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A Qualitative View of Problem-Solving in the Context of Large Organisations

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Abstract

In the context of organisational problem-solving in a turbulent and unpredictable business environment, it is argued that leaders and managers must transcend historical concepts. A more suitable approach for the future suggests that organisations should be viewed as complex, non-linear systems rather than collections of functional entities. When considering the implications for the information processing aspect of problem-solving, it becomes apparent that a more qualitative approach helps describe the crucial roles that both the individual problem solver and their cultural context play. Particularly, as most problem-solvers construct linear approximations of the organisation by hierarchically positioning the salient functional entities and their relationships necessary to achieve strategic objectives. From a Western perspective, one of the most significant individual differences of the problem solver is the personality trait of openness, which contributes to an individual's capability for nonlinear thinking. Conversely, for linear thinking, cultural factors play a pivotal role, involving two distinct aspects: the social culture of the 'concrete' phase of early years learning, which shapes cognitive development, and in later years, organisational culture, which affects behaviour within the organisation. Both of these factors are implicated within the concept of psychological climate. Thus, individuals lacking significant support from openness tend to maintain linear competence, while those with substantial support demonstrate both linear and nonlinear competence. Furthermore, in large organisations, creativity is considered to include both linear (incremental) and nonlinear (radical) outcomes, prompting further inquiry into the question, "Why haven't managers embraced complexity?" (Straub, 2013).

Keywords: discrepancy analysis, process, creativity, organisational change, efficiency, strategy, linear & nonlinear cognitive styles

Introduction

The importance of problem-solving for progress in both social and commercial aspects of organisations, as well as for individuals, necessitates a broader understanding of the rationale behind changes to the internal arrangements of an organisation (Atwater et al., 2008; Gorodnichenko & Roland, 2011; Vernon et al., 2016). The idea that businesses should be studied and understood as a single entity is based on the notion that a business cannot perform effectively if each function tries to optimise its performance in isolation. This view of an organisation as a single entity is often referred to as the systems view of organisations (Atwater et al., 2008). However, the systems view, with its close association with structure, system dynamics, and simulation, suggests a challenging role for it in everyday problem-solving. While accepting the view that the organisations should be considered as a single entity, it is argued that the concepts of strategy, linear, and nonlinear thinking offer a more useful approach (Bratianu & Vasilache, 2009; Ohmae, 1982; Van der Heijden, 2015; Vance et al., 2007).

This study is from a Western cultural perspective and explores organisational problem-solving from both linear and nonlinear viewpoints. The study utilises a qualitative research methodology to systematically gather and analyse primarily non-numerical data. The focus is on understanding the interplay of individual differences, the work environment, and processes in problem-solving settings. Such an approach is valuable for evaluating complex phenomena such as: experiences of problem-solving, idea generation, and social contributions and interactions, that resist easy measurement or quantification.

Furthermore, the study characterises large organisations as entities where significant size, scope, and complexity are evident. This often includes a sizable workforce, substantial revenue, and a wide geographical presence and influence, exemplified by corporations such as multinational oil companies.

While the main structural boundary lies between the organisation and the competitive market for customers, a major concern is to understand how problems are defined, ideas generated, selected, and implemented, which stem from concerns about both internal efficiency and market leadership. Here, theories associated with knowledge, process stages, cognitive styles, and psychological climate are considered from the perspective of the practice of problem-solving in large organisations (Clapp & Ruckthum, 2023). Particularly, the focus is on their relationship with internal efficiency and external strategy, as well as the substrate on which changes take place.

Problem-solving is a well-understood, ubiquitous term, and while the associated activity is engaged in many times a day by all individuals, a definition helps frame the concept. Here, organisational problem-solving is defined as ‘the act of finding a way to restore or enhance performance of any malfunctioning process or situation.

While many other definitions exist, this term relates to the most salient of the many mutually supporting strands of problem-solving, such as the four ‘P’ model, Process, Products, People, and Press (Beresnevičius, 2013; Rhodes, 1961).

Which for this study is defined as:

- Process. The four-stage problem-solving process, problem identification, idea generation, solution selection, and implementation.
- Products. Ideas both incremental and radicle.
- People. Individual Differences of linear and nonlinear thinking (cognitive styles).
- Press. Psychological climate and its supports and constraints.

In the context of large organisations, creativity is assumed to encompass outcomes that include both linear (incremental) and nonlinear (radical) concepts. This perspective is inconsistent with the popular view which often associates creativity solely with radical concepts, while casting aside incremental ideas (and the individuals who generate them) as lacking creativity. The theoretical connection between these concepts lies in their ability to provide models of change, albeit from different stylistic domains (Dewar & Dutton, 1986; Kirton, 1976, 2011; Madjar et al., 2011).

Thus, the linear and incremental models assume that change occurs in a straight line, with each step leading in a predictable and predetermined way to the next, accumulating over time to describe a linear trajectory of growth or development. The nonlinear and radical concepts follow a path where both involve transformative change and emphasise the importance of complexity, which cannot be explained or predicted by linearity. The convergence of the polar descriptors incremental and linear, along with radical and nonlinear, leads to a position where the various descriptors of other concepts, all concerned with polarities that define the way change is conducted, can also be similarly integrated. This applies particularly to individual differences in the psychological domain, where a number of different labels are in use, e.g., conformity and originality (Kirton, 2011, as in cognitive style), structured and unpatterned (Salton, 1996), linear and nonlinear (Bratianu & Vasilache, 2009), and the hedgehog and the fox (Berlin, 1953; Meynhart et al., 2017; Tetlock, 2017), linear and nonlinear (Vance et al., 2007). All have different polar labels while having the same or very similar conceptual content. Some are described as bipolar (Kirton, 1976), others as two independent factors (Meynhart et al., 2017). All of these variables have been conceptualised as having a significant effect on the content of mental models and empirically tested to validate the style of ideas that are offered as potential solutions (Clapp, 1991; Gilson & Madjar 2012; Malik et al., 2019; Madjar et al., 2011). Resulting from such conceptual integration, two theory-based archetypes emerge that encompass the many different descriptors of what is generally accepted as cognitive style.

Linearity, as an archetype, describes the relationship between a dependent and an independent variable as being represented by a straight line on a graph. Thus, a change in the independent variable produces the same proportionate change in the dependent variable ($y=mx+c$). The roots of linear metrics reside in early life cause-and-effect learning, while also involving the principle of superposition where problems can be decomposed into solvable modules. Social life has also been strongly linearised by measures of physical quantities, by legislation, and democracy (Bratianu & Vasilache, 2009; Vance et al., 2007).

