakes and uncertainties.

The present paper follows a similar logic. The interpretive and functionalist paradigms diverge ontologically; however, their pragmatic complementarity emerges in the early phases of problem analysis, where subjective rich pictures surface system components and boundaries that subsequently inform the construction of feedback mechanisms and causal dynamics. Reconciling these philosophical differences is achieved, following Mingers and Gill [9] and Jackson [10], through sequential deployment where interpretive divergence comes first and structural modeling second, as different methods can address different dimensions of complexity within an intervention without requiring the two tools to share the same assumptions about reality, as elaborated further in Section 5.

3. Interactive Planning and Idealized Design

Interactive planning, developed by Ackoff in the 1980s, is grounded in the principle that stakeholders should actively participate in shaping their own future, captured in his phrase ‘plan or be planned for’. It can be applied wherever selected stakeholder participation adds motivation and commitment to the planning process in a facilitated (re)design effort. Rooted in Ackoff’s desire to ‘improve the future’, it places the professional in the role of fostering open debate and stimulating stakeholder creativity in designing a desirable future and the means to achieve it [14].

Interactive planning assumes that organizations generally face interconnected problems that cannot be solved independently, regardless of their context [15]. These issues, referred to by Ackoff as ‘messes’, are conceptualized as systems of problems. The foundation of interactive planning is the idea that a mess cannot be effectively approached by breaking it down into separate problems and solving each separately. Such solutions tend to be short-lived and frequently counterproductive, as resolving one problem often generates new ones that obstruct the resolution of others [4].

Idealized design is the most distinctive feature of interactive planning, through which stakeholders design the system that they would replace the current system if they were free to do so. Idealized design shifts the focus from predicting the future to actively shaping it [1]. Unlike other planning approaches that assumed the future was set and tried to predict it, idealized design is built on the belief that the future can be influenced, making prediction less important than design [4]. It draws on Aristotle’s teleological thinking, in which the future is not predetermined but can be shaped by the choices and goals one decides to pursue [16].

As shown in Figure 1, idealized design is structured around a series of phases. The process begins with mess formulation, which involves a systems analysis of the current situation, an obstruction analysis that identifies internal conflicts and gaps, and the development of reference projections and reference scenarios describing how the system would evolve if no changes were made. This is followed by ends planning, where stakeholders collectively envision and design an idealized future state of the system, free from financial and political constraints, subject only to technological feasibility, operational viability, and the capacity for learning and adaptation.

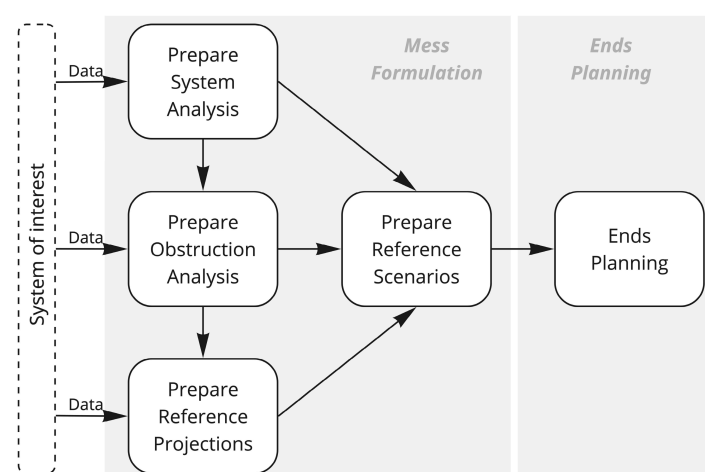


Figure 1. Idealized design framework.

While these phases are categorized under the general term of idealization in interactive planning, the remainder of the interactive planning process is referred to as realization,

which includes Means planning that determines how to move forward, resource planning, and the design of implementation and control [17].

As discussed in the previous section, methodological pluralism encourages the combination of methods and methodologies to better address complex and problematic situations. Idealized design is no exception and has been proposed for use within other frameworks where systems thinking tools are combined to advance design practices. One example is the systemic design toolkit, proposed by Jones [18], which organizes seven stages guiding practitioners through complex design processes. Each stage draws on different systems methods depending on the intent of the stage. For instance, the “Understanding the System” stage employs CLDs and system mapping, while the “Defining the Desired Future” stage draws on idealization and scenario mapping, reflecting Ackoff’s [1] idealized design approach. This allows practitioners to integrate systems thinking vocabularies appropriate to each stage of a complex project, therefore justifying a multimethodology approach for addressing wicked problems in sociotechnical systems. Yet in such frameworks, idealized design is one component among many, rather than the baseline through which complementary methods are combined.

While such examples illustrate idealized design being incorporated into broader design frameworks, enriching idealized design itself with complementary systems methods is however limited in the literature. Serrat [3] argues that idealized design, while promising, should not remain purely an intellectual exercise. He suggests that for idealized design to be practical and impactful, it should be integrated with complementary methods that bring a more outside-in perspective to the process, such as force field analysis, participatory methods, social network analysis, and stakeholder analysis, among others, to better engage with the complexity of real-world contexts. While Serrat’s suggestion points to the need for methodological complement, it does not provide a structured framework that specifies which tools to integrate, at which phases, and on what theoretical grounds.

Among the limited contributions in this area, one prominent example that uses interactive planning and idealized design as a meta-framework containing different tools is the work of Pourdehnad and Welfer [19], who integrated design thinking, complexity thinking, and systems thinking within a single consulting intervention. They employed methods and techniques including the Cynefin framework, rich pictures, creative holism, system dynamics models, and viable system models, as well as tools such as SWOT analysis, Porter’s five forces, and influence diagrams within an interactive planning process to facilitate the organizational redesign of a graduate student government at the University of Pennsylvania. Their consulting project demonstrates the practical viability of combining multiple tools within an idealized design process, involving nearly 800 stakeholder participants across mess formulation and ends planning. While their work is rich in terms of using complementary methods and approaches, it draws on tools not only from the systems discipline but also from design thinking and complexity thinking, and it remains primarily practice-oriented rather than framework-driven. As such, the theoretical justification for integrating specific tools in relation to particular phases of idealized design, as well as a replicable structured framework for practitioners, remains limited in their work. The present paper addresses this gap by proposing an enriched idealized design framework in which each complementary tool, drawn exclusively from the systems thinking tradition, is explicitly mapped to a specific phase of the idealized design process and justified on theoretical grounds, providing practitioners with a structured and replicable cascade from mess formulation to ends planning.

