Chapter 1
Introduction to Framing and "Solving" Problems

ABSTRACT

The authors present an overview of the four phases of problem solving: (1) problem identification; (2) solution design; (3) implementation; and (4) evaluation. The four types do not of course exhaust all the various kinds of problems and types of complexity. They are merely a start. And it's definitively not the case that one cannot prefer one or more of the types at the same time. Nonetheless, typically, one prefers one more than the others. Likewise, while all four phases are of equal importance, the authors are primarily concerned with the problem identification phase. For if we end up "solving the wrong problem(s) precisely," then we only end up adding to complexity.

"The greatest challenge to any thinker is stating the problem in a way that will allow a solution." — Bertrand Russell

Learning Objectives

- Define what constitutes a 'mess', 'problem', and 'exercise'
- Differentiate a 'mess' from an 'exercise'
- Identify steps to frame a 'problem'
- List four different problem treatments
- Describe the three elements of Ends Planning
- Explain the Diamond Model's four phases of problem solving

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INTRODUCTION

In a small coastal town named Seaville, residents began noticing peculiar changes. The local beach, where families spent their summers building sandcastles and picnicking, started shrinking. Each year, there was less and less space to lay out a beach towel, and some of the oldest beachfront cafes had to be abandoned due to increasing water levels. The town's fishermen, who had fished the nearby waters for generations, began complaining about decreasing fish catches and the unpredictability of the weather.

Meanwhile, inland, farmers faced their own set of challenges. Unpredictable rain patterns meant that some months saw intense flooding, while others brought drought-like conditions. Crops that once thrived in Seaville started failing, and the apple orchard that held the town's annual apple-picking festival produced fewer apples each year. Residents also started experiencing hotter summers and colder winters, with many elderly citizens finding it particularly challenging to cope with the extreme temperatures.

All these changes in Seaville weren't isolated incidents but were interconnected symptoms of a larger issue: climate change. The rising sea levels affected the beach and fishing patterns, while the changing weather patterns impacted agriculture and daily life. Seaville's challenges were not singular problems that could be tackled individually but a complex web of interrelated issues—a true "mess". Addressing one concern without considering the others would only provide temporary relief and potentially exacerbate other problems.

Let's delve deeper into the complex web of interrelated issues Seaville faces due to climate change:

Rising Sea Levels

Seaville: As the global temperatures rise, polar ice caps melt and cause sea levels to increase. In Seaville, this results in the gradual loss of beachfront. The increased salinity from seawater intrusion can contaminate freshwater sources and affect local aquifers, making freshwater less available for the community.

Farmer's Fields: Farmlands near the coast experience saltwater intrusion, which damages the soil quality, making it less fertile and harder for crops to thrive.

Changed Rainfall Patterns

Seaville: Inconsistent rain affects the town's infrastructure. Sudden heavy rainfall can cause local flooding, affecting homes and businesses, while prolonged dry periods can deplete local reservoirs, leading to water shortages.

Farmer's Fields: Erratic rainfall makes it challenging for farmers to predict the best times for planting and harvesting. Floods can drown crops, while drought conditions can wither them away.

Shifts in Biodiversity

Seaville: As sea temperatures change, certain marine species that the local fishermen rely upon move to colder waters or die out, affecting the fishing industry. New, sometimes invasive species might move in, affecting the balance of the local ecosystem.

Farmer's Fields: Changes in local biodiversity can introduce new pests or diseases that attack crops. The decrease in beneficial insects, like bees, affects pollination and reduces yields.

Temperature Extremes

Seaville: Hotter summers mean residents consume more energy for cooling, straining the local power grid. The elderly or those without proper housing face health risks during heatwaves. Colder winters increase heating costs and can disrupt the regular activities of the town.

Farmer's Fields: Extreme temperatures can kill crops or reduce their growth period. Certain crops might no longer be viable if temperatures continue to rise.

Economic Strains

Seaville: As the beach shrinks and fishing yields decrease, tourism and fishing, two primary sources of income for the town, decline. This can lead to job losses and reduced income for many families.

Farmer's Fields: Reduced yields and the unpredictability of crops mean farmers face financial instability. Some might need to change their farming methods or the crops they cultivate, requiring investment and new skills.

Each of these challenges does not stand alone but is connected in myriad ways. For example, economic strains in Seaville due to reduced tourism can mean fewer people buying local produce, further impacting the already struggling farmers. This intricate interplay of issues exemplifies a "mess", where problems are interconnected, and addressing one in isolation is extremely unlikely to lead to a comprehensive solution.

If we think of a spectrum of discreteness both in the structure and boundaries of a perceived problem or challenge, then at one end of the spectrum, we have exercises. These are well-bounded, well-structured; you basically know what the answer will be, but not necessarily the magnitude. At the other end of the spectrum, we have 'messes.' These are unbounded, unstructured, and highly interconnected… there is no clear end or beginning. Bridging between 'exercises' and 'messes' are 'problems.' Problems are instances where one can extract a representation of an aspect of a mess that can then be broken down into a series of exercises (which can be solved) and thus become the basis for decisions to be made. It is important to note that messes can be extremely challenging to confront due to the ambiguity in who the actual stakeholders are. Table 1 presents a summary of the attributes of exercises, problems, and messes.

Table 1. Differences between exercises, problems, and messes

EXERCISES	PROBLEMS	MESSES
*Bounded *Structured *Well-Defined *Existing Algorithms *Established "Rules" *All stakeholders in strong agreement	*Establish base assumptions *Questions to be answered *Abstracted from messes *Well-Specified *Identify plausible "Rules" *Requires Effective Communication	*Unbounded *Unstructured *Ill-Defined *Heuristics (judgment) *No established "Rules" *Strong Stakeholder Disagreement *Ineffective Communication
*Apply to all stakeholders (stakeholder independent)	*Discover stakeholders	*Involves hidden/improbable/ignored stakeholders

This chapter arms the reader with knowledge so that they are not either (a) immobilized by indecision when faced with a mess or (b) oversimplify the problem so as to 'solve the wrong problem precisely', but rather arm them with the tools to confront and responsibly navigate the complexities of messes and extract representative problems upon which exercises can be applied and decisions made and/or solutions implemented.

RECOGNIZING MESSES

Messes are unbounded (having no apparent beginning or end), unstructured (lacking an obvious and/or explicit organization), and ill-defined (having a high degree of vagueness, ambiguity, and lack of clarity), which as a result, routinely have hidden, improbable, and ignored stakeholders. As a result of the hidden, improbable, and ignored stakeholders, the stakeholder group is largely undefined and the ability to promote "solutions" to problems is greatly constrained because you don't really know who you're talking to or what decision criteria they are using to arrive at any particular decision. On the other hand, Exercises are bounded, structured, and well-defined, which means the stakeholder groups are more explicitly defined and their decision-making criteria are more straight-forward, resulting in 'easier' decisions.

The concept of a 'Mess' stems back to Russell L. Ackoff, who originally appropriated the word 'Mess' (Ackoff, 1971, 1977, 1999) to stand for a whole system of problems that were so interconnected such that one couldn't take any of the so-called individual problems out of the Mess and attempt to analyze it on its own without doing irreparable damage both to the so-called individual problem and entire Mess of which it was an integral part. In short, the problems that constitute a Mess are so interconnected such that they are constantly changing in response to one another. Given their complexity and constantly changing nature, one never "solves Messes," certainly not in the ways that one does Bounded, Well-Structured Exercises. The best one does is to cope with Messes as best one can.

PROBLEM TREATMENTS

As discussed above, from Ackoff's perspective, a "mess" is a complex web of interrelated issues that cannot be solved individually; they must be managed as a whole. The first step in dealing with a mess is to understand its scope and its interconnected components. Ackoff would advocate for a systems-thinking approach, where one maps out the elements of the mess and the relationships between them. This mapping not only provides a comprehensive view but also highlights areas where specific problems could be extracted for more targeted interventions.

Once the mess is understood systemically, the next step is to identify specific "problems" within the mess that are sufficiently independent to be treated individually. These problems should be 'bite-sized,' meaning their solutions should be actionable and measurable, but they should also be 'juicy,' meaning solving them would create noticeable positive change within the larger system. For example, in the case of climate change affecting the coastal town Seaside, one identified problem could be the erosion of the beachfront, which is easier to tackle compared to the entire mess of climate-related issues affecting the town.