Nonlinearity, as an archetype, describes a dependent and an independent variable, where the relationship between them is represented by a polynomial, a logarithm, an exponential, etc. Given measures for each variable, the graph takes the form of a curved or discontinuous line. The roots of nonlinearity lie in the complex interactions between entities in the social, organisational, and the natural worlds. Nonlinearity is characterised by relationships and dependencies between entities that are interconnected such that feedback occurs and outcomes cannot be accurately described by linear equations (Bratianu & Vasilache, 2009; Vance et al., 2007). Furthermore, both archetypes can be used to describe concepts and variables that have an effect on the processing activity and outcomes from each stage of the problem-solving process.

Literature Review

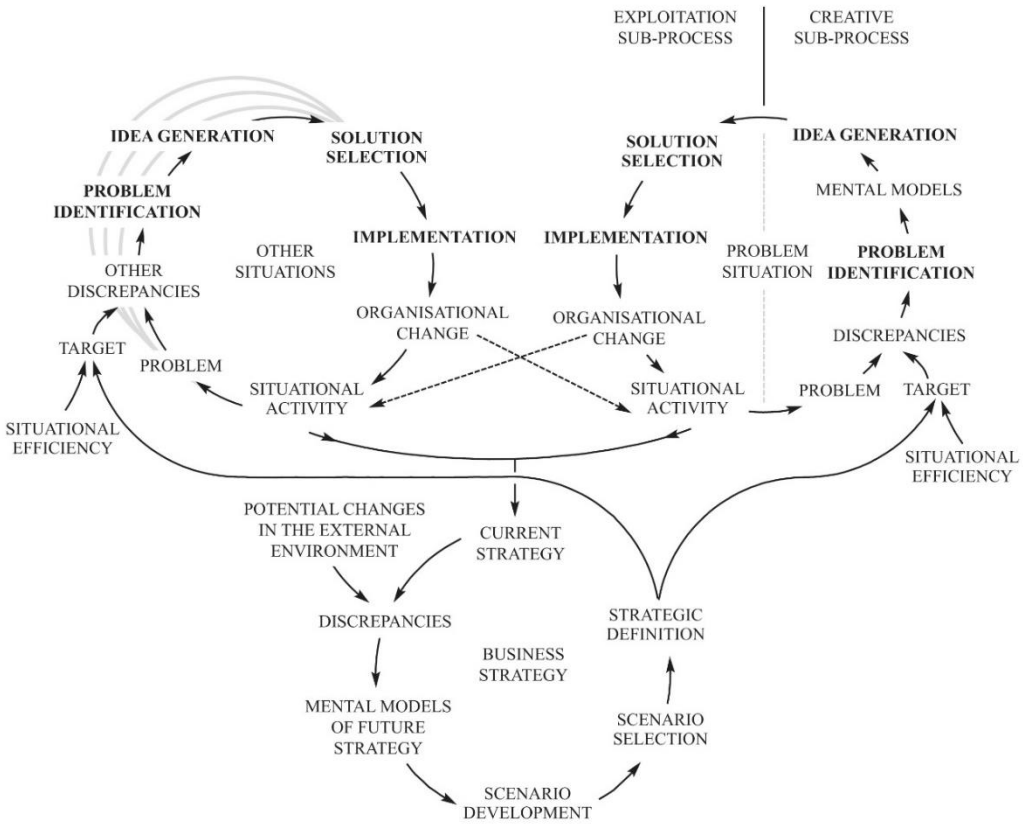
The Problem-Solving Process and the Salient Variables

Despite many variations, a similar process is used in organisations to describe the context within which problem-solving for internal and external issues occurs (See Fig 1). The circular section of the diagram labelled 'problem situation' illustrates internal problem-solving as a series of stages that sequentially process information from problem identification through to solution implementation. These problems, typically focused on efficiency, lead to changes within the situation that have two effects: one that resolves the problem and another, incidental (sometimes referred to as side effects), which affect various parts of the organisation (labelled 'other situations'). When these latter effects are considered detrimental by the 'other situations,' feedback is provided to oppose the original change (Morecroft, 2015). It is these iterations that managers spend much of their day resolving.

Another set of changes arises from the necessity for an organisation to maintain alignment with developments in the external business environment. These activities are defined as 'Business Strategy' (See Fig 1) and are implemented through adjustments to competency development targets and capital deployment within the organisation. This is how strategy takes effect.

Figure 1

The Context of Problem-Solving in Organisations



Note: Dotted lines represent feedback as conversations between individuals in the organisation (particularly managers) that concern incidental and main effects from problem solving.

When the different stages of the problem-solving process are considered, stages one and two are commonly referred to as the 'creative sub-process' while stages three and four as the 'exploitation sub process' (Goncalo & Staw, 2006; Yao et al., 2012; Zacher et.al., 2016). Furthermore, it is within these two sub-processes that the scaffolding on which many of the other variables perform their role comes into view. Two approaches have been proposed, one where individual and differences are used to account for the outcomes of the different stage of the problem-solving process (Herrmann, 1995; Salton, 1996). The other involves the use of the content of mental models to account for such outcomes (Lynam et al., 2012; Simon, 1985). While these two approaches are often described as independent, they both can be considered as different descriptions of the content of 'thinking' and in combination each offering different contributions to knowledge and understanding.

Problem Typology

When considering problem-solving, the first encounter is with the problem itself. Wesselink and Hoppe (2010) offer a perspective on defining the structure of a problem based on the deviation between what "is" and what "ought" to be. The "is" pertains to the available relevant knowledge and events, that enable understanding the problem with varying degrees of certainty. The "ought" pertains to ideals and operational norms that are at stake, where disagreements and ambiguity exist, and agreement is crucial.

Thus, the definition of the problem's structure lies within the space of two orthogonal vectors: certainty and agreement. The highs and lows of these two vectors describe four quadrants:

- When certainty and agreement are both high, they describe structured problems (consistent with linear thinking).
- Lows on both certainty and agreement describe unstructured problems (consistent with non-linear thinking).
- Alternating highs and lows of the two vectors describe moderately structured problems. Here, high certainty and low agreement concern outstanding issues of constraints and supports from values and norms,
- While low certainty and high agreement concern outstanding issues of structural understanding, where perceptions can include networks or hierarchies.