4. Complementary System Methods and Approaches

While interactive planning and idealized design have been presented earlier, this section provides a brief introduction to the complementary systems methods and approaches used in this paper to enrich the idealized design framework. Rich pictures, CLDs and related system archetypes, and the leverage points typology are presented in the following subsections.

4.1. Rich Pictures

Rich pictures are a technique used in the first phase of the SSM learning cycle, originally developed by Peter Checkland [20], where the purpose is to develop a shared understanding of the current situation. Rich pictures provide a comprehensive yet accessible representation of a specific phenomenon or situation [21] and are well-suited to capture complexity and dynamics [22]. They portray relationships, entities, structures, and viewpoints in a non-linear manner. In essence, they attempt to represent everything that can be known about a messy situation in an open and unstructured way. They also represent more subjective aspects of the situation like characters, feelings, conflicts, and prejudices [23]. Their value lies not only in helping to understand the system, its potential boundaries, components, actors, and relationships, but also in capturing the nature and extent of those relationships. Different types of connection lines illustrate how components influence one another, whether one-way or two-way, how strong those connections are, and even where connections are absent, represented by a cross on the line.

Rich pictures can be used as a standalone technique to represent a situation, as an initial ‘finding out’ phase within SSM [21], or in combination with other systems thinking techniques such as the Viable System Model [24] and systemic planning methods [25]. Additionally, although rich pictures are originally intended to illustrate the current situation, the technique is also used to depict future scenarios and possible ways forward [26,27]. Regardless of how they are applied, the technique is considered powerful in unexpected ways, as it facilitates experiential learning that is often considered convincing and reliable [23].

4.2. Causal Loops Diagrams and System Archetypes

System dynamics is a field that aims to capture the underlying causes of system behavior. Within this field, CLDs are visual tools that map the causal relations and feedback loops through which a system’s components influence each other over time. Each causal link has a polarity that is positive when two variables move in the same direction, and negative when they move in opposite directions [28]. Causal relationships also help build narratives about specific problems or issues [29]. Examining a problem from a causal perspective helps uncover the underlying structural forces driving system behavior and reveals the feedback mechanisms that shape it [30]. CLDs represent these dynamics through two types of feedback loops. Reinforcing loops amplify change within the system, pushing it toward continuous growth or decline. Balancing loops, by contrast, stabilize the system around its goals or limits. Given that unlimited growth is not possible [29], balancing loops are commonly understood as goal-seeking loops that regulate system behavior [31].

Studying the recurring relationships and patterns between reinforcing and balancing loops, along with the role of delays, has led to the identification of common frequently occurring system archetypes [10]. These archetypes provide an initial understanding of the regular patterns of behavior that are easy to identify in new or unfamiliar problematic situations. One example is the “limits to growth” archetype, in which reinforcing growth loops unintentionally trigger balancing loops that slow or reverse that growth. Other well-known archetypes include “shifting the burden”, “success to the successful”, “fixes that fail”, and “eroding goals”, among others [32].

4.3. Leverage Points Framework

Leverage points are listed as a method frequently applied in the context of system dynamics methodology, alongside others such as CLDs, system archetypes, and microworlds [10]. They are acknowledged as points of power, where a small change can lead to a large shift in system behavior [33]. Although identifying such points may seem straightforward, they are frequently counterintuitive due to the complex and often unpredictable behavior of systems. Moreover, even when leverage points are recognized, they are often applied in the wrong direction, systemically worsening the problems they are intended to solve.

Leverage points are listed in twelve levels, ranging from less effective to highly effective [33]. While constants and parameters such as subsidies, taxes, and standards are considered relatively weak intervention points, paradigms such as the mindset out of which the goals of a system arise are considered the most powerful. At the very top, however, sits the ability to transcend paradigms, which goes even beyond changing a paradigm. This means maintaining flexibility and remaining unattached to any single paradigm, recognizing that no paradigm represents the complete truth.

To identify and study the twelve leverage points listed by Meadows [33], systems scholars have attempted to categorize them under more general typologies to make them easier to recognize. One such framework is presented by Abson et al. [34], which classifies leverage points into four main levels. Beginning from the least effective, parameters represent the relatively mechanistic characteristics of a system that are typically targeted by policymakers. One level up, feedbacks refer to the interactions between different system components that drive the internal dynamics of a situation. The next level, design, relates to the structure of information flows, rules, power, and agency within a system, where changes at this level have a higher impact than interventions at the parameter or feedback levels. The deepest and most impactful level is intent, which is the hardest to change but has the greatest effect on the system, as it concerns the underlying goals, values, and worldviews of actors that shape the emergent direction to which the system is oriented.

5. Developing an Enriched Idealized Design Framework

The process of idealized design is conceptually straightforward from systems analysis to ends planning, yet scholars argue that integrating tools and modeling techniques would make it more actionable and practically applicable [3]. According to Ackoff [35], experimentation and modeling can be employed as complementary approaches. Building on this suggestion, this section proposes the integration of modeling techniques rooted in systems thinking into the idealization phase. Table 1 summarizes the complementary methods and techniques introduced in the previous section, presenting their characteristics, role in idealized design, and the phases they support. Each method is then elaborated in the following subsections with the aim of developing an enriched idealized design framework.

Table 1. Overview of complementary methods integrated into the idealized design.

Method	Characteristics	Role in Idealized Design	Phase Supported
Rich pictures	Visual tools that map the components, relationships, and interdependencies of a messy situation, capturing both objective elements and subjective stakeholder perspectives	Provides a comprehensive understanding of the system as a whole and helps identify deficiencies, weakly established connections, and obstacles that reflect how the system currently operates.	• Systems analysis • Obstruction analysis

Table 1. *Cont.*

Method	Characteristics	Role in Idealized Design	Phase Supported
Causal loop diagrams	Maps causal relations and feedback loops through which a system's components influence each other over time, showing reinforcing and balancing dynamics.	Models the feedback structures driving system behavior, making the dynamics behind worst-case scenarios visible to support reference scenarios development.	- Obstruction analysis - Reference projections
System archetypes	Recurring structures that capture common patterns of system behavior that tend to emerge and persist across different contexts.	Surfaces hidden assumptions and undesirable long-term patterns to support scenario development, and when inverted, guides the envisioning of the ideal state.	- Reference scenarios - Ends planning
Leverage points	Places in a system where a small change can lead to a large shift in system behavior, classified into four levels of increasing depth: parameters, feedbacks, design, and intent.	Provides a structured framework for envisioning the ideal state by prioritizing intervention areas from shallow to deep.	Ends planning

5.1. Integrating Rich Pictures

Rich pictures, as an initial tool for exploring a system in SSM, provide a comprehensive visual representation of a messy situation, referred to by Checkland as an ill-defined problem situation. The notion of a messy situation is also central to Ackoff's interactive planning, where it is referred to as a "system of problems" or mess. In such situations, Ackoff rejects the idea of an objective, value-free perspective and instead advocates for a value-full perspective that emerges from the diverse reflections of stakeholders, which is also captured in a rich picture [12]. Such shared conceptualization suggests an inherent compatibility between rich pictures and idealized design, making rich pictures a suitable complementary approach, particularly in the early phases of the idealized design process. In the mess formulation phase, specifically during system analysis, rich pictures help researchers develop a comprehensive understanding of the system as a whole. In the obstruction analysis phase, missing or weakly established connections can visually highlight deficiencies and shortcomings in how the system currently operates.