After extracting a problem, Ackoff would suggest applying problem treatments, or solutions, specifically designed for it. Using established methodologies and tools, one can devise strategic plans, set measurable objectives, and allocate resources to tackle the problem effectively. However, Ackoff would remind us that solving one problem should be seen as a part of the overall strategy for managing the mess, not as an end in itself. Therefore, any solution applied should be continually assessed for its impact on the other components of the mess, ensuring that solving one problem does not inadvertently make another problem worse. Understanding that one can't necessarily solve a mess, but one may be able to treat problems

There are four ways of treating problems: absolving, resolving, solving, and dissolving (Ackoff, 1999).

- Absolving a problem is ignoring a problem and hoping it will just go away or self-resolve itself. No active problem solving occurs.
- Resolving of a problem is an action(s) that yields an outcome that is satisfactory. An attempt is made to find the cause of the problem and the remove or suppress it.
- Solving a problem is an action(s) that optimizes an outcome that is desirable.
- Dissolution of a problem eliminates it by redesigning the system that contains it so that the context for the problem is removed.

Problem treatments vary based on the complexity of the problem (Table 2). Exercises, for example, lend themselves for resolving and solving. These types of problems, because they are well-structured, bounded, well-defined, and with clear stakeholders can typically be solved directly or resolved to great satisfaction of all involved parties. Messes on the other hand, tend to employ absolving and dissolving due to the nature of the mess where the actual problem (or problems) are ill-defined, unbounded, and unstructured. Well formulated problems tend to lend themselves to resolving, solving, and dissolving.

Table 2. Summary of problem treatments

PROBLEM TREATMENT	EXERCISES	PROBLEMS	MESSES
Absolving	Less Relevant	Less Relevant	Very Relevant
Resolving	Relevant	Relevant	Very Relevant
Solving	Very Relevant	Very Relevant	Less Relevant
Dissolving	Less Relevant	Relevant	Very Relevant

Additionally, there are some problems that require more time to address than others. In these instances, one can leverage the concepts of Ends Planning (Ackoff, 1999), which consists of designing a desired future and extracting from it those ends that can be achieved in incremental temporal steps:

Goals – Ends that are expected to be obtained within the near-term (timeframe of months to years);
Objectives – Ends that are expected to be immediately achieved, but rather through a series of goal sessions (timeframe of years to decades); and
Ideals – Ends that are believed to be 'unattainable' in that one makes continuous progress to achieve or maintain, without a formal 'end' (ie being safe, being a good parent, being financially responsible).

Ends Planning enables one to take more complicated and/or complex problems that span years if not decades and divide them up into a series of sequential mini problems that can be managed in a reasonable period of time. This approach enables one to take otherwise daunting or intimidating problems and break them down into smaller more doable problems.

Consider the issue of water pollution affecting both Seaville's residents and the nearby farmer's fields. This is a complex problem with multiple, interconnected causes such as agricultural runoff, industrial waste, and poor sewage management. Here are examples of actions that can be taken in the short term, medium term, and long term:

Goals: Short Term (i.e., Within One Year)

- Public Awareness Campaign: Start an immediate awareness campaign on water conservation and the dangers of water pollution. Share steps for safe water use and ways to minimize pollution.
- Water Quality Testing: Implement rigorous water testing in Seaville and the farmer's fields to identify pollution levels and sources.
- Emergency Filtration Systems: Install temporary water filtration units at critical points where water pollution is highest.
- Regulatory Enforcement: Strengthen and enforce existing regulations on industrial waste discharge and agricultural runoff.

Objectives: Medium Term (i.e., Three to Five Years)

- Upgrade Sewage System: Begin upgrading the sewage treatment plants to better handle contaminants.
- Natural Filtration Systems: Collaborate with farmers to establish buffer zones with plants that naturally filter water before it enters local rivers or groundwater.
- Local Legislation: Pass laws that require agricultural and industrial operations to adopt cleaner practices, with incentives for early compliance.

- Community Monitoring: Establish a community-led water monitoring system that allows residents to report issues or test water quality.

Ideals: Long Term (i.e., More Than Ten Years)

- Large-Scale Infrastructure: Build a state-of-the-art water treatment facility capable of handling the water needs for both Seaville and the surrounding agricultural areas.
- Sustainable Farming: Promote and subsidize sustainable farming practices that not only increase yield but also minimize water pollution.
- Education: Integrate water conservation and pollution control into educational curriculums from elementary school through high school.
- Green Urban Planning: Redesign urban spaces in Seaville to include more green areas that naturally filter water and decrease the likelihood of floods, which can exacerbate water pollution.

By taking targeted actions in the short, medium, and long term, it's possible to make substantial progress in addressing the complex issue of water pollution in Seaville and the farmer's fields.

SENSEMAKING

Sensemaking was a concept introduced by Karl Weick in the 1970s who argued that organizations are central arenas for making sense of things due to their inherent complexities. It can be understood as a methodology to structure the unstructured and give meaning to experiences that are initially perceived as random or chaotic. It's a process through which individuals or groups come to understand and give meaning to complex or unfamiliar situations. When faced with such situations, individuals engage in data collection, interpretation, and interaction, reflecting on their findings, and then decide on a course of action. Feedback loops are integral, allowing for adjustments based on new data or outcomes.

Key Concepts

1. **Retrospection**: Sensemaking often occurs post-event, reflecting on experiences to understand them.
2. **Identity**: Who we are shapes how we interpret events.
3. **Enactment**: Through actions, individuals can shape their environments.

4. **Ongoing**: Sensemaking is continuous; as we get more information, interpretations may change.
5. **Social**: Interactions with others play a significant role in how we make sense of events.
6. **Cues**: Small details or cues can significantly shape understanding.
7. **Plausibility over Accuracy**: People tend to prioritize narratives that make sense over those that are necessarily accurate.

Sensemaking is a vital cognitive and social process where individuals and groups interpret ambiguous situations. Over the past five decades, it has been a key area of academic exploration, revealing the complex interplay of individual cognition, social interactions, and organizational contexts in shaping how we understand the world around us.

Imagine a coastal community that, over the years, has experienced hurricanes but generally of manageable magnitudes. However, in recent years, they've observed an uptick in the frequency and intensity of these hurricanes, leading to more frequent evacuations, greater damage, and more prolonged recovery periods. This change disrupts the community's previous understanding and expectations.

1. **Disruption**: The community recognizes a pattern of more frequent and more intense hurricanes.
2. **Data Gathering**: Community leaders gather historical weather data, consult climate scientists, and review records of local hurricane impacts over the past decades.
3. **Interpretation**: Initial data suggests a link between global climate change and the rising intensity of hurricanes. Warmer ocean temperatures might be fueling more powerful storms.
4. **Interaction**: Community forums are held where residents share their personal experiences. Scientists present their findings, and local emergency services share their challenges. There's a consensus that this is not a temporary anomaly but possibly the new norm.
5. **Reflection**: The community realizes that while immediate disaster response is crucial, there's a need for long-term strategies to adapt to this new reality, such as improved infrastructure, updated evacuation plans, and better public education on hurricane preparedness.
6. **Action**: They decide to allocate funds to bolster sea defenses, revise building codes for new constructions to be more hurricane-resistant, launch a public awareness campaign about hurricane preparedness, and collaborate with neighboring communities for coordinated evacuation plans.

7. **Feedback Loop**: After implementing the changes, the community closely monitors the effects of subsequent hurricanes, assesses the efficacy of their preparations, and remains open to revising their strategies based on real-world outcomes and evolving scientific understanding.

As these strategies are implemented, the community would then monitor their effectiveness during subsequent hurricanes, adjusting as needed based on outcomes and updated scientific insights. Through sensemaking, this community could better understand, adapt to, and prepare for their changing reality. In this scenario, the coastal community uses sensemaking to understand and adapt to the changing patterns of hurricanes, leading to both immediate and long-term strategies to enhance resilience and safety.

CONCEPTUAL MODELS

A conceptual model serves as a representation of a system (or sub-system), capturing its significant elements and the relationships among them. Think of it as a mental map or a simplified sketch that outlines a system's structure and behavior. Unlike detailed models, which may be laden with specifications and intricate calculations, a conceptual model focuses on the broader picture, highlighting key components and their interactions.