A similar but more general definition of problem structure is provided by Pretz et al. (2003), indicating that well-defined (structured) problems include goals, a clear path to a solution, and obstacles to solution that are all clearly based on abstracted information. In contrast, ill-defined (unstructured) problems are characterised by a lack of a clear path to a solution and including a lack of specific goals, information, and resources to be used in problem-solving.

It has been suggested that both structured and unstructured problems exist as a dichotomy (Morecroft, 2015). The inclusion of moderately structured problems (Wesselink & Hoppe, 2010) and combinatorial complexity (Sterman, 2000) suggests that such a dichotomy may represent the two extremes of a continuum. However, when considering problem descriptions, the issue concerns the identification of a unique set of differentiating characteristics, not the description of a continuous variable. As such, the essential differentiating factor between nonlinear and linear typology is that a nonlinear problem contains feedback between the entities within the problem, while in linear problems such feedback is absent. Regarding problem typology, while there are many alternative descriptors including linear and nonlinear, current literature favours the more generic, well-defined or ill-defined when describing problems.

Cognitive Styles and Mental Models

Once the problem has been located and defined, the next challenge is to construct the substrate upon which potential solutions can be generated.

The roots of cognitive styles indicate that linear thinking develops as an early-learned competence (Piaget, 1954), while nonlinear thinking emerges as a personality variable (openness) in early adolescence (Costa & McCrae, 1992). Differences in thinking styles among individuals come with their own strengths and weaknesses. Linear thinking can be beneficial for analysing problems and developing solutions, yet it may be constrained by its focus on cause-and-effect relationships. Nonlinear thinking can aid in understanding complex problems, though its application in organisational contexts can be more challenging.

Linear thinkers tend to form mental models that are simpler and more straightforward. They are more likely to focus on the cause-and-effect relationships between events. Linear thinkers tend to be more analytical, organised, and detail-oriented. They often end their search for further understanding and solutions when their first sufficient solution is found (Plous, 1993; Sterman, 2000). Doerner (1980) also found that some people think in single-strand cause and effect. Meanwhile, Kirton (1976, 2011) suggested that adapters, people concerned with conformity, when problem-solving, 'produce ideas with their finger on the stop button'.

Nonlinear thinkers, on the other hand, tend to form mental models that are more complex and nuanced. They are more likely to consider the interconnectedness of events and the possibility of multiple outcomes. Nonlinear thinkers are positively related to the personality variables of openness and extraversion and are more radically creative, imaginative, and holistic in their thinking. They are more comfortable with ambiguity and are more likely to take risks and think in multiple causal pathways. Kirton (1976, 2011) suggested that people at the more innovative end of the cognitive style spectrum, concerned with originality, when problem-solving, consider multiple pathways and proliferate ideas. In Groves et al. (2008), the correlation between processing style and the source of information utilised by individuals was explored. These sources were initially labelled as internal and external but are more accurately defined as knowledge-based and situational-based. Groves found that a preference for knowledge-based information was associated with nonlinear thinking, whereas a preference for situational information was linked to linear thinking. Furthermore, he proposed that individuals who exhibit a preference for either linear or nonlinear information sources also tend to favour a corresponding approach to processing information for decision-making.

Mental models serve as a processing substrate where input/output transformations occur at each stage of the process. Within this overall process, knowledge from the problem-solver converges with the abstracted salient points of the problem, and the output from a preceding stage is transformed to provide input content for the next stage in the process. The rationale behind the utilisation of mental models is to provide substrates where the processing (transforming) requirements for any of the stages of the process can occur. Consequently, mental models are constrained by the style in which an individual problem-solver abstracts information and then employs it in model construction (Van Rensburg et al., 2022). Here, both cognition and knowledge affect the quality of an individual's mental models in several important areas:

- Content: Addressing salient issues.
- Structure: Handling linear, combinatorial complexity, or non-linear structures present in real-world problems.
- Thinking style: Incorporating both linear and/or nonlinear approaches in problem-solving.
- Learning: Utilising knowledge of how reality works.

- Motivations: Fostering the desire to generate elegant and viable solutions.
- Outcomes: Generating ideas as potential solutions, decisions, and plans for implementation.

Among these aspects, structure is particularly crucial, as it provides a framework for making sense of the problem or situation at hand. However, the focus on structure and problem types has often overshadowed the consideration of thinking styles, especially concerning linearity and nonlinearity, and their impact on the outcomes from the stages of the problem-solving process.

Typology of Ideas

While ideas are potential solutions to problems, they are also discrete entities that are mostly described by the effect they have on the structure and content of the problem situation, e.g., radical or incremental. Consistency of definition of idea style with thinking styles would help, as it is the individual difference of thinking style which produces ideas with such profoundly different effects (while acknowledging that other variables have a role in organisational change). It is also recognised that the same idea in one situation may be considered radical, while in a different situation it may be considered incremental. However, an idea ceases to be novel (although its effect may still be radical) once it has been implemented, which would account for this confusion.

Labelling an idea by its effect (incremental or radical) rather than its form (linear or nonlinear thinking) seems to offer parallel descriptors. Also, leaning towards Kuhn (1970), where the term 'paradigm' is used to define the separation between two areas of consideration—paradigm-consistent and paradigm-breaking—has been used to define two different forms of ideas (Clapp, 1991).

A different perspective on types of ideas has been linked to different areas of application, e.g., technology, politics, business, and education; however, such differences do not address the intrinsic differences between ideas. While solving a problem, some ideas merely improve the situation compared to other ideas that transform the situation (Dewar & Dutton, 1986). In a parallel context of management styles, a similar differentiation can be found where transactional and transformational are used to define the different outcomes of management styles. However, for idea typology, current literature favours the terms 'radical' and 'incremental,' which describe the form of change the idea delivers to solve the problem rather than any intrinsic difference between the actual ideas.

Culture

When considering culture within large organisations, it's common to encounter numerous sub-groups with fiercely guarded functional identities. Consequently, it shouldn't be surprising that overall, the organisational culture may lack widely shared content. From a psychological perspective, individual experiences, rooted in shared beliefs among members of specific groups, give rise to shared expectations of behaviour (Cooke & Szumal, 1993). These expectations derive from various traditions, values, beliefs, and norms associated with distinct geographic, social, organisational, and functional boundaries, which persist in individual memory. This leads to culture being commonly defined as a learned set of values and beliefs that people hold in common regarding nature and the society in which they live. More specifically, it pertains to the professions they represent or the organisations they work for.