Rich pictures and idealized design are parts of SSM and interactive planning respectively, two methodologies that share deeper philosophical foundations further justifying their combination. According to Midgley [5], both draw on evolutionary learning theories, meaning that a shared understanding develops gradually from acknowledging the mess and explorations of ideal scenarios rather than being decided in advance. Both are also positioned within the same cell of Jackson and Keys' System of Systems Methodologies (SOSM) [6] under the complicated-pluralist category, although interactive planning tends to target relatively more complicated problems. Both are further characterized as Type E, that is, systems approaches designed to address "people complexity", prioritizing the complexity arising from people and their different perspectives rather than that stemming from the design of complex adaptive systems [10].

The similarities discussed above support the view of idealized design and rich pictures as complementary methods. However, examining their differences reveals how each can compensate for the limitations of the other, particularly in areas where one alone does not provide a sufficient basis for problem-solving. At the ontological level, Ackoff's idealized design takes both a subjective and objective position, while rich pictures are almost entirely subjective. This distinction means that, whereas idealized design directly

encourages participants to consider real-world structures such as organizational design and environmental conditions, it offers comparatively fewer tools for surfacing and contrasting the subjective interpretations and worldviews of different stakeholders. Developing rich pictures can therefore fill this gap by providing an informal space for stakeholders to express their perceptions, conflicts, and concerns about the problematic situation. In this way, rich pictures complement the more structured and objective orientation of interactive planning, particularly in the mess formulation phase, by enabling a deeper exploration of stakeholder subjectivity.

In terms of flexibility, rich pictures offer a practical advantage in the early phases of interactive planning. While mess formulation in interactive planning requires considerable time, resources, and consensus to be effective, rich pictures can be developed quickly and with relatively few resources, without requiring prior agreement among participants. This makes rich pictures a practical and accessible starting point in the idealized design process, especially when full consensus among participants is hard to achieve.

Furthermore, this paper proposes extending the use of rich pictures beyond the mess formulation phase to ends planning, where they can be used to visually represent the idealized future state of the system. While this goes beyond how rich pictures are traditionally used in SSM to capture the current problematic situation, such extensions are well established in the literature. Berg et al. [36] demonstrate that rich pictures can be applied productively outside of their original SSM context, and Bell and Morse [37] show that the tool's value lies in its capacity to help people think and act collectively through visual representation, not only in describing a problematic situation. Therefore, this extension offers stakeholders a simple and shared visual representation of the desired future they are collectively envisioning.

In sum, while interactive planning provides a structured framework for redesigning a system toward an idealized future state, it could potentially benefit from the interpretive depth that rich pictures bring to the early stages of the process. By capturing the human and social dimensions of a messy situation in an informal and participatory way, rich pictures support the mess formulation phase, resulting in an idealization process that is more informed and better shaped by the perspectives of those involved. Their integration into the idealized design framework therefore represents a useful contribution that combines the strengths of two well-established systems traditions.

5.2. Integrating System Dynamics Tools

Just as rich pictures were proposed to complement the early phases of idealized design, system dynamics tools can further enrich the process by bringing a dynamic understanding of system behavior to mess formulation. Gharajedaghi [38], who was mentored by Ackoff and worked alongside him for over three decades, explains that mess formulation is a three-phase process consisting of searching, mapping, and telling the story. The searching phase involves three types of inquiry: systems analysis, obstruction analysis, and system dynamics. Specifically, it focuses on pattern recognition through identifying trends, behavioral patterns among actors, and causal and feedback loops. The next phase, mapping the mess, aims to reveal how elements of the system depend on one another and how the situation behaves dynamically. This requires keeping in mind the counterintuitive behavior that characterizes complex social systems. Therefore, system dynamics is directly embedded in these two phases. The third phase, telling the story, is concerned with how the findings of the mess formulation are packaged and communicated to stakeholders. According to Gharajedaghi [38], the mess is not a prediction but rather an early-warning signal, and communicating it clearly is just as important as the analysis behind it. Subsequently, it generates a collective motivation for change. In

this regard, CLDs can be used as communication tools, translating feedback structures and interdependencies into a visual narrative that makes the dynamics of the situation meaningful to all participants.

The compatibility between idealized design and system dynamics can be traced back to the founders of both approaches themselves, Ackoff and Forrester, who engaged in a direct intellectual exchange in the same Special Issue of the *System Dynamics Review* in 1994. Both scholars shared a common interest in understanding and improving complex systems, particularly social systems. Forrester [31] recognized that participatory approaches are effective at gathering information from real-world participants, which he saw as an important first step in system dynamics modeling. At the same time, he argued that building and simulating models can add rigor and clarity to the understanding of complex feedback structures that participation alone cannot fully provide. Ackoff [35] similarly recognized that social systems need both purposeful design and an understanding of how their parts interact over time. Taken together, their views suggest that idealized design and system dynamics are not competing approaches but rather approaches that can strengthen each other, where stakeholder participation and design thinking are enriched by dynamic modeling.

Building on this shared recognition, examining the theoretical foundations of CLDs further illustrates how it can specifically advance idealized design. CLDs deal with structural complexity [39], as opposed to the people complexity that interactive planning addresses, as mentioned earlier. This distinction reflects a broader pattern within the systems movement, where different methodologies address different dimensions of complex problems and are complementary rather than competing [40]. As Lane [39] points out in his discussion of the underlying philosophical and theoretical foundations of Forrester's system dynamics, it provides predictions of what is likely to occur based on declared assumptions. This is very similar to the idea behind the reference projection in idealized design, proposed by Ackoff as the third step of mess formulation. Furthermore, Lane [39] notes that by changing the assumptions built into the model, system dynamics is capable of suggesting to stakeholders what must change, including aspects of their own thinking, in order to attain a more desirable future. This aligns closely with the core purpose of idealized design, which is concerned with shaping and designing a system's desired future.