The idea of conceptual modeling is not new. Its roots can be traced back to ancient civilizations where rudimentary diagrams or physical models were used to depict various systems, from the arrangement of celestial bodies to architectural plans of significant structures. However, the term gained more formal recognition in the mid-20th century, notably within the realms of systems theory and computer science. Here, conceptual models emerged as vital tools, aiding in the design of complex systems, software, and even aiding scientific understanding by providing abstract representations of phenomena.

Conceptual models play an indispensable role in multiple disciplines, from natural sciences to social sciences and engineering. They help stakeholders visualize and understand a system, making complex ideas more digestible. By highlighting primary elements and their interconnections, such models enable improved communication, fostered collaboration, and streamlined decision-making. Moreover, they often serve as foundational blueprints upon which more detailed, quantitative models can be built.

Before diving into the creation of a conceptual model, it's paramount to define its purpose. Is it being developed to understand a natural ecosystem, design a software interface, or perhaps guide policy decisions? Once the purpose is clearer, the scope can be delineated, determining which components of the system should be included and which can be overlooked for the sake of simplicity.

With a clear understanding of the purpose and scope, the next step is to identify the major components or entities of the system. This is often an iterative process, involving brainstorming sessions, literature reviews, and consultations with experts. Once these elements are pinned down, their relationships or interactions need to be charted out, considering how one component affects or is affected by another.

Creating a conceptual model is rarely a linear, one-off endeavor. Instead, it's an iterative process, where the model is continually refined as more information becomes available or as feedback is received from stakeholders. A well-constructed conceptual model, rooted in clarity and simplicity, can be an invaluable tool, bridging the gap between complex realities and comprehensible representations, aiding understanding, and paving the way for more detailed analyses.

Conceptual models are visual representations, and a variety of techniques are utilized to effectively convey the structure and dynamics of a system or concept. Here are some common techniques used to illustrate conceptual models:

1. **Flowcharts**: These diagrams represent processes or systems using boxes of various shapes to depict specific stages, activities, or entities. Arrows guide the viewer, showing the flow or sequence of steps.
2. **Mind Maps**: Originating from brainstorming sessions, mind maps radiate from a central concept or idea. Branching out, they illustrate sub-concepts or related ideas, providing a hierarchical view of the system.
3. **Venn Diagrams**: Used primarily to showcase relationships between different sets, Venn diagrams utilize overlapping circles or other shapes to indicate shared characteristics or intersections between entities.
4. **System Dynamics Diagrams**: These models, often used in systems thinking, represent feedback loops, stocks, and flows. They are particularly useful for depicting how components of a system interact and influence one another over time.
5. **Spider Diagrams**: Similar to mind maps but more structured, spider diagrams branch out from a central theme, capturing main ideas and then further sub-ideas or details.
6. **Concept Maps**: These are structured graphs that illustrate the relationships between concepts, usually shaped as circles or boxes. They differ from mind maps by their structure and the nature of the relationships they depict. They may include labeled arrows or linking phrases like "gives rise to" or "results in" to describe the nature of the relationship between concepts.

7. **Matrix Diagrams**: Using rows and columns, matrix diagrams showcase the relationships or connections between two or more lists. This is particularly useful when you want to depict how different elements correlate or interact.
8. **SWOT Analysis**: Often utilized in business and strategy development, SWOT diagrams segment information into Strengths, Weaknesses, Opportunities, and Threats, providing a clear overview of the internal and external factors affecting an entity.
9. **Storyboarding**: Originating from film and animation, storyboards sequence images or panels in a linear fashion to depict the flow of events, user interactions, or system processes.
10. **UML (Unified Modeling Language) Diagrams**: Widely adopted in software engineering, UML diagrams come in various forms (like use case diagrams, sequence diagrams, and class diagrams) to represent different aspects of software systems.

Selecting the right technique depends on the specific needs of the project, the nature of the system being modeled, and the audience's familiarity with the method of representation.

VENN DIAGRAMMING MESSES TO PROBLEMS

It can be helpful to provide some boundary and structure to enable logical and structured framing of problems. One can take a very broad subject and break it down into smaller, more manageable components that are still consistent with the nature and characteristics of the mess but allow for the application of more explicit definition as well as the ability to separate out subtopics.

Venn diagrams offer a visual way to segment and organize the components of a "mess" by representing them as overlapping circles. Each circle can represent a different aspect or factor within the larger system. The points where these circles overlap indicate areas of intersection or interrelation among the issues at hand. For example, if you're dealing with a mess related to community health, one circle might represent healthcare access, another could represent local environmental factors, and yet another might symbolize economic conditions. The overlapping regions could reveal specific problems like inadequate healthcare for low-income families in polluted areas, which combines elements from all three circles.

By isolating these overlapping regions in a Venn diagram, one can identify specific problems that might be more manageable than trying to tackle the entire mess at once. These intersections often present themselves as "key leverage points" where intervention can produce the most significant impact on the system as a whole.

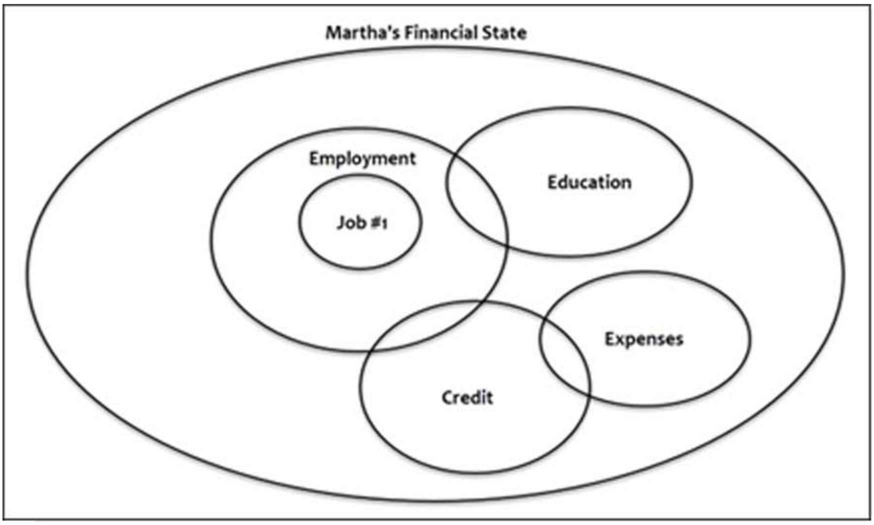
Once you've used a Venn diagram to break the mess down into these more specific, intersecting problems, you can apply targeted treatments to each. For instance, in our community health example, focused efforts could be made to improve healthcare access specifically in low-income, high-pollution areas. These more contained issues are easier to define, measure, and solve, making a Venn diagram a useful tool for translating a complex mess into actionable problems.

Consider the following. Martha is a single mother struggling to support herself and her two children. As a low-skilled worker, she earns only $3000 a month. Unfortunately, she needs a minimum of $3500 to adequately feed, clothe, and house herself and her two children. Martha's problem is not merely the difference between $3500 and $3000. The real problem is not one of arithmetic or Finance alone. Martha already knows too well the amount she's short every month. The real problem is multi-faceted and layered. Does Martha get support from the father of the children? Does she have access to child-care? Does it even exist? Why, why not? How can Martha's family help? Do they even want to? Can she enroll in an educational program or programs that will give her the true skills she needs to get a better paying and more rewarding job? Can Social Services help? Can a Social Worker steer her to the right programs?

If we examine Martha's story, she was in a situation where she had $3500 in expenses each month, but only $3000 in income. If we consider this equivalent to Martha's Financial State, we observe that there are many facets to her situation. Use of Venn diagrams can be a useful way to organize the various elements, acknowledge interrelationships, and then address individual components that would then impact the overall condition of Martha's financial state. A Venn diagram uses overlapping circles or other shapes to illustrate the logical relationships between two or more sets of items and graphically organize things, highlighting how the items are similar and different.