Following Hofstede (1980), the dimension concerned with individualism-collectivism was found to be most important in separating societal groups, particularly countries east and west (Markus & Kitayama, 1991; Singelis, 1994). While initially described as a bipolar dimension, empirical analysis has suggested two independent dimensions (each with two separate factors: Horizontal and Vertical (Cozma, 2011). In evaluating individualism-

collectivism and its relationship with the creative and exploitative sub-processes, Yao et al. (2012) found that both horizontal individualism and horizontal collectivism are related to idea generation, while vertical collectivism was related to idea implementation.

In organisations, where individuals usually spend a large amount of time, a further set of cultural supports and constraints add to those from social culture and have been operationalised using many different constructs. Cameron and Quinn (1999) used ‘competing values’ to form the dimensions 'flexibility-stability' and 'integration-differentiation', where flexibility and differentiation support the more radical change or ‘doing things differently’, while integration and stability support incremental change or ‘doing things better’ (Drucker, 1969; Kirton, 1976, 2011).

From the perspective of an individual within an organisation, there exist additional constraints and supports linked to the priorities of the local work environment. Here, the concept of psychological climate integrates various aspects ranging from social and organisational culture to local situational priorities (Moran & Volkwein, 1992).

The use of contrasting concepts, such as 'supports and constrains,' provides a common framework for delineating local interactions among relevant individuals involved in problem-solving. In large organisations, supports tend to favour incremental solutions, while constraints tend to hinder more radical approaches. This, in turn, creates cognitive dissonance for nonlinear thinkers. If acceptable coping mechanisms are unavailable to the individual, the psychological cost of stress may drive these nonlinear thinkers, who are often the source of radical ideas, to leave the organisation in search of a more compatible environment. In doing so, they inadvertently reinforce the pattern of supports and constraints within the organisation. Also, by implication, interventions aimed at modifying stylistic thinking are likely to fail (Clapp, 1993; Shao et al., 2019; Schneider, 1987).

A fundamental characteristic of psychological climate is its reliance on employee perceptions regarding the emergent features of their overall organisational environment, forming a personal 'outlook' (Kelly, 1963). Schneider's (1975) assertion that 'climates are for something' directs attention towards key dimensions involved, such as 'Safety' (Zohar, 2014) and 'Problem solving' (Clapp, 1991). Thus, when evaluating problem-solving activities holistically, both linear and nonlinear concepts can encapsulate many (if not all) of the associated variables, aiding in understanding when addressing questions like, 'Why haven't managers embraced complexity?' (Straub, 2013).

Table 1 shows the effect of the salient variables of individual differences of cognitive style (linear and non-linear thinking) along with psychological climate when each stage of the problem-solving process is considered as an information processing entity. Here, for each stage, input data is processed to provide outputs that are suitable input data for a succeeding stage. The multiple stages of such a process offers the opportunity to integrate different knowledge, culture, and thinking (be it linear or non-linear) of different individuals as they act to providing the processing activity for each stage:

Table 1

The Four 'Ps' of Problem-Solving Linking Process with the Situational Variables

Process	Products		People	Press
Problem-Solving Stage	Stage Input	Stage Output	Processing Emphasis of Problem-Solver	Psychological Climate (large organisation)
Problem Identification	Visible Events Problem Topology may be well-defined or Ill-defined	Singular Mental Model of Potential Causality	Linear	Supports
		Multi Mental Models of Potential Causality	Non-Linear	Constraints
Idea Generation	Singular Mental Models of Problem	Incremental (Linear) Idea for Potential Solutions	Linear	Supports
	Multi Mental Model of Potential Causality	Multi (nonlinear) Ideas for Potential Solutions	Non-Linear	Constrains
Solution Selection	Single idea	Idea suitable for Implementation or feedback for further ideas	Linear	Supports
	Multi Ideas for Potential Solutions	Idea selected for Potential Solution	Non-Linear	Constraints
Solution Implementation	Singular solution	Acts as Sponsor selects Project Manager	Linear	Supports
	Selected solution	Delegates Implementation	Non-Linear	Constrains

Note: Additional complexity of the solution generation/selection stages where both incremental and/or radical may be generated and/or selected.

Other implicated individual differences that influence the processing activity involve personality variables such as openness (Costa & McCrae, 1992) and attributional complexity (Fletcher et al., 1986) both related to cognitive style (Vance et al., 2015).

Also, involved are environmental variables such as social culture (Tomasello, 1999) and organisational culture (Cameron & Quinn, 1999) organisational climate (Schneider, 1975) all related to psychological climate. These variables also play a significant part in the motivation aspects of the outcomes from the different process stages (Amabile et al., 1994).

The Operational Activities of the Creative Sub-Process

The generally accepted view is that the sub-process consists of two stages: problem identification and solution generation (see Fig 1). This view closely follows creativity theory, particularly that concerned with the sensemaking framework (Unsworth, 2001; Weick, 1995), where diagnostic frames are concerned with making sense of problems and their structure through previous knowledge (of how things work) and visible events that lead to the construction of mental models. Prognostic frames involve utilising these models as a foundation for generating both incremental and radical ideas, both of which are considered to be within the concept of 'creativity' and propose solutions containing potential courses of action (Kirton, 2011; Senge, 1999; Simon, 1985; Tolkamp et al., 2022).

Other studies have combined these two frames on the basis that the only tangible and measurable output concerns ideas (Yao et al., 2012; Zhang & Bartol, 2010). Still, others have shown that a three-factor solution is a better fit to the overall framework where the diagnostic frame separates into two distinct factors: information search and problem construction (Henker

et al., 2015). While the latter two views may offer theoretical insight, the two-frame solution of diagnosis and prognosis offers a clear aid to organisational understanding.