Beyond these theoretical foundations, Jackson [10] argues that system dynamics in practice helps practitioners look beyond the surface appearance of a messy situation to uncover the underlying feedback structures shaping system behavior. In idealized design, the transition from mess formulation to ends planning through reference scenarios reflects this kind of deeper exploration, suggesting that system dynamics can be usefully integrated at this stage of the process. One way this integration can work is through the explicit modeling of feedback loops. Positive feedback loops drive exponential growth or decline, pushing the system toward states of maximum instability that it cannot sustain in the long term. Although in reality balancing loops always exist to bring the system back toward stability, focusing particularly on reinforcing loops is what reference projections in idealized design seek to capture, where participants are asked to project the worst-case scenarios of the current system. Therefore, modeling reinforcing loops in a given situation can support the construction of reference projections by making the dynamics behind worst-case scenarios more visible and concrete to participants.

While CLDs help map the feedback structures of a specific situation, system archetypes offer a complementary lens by identifying recurring patterns of behavior that commonly emerge across different systems [32]. In interactive planning, rather than offering a valid forecast, reference scenarios provide a tool for exploring critical assumptions about how the system might behave if current trends continue [12]. System archetypes align well with this

purpose, as they bring hidden assumptions to the surface and reveal undesirable long-term patterns that participants might easily miss. For example, the “fixes that fail” archetype illustrates how a short-term solution appears to work temporarily but creates unintended consequences over time, making the original problem worse. Similarly, the “success to the successful” archetype shows how a group with initially greater resources continues to grow stronger while others gradually fall behind. Both patterns represent the kind of worst-case stories that reference scenarios in idealized design seek to make visible, giving participants a structured way to recognize and articulate how the current system is likely to get worse over time. Two other system archetypes that closely mirror reference scenarios are “limits to growth” and “eroding goals”, both of which illustrate the gradual and often unnoticed decline of a system. While the former shows how current trends eventually reach their limit and the system struggles to maintain its performance if nothing changes, the latter captures how, when faced with a problem, the goal itself is quietly lowered over time instead of the problem being solved. This is particularly relevant to reference scenarios, as it reflects how organizations gradually come to accept decline as normal without realizing it.

We argue that a proposed use of system archetypes beyond reference scenarios is that if archetypes reveal recurring patterns of decline in a system, they can logically fulfill a second purpose in ends planning by being inverted. In system dynamics literature, understanding a problematic feedback structure is considered a prerequisite for redesigning it [30]. For example, where “eroding goals” shows how standards quietly drop over time, the ideal opposite would be a system where goals are continuously raised in response to progress. Where “limits to growth” shows how growth stops because certain problems are left unresolved, the ideal opposite would be a system designed to identify and address those problems before they block further progress. This inversion essentially turns each archetype into a design principle, giving participants a structured starting point for imagining what the ideal system should look like. However, using archetypes too rigidly as design templates could limit creativity and push the process toward a fixed structure, when idealized design is meant to be open and free from preconceptions. Since creativity and designing are central strengths of Ackoff’s idealized design [15], archetypes should act as a starting point for envisioning the ideal situation rather than limiting the process to fixed structures.

5.3. Integrating Leverage Points

When dealing with the envisioned ideal state of a system in the idealized design process, one important question is where to begin. This vision, captured in ends planning, is the determination of what the organization would like to be [4]. Following the entire framework of mess formulation, including systems analysis, obstruction analysis, and reference projections and scenarios, naturally highlights system areas that could be changed toward an idealized future. According to Gharajedaghi [38], mess formulation seeks to identify the areas of greatest leverage, points of vulnerability, and the internal dynamics that could eventually lead to the system’s destruction. This understanding of what could go wrong provides the necessary context against which the idealized future of the system can be designed. However, designing that future still requires creativity, thoughtful reflection, and the removal of self-imposed constraints that are often accepted passively. Ackoff himself reflected on removing or overcoming such constraints to promote creativity [41], yet translating this into practice remains challenging, as few frameworks or guidelines exist to lead practitioners toward an idealized design. For example, Pourdehnad [4] situated ends planning within a design thinking framework. He specified that the process begins with preparing initial interactive designs, which are then iteratively modified and consolidated until a comprehensive design supported by stakeholder consensus is achieved. However,

it should be noted that the final output may exceed the boundaries of the specific problem participants originally aimed to solve [26]. Given this, the present paper proposes that the leverage points framework developed by Meadows [33] could be used as an entry point for thinking about the ideal future state of a system, which essentially concerns identifying where the intervention would have the most positive impact.

The idea that leverage points and idealized design can potentially complement each other has not yet been studied as a unified framework in the literature. However, scholars like Jones [42] frame the goal of systemic design as targeting highly leveraged, well-reasoned, and preferred changes in complex situations. This implicitly reflects the importance of orienting idealized design toward high-leverage areas of a system, though a framework for identifying where such leverage can actually be found remains absent. This gap matters, as without structural grounding, design-led approaches risk producing unrealistic and overly ambitious futures, what Jones [42] describes as “hubris”. It is also addressed by Ackoff [1], who distinguishes idealized design from utopian thinking by arguing that an ideal future must remain grounded in the realities of the system to be operationally viable and technologically feasible. Therefore, we argue that the leverage points framework could provide practitioners with a practical means of identifying where in a system an idealized future state can most realistically and effectively be pursued.

A desirable future designed in ends planning concerns ‘where to go’ [10] and involves defining the direction of the system in terms of ideals, objectives, and goals. Ackoff [43] suggests that this ideal state should cover many dimensions of the organization, including products, services, markets, distribution systems, organizational structure, and financial structure. However, the notion of ideals as ultimate ends [10] implies that ends planning should prioritize changes that reshape the entire system rather than only adjusting its parts. This aligns with the leverage points framework developed by Meadows [33] and further elaborated by Abson et al. [34] into four levels of increasing depth: parameters, feedbacks, design, and intent. The deepest level, intent, refers to the norms, values, goals, and worldviews that shape the emergent direction of a system, which corresponds to what the notion of ideals stimulates in ends planning. Accordingly, other operational dimensions of the ideal state identified by Ackoff [43], such as organizational structure, can be situated at shallower leverage points, informed and constrained by the deeper intent established first. This hierarchical structure of leverage points suggests that they can provide a structured entry point for thinking about the ideal state of a system.

To operationalize the translation from mess formulation to leverage point levels, the rich picture can be used as a reference point. Tangible elements such as missing connections, broken lines, specific tools, and available resources could point to shallow leverage levels, as they represent the most visible and operational aspects of the system. Elements reflecting unclear roles, unequal resource distribution, boundaries around certain groups, and fragmented coordination among actors tend to point to higher leverage levels. The deepest elements, such as power dynamics, cultural assumptions, conflicting goals, and dominant worldviews, point to the highest leverage level, which has the greatest potential for transformative impact. The feedback level, by contrast, is informed by CLD outputs rather than the rich picture directly, as feedback structures only become visible once causal relationships are formally modeled.