Figure 1 presents an example where differing elements that contribute to Martha's financial state can be inventoried and illustrate relationships. If we start with Martha's Employment and draw a circle is largely influenced by her current job (Job #1), but also by her educational background (Education). Her credit is impacted by her employment as well as her expenses. While these are simple illustrations, they do show the utility of using Venn diagrams to aid in 'making sense of the mess' and providing structure and boundaries to what would otherwise be a jumble of issues and topics.

Figure 1. Organization of differing elements that contribute to Martha's financial stat using a Venn diagram



DIAMOND MODEL

The Diamond Model is most associated with Michael E. Porter, a renowned economist and professor at Harvard Business School. The model was originally developed to analyze competitive advantage among nations and industries, aiming to explain why some industries in certain nations are competitive internationally while others are not. The framework was introduced in Porter's seminal work, "The Competitive Advantage of Nations," published in 1990. Over time, the Diamond Model has been adapted for various other contexts beyond international competitiveness, including problem-solving and strategy development in a wide array of fields.

The Diamond Model has found a second life as a strategic framework for problem-solving across various domains. The model's emphasis on interconnected factors that contribute to a particular outcome has proven applicable to complex problem-solving situations. Its four-point structure, which encompasses problem identification, solution design, implementation, and evaluation, has been employed to systematically dissect and address intricate issues beyond trade and industry competitiveness. Whether it's tackling environmental challenges, healthcare inefficiencies, or organizational dilemmas, the Diamond Model provides a structured approach to identify key leverage points and to design, implement, and evaluate targeted interventions, thereby offering a comprehensive and flexible strategy for problem-solving.

Problem Identification is the first and foundational step in the Diamond Model process where the issue at hand is clearly defined and scoped out. Through data gathering, stakeholder interviews, and analytical tools, the problem is not just identified but also quantified to understand its extent and impact. Example outcomes of the problem identification step might include: (a) A comprehensive report outlining the high attrition rate in a company; (b) A health impact study identifying the specific areas most affected by air pollution; or (c) A needs assessment survey showing a community's lack of access to clean drinking water.

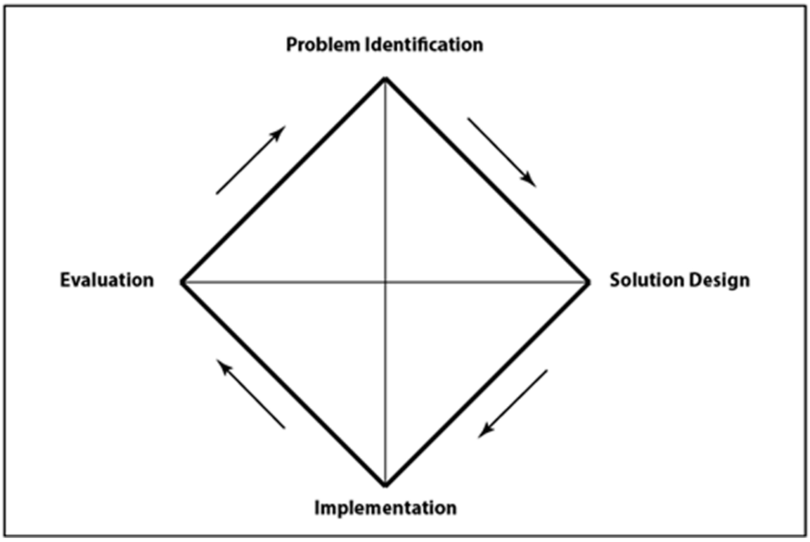
Once the problem identification step has concluded, the Solution Design stage begins. At this stage, various alternative solutions are brainstormed, assessed, and compared to identify the most effective and efficient way to address the problem. Criteria such as cost, feasibility, and long-term impact are considered. In the Solution Design phase of the Diamond Model, constructing an 'exact model' can be an invaluable approach for creating a detailed and accurate representation of the problem at hand and the potential solutions. This model, often crafted through mathematical formulas, simulations, or specialized software, serves as a blueprint that captures essential variables and their relationships. For instance, if the problem is traffic congestion, an exact model could use real-time data and algorithms to simulate how different solutions like widening roads or implementing a new public transit system would impact traffic flow. The model helps in anticipating potential bottlenecks, costs, and other issues before actual implementation, thereby aiding in the selection of the most effective solution. By creating an exact model, stakeholders can scrutinize each option under conditions that closely mirror reality, thus significantly reducing uncertainties and providing a robust basis for decision-making. Outcomes from the Solution Design process might include things such as: A shortlist of three potential engineering solutions to improve a city's public transportation system; A detailed proposal for implementing remote working policies to reduce attrition in a company; or An environmental impact assessment for different methods of reducing air pollution in a specific area.

Once a solution is chosen, a detailed plan is developed for its execution and the Implementation phase begins. This implementation plan includes resource allocation, timelines, and responsible parties. Then the plan is put into action. Implemented solutions might include actions such as: (a) Construction of a new light rail system in a city, based on the selected engineering solution; (b) The rollout of a new remote working policy, complete with training sessions and IT infrastructure upgrades; or (c) The installation of air purifiers and green spaces in areas identified as most polluted.

The final step of Evaluation involves assessing the outcomes against the objectives set during the problem identification and solution design stages. This helps in understanding the effectiveness of the solution and provides insights for future endeavors. Evaluation findings might include: A post-implementation study showing a 20% increase in public transportation usage; Employee surveys and attrition data showing a 30% reduction in turnover after the remote working policy was implemented; or Air quality measurements showing a 15% improvement in the targeted areas following the environmental interventions.

Each step of the Diamond Model is critical for ensuring that the problem is not just addressed but solved in a manner that is sustainable and beneficial in the long term.

Figure 2. Overview of the Diamond Model and the four problem solving phases



Let's examine two example case studies utilizing the Diamond Model as a framework.

Diamond Model Example One: Poor Elevator Service

The manager of a large office building was receiving mounting complaints about poor elevator service such that he felt he had no choice but to call in an outside consultant to help him with the problem. The consultant recommended putting in new elevators with different ones going to different floors. The trouble with this is that it proved so costly that it was cheaper to tear down the current building and build a new one from scratch. Fortunately, one of the clients in the building was a Clinical Psychologist. When she heard about the problem, she approached the manager with a very different solution. She recommended putting mirrors in the lobby so that people could basically occupy themselves while waiting for the elevators. Today, we would of course put in large TVs so people could watch CNN. The cost of putting in TVs is substantially less than putting in new elevators such that it doesn't even come close.

The important point of this example is that there is all difference in the world between saying the problem is fundamentally in the building versus in the people. The initial problem being sensed was that of submitted complaints for poor elevator service. One perception centered around structural deficiencies, while the other centered around the feelings of poor service, where a distraction would likely remedy the perception of poor service much more efficiently and cost-effectively than rebuilding the entire elevator bank with new elevators. Of course, at some point, new elevators may be needed, but it's more than worth it to try TVs first.

The Solutions phase forms an Exact Model of the problem that allows for quantitative analyses and bounded uncertainties. The initial system structure, boundaries, stakeholders, and assumptions are further developed and refined. A formal listing of stakeholder requirements is required. Operational assumptions are clearly identified and inventoried. There is frequently substantial data collection and development of numerical models to inform anticipated outcomes. This stage of the process is largely quantitative, and the goal is to minimize uncertainties as much as possible. Elements of the solution process are analyzed, such as operational timelines, costs, and required resources.

In developing the Exact Model, success criteria (how can one ascertain if the implemented solution remedies the sensed problem) need to be defined explicitly. Criteria for success will then be monitored during the later Implementation Phase to confirm that the implemented solution fully remedies the initial problem.

In the case of our elevator scenario, the Syntactic Phase would collect user data, develop quantitative models to analyze the optimal number of TVs required, where they are placed, what shows are made available to which groups of elevator riders. The success criterion would be a reduction of complaints by (for example) 80% per year.

The Solution Phase consists of extracting the optimal solution from "Exact Model." During this phase, one will aim to satisfy as many of the stakeholder criteria as possible. Key decision-makers review the options generated during the Syntactic Phase and choose the selected Solution configuration for implementation.

For the elevator scenario, this would encompass the building management team reviewing the evaluated scenarios and final recommendation for the number of TVs required, where they are placed, what shows are made available to which groups of elevator riders. The building management team would then either concur with the final recommendation or request a return to the Syntactic Phase if they felt some elements were either omitted or inadequately evaluated.