Problem Identification

The most important outcome of problem identification is the construction of the diagnostic frame (mental model) from the analysis of real-world symptoms. This leads to the identification of a 'critical issue' that characterises the problem, which is a fundamental starting point for the solution to all types of problems (Ohmae, 1982). The analysis process evaluates the differences between the current reality and a mental image of a desired future state. Observable signs and symptoms, the thinking style, and implicit knowledge of the problem solver are used to make sense of potential causes. The iterative testing of different signs and symptoms for causality eliminates some while retaining the more relevant as part of assembling the content of the mental model, which in turn provides a substrate for the generation of potential solutions. Sterman (2000) described the outcome from this stage as: 'regardless of the source of the problem, the initial definition is rarely more than a set of visible events, some causal variables, an implied structure of the problem, and some hypotheses that require validation.' The problem most easily understood is described as well-defined (Pretz et al., 2003) and refers to situations within an organisation where a performance gap appears due to a malfunction and requires corrective action to restore or improve performance. Such problems occur frequently, and as such, are easily recognisable by individuals within the organisation. Here symptoms (effect) and cause are close together and after a short analysis (or where the analysis has already been determined by others), solutions are easy to describe (Bunker & Alban, 2006; Ruckthum & Clapp, 2008). Where the performance gap is remote from the cause, the problem is validated by evaluating the pathway towards the cause. To paraphrase Simon (1985): 'If you are looking for a needle in a haystack, first ask which haystack'.

Once the cause has been identified, the focus shifts to the restoration of performance. This is of particular concern in large organisations where problems may not be articulated in a manner conducive to devising potential solutions until significant analysis has been conducted. Such issues typically involve multiple stakeholders and are often characterised as linear but combinatorically complex (Sterman, 2000). For example, problems in a sales office might only become apparent after a decline in revenue is indicated by financial reports. Consequently, the analysis commences with financial data and involves other functional areas such as production, quality control, and customer relations, thereby eliminating many possibilities before pinpointing the problem in sales. Only then can the underlying cause be addressed in a manner conducive to generating potential solutions.

When problems involve multiple interconnected groups, both internal and external to the organisation, with complex feedback mechanisms and spanning across space and time, they are referred to as ill-defined (Pretz et al., 2003). Moreover, they are often described as following a non-linear model due to the effects of feedback (Bratianu & Vasilache, 2009; Richmond, 2003; Sterman, 2000). Initially, such problems can be challenging to comprehend. They commonly arise from changes in technology, social culture, or the competitive market external to the organisation and are typically termed strategic actions aimed at enhancing the organisation's competitiveness relative to its rivals (Ohmae, 1982). Van der Heijden (2015) further elaborates on this perspective from a strategic planning viewpoint, particularly focusing on reaching consensus on a strategic direction for the organisation. These strategic pathways, depicted as scenarios, are crafted from complex assessments of potential futures projected onto the present, thereby defining potential organisational realignments, often involving structural or competency adjustments in the short and long term, both politically and environmentally. Van der Heijden (2015) emphasises the importance of continuously acquiring knowledge to

navigate this ever-changing landscape, stating, "Learning for this world has to do with learning what are useful questions to ask and learning how to keep on learning since the questions keep changing. There is no place to settle down, no time to stop asking" (p. 297).

Given the uncertainty posed by external cultural or competitive factors, the assumption of internal stability is untenable and can hinder efforts to justify strategic realignments of internal structures and competencies to accommodate these uncertainties. Internal changes not only sustain efficiency but also serve as a manifestation of strategy (Eden, 1992; Van der Heijden, 2015). Additionally, scenarios offer various potential solutions, each with different outcomes, allowing management to select the most appropriate course of action. These scenarios serve as structural models encompassing the critical variables of a viable future business model, alongside the distinct competencies necessary for achieving competitive advantage and profitability leadership.

In summary, problem identification is arguably the most critical stage in the process. At this juncture, events are comprehended through both linear and nonlinear transformations to construct knowledge and mental models, serving as the foundation from which potential solutions can be derived. However, both perspectives necessitate the observation and sense-making of discrepant events, albeit in different contexts (the external business environment and the internal organisational environment). Moreover, such sense-making is integral to the initial stage of the creative sub-process, where both linear and nonlinear substrates bolster potential solutions.

Solution Generation

The first step in problem-solving is to understand the problem. However, individual differences between problem-solvers (linear or nonlinear) introduce different information processing strategies that result in different views of the real-world problem (Kirton, 1976; Simon, 1985; Salton, 1996). The mental models so generated are referred to as diagnostic frames, a substrate from which potential solutions are generated. Whereas the prognostic frame is responsible for the actual production of ideas (incremental or radical) that are potential solutions to the problem.

When problem-solving, the two frameworks interact, but they do not proceed sequentially. Instead, there is a frequent interchange between the two; the prognostic frame activates as soon as there is enough content in the diagnostic frame to generate potential solutions (Simon, 1985). Early solutions may iterate around these two frames as the understanding of the constraints and structural relationships of the problem definition are challenged. Each iteration uses different space and knowledge boundaries that contribute different information into the diagnostic frame and introduce different aspects of the problem into the substrate for the generation of ideas as potential solutions to the problem.

While the content of the diagnostic frame is supported by the style of the problem-solver, it is developed only to the extent necessary for the prognostic frame to generate viable problem solutions (Simon, 1985). Also, the cultural input from both individualism and collectivism has been found to be supportive of the prognostic frame and ideas generated (Baer, 2015; Yao et al., 2012). However, within large organisations, because of the significance of rules that regulate activities and the need to conform, the perceptions of supports and constraints from psychological climate are considered constraint-dominated (Katz & Kahn, 1978, p297) and are more supportive of incremental ideas (Clapp, 1991).

In summary, the first two stages of the problem-solving process are closely bound together, where the only tangible output is ideas that offer a potential solution to a problem. The first stage, concerned with the content of the diagnostic frame, is related to the personal style of the individual problem-solver, be it linear or nonlinear. The second stage is concerned

with the prognostic frame and the production of ideas as solutions to the problem, supported by cultural influences of individualism and collectivism through psychological climate.

The Operational Activities of the Exploitation Sub-Process

When considering creative problem-solving in large organisations, the implications of linear-nonlinear styles extend beyond the identification of problems and solution generation to decision-making and the allocation of resources to sustain implementation. The last two stages of the problem-solving process comprise the exploitation of solutions generated by the creative subprocess. Sutton (2005), from the perspective of project content (not management), describes two situations. The first is where projects are characterised by consensus at the beginning regarding the required outcome. Also, any complexity, should it exist, tends to be easily manageable. The second type of project is viewed as dealing with multiple and powerful stakeholders, often with rival agendas, where agreement is difficult to achieve. Here, due to the complexity involved, outcomes become more ambiguous and even contentious. These views, while from a different perspective, fall within the domain of problem definitions of well-defined and ill-defined respectively and reflect issues concerned with efficiency and strategy.