Drawing on the three complementary techniques and methods discussed above, Figure 2 presents the proposed enriched idealized design framework. It keeps the original sequencing of the idealized design while embedding systems thinking tools at each phase to advance its practical application.

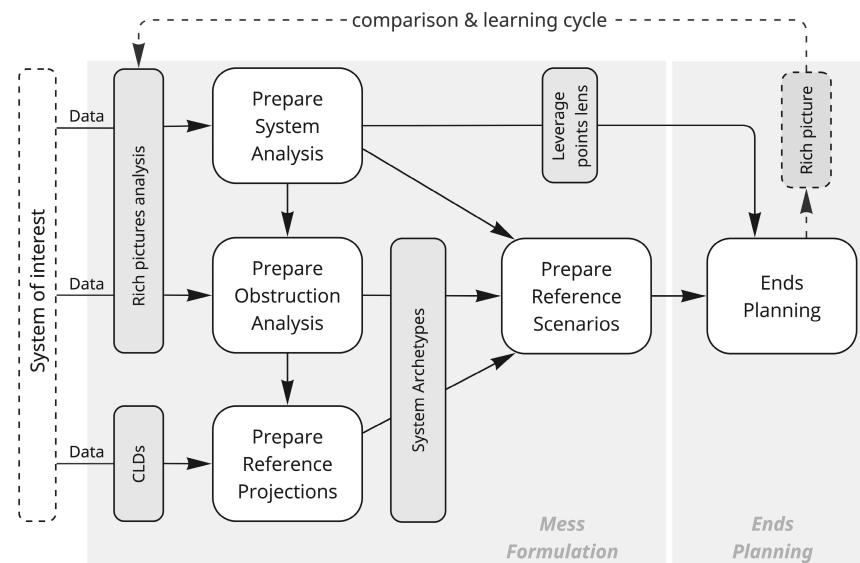


Figure 2. Idealized design proposed framework.

As illustrated in the figure, the framework follows a progressive cascade from mess formulation to structural dynamics and ends planning. The process begins with rich pictures, which facilitate a participatory exploration of the mess within the system-in-focus by feeding both systems and obstruction analysis. CLDs then capture the feedback mechanisms driving systemic behavior, supporting the development of reference projections. Simultaneously, system archetypes translate the barriers identified in the obstruction analysis and the dynamics of the reference projections into recurring structural patterns that inform reference scenarios. These archetypes, when inverted, provide a generative starting point for envisioning the ideal state. The dashed line between reference scenarios and ends planning in Figure 2 reflects the creative nature of this transition, where insights from mess formulation inform but do not prescribe the idealized future envisioned in ends planning.

Findings from the initial systems analysis also inform the identification of leverage points, which guide ends planning. Instead of preparing a wish list that could be utopian, these points show where the system is open to change toward an ideal situation. This transition moves from the deepest level of intent, such as changing the system's goals and values, down to the constants of the system at the operational level. In this way, the idealized design framework is enriched with methodological pluralism while maintaining its participatory and action-oriented nature. Importantly, this progressive cascade operates through a boundary-spanning logic, where the outputs of each preceding tool serve as structural inputs for the next, bridging the gap between stakeholder perception and systemic structure. Each tool therefore builds on what the previous one has produced, as the subjective understanding developed through rich pictures actively informs the construction of CLDs, which in turn feed into system archetypes and leverage point identification. The framework's contribution therefore lies not in the individual tools themselves, which are well established in the systems thinking literature, but in the theoretically justified logic of their integration within the idealized design sequence. By positioning the interpretive outputs of rich pictures as structural inputs for CLDs, the framework creates a methodological bridge that standard idealized design lacks. This boundary-spanning connection ensures that ends planning and the resulting prioritized interventions are not abstract or disconnected from the system's actual dynamics, but are grounded in the specific systemic obstructions and feedback structures surfaced in the earlier phases of mess formulation. Figure 3 illustrates these boundary-spanning connections, mapping the specific outputs of each tool that become inputs for the next.

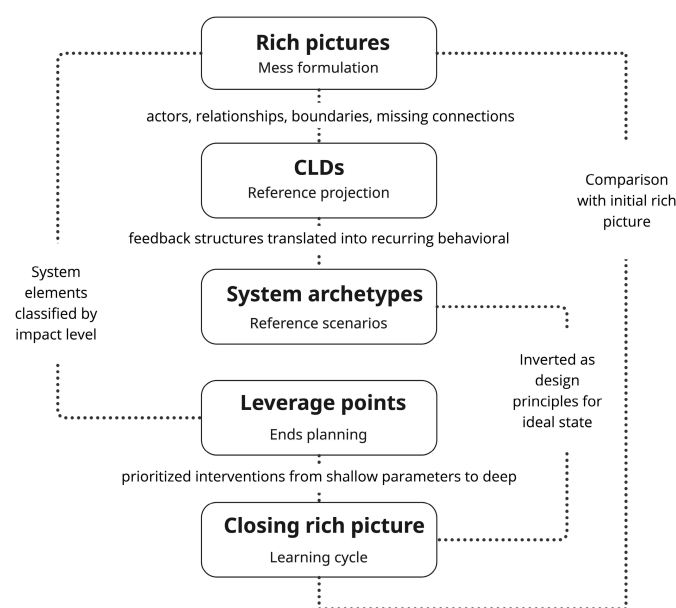


Figure 3. Output–input connections between systems thinking tools.

The connection between rich pictures and CLDs operates through a clear translation process. Actors and stakeholders identified in rich pictures become CLD variables representing their states. Rich pictures identify the epistemological boundary of the research inquiry, ensuring that when building CLDs, critical factors are not omitted. This is theoretically grounded in previous research on the compatibility of multimethodology approaches combining soft and hard systems methods [44,45] and empirically supported by work demonstrating how qualitative information in rich pictures directly informs the construction of CLDs [46]. Specifically, actors whose behavior directly drives or hinders the system and are connected to many other elements in the rich picture are prioritized as CLD variables and converted into relevant system factors. The nature of relationships between elements in the rich picture also provides insight into the causal links in CLDs and their polarity. Strong and well-established connections translate into direct causal links, while missing or weakly established connections highlight deficiencies in the current system that CLDs then model through feedback structures. Conflicts and tensions between actors, for example illustrated by crossed or broken lines, indicate that one element could negatively affect another, translating into negative causal links. Delays indicated in rich pictures through relevant symbols translate into delay marks on causal links, capturing the lag between cause and effect that shapes system behavior over time.