Diamond Model Example Two: Seaville Erratic Rainfall Patterns

Let's apply the Diamond Model to one specific issue from Seaville and the farmers' fields: erratic rainfall patterns leading to both flooding and drought first discussed in this chapter.

The first step is Problem Identification, which aims to clearly identify and understand the problem. In Seaville and the surrounding farmland, erratic rainfall is causing both flooding and drought, which in turn affects residential areas, agriculture, and local businesses. Data on rainfall patterns, flood occurrences, and drought periods would be gathered and analyzed to quantify the extent of the problem. Community input could also be collected to understand the human impact, such as property damage or reduced crop yields.

Having identified that the problem of interest is erratic rainfall, the Solution Design stage begins where various potential solutions are brainstormed and compared. For example, one solution could involve building a dam and reservoir system to store excess rainwater, which could then be released during dry periods. Another option might be to implement green infrastructure solutions like rain gardens and permeable pavements in Seaville to help manage stormwater and reduce flooding. For the farmland, drought-resistant crop varieties could be considered. Each option's cost, feasibility, and potential impact would be assessed.

Once a solution has been chosen—let's say the dam and reservoir system—it's time to move into action, which is the Implementation phase. This phase involves detailed planning, securing funding, and actual construction. Local authorities would work with engineers, environmental scientists, and the community to implement the system.

After the dam and reservoir are operational, the effectiveness of this solution would be assessed as part of the Evaluation phase. Key performance indicators might include reduced instances of flooding, more consistent water supply for agriculture, and overall community satisfaction. If the system does not meet these objectives, then the reasons for its shortcomings can be identified.

The Diamond Model allows for iterative problem-solving; the evaluation phase could reveal new insights that necessitate revisiting earlier stages. Perhaps the dam and reservoir successfully prevent flooding but don't sufficiently address drought conditions in the farmland. In that case, the model guides stakeholders back to the drawing board for refining or supplementing the initial solution, ensuring that the approach remains flexible and adaptable.

CLARITY TEST

Problem delineation and formulation can greatly benefit from the 'clarity test.' The 'clarity test' is a means by which to sharpen a problem statement so it is 'well-specified.' Well-specified refers to a situation where complete information is given so that there would be agreement that the event or topic had or had not occurred. The example given is (Henrion, 1990):

Imagine a clairvoyant who could know all the facts about the universe, past, present, and future. Given the description of the event or quantity, could she say unambiguously whether the event will occur (or has occurred), or could she give the exact numerical value of the quantity? If so, it is well-specified.

Thus, the "price of gasoline" would not pass the clarity test. The clairvoyant would want to know what kind of gasoline, sold where and when, before she could give its exact value. An adequate specification of the quantity might be "the average retail price of regular unleaded gasoline in dollars per gallon observed at service stations in the northeastern United States on January 1, 1990." Without such precision, vagueness about what the parameter represents is liable to get confounded with uncertainty about its true value.

The Clarity Test can be a very useful tool to aid in the configuration of success criteria for the implemented solution. This technique forces specificity of the outcome(s) and helps achieve alignment across multiple stakeholder groups.

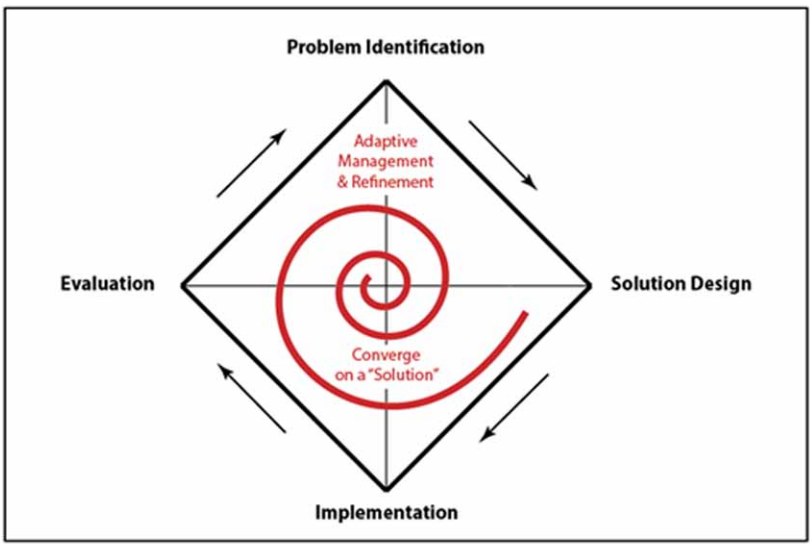
ADAPTIVE MANAGEMENT AND LEARNING

Learning is near impossible unless one is aware of the possible and actual errors or the skew between the anticipated outcome vs the actual outcome. During the implementation phase, it is critical that the deployed solution be monitored to ascertain the skew between the anticipated outcome vs the actual outcome. When the assumed and actual conditions are in general agreement, no action is required. However, if there is a significant skew or deviation (on the order of 20% or more), something may have gone wrong or gone exceptionally right. In such situations, diagnostic evaluations can be very helpful to find what generated the skew and identify potential corrective actions. There are four primary mechanisms for generation of significant skew (Ackoff, 1999):

1) The information used in making the decision was in error;
2) The decision-making process may have been faulty;
3) The decision may not have been implemented as intended; and
4) The environment may have changed in a way that was not anticipated.

Reviewing these four questions in instances with significant skew between the actual outcome(s) and the intended outcome(s) will almost always provide valuable insights into explaining what went wrong and why and what corrections are needed. The Adaptive Management process (Figure 3) allows for updating and refinement of data, assumptions, and even formulation of the problem. This iterative process is followed until the skew between the actual outcome(s) and the intended outcome(s) is reduced to a tolerable level.

Figure 3: Inclusion of adaptive management and refinement based on feedback during the implementation phase...did the developed solution dissolve the sensed problem?



ADDITIONAL TOOLS, METHODS, AND STRATEGIES

Confronting messes, especially in the context of systems thinking and complexity, requires a variety of tools and methods. A summary of ten notable tools/methods, their primary developers, and their associated time periods is presented below:

Systems Thinking - A holistic approach that focuses on the interrelationships between components of a system rather than individual parts in isolation.

Developer: Ludwig von Bertalanffy

Time Period: 1950s-1960s

Example Applications:

- Environmental management: Understanding the interactions between species, climate, and human intervention in an ecosystem.
- Healthcare: Viewing hospitals as systems to better understand patient care paths, workflow, and resource allocation.
- Urban planning: Addressing the interconnected issues of transportation, housing, infrastructure, and the environment in growing cities.

Additional Readings (Ludwig von Bertalanffy):

- General System Theory: Foundations, Development, Applications
- Robots, Men, and Minds: Psychology in the Modern World
- Problems of Life: An Evaluation of Modern Biological Thought

Soft Systems Methodology (SSM) - A process used to understand and deal with complex problems by viewing them as systems to be explored and modeled.

Developer: Peter Checkland

Time Period: 1970s

Example Applications:

- Business process re-engineering: Identifying inefficiencies in company operations and designing better workflows.
- Community development: Engaging stakeholders in designing interventions for community challenges.
- Information systems design: Understanding user needs and requirements in software development.

Additional Readings (Peter Checkland):

- Systems Thinking, Systems Practice
- Soft Systems Methodology: A Thirty Year Retrospective
- Information, Systems and Information Systems: Making Sense of the Field (with Sue Holwell)

Scenario Planning - Strategic planning method used to make flexible long-term plans by considering various possible future scenarios.

Developer: Herman Kahn, with development in corporate contexts by Royal Dutch Shell

Time Period: 1960s-1970s

Example Applications:

- Energy sector: Predicting future energy needs and potential shifts to renewable sources.

- Financial forecasting: Planning for potential economic downturns or global market changes.
- Pandemic preparedness: Anticipating various disease outbreak scenarios and planning responses.

Additional Readings (Herman Kahn):

- On Thermonuclear War
- The Year 2000: A Framework for Speculation on the Next Thirty-Three Years (with Anthony J. Wiener)
- Thinking About the Unthinkable

Strategic Option Development and Analysis (SODA) - Uses cognitive mapping to capture individual or group perceptions and structure complex decision-making situations.