Two key roles are also important to ensure continuity and success of this subprocess. The roles and responsibilities are supported by culture (Yao et al., 2012), where vertical collectivism (hierarchical power) and process support much of the activity. The two roles are:

The Sponsor. This is the person or group who commissions the project. Ideally, they will also have a significant line responsibility in the part of the organisation where the problem exists. They will be responsible for the selection of the most viable solution from those available. Further responsibilities include promoting the project to all stakeholders and groups whose cooperation will be required (including those parts of the organisation who may experience side effects from the project). Also, significantly, ensuring that sufficient resources (people, time, admin support, finance, etc.) are made available to the project to ensure success.

The Project Manager. This is the person appointed by the sponsor to manage the implementation stage of the process. The main responsibility of the project manager is to deliver the desired project outcomes within the scope, schedule, quality, budgetary, and time constraints defined by the sponsor. It involves the application of knowledge, skills, tools, and techniques to effectively initiate, plan, execute, monitor, control, and close a project. Additionally, regularly tracking the project's progress against the plan to ensure that it stays on track and any deviations are identified is a significant responsibility. Adjustments may be made, as agreed with the sponsor, to address risks, changes in scope, resource constraints, or other factors that impede project success. Both of these roles are of significant importance to the management of problem solutions and their implementation, where ownership, commitment, and resources are key issues if progress and outcomes are to be achieved.

Solution Selection

To ensure the validity of the evaluation process, it is necessary to evaluate different ideas using a consistent framework so that each idea is evaluated within the same solution space. Typically, when evaluating solutions, factual information on the risk, benefits, and costs of each potential solution plays a significant role in the final selection. However, the following aspects make a material contribution to the success of the project:

Feasibility: It should be clear what the solution is and how it could be implemented given the skills and resources available and the constraints and supports that exist.

Acceptability: The problem solution should ideally have acceptance from all of the relevant stakeholders.

Effectiveness: Will the solution be effective in solving the problem? Will the solution

offer additional benefits in the short and long term beyond solving the current problem?

Cost/Benefit Analysis: Are the cost estimates realistic? Are the risks manageable, and benefits realisable? What resources will be affected either positively or negatively?

Impact: What are the disadvantages of the solution? A solution may solve the current problem but create foreseeable future problems. Are there any side effects that could affect different parts of the organisation?

With a comparative set of data for each idea, an informed decision can be made as to which idea offers the best match to the organisational needs in solving the problem. The multifaceted nature of any solution and the risk of not achieving some of the expected outcomes need careful evaluation. It may be that cost and time overruns are acceptable if other more widespread advantages are achieved. However, other biases can influence the decision. Bias in decision-making occurs when there is a prejudice or inclination towards a particular option or outcome, leading to an unbalanced or distorted decision. Bias can arise from various sources, including personal beliefs, emotions, cognitive limitations, societal influences, and organisational constraints. Tetlock (2017, pp. 72) found that people with a personal style aligned with non-linear thinking showed greater accuracy in their decision-making in both short- and long-term decisions. "Accurate decisions are those that align with the available evidence, logical reasoning, and a comprehensive evaluation of alternatives". However, if none of the solutions offered are considered viable, it may be necessary to consider re-evaluating the problem, as sometimes the problem definition changes in the light of this first evaluation, particularly where only one potential solution is available.

In summary, effective decision-making is generally concerned with accurate evaluation of benefits and risks and is achieved by employing objective reasoning in the evaluation of alternative solutions or scenarios. Accuracy is improved by minimising bias and avoiding subjective influences.

Implementation

The implementation stage is a crucial step in the problem-solving process, where the identified solution is made operational by introducing better or different ways of doing things. This requires understanding and planning the necessary changes, along with the commitment of the people responsible for sustaining their use. It is important to secure the support of all stakeholders before implementing a solution. This includes employees, customers, and other individuals who will be affected by the solution, ensuring that the valuable thinking that has gone into solving the problem becomes reality. Managing such responsibilities usually requires a project team, as it may in other stages of the process if the problem requires a number of people with diverse skills or knowledge. An increased need for diversity in skills and knowledge unfortunately it also generates a more complex management task.

The implementation phase can be broken down into three main steps:

1. Planning. The project manager needs to develop a plan for how the solution will be implemented. This plan should include a realistic timescale and the required resources (e.g., financial, human, administrative support, etc.) necessary to meet the completion date. The project manager should highlight to the sponsor any potential deviations between the plan and any current expectations already formed, including difficulties that may arise during implementation. Together with the sponsor, strategies should be developed for overcoming these challenges.

2. Implementation. In this step, the project manager activates the plan. This involves making changes to the way things are done by commissioning new technology, training people on new procedures, and identifying any changes to user requirements. The project manager's main responsibilities include monitoring the implementation process closely and making

adjustments as needed to maintain planned progress. Additionally, there is a need to keep the sponsor informed of progress, addressing any concerns, and resolving any issues that arise.

3. Post-Implementation Evaluation. In this step, the project manager assesses the effectiveness of the solution. This involves collecting data on how the solution is working, surveying users, and conducting interviews. The project manager should use this information to document whether the solution is meeting the desired goals and to identify any areas that may need attention before formally closing the project.

Implementation is the phase where most costs and resources are expended, and if not adequately planned, it is where failure is most evident. If solutions have been selected but the resources needed for implementation are not made available, either due to organisational shortages or withheld for political reasons, useful ideas are lost to the organisation. Moreover, in scenarios where the selected solution may involve radical realignment to parts of the organisation, the sponsor of the change will likely be a more senior member of the organisation to protect the integrity of the project.

In summary, the implementation phase of the problem-solving process is often the most challenging, but it is also the most important. By carefully planning and preparing for implementation, the project manager can increase the chances of success.

Results and Discussion

In this discussion, the focus is on the qualitative operational context of problem-solving. Three aspects are of concern: the types of problems encountered, the process used to achieve the desired goals, and the influences, both external and internal to the organisation, that either support or constrain performance. As part of the discussion, references are used to contextualise findings, support interpretations, or compare results with existing literature. This differs from quantitative research, where references are mainly used to support statistical analyses or empirical data.