The transition from CLDs to system archetypes follows a similarly grounded logic. The reinforcing and balancing feedback loops identified through CLDs are compared against established archetype patterns [32], helping to identify which recurring patterns of decline apply to the system and providing the basis for reference scenarios. Simultaneously, the system elements identified through rich pictures are discussed through the lens of leverage points to assess how each element could affect the system as a whole [34], classifying them from shallow operational parameters to deep systemic intent.

System archetypes, when inverted, translate patterns of decline into structured starting points for envisioning the ideal state in ends planning, as elaborated in Section 5.2. This inversion is grounded in Ackoff's [15] idealized design logic, which positions the understanding of current systemic failures as the necessary foundation for envisioning a desirable state. One of the most influential and widely cited works of the 1970s, mainly authored by Meadows [33], takes this as its core, named *Limits to Growth*, meaning that the

identification of patterns of limits are points to growth, which justifies this conversion from failure patterns to ideal states.

Together with the prioritized intervention areas identified through leverage points, these starting points inform the closing rich picture, which captures the ideal state visually. Since idealized design facilitates widespread learning by ensuring that stakeholders actively participate in the design process [1] and is subject to continuous improvement [2], this closing rich picture enables a direct visual comparison with the initial rich picture, making the shift from the current to the ideal state more visible and understandable. This comparison helps guide the development of further steps within a learning cycle, represented in Figure 2 by the dashed rich picture in the top right corner, which visually distinguishes it from the initial rich picture and indicates its role as a reflective closing step rather than a primary analytical tool.

6. Practical Considerations and Implications

The implementation of the enriched idealized design framework introduces several practical considerations regarding facilitation, stakeholder dynamics, the risk of groupthink in stakeholder-driven processes, the difficulty of identifying and influencing deep leverage points, resource allocation, and the nature of the problem context in which the framework is applied.

First, a high level of facilitation expertise is required to manage the transition from interpretive rich pictures to structural CLDs and the identification of system archetypes. The proposed framework addresses this challenge by providing a structured sequence with a clear rationale for each tool at each phase, offering methodological scaffolding that guides the facilitator through the orchestration of diverse tools. In practice, each transition involves a structured participatory activity. Rich pictures are developed through open group sessions in which stakeholders freely represent actors, relationships, and conflicts from their own perspectives. CLDs are built through collective review of the rich picture, where participants identify key variables, develop causal relationships between them, and decide on whether loops reinforce or balance system behavior. Archetypes are then recognized through structured comparison of feedback loops against established patterns, and leverage points are prioritized through group discussion around intervention areas, positioned against leverage point levels. However, to facilitate all of this, domain expertise and familiarity with the tools are necessary.

Second, the risk of groupthink or premature consensus is specifically mitigated by the framework's sequencing. By utilizing rich pictures in the earliest stages of mess formulation, the process prioritizes interpretive divergence to capture conflicting perspectives and subjective worldviews. This ensures that structural modeling and archetype inversion are grounded in a variety of stakeholder perceptions rather than a singular dominant narrative.

Third, identifying and influencing deep leverage points such as system intent and paradigms represents a qualitative rather than a quantitative challenge. The framework treats these deep points as directional design principles in ends planning to ensure that interventions target the system's goals and values rather than remaining at the surface level of operational adjustments.

Fourth, the integrated approach necessitates a greater investment of time and analytical effort than standard idealized design due to the additional requirement for structural modeling. However, this trade-off is strategically designed to prevent what Jones [42] describes as "utopian hubris", which refers to the risk that design-led approaches produce unrealistic and overly ambitious futures disconnected from systemic reality. The framework ultimately provides the rigor necessary to identify transformative interventions that avoid common recurring patterns of decline, such as "fixes that fail" or "eroding goals".

Fifth, the nature of the problem context should be taken into account, specifically whether it is complex or complicated. Complex problems involve constant flux with high levels of uncertainty, where emergent behavior, unpredictable dynamics, and interdependent factors contribute to the difficulty of the situation. Complicated contexts, on the other hand, involve cause and effect relationships that are separated over time and space but can be discovered through analysis and expert help. Sense-making frameworks such as the Cynefin framework [47] can help stakeholders recognize the nature of their problem context before engaging with the idealized design process. The proposed enriched idealized design framework contributes to addressing both types of problems. Rich pictures address the complex nature of the problem, capturing the subjective, emergent, and varied dimensions of the mess. CLDs, system archetypes, and leverage points then bring structure to the process by identifying discoverable patterns and intervention areas, representing the complicated domain in the Cynefin framework [47]. Facilitators should therefore help stakeholders appreciate which aspects of their problem context fall within the complex or complicated domain at the beginning of any application, ensuring that the appropriate tools and approaches are engaged accordingly.

Finally, while the framework provides a structured and theoretically grounded approach, its empirical validation in a real participatory setting remains an important direction for future research. The retrospective empirical demonstration presented in the following section draws on our existing longitudinal empirical work to demonstrate how the integrated tools operate within the idealized design sequence, and does not represent a direct empirical test of the full enriched framework. This is consistent with established practice in systems thinking research, where frameworks are proposed through theoretical synthesis and retrospective empirical grounding before prospective validation. Meadows' leverage points framework [33], for instance, was initially advanced as a conceptual structure synthesized from existing systems dynamics theory and practice, and has since become one of the most widely applied frameworks in the field.

Future application with stakeholders explicitly following the enriched sequence from beginning to end would allow for a more rigorous assessment of its practical effectiveness and the added value of each integrated tool.

7. Enriched Idealized Design Framework to CT Education: A Retrospective Empirical Demonstration

This section presents a retrospective empirical demonstration of the enriched idealized design framework in the context of CT education. CT is a cognitive skill and mindset rooted in computer science concepts such as algorithm design, logical reasoning, and pattern recognition. It refers to a structured mental process for problem-solving that involves understanding a problem, decomposing it into smaller parts, and developing solutions in a way that can potentially be processed by a computer [48]. It is also considered a fundamental competency that should be developed and applied in their everyday activities and challenges [49].