Developer: Colin Eden and Fran Ackermann

Time Period: 1980s

Example Applications:

- Corporate strategy development: Aligning team perceptions and mapping organizational goals.
- Conflict resolution: Structuring and understanding points of contention in negotiations.
- Project management: Understanding and planning complex projects with multiple stakeholders.

Additional Readings (Colin Eden):

- Making Strategy: The Journey of Strategic Management (with Fran Ackermann)
- Cognitive Mapping: A Step Towards Feasible Management of Complexity
- On the Nature of Cognitive Maps (with Fran Ackermann)

Horizon Scanning - A method to systematically identify opportunities and threats in the distant future.

Developer: Various contributors across multiple fields, particularly in governmental foresight

Time Period: Late 1990s onwards

Example Applications:

- National security: Identifying potential threats or geopolitical shifts.
- Technology forecasting: Anticipating technological advancements and their implications.
- Environmental conservation: Recognizing emerging threats to biodiversity or habitats.

Cross-Impact Analysis - A method to estimate how changes in one variable affect changes in other variables in a system.

Developer: Theodore Gordon and Olaf Helmer
Time Period: 1960s
Example Applications:

- Product development: Estimating how changes in product features might impact sales or market reception.
- Environmental policy: Gauging how interventions might affect various environmental metrics.
- Social policy evaluation: Understanding how policy changes might affect various societal indicators.

Additional Readings (Theodore Gordon):

- The Delphi Method: Techniques and Applications (with others)
- Future Studies: Qualitative and Quantitative Methods (with Jerome C. Glenn)
- Environments of the Future (with Olaf Helmer)

Causal Loop Diagrams (CLD) - Visual tools used to explore and display how different variables in a system are interrelated.
Developer: Jay W. Forrester and others in the field of system dynamics
Time Period: 1950s-1960s
Example Applications:

- Climate change research: Modeling the interactions between greenhouse gas emissions, temperature rises, and feedback loops.
- Economic modeling: Understanding the factors driving inflation, employment, and growth.
- Population studies: Analyzing birth rates, death rates, and migration patterns.

Additional Readings (Jay Forrester):

- Industrial Dynamics
- Principles of Systems
- Urban Dynamics

Morphological Analysis - A method to systematically structure and investigate complex problem spaces.
Developer: Fritz Zwicky
Time Period: 1960s
Example Applications:

- Product design: Exploring potential design configurations and innovations.
- Astrobiology: Analyzing potential life-form structures in extraterrestrial environments.
- Military strategy: Evaluating potential tactical scenarios and approaches.

Additional Readings (Fritz Zwicky):

- Discovery, Invention, Research: Through the Morphological Approach
- Morphological Astronomy
- Entdecken, Erfinden, Forschen im Morphologischen Weltbild

Multi-Criteria Decision Analysis (MCDA) - A tool that helps in making decisions involving multiple criteria, often used when dealing with complex scenarios.

Developer: Various developers in operational research

Time Period: 1970s onwards

Example Applications:

- Infrastructure development: Prioritizing projects based on cost, benefit, environmental impact, and other criteria.
- Pharmaceutical R&D: Deciding which drugs to develop based on potential impact, profitability, and ethical considerations.
- Natural resource management: Evaluating land use options considering ecological, economic, and social factors.

The Cynefin Framework - A decision-making framework that helps to understand the nature of complex problems and how to approach them.

Developer: Dave Snowden

Time Period: 1990s

Example Applications:

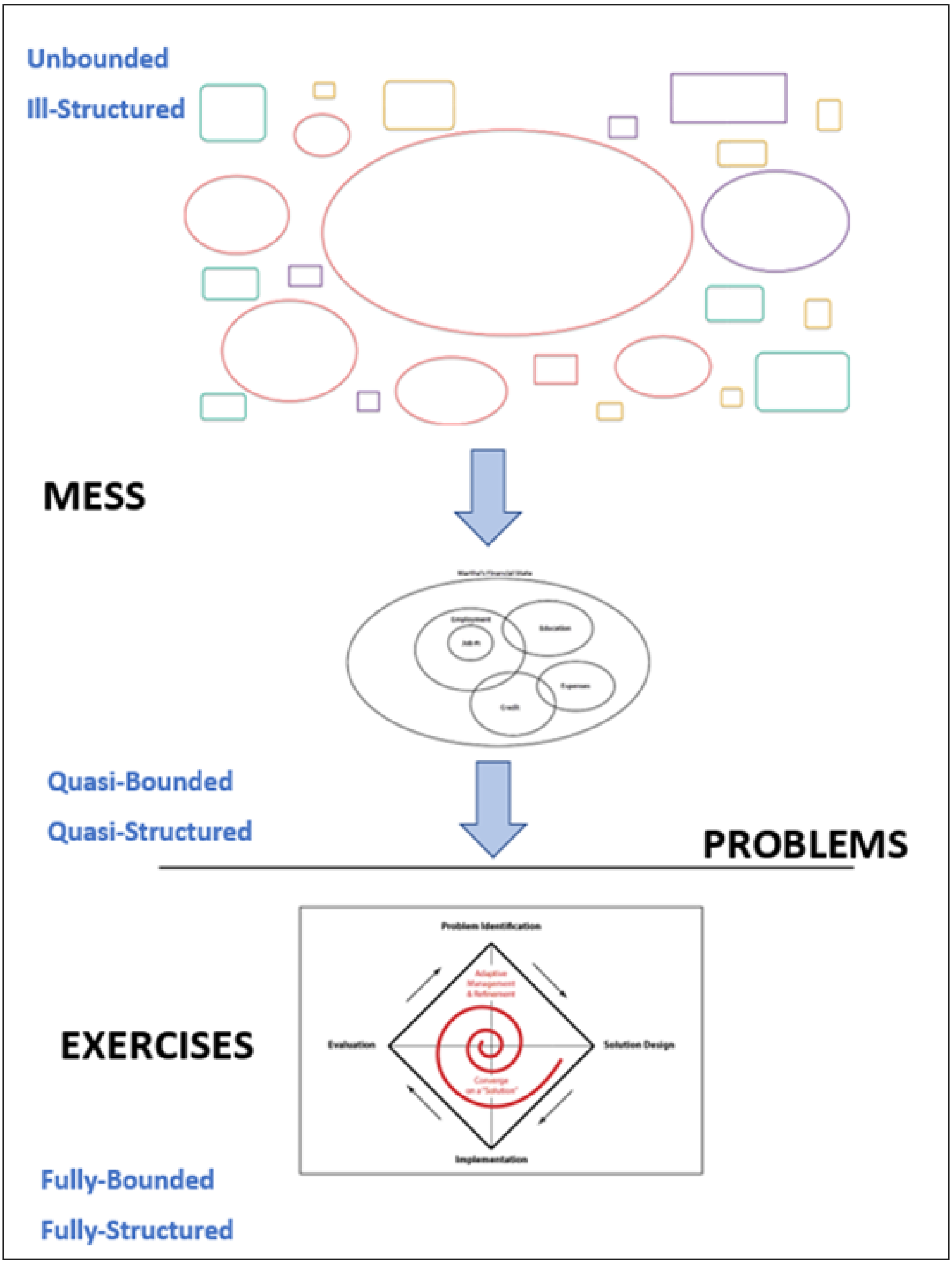
- Organizational change: Guiding companies in navigating change based on the complexity of their situations.
- Crisis management: Assisting leaders in responding to unforeseen events or emergencies.
- Innovation strategy: Helping organizations decide whether to pursue incremental improvements or radical innovations based on the nature of their challenges.

Additional Readings:

- Complex Acts of Knowing: Paradox and Descriptive Self-awareness (journal article)
- A Leader's Framework for Decision Making (with Mary E. Boone in Harvard Business Review)
- Storytelling: An Old Skill in a New Context (in Business Information Review)

While many of these methods have roots in earlier periods, they have been refined and evolved over time, often borrowing from each other and merging with contemporary thinking. Each of these tools and methods have the potential be applied in various sectors and contexts, depending on the nature and complexity of the challenges faced.