Also, with a clearer understanding of the definition of linear and nonlinear constructs and their application to the definition of the variables that surround problem-solving (e.g., ideas, thinking styles, problem definition, psychological climate), many alternative labels and descriptions can be avoided.

The types or styles of problems encountered

A number of different terms have been used as descriptors for what are essentially two styles of problems, namely well-defined and ill-defined (or structured and unstructured). As a consequence of the proposed use of moderately structured and combinational complex to also define problems, it has been suggested that polar descriptors represent poles of a continuum. However, an alternative view is provided by the polar descriptors linear and nonlinear. Here, the essential characterising difference is where nonlinear problems contain feedback between the entities within the problem while in linear problems such feedback is absent. With such a discrete difference between the content of the two poles, it is difficult to hypothesise the existence of a continuum of gradations or a continuous variable (see Appendix 1).

Process

The generally accepted four-stage change process has been used along with the associated stage definitions (see Fig 1). The products from processing the content of the first two stages of the process are considered as the more creative part, while the latter two stages form the part concerned with the exploitation of the creative opportunity. From a process view, it was found that the different stages adequately cover the process need of operational problem-solving. However, operationally, the two stages of the creative sub-process can usefully be considered as a single stage (Zhang & Bartol, 2010), particularly as the only tangible outcome is the quantity, style, and quality of ideas produced. The content of the last two stages is concerned with the more political issues of organisational choice and resource allocation. Thus, for large organisations, incremental rather than the more radical solutions are favoured; the latter, by default, involve more risk. Also, feedback is evident as information is fed back from the different stages of the change process to challenge and better define the products from earlier stages. Successive solutions to residual problems lead to a spiral of change as optimal organisational performance is approached (Gabora, 2018; Goldratt, 1990; Kirton, 2011) This has much in common with the organizational development (OD) process (Cummings & Worley, 2009).

Influences Internal and External

When considering each stage of the problem-solving process as following an information processing model, the process describes a pathway to the resolution of the problem. However, the actual processing activity is provided by two broad elements: characteristics of both the situational environment and those of the individual problem solver.

Psychological Climate

Culture has its roots in the norms and values of society, including the organisation and other internal functional groups. For organisations, it can be operationalised as constraints and supports perceived by an individual as a local psychological climate. A key attribute of such a climate is that it involves employee perceptions regarding the emergent properties of their overall environment, a personal 'outlook' (Kelly, 1963). The comment by Schneider (1975) that 'climates are for something' provides a focus for the salient dimensions involved. In organisations where individuals spend much of their day, psychological climate is induced by the culture of the particular business function, be it research or production. However. the business culture in large organisations tends towards psychological climates that support linear thinking while nonlinear thinking is constrained. Furthermore, where a business function requires a significant deviation from such a position 'cognitive dissonance' exists, affecting both organisational conversations and staff development (Schneider, 1987).

Linear Thinking

Sterman (2000) defines linear thinking as a cognitive style that follows a logical, step-by-step progression breaking down problems into smaller, more manageable steps until a solution becomes available. Also, for management, transactional leadership follows a similar framework of exchange of units of work for units of reward as does extrinsic motivation. Furthermore, aside from the process, linear thinking is often described as a psychological construct; however, there is little direct support from any of the main personality variables (e.g., conscientiousness) for linear thinking (Yilman, 2020). An alternative view is provided where

cognitive development in early years has been strongly linearised over time by simplified answers to early learning questions of 'why,' all within the concrete phase of individual cognitive development (Piaget, 1954). Also, in our social life, linearity pervades everyday transactions; e.g., twice the amount of a product costs twice as much (Bratianu & Vasilache, 2009). These roots result in linear thinking being seen as a learned way of processing information (the mental equivalent of learning to walk), and while sometimes described as a cognitive style, it is a learned construct and may be more accurately viewed as a common competence or skill.

Nonlinear Thinking

This style of thinking is characterised by an understanding of the way feedback between the entities within the problem affects the observed behaviour and the way the substrate of mental models is constructed. It includes expansion in multiple directions and exploring complex, seemingly unrelated knowledge in the creation of novel ideas that others may miss. This description parallels a number of cognitive styles from the personality domain that have genetic origins (Costa & McCrae, 1992; Hayes & Allinson, 1998; Kirton, 1976; Meynhart et al., 2017; Tetlock, 2005). The more significant of the personality variables is 'openness,' which is part of the big five frameworks (Costa & McCrae, 1992). Openness has facets of Fantasy, Aesthetics, Feelings, Actions, Ideas, and Values and is consistent with nonlinear thinking. Also, openness is an important influence in the evaluation of nonlinear problems and the production of nonlinear ideas (Madjar et al., 2011; Malik et al., 2019; Yilman, 2020).

Piaget (1954) shows concrete (linear) thinking develops as an early-years learned (cultural) competence while Costa and McCrea (1992) show 'openness' as a (genetic) personality variable rooted in temperament (Keirsey, 1991), which acts as the root of nonlinear thinking and appears in early adolescence. Kazi and Galanaki, (2020) (Kuhn et al., 1977) shows people (some 50%) fail to operate as formal (nonlinear) thinkers and remain as linear thinkers, while formal thinkers (the other 50%) can be considered as nonlinear thinkers. However, unrecognised, being masked by the consideration of thinking styles as preferences, is the retained competence to perform linear thinking by nonlinear thinkers. The two styles, linear and nonlinear, while having distinctly different content descriptions, are sometimes assumed to be conceptually bipolar. Here measurers are constructed using one or the other of the polar content descriptions along with the assumption that low scores define the other pole (Bratianu & Vasilache, 2009; Costa & McCrea, 1992) Such a position ignores the fact that the two poles have distinctly different content and as such are potentially independent (Groves & Vance, 2015; Meynhart et al., 2017).

Furthermore, an organisation exists as a complex network of functional entities between which information flows and within which feedback occurs and emergent properties appear. Thus, in addressing the question of 'Why managers haven't embraced complexity' (Straub, 2013), it is necessary to evaluate how such complex networks are controlled (or managed) to achieve their strategic objectives.