Among other sectors, in the educational context, CT is considered essential for all students, alongside critical thinking, creativity, collaboration, and communication [50]. Consequently, CT has become an integral component of educational frameworks, either as a standalone subject or integrated across other subjects. However, despite its growing importance, its integration into education faces several challenges, ranging from theoretical understanding to practical implementation, including a lack of consensus on the definition and conceptualization of CT, inconsistent pedagogical approaches, insufficient teacher training, and a lack of standardized assessment tools [51]. In light of these challenges, the framework was applied retrospectively to the systemic and interconnected nature of

CT integration, drawing on empirical work conducted over a five-year doctoral research period, collecting data from a diverse range of stakeholders, including students, preservice teachers, and in-service teachers in both formal and after-school settings. It was used to map the current state, identify obstructions, and develop reference projections and scenarios to ultimately envision a desired future for CT education within the Swedish K-9 context. This empirically grounded context provides an example of a complex problem context through which the framework's orchestration logic can be illustrated. The goal of this illustration is therefore to show how the tools interact through the progressive cascade, rather than to report new empirical findings on CT education itself.

In the first phase, a systems analysis of CT education was done using a rich picture to illustrate the broader context and interconnections in CT education. The rich picture was developed through an iterative process of reviewing empirical work conducted in the involved projects, identifying system components, and mapping the relationships and interdependencies among them [52]. It visually represented the various elements influencing CT education, including contexts, stakeholders, theoretical and pedagogical strategies, and technological tools. Figure 4 presents the rich picture developed to represent the current state of CT integration into the educational context, capturing the key actors, relationships, and interdependencies.

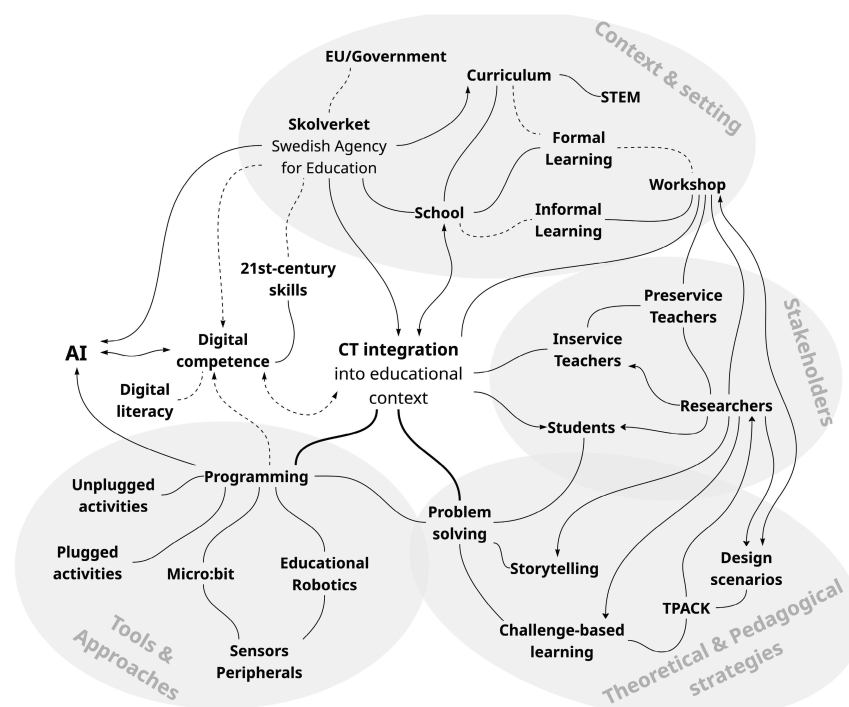


Figure 4. Rich picture of CT integration into the educational context (adapted from [52]).

The rich picture was then discussed through the lens of leverage points to show how each of these elements could affect the system as a whole. For example, context and settings as a leverage point refer to formal and informal learning environments, national curricula, and policy frameworks that influence CT integration. The other leverage point, theoretical and pedagogical strategies, provides structured approaches that encourage problem-solving and computational design. Tools and approaches such as educational robotics, unplugged activities, and digital microcontrollers were also considered as another leverage point that plays a crucial role in making CT accessible and engaging for students. The rich picture also informed the second phase, obstruction analysis, by highlighting areas within the system that challenge or obstruct successful integration, such as the absence

of clear national guidelines for CT, limited teacher training and pedagogical support, the passive role of students limiting their agency and participation in co-creating CT-related activities, and conflicting interests and priorities among stakeholders.

The next phase, system dynamics modeling, contributed to reference projections in CT education by capturing the feedback mechanisms that drive or hinder its integration. Two feedback loops were modeled using CLDs [7,22]. The first focused on coding-centric CT approaches, revealing how dependence on coding, reinforced by teacher-friendly tools, drives the misconception that CT is equivalent to coding, leading to imbalanced resource allocation and leaving broader CT competencies underdeveloped. The second CLD modeled teacher competence development, showing how curriculum adjustments produce short-term improvements but simultaneously increase teacher workload and stress, reducing motivation and creating a balancing loop that slows long-term progress. Together, these models informed the reference projections by showing that if left unchanged, both reinforcing loops would push CT education toward increasingly narrow and unsustainable scenarios.

These CLDs were then developed and translated into system archetypes to support reference scenarios and further provide insights for the idealization phase in ends planning. Four archetypes were identified as particularly relevant to CT education [7,22]. The 'Limits to Success' archetype revealed how curriculum revisions initially improve teacher competence but eventually raise workload and stress, reducing motivation and slowing long-term progress. The 'Shifting the Burden' archetype showed how reliance on coding platforms as quick fixes temporarily improves student engagement but delays deeper investments in teacher training and curriculum development. The 'Fixes that Fail' archetype illustrated how coding-focused curricula address CT skill gaps in the short term but gradually limit students' ability to transfer problem-solving skills beyond computing. Finally, the 'Success to the Successful' archetype demonstrated how coding-centric approaches receive more resources due to their visible short-term outcomes, leaving broader CT competencies underdeveloped. Together, these archetypes informed the reference scenarios and pointed toward thinking about idealized design for reforming CT education, including managing teacher workload, prioritizing sustainable investments, broadening CT beyond coding, and ensuring equitable resource allocation across CT competencies.