Figure 4. Summary of the problem-solving sequence to traverse from a potentially overwhelming mess to implemented solutions, as outlined in this chapter



CONCLUSION

This chapter introduced the concept of exercises, problems, and messes. Exercises are well-bounded, well-structured; you know what the answer will be, but perhaps not the magnitude. Messes are unbounded, unstructured, and highly interconnected… there is no clear end or beginning. Bridging between 'exercises' and 'messes' are 'problems.'

For situations where we find ourselves in a 'mess' (unbounded, ill-structured), we can extract from the mess a subset of conditions using tools such as Venn diagrams, to frame quasi-bounded and quasi-structured "problems" to which the Diamond Model approach to problem solving can be applied. This problem-solving approach provides more explicit structure and boundaries so that a series of exercises can be applied to develop a conceptual model; then a more exacting model from which a preferred solution can be identified and implemented, with success criteria in place so that if significant skew between the intended and actual outcomes occur, we have the ability to refine and revise using adaptive management approaches. Figure 4 shows a summary of the problem-solving sequence to traverse from a potentially overwhelming mess to implemented solutions, as outlined in this Chapter.

COMPREHENSION EXERCISES

1) Which of the following best defines a 'problem'?
   a. A situation that is already perfectly understood and resolved.
   b. A situation with a specific challenge that seeks resolution.
   c. Multiple interrelated situations without clear solutions.
   d. An everyday routine that requires no critical thinking.
2) When employing Ackoff's method of "Resolving", what is the primary goal?
   a. To ignore the problem.
   b. To find the absolute best answer regardless of consequences.
   c. To implement good enough solutions, not necessarily the best or optimal ones.
   d. To redesign the system entirely to prevent the problem's occurrence.
3) Why is the Evaluation step important in the Diamond Model?
   a. To brainstorm alternative solutions
   b. To gather data about the problem
   c. To implement the chosen solution
   d. To assess the effectiveness of the implemented solution

4) Which scenario best exemplifies a 'problem'?
   a. Navigating the interwoven socio-economic challenges of an entire continent.
   b. Finding a way to prevent a particular chemical reaction in a science experiment.
   c. Addressing all the factors of urbanization in growing cities globally.
   d. Living daily life without any specific challenges.
5) According to Ackoff, which of the problem treatments seeks the best possible answer but might inadvertently lead to the emergence of new problems?
   a. Resolving
   b. Solving
   c. Dissolving
   d. Absolving
6) What activities are typically carried out during the Implementation phase of the Diamond Model?
   a. Identifying problems
   b. Brainstorming solutions
   c. Executing the chosen solution
   d. Evaluating the effectiveness of solutions
7) What is the primary focus of the Solution Design step in the Diamond Model?
   a. Implementing the chosen solution
   b. Evaluating the effectiveness of various solutions
   c. Brainstorming and comparing various alternative solutions
   d. Identifying the scope and impact of the problem
8) Why are structured methodologies often useful in addressing problems?
   a. Problems are typically broad and undefined.
   b. Problems require consideration of countless interconnected issues.
   c. Problems usually present specific challenges that can be tackled systematically.
   d. Problems don't require any systematic approach.
9) Which of the following is a characteristic of a problem?
   a. Lack of any clear objectives.
   b. Defined parameters and boundaries.
   c. No potential solutions exist.
   d. Always evolving without any potential for resolution.
10) If a company is trying to determine why a particular software keeps crashing, they are trying to solve a:
   a. Mess.
   b. Routine.
   c. Problem.
   d. General concept with no specifics.

11) Which of the following best defines a 'mess' in a systemic context?
    a. A single, well-defined problem with a straightforward solution.
    b. An easy-to-understand situation with clear boundaries.
    c. A complex situation comprised of multiple interrelated problems without a single well-defined solution.
    d. A routine task with predetermined steps.
12) Which scenario best exemplifies a 'mess'?
    a. Solving a linear equation in mathematics.
    b. Determining the best route for a road trip.
    c. Addressing climate change and its impacts on global ecosystems, economies, and societies.
    d. Baking a cake by following a specific recipe.
13) In the context of Ackoff's problem treatments, which approach involves hoping the problem will vanish on its own without any active intervention?
    a. Dissolving
    b. Resolving
    c. Absolving
    d. Solving
14) Why is addressing a mess often challenging?
    a. It requires only one specialist's expertise.
    b. It can be solved by a single formula or method.
    c. It is static and doesn't evolve over time.
    d. It involves interconnected issues and solving one may impact or complicate others.
15) Which of the following is NOT a characteristic of a mess?
    a. Dynamic and ever-changing nature.
    b. Interrelated sets of problems.
    c. Clear boundaries and singular solutions.
    d. Difficulty in defining completely.
16) If a city is dealing with economic decline, rising crime, failing education systems, and social unrest all at once, it is likely facing what?
    a. A straightforward problem.
    b. An exercise.
    c. A mess.
    d. A defined task with a clear solution.
17) In which step of the Diamond Model is data gathered to define the scope and impact of the issue?
    a. Evaluation
    b. Solution Design
    c. Implementation
    d. Problem Identification

18) What are the four key steps of the Diamond Model for problem-solving?
    a. Research, Planning, Execution, Feedback
    b. Problem Identification, Solution Design, Implementation, Evaluation
    c. Input, Process, Output, Feedback
    d. Assessment, Planning, Execution, Review
19) Which of the following IS NOT, according to Ackoff, an element that may cause significant skew between the actual outcome and the intended outcome?
    a. The information used in making the decision was perfect
    b. The decision-making process was perfect and flawless
    c. The decision may not have been implemented as intended
    d. The environment may have changed in a way that was not anticipated
20) In Ackoff's problem treatments, which method involves redesigning the system to eradicate the conditions causing the problem?
    a. Absolving
    b. Resolving
    c. Solving
    d. Dissolving

REFERENCES

Ackoff, R. L. (1974). *Redesigning the Future: A Systems Approach to Societal Problems*. John Wiley & Sons.

Ackoff, R. L. (1978). *The Art of Problem Solving: Accompanied by Ackoff's Fables*. John Wiley & Sons.

Ackoff, R. L. (1981). *Creating the Corporate Future: Plan or Be Planned For*. John Wiley & Sons.

Ackoff, R. L. (1999). *Ackoff's Best: His Classic Writings on Management*. John Wiley & Sons.

Ackoff, R. L., & Emery, F. E. (1972). *On Purposeful Systems*. AldineTransaction.

Ackoff, R. L., & Gharajedaghi, J. (1971). Towards a System of Systems Concepts. *Management Science*, *17*(11), 661–671. doi:10.1287/mnsc.17.11.661

Ackoff, R. L., & Rovin, S. (2003). *Redesigning Society*. Stanford University Press.

Axelrod, R., & Cohen, M. D. (2000). *Harnessing Complexity: Organizational Implications of a Scientific Frontier*. Free Press.

Brillinger, D. (2002). John Tukey: His Life and Professional Contributions. *Annals of Statistics*, *30*(6), 1535–1575. doi:10.1214/aos/1043351246

Checkland, P. (1981). *Systems Thinking, Systems Practice*. John Wiley & Sons.

Churchman, C. W. (1968). *The Systems Approach*. Dell.

Churchman, C. W. (1979). *The Systems Approach and Its Enemies*. Basic Books.

Dewey, J. (1963). *Experience and education*. Collier Books.

Edwards, A. W. F. (2004). *Cogwheels of the mind: The story of Venn diagrams*. Johns Hopkins University Press. doi:10.56021/9780801874345

Euler, L. (1768). *Lettres à une Princesse d'Allemagne sur divers sujets de physique et de philosophie*.

Flood, R. L., & Carson, E. R. (1993). *Dealing with Complexity: An Introduction to the Theory and Application of Systems Science*. Plenum Press. doi:10.1007/978-1-4757-2235-2

Forrester, J. W. (1961). *Industrial Dynamics*. MIT Press.

Gharajedaghi, J. (2005). *Systems Thinking: Managing Chaos and Complexity: A Platform for Designing Business Architecture*. Butterworth-Heinemann.

Grimaldi, R. P. (2004). *Discrete and Combinatorial Mathematics: An Applied Introduction*. Addison-Wesley.

Henrion, M. G. (1990). *Uncertainty: A Guide to Dealing with Uncertainty in Quantitative Risk and Policy Analysis*. University of Cambridge.