To better understand how change is accommodated in the nonlinear, complex network of reality of an organisation, a linear approximation is constructed by positioning hierarchically the salient functional entities and their relationships necessary to achieve the strategic

objectives of the organisation (Burke & Litwin, 1992). This transformation generates a linear map (organisational chart or organigram) of the complex network as perceived and understood by all involved individuals, possibly focusing solely on the local part. The resulting map can then be used in conjunction with the problem-solving process to address any problems and their potential solutions arising from internal rearrangements to maintain efficiency or from changes in the external environment necessitating adjustments to current strategy. Any resulting change reverberates through both the complex network and its linear equivalent, creating conversational feedback that addresses observed discrepancies in expectations. These conversations are primarily between managers from the different functional groups involved. In cases where conversational feedback fails to produce resolution or compromise, the issues can be escalated to higher levels in the hierarchy for resolution. Thus, complex issues can be resolved incrementally by iterating where necessary, utilising linear thinking potentially accessible to all individuals. This approach helps sidestep the necessity of understanding the more intricate emergent effects linked with nonlinear systems. In this context, feedback, hierarchy (bureaucracy), and sufficient time offer a convenient technique for linearising nonlinear structural activities evident in social and organisational affairs (Czerwinski, 1998).

Conclusions

Problem-solving has become a generic concept used to describe a process that uses the analysis of problems to produce stylised ideas (both incremental and radical) as potential solutions. If implemented, these solutions offer change across various domains within both the arts and the sciences (e.g., leadership, as discussed by Bass & Avolio, 1994), political decision-making (explored by Meynhart et al., 2017; Tetlock, 2005), fashion and art (Hogan et al., 2018), and performing arts (Clements et al., 2018).

In large organisations, the salient variables and their relationships affect the processed outcomes at all stages of the problem-solving process. In the creative subprocess, problems are identified and internalised by individuals as mental models that provide a substrate varying in content, on which stylised ideas can be produced as potential solutions. Such solutions range from the linear (simple cause and effect) to the nonlinear, where feedback, and emergent properties are involved. In the exploitative subprocess, where selection between multiple potential solutions takes place, nonlinear thinking offers better calibration for both short- and long-term decisions (Tetlock, 2017). For implementation, linear thinking involving step-by-step progression and attention to detail is supported by vertical collectivism (hierarchical power).

To gain a deeper understanding of how change is managed within the nonlinear, complex framework of an organisation, a linear approximation can be created by hierarchically arranging the key functional entities and their interconnections to the strategic objectives. Typically, this transformation is depicted through an organisational map or organigram. This perspective shapes discussions surrounding change and its impacts, often with the goal of enhancing efficiency or aligning the organisation with shifts in strategic direction.

Limitations of Findings

Much of the process and behaviour illustrated in this study has been developed and evaluated within Western organisations. As some of the more significant variables have their roots in culture it can be expected that cultural differences will play an important part in replicating the findings impacting organisations for function, size and country but not industry. However, this does not necessarily apply to the findings concerning process, e.g., problem solving as a series of stages and the issues related to efficiency where it is suggested that most OD initiatives would benefit from including strategy as part of any evaluation of efficiency.

Further Research

A number of aspects require further investigation. Much of the process and behaviour illustrated in this study has been developed and evaluated within Western organisations. As some of the more significant variables have their roots in culture it would be informative to evaluate similar activities from an Eastern perspective.

Piaget's theory suggest that linear thinking is developed from learning in early childhood from cultural immersion. This is a Western view of childhood development it would be informative to evaluate childhood development as it relates linear and nonlinear thinking from an Eastern perspective.

Measures of linear and nonlinear thinking need to be translated/adapted for prospective cultures and evaluated statistically for convergent parameters particularly the independence of the two domains (Bagozzi & Foxall, 1995; Kirton, 1976; See Groves & Vance, 2015).

Similar to 7.3 a measure for psychological climate for organisational change need to be developed and evaluated.

More importantly, for any organisational change, evaluating whether introducing scenario development as a process for evaluating strategy alongside efficiency will enhance the outcomes of any organisational development (OD) initiative (see Fig. 1).

Appendix 1: Archetypes of the Thinking and the Structural Domains

Linear

In the archetype, there is a dependent and an independent variable, and this relationship may be represented by a straight line on a graph. Thus, the same change in the independent variable produces the same change in the dependent variable (y=mx+c) (Bratianu & Vasilache, 2009).

Linear thinking is a cognitive style that follows a logical, step-by-step progression, breaking down problems into smaller, more manageable steps until they reach a solution (Groves & Vance, 2015; Sterman, 2000). It is often associated with problems that have a single starting point, emphasising clear cause-and-effect relationships and structured analysis.

Linear structure refers to a type of assembly or structure where elements are organised sequentially in a straight line or a single path. It implies a straightforward progression from one element to the next without branching or deviation. In a linear structure, each element has a clear predecessor and successor, creating an 'if-then' logical relationship between them.

Combinatorial Complexity

In the archetype, most people think of complexity in terms of the number of entities in a system or the number of combinations that must be considered in making a decision. Such problems are highly complex, but the complexity concerns locating the optimum from a vast number of linear solutions (Sterman, 2000).

Combinational Thinking concerns locating an optimal path length between entities, or optimal combinations of entities (e.g., the traveling salesman problem).

Combinational Structure concerns many linear related entities.

Nonlinearity

In the archetype, the relationship between a dependent and an independent variable is represented by a polynomial, a logarithm, an exponential, etc. Given appropriate measures for each variable, the graph takes the form of a curved or discontinuous line.

Nonlinear thinking is a cognitive style characterised by expansion in multiple directions and exploring complex, novel, non-sequential, and non-traditional connections and relationships between variables. Nonlinear thinkers tend to proliferate ideas and are able to see solutions that others may miss.

Nonlinear structure. A nonlinear structure concerns the relationships between variables that are not additive or proportional. Changes in one variable can have non-proportional effects on other variables. Nonlinear structures often require more complex mathematical models or causal diagrams to represent their iterative nature and the presence of feedback.

Dynamic Complexity

In the archetype, dynamic complexity concerns systems thinking in a way that enables understanding and simulation of a real-world situations where everything is seen as interconnected and interdependent.

Systems thinking is a technique that concerns the understanding of complex systems, such as the organisational environment or the economy. It can help see how changes in one part of a system can have effects on other parts of the system. Such thinking precedes simulation of the structure to understand its performance and how things work in the real world, including bounded rationality and modularity.

System structure is characterised by interconnectedness, feedback loops, time delays, and self-organisation, and how stocks and flows work together to achieve the system's goals. Such structures are usually nonlinear but do not preclude linear relationships. Similar structures are often found in nature and in fields such as politics, engineering, and economics.

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