Building on the insights from mess formulation, ends planning in the context of CT education was the last phase of idealization [26]. Envisioning an ideal state was done through reversing worst-case scenarios already developed into ideal states. Collected data from in-service teachers provided initial data for discussing ideal scenarios. To structure this idealization, the leverage points framework provided a clear progression from shallow to deep interventions, recognizing that shallow interventions at the parameter and feedback levels are easier to implement but have limited systemic impact, while deep interventions at the design and intent levels are harder to change but have the greatest potential for transformative and lasting improvement. At the parameter level, operational dimensions such as specific tools, activities, and assessment methods can be aligned to better support CT integration across different educational settings. At the feedback level, the ideal system incorporates mechanisms that monitor and respond to teacher workload, student engagement, and learning outcomes in sustainable ways, replacing the reactive cycles identified in the reference scenarios. At the design level, the ideal state involves restructuring the rules, roles, and resources that govern CT education, including equitable access to training, consistent curriculum frameworks, and collaborative stakeholder engagement. Finally, at the deepest level of intent, the idealized CT education envisions a system oriented toward broad, interdisciplinary problem-solving skills applicable across various contexts, where creativity, collaboration, and critical thinking are central rather than coding alone. This

hierarchical approach helped to structure the idealized future of CT education based on the identified mess formulation in a way that is easier to understand and communicate to stakeholders. Table 2 illustrates selected examples of how CT education problems identified through mess formulation are mapped to their corresponding leverage levels, demonstrating how this guides stakeholders from shallow operational adjustments toward deeper systemic interventions.

Table 2. Mapping CT education problems to leverage levels and expected impact.

CT Education Problem	Leverage Level	Ideal State	Expected Impact
Lack of standardized tools and assessment methods	Parameters	Aligned tools, activities, and assessment methods across educational settings	Low–moderate (improves diversity but not structure)
Teacher workload and stress from curriculum adjustments	Feedbacks	Monitoring mechanisms that respond sustainably to workload and learning outcomes.	Moderate (stabilizes system behavior over time)
Inequitable access to training and fragmented curriculum frameworks	Design	Restructured rules, roles, and resources governing CT education, including equitable access to training, consistent curriculum frameworks, and collaborative stakeholder engagement.	High (improves long-term capacity and system-wide coherence)
Coding-centric mindset limiting broader CT competencies	Intent	System oriented toward broad interdisciplinary problem-solving where creativity and critical thinking are central	Transformational (deep systemic change)

This distinction between shallow and deep interventions is important to the framework, as it prevents ends planning from remaining at the surface level of operational adjustments and instead directs stakeholder attention toward the deeper systemic changes that are most likely to produce sustainable transformation.

This retrospective example, therefore, demonstrates how different systems thinking tools are integrated into the idealized design process in the context of CT education, showing that rich picture, CLDs, and system archetypes can collectively support mess formulation, reference projections, and ends planning.

8. Limitations and Future Research

The enriched idealized design framework represents a methodological contribution aimed at providing practitioners with a replicable approach. Several limitations, however, should be noted. The retrospective empirical demonstration illustrates the conceptual coherence and applicability of the orchestration logic rather than constituting a standalone empirical claim. Consequently, the framework has not been empirically validated in a real participatory setting, and this remains an important direction for future research.

The scope of the framework is also a limitation worth acknowledging. It currently addresses only the idealization phases of interactive planning and does not yet extend to the realization phases of means planning, resource planning, and implementation and control. Future research should explore how the enriched framework could be extended to

cover the full interactive planning cycle, and investigate its application in diverse sectors such as healthcare. Furthermore, while the inversion of system archetypes as a generative starting point for ends planning is discussed in Section 5.2, a more detailed facilitation guide for how practitioners apply this inversion in practice has not been developed and represents a direction for future research.

A further limitation concerns the lack of formal interrater agreement on how to interpret the outputs of the framework's tools, particularly rich pictures. Rich pictures are inherently subjective and open to multiple interpretations, and different facilitators or researchers may translate the same rich picture into CLDs or identify leverage points differently. Within the retrospective demonstration, participants reached a shared understanding through a second iterative workshop, providing a degree of communicative validity. This interpretive variability therefore represents a limitation that future prospective applications of the framework should explicitly acknowledge and address.

Finally, several forms of validity that could in principle be assessed without empirical data have not been formally evaluated. Following the typology of validity proposed by Lim [53], the framework argues for content validity in that the selected tools collectively address all key phases of the idealized design process without leaving any phase unsupported, as justified through the systems thinking literature. Face validity has not been formally assessed, as this requires domain experts or practitioners to evaluate whether the framework is credible and appropriate for enriching idealized design in practice. While the framework's structured sequence and theoretical justification suggest initial face validity, formal expert panel evaluation is an important step for future validation. In addition, construct validity cannot yet be confirmed without empirical evidence to show that the integrated tools capture what they are theoretically expected to capture and nothing beyond that.

Addressing these limitations through prospective empirical studies, expert validation, and application of the framework across different problem domains would therefore strengthen both its theoretical grounding and practical credibility.

9. Conclusions

This paper has presented an enriched idealized design framework that addresses the practical limitations of traditional interactive planning by systematically integrating complementary systems thinking tools. The primary contribution is that the practicality and applicability of idealized design can be enhanced through the orchestration of multimethodology, specifically through the progressive cascade from mess formulation to interventional prioritization. By embedding rich pictures, CLDs, system archetypes, and the leverage points framework into the original idealized design sequence, this paper provides a structured, action-oriented approach to redesigning complex systems, bridging the gap between the high-level philosophy of "planning for the future" and the practical necessity of identifying specific, targeted interventions.

In the face of wicked problems characterized by uncertainty and stakeholder divergence, traditional fragmented problem-solving often yields suboptimal solutions. This research suggests a structured methodological framework for stakeholders to proactively influence their desired future, aligning with the principle that systemic states can be intentionally designed rather than merely anticipated through predictive trends. By providing a structured means to move from mess formulation to ends planning, the framework is designed to keep idealized visions grounded in systemic reality while targeting the high-leverage points of change.

The retrospective empirical demonstration in the context of CT education showed how the progressive cascade of integrated tools can collectively navigate a complex problem

situation. Rich picture surfaced the subjective and multifaceted dimensions of the problem context, CLDs and system archetypes revealed the underlying feedback structures driving systemic decline, and the leverage points framework provided a structured pathway from shallow operational adjustments toward deeper systemic change. Together, these tools demonstrated the framework's capacity to ground idealized visions in systemic reality rather than abstract idealization.

In conclusion, by harmonizing the interpretive depth of soft systems with the structural rigor of system dynamics, the enriched idealized design framework supports stakeholders to not only envision a more desirable future but also to identify the relevant leverage points necessary to bring it into being.

Author Contributions: Conceptualization, A.H.; methodology, A.H. and S.S.; writing—original draft preparation, A.H., F.D. and S.S.; writing—review and editing, F.D. and S.S.; supervision, F.D. and S.S. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Data Availability Statement: No new data were created or analyzed in this study. The empirical work referenced in the retrospective demonstration has been reported in previously published works by the authors [7,22,52].

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

SD	System Dynamics
SSM	Soft Systems Methodology
CLDs	Causal Loop Diagrams
CT	Computational Thinking
SOSM	System of Systems Methodologies

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