Holland, J. H. (2014). *Complexity: A Very Short Introduction*. Oxford University Press. doi:10.1093/actrade/9780199662548.001.0001

Holt, J. (1902). A Set of Postulates for the Logic of Classes. *Transactions of the American Mathematical Society*, *3*(3), 343–370.

Kesten, H. (1968). *An Introduction to Probability Theory and Its Applications* (Vol. 1). John Wiley & Sons.

Meadows, D. H. (2008). *Thinking in Systems: A Primer*. Chelsea Green Publishing.

Minsky, M. L. (1967). *Computation: Finite and Infinite Machines*. Prentice-Hall.

Mitroff, I. I., & Linstone, H. A. (1993). *The Unbounded Mind: Breaking the Chains of Traditional Business Thinking*. Oxford University Press.

Morin, E. (2008). *On Complexity*. Hampton Press.

Raiffa, H. (1968). *Decision Analysis: Introductory Lectures on Choices Under Uncertainty*. Addison Wesley.

Richardson, G. P., & Pugh, A. L. III. (1981). *Introduction to System Dynamics Modeling with DYNAMO*. MIT Press.

Rittel, H. W. J., & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy Sciences*, *4*(2), 155–169. doi:10.1007/BF01405730

Senge, P. M. (1990). *The Fifth Discipline: The Art & Practice of The Learning Organization*. Currency Doubleday.

Simon, H. A. (1969). *The Sciences of the Artificial*. MIT Press.

Stacey, R. D. (1996). *Complexity and Creativity in Organizations*. Berrett-Koehler.

Sterman, J. D. (2000). *Business dynamics: Systems thinking and modeling for a complex world*. Irwin/McGraw-Hill.

Tufte, E. R. (1983). *The Visual Display of Quantitative Information*. Graphics Press.

Ulrich, W. (1983). *Critical heuristics of social planning: A new approach to practical philosophy*. Haupt.

Venn, J. (1880). On the Diagrammatic and Mechanical Representation of Propositions and Reasonings. *The London, Edinburgh and Dublin Philosophical Magazine and Journal of Science*, *9*(59), 1–18. doi:10.1080/14786448008626877

Waldrop, M. M. (1992). *Complexity: The Emerging Science at the Edge of Order and Chaos*. Simon & Schuster.

APPENDIX- COMPREHENSION EXERCISES: SOLUTIONS

1) Which of the following best defines a 'problem'?
   a. A situation that is already perfectly understood and resolved.
   b. A situation with a specific challenge that seeks resolution.
   c. Multiple interrelated situations without clear solutions.
   d. An everyday routine that requires no critical thinking.

Recommended Answer: b. A situation with a specific challenge that seeks resolution.

2) When employing Ackoff's method of "Resolving", what is the primary goal?
   a. To ignore the problem.
   b. To find the absolute best answer regardless of consequences.
   c. To implement good enough solutions, not necessarily the best or optimal ones.
   d. To redesign the system entirely to prevent the problem's occurrence.

Recommended Answer: c. To implement good enough solutions, not necessarily the best or optimal ones.

3) Why is the Evaluation step important in the Diamond Model?
   a. To brainstorm alternative solutions
   b. To gather data about the problem
   c. To implement the chosen solution
   d. To assess the effectiveness of the implemented solution

Recommended Answer: D

4) Which scenario best exemplifies a 'problem'?
   a. Navigating the interwoven socio-economic challenges of an entire continent.
   b. Finding a way to prevent a particular chemical reaction in a science experiment.
   c. Addressing all the factors of urbanization in growing cities globally.
   d. Living daily life without any specific challenges.

Recommended Answer: b) Finding a way to prevent a particular chemical reaction in a science experiment.

5) According to Ackoff, which of the problem treatments seeks the best possible answer but might inadvertently lead to the emergence of new problems?
   a. Resolving
   b. Solving
   c. Dissolving
   d. Absolving

Recommended Answer: b) Solving

6) What activities are typically carried out during the Implementation phase of the Diamond Model?
   a. Identifying problems
   b. Brainstorming solutions
   c. Executing the chosen solution
   d. Evaluating the effectiveness of solutions

Recommended Answer: c. Executing the chosen solution

7) What is the primary focus of the Solution Design step in the Diamond Model?
   a. Implementing the chosen solution
   b. Evaluating the effectiveness of various solutions
   c. Brainstorming and comparing various alternative solutions
   d. Identifying the scope and impact of the problem

Recommended Answer: c. Brainstorming and comparing various alternative solutions

8) Why are structured methodologies often useful in addressing problems?
   a. Problems are typically broad and undefined.
   b. Problems require consideration of countless interconnected issues.
   c. Problems usually present specific challenges that can be tackled systematically.
   d. Problems don't require any systematic approach.

Recommended Answer: c) Problems usually present specific challenges that can be tackled systematically.

9) Which of the following is a characteristic of a problem?
   a. Lack of any clear objectives.
   b. Defined parameters and boundaries.
   c. No potential solutions exist.
   d. Always evolving without any potential for resolution.

Recommended Answer: b) Defined parameters and boundaries.

10) If a company is trying to determine why a particular software keeps crashing, they are trying to solve a:
    a. Mess.
    b. Routine.
    c. Problem.
    d. General concept with no specifics.

Recommended Answer: c) Problem.

11) Which of the following best defines a 'mess' in a systemic context?
    a. A single, well-defined problem with a straightforward solution.
    b. An easy-to-understand situation with clear boundaries.
    c. A complex situation comprised of multiple interrelated problems without a single well-defined solution.
    d. A routine task with predetermined steps.

Recommended Answer: c. A complex situation comprised of multiple interrelated problems without a singular solution.

12) Which scenario best exemplifies a 'mess'?
    a. Solving a linear equation in mathematics.
    b. Determining the best route for a road trip.
    c. Addressing climate change and its impacts on global ecosystems, economies, and societies.
    d. Baking a cake by following a specific recipe.

Recommended Answer: c. Addressing climate change and its impacts on global ecosystems, economies, and societies.

13) In the context of Ackoff's problem treatments, which approach involves hoping the problem will vanish on its own without any active intervention?
    a. Dissolving
    b. Resolving
    c. Absolving
    d. Solving

Recommended Answer: c. Absolving

14) Why is addressing a mess often challenging?
    a. It requires only one specialist's expertise.
    b. It can be solved by a single formula or method.
    c. It is static and doesn't evolve over time.
    d. It involves interconnected issues and solving one may impact or complicate others.

Recommended Answer: d. It involves interconnected issues, and solving one may impact or complicate others.

15) Which of the following is NOT a characteristic of a mess?
    a. Dynamic and ever-changing nature.
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    c. Clear boundaries and singular solutions.
    d. Difficulty in defining completely.

Recommended Answer: c. Clear boundaries and singular solutions.

16) If a city is dealing with economic decline, rising crime, failing education systems, and social unrest all at once, it is likely facing what?
    a. A straightforward problem.
    b. An exercise.
    c. A mess.
    d. A defined task with a clear solution.

Recommended Answer: c. A mess.

17) In which step of the Diamond Model is data gathered to define the scope and impact of the issue?
    a. Evaluation
    b. Solution Design
    c. Implementation
    d. Problem Identification

Recommended Answer: d. Problem Identification

18) What are the four key steps of the Diamond Model for problem-solving?
    a. Research, Planning, Execution, Feedback
    b. Problem Identification, Solution Design, Implementation, Evaluation
    c. Input, Process, Output, Feedback
    d. Assessment, Planning, Execution, Review

Recommended Answer: b. Problem Identification, Solution Design, Implementation, Evaluation

19) Which of the following IS NOT, according to Ackoff, an element that may cause significant skew between the actual outcome and the intended outcome?
    a. The information used in making the decision was perfect
    b. The decision-making process was perfect and flawless
    c. The decision may not have been implemented as intended
    d. The environment may have changed in a way that was not anticipated

Recommended Answer: a. The information used in making the decision was perfect

20) In Ackoff’s problem treatments, which method involves redesigning the system to eradicate the conditions causing the problem?
    a. Absolving
    b. Resolving
    c. Solving
    d. Dissolving

Recommended Answer: d. Dissolving