

# **A Complex Adaptive Systems (CAS) Approach to**

## **Public Policy Decision Making**

**Society for Chaos Theory in Psychology in the Life Sciences**

**August, 1998**

Glenda H. Eoyang  
The Union Institute  
Chaos Limited

[Eoyang@chaos-limited.com](mailto:Eoyang@chaos-limited.com)

Lois Yellowthunder, Ph.D.  
Postdoctoral Associate  
Department of Anthropology  
University of Minnesota

[lois.yellowthunder@co.hennepin.mn.us](mailto:lois.yellowthunder@co.hennepin.mn.us)

Victor Ward  
Community Faculty  
Metro State University

[vic.ward-1@tc.umn.edu](mailto:vic.ward-1@tc.umn.edu)

Please do not reproduce or distribute without permission.

### **Abstract**

Public leaders depend on the appearance of certainty and stability to maintain their credibility. To sustain this explanatory model, they present their decisions as the result of a rational decision-making process. The general perception is that good decisions result from well designed processes, carefully adhered to. They are based on thorough and thoughtful analysis of trustworthy data. Any public official should be able to describe in detail the sanctioned decision-making process.

Reality does not, however, match perception. The same people who describe an official, rational decision-making process will appeal to many other patterns when they describe their experiences with projects. The reality of public policy decision making simply does not match the assumptions or constraints of the linear, predictable, common decision models.

An alternative approach to public policy decision making is proposed. Assumptions and map of the approach are based on dynamics of complex adaptive systems (CAS). By acknowledging the nonlinear,

iterative, high dimensional nature of public policy issues, the CAS approach allows policy makers and analysts to adopt a more realistic view of the decision-making process.

The paper includes a critique of current problem solving approaches, a list of guidelines for policy development and implementation in a CAS, and an outline of a CAS map for decision making.

## **Introduction**

Public policy decision making is a complicated and unpredictable process. Many contingencies influence the journey and the outcome as an issue moves from its definition to its intended resolution in public policy. The number and relative strengths of various stakeholder groups change over time. Data, which might influence rational decision making, is incomplete, inconsistent, or non-existent. Elected and appointed officials split their focus between technical content of a decision, funding structures and decisions, its influence over future employment, and the need for a solution to a perceived problem. The press focuses public attention on some aspects of a complicated decision, while overlooking others entirely. Many public policies (such as those related to health care, welfare, economic development, and education) involve many different and interdependent factors that must be understood and balanced against each other. Personal and political passions rise in response to many issues that are debated in the public policy arena. Most issues have long and tangled histories characterized by strong and conflicting opinions among constituencies. Levels of knowledge, skill, and experience vary greatly between individuals and among stakeholder groups. Compressed timeframes lead to high-pressure situations in which decisions must be quick and action must be decisive. Legal, regulatory and political factors constrain most, if not all, public policy decisions. These, and many other complicating factors, make public policy decision making a highly complex and uncontrolled process.

Policy analysts and other public servants recognize the messy nature of their decision-making processes, but they continue to rely on models and methods of decision making that reflect linear, rationalist approaches. Figure 1 represents the steps that are generally accepted as an effective and efficient process for public policy decision making. Some policy analysts acknowledge a modicum of nonlinearity in their

process by making feedback loops explicit between steps. Figure 2 shows this more interactive process model. Experience in the policy analysis arena, however, indicates that the process is much more messy and unpredictable than either of these diagrams can indicate.

This mismatch between the articulated and experienced models of decision making is a perfect example of Argyris's distinction between espoused theory and theory in use. In his model, humans make meaning in two distinct contexts: abstracted thought and embedded action. A belief or understanding that is held in thought (espoused theory) may or may not hold true in experience (theory in use). Everyone involved in making public policy can think about the process as if it were well regulated and linear.

Their project plans and shared discourse may revolve around the orderly steps of the problem solving method, which is their espoused theory. In reality, however, they experience the process as a surprising, uncontrolled, and emergent phenomenon. This distinction between espoused theory and experience leads to a variety of unpleasant outcomes. Participants blame themselves or others when the process does not progress as it should. Resources are wasted in pursuit of the perfect and controlled response. Opportunities are missed when serendipity is damped or ignored because it does not fit in the expected scheme. Personal and professional frustration result when well laid plans prove ineffective. When a difference arises between espoused theory and theory in use, most practitioners try to shift their experience to match the accepted theory. They work even harder to get control of the decision-making process and to force it into the linear and predictable pattern. Given the complex nature of the environment in which public policy is made, such a rationalization of the problem seems impossible. The other option for resolving the dissonance is to develop an alternative espoused theory that more nearly matches experience.

The purpose of this paper is to investigate how the science of complexity might be used to describe the decision-making process as it is experienced by public policy practitioners. Complexity can lay the groundwork for a new approach that reflects real-world decision making more accurately than models of the past. To reach this goal, the paper articulates the ways in which the decision-making process, as it is experienced, reflects the behaviors of a complex adaptive system (CAS). It suggests a list of guidelines and

a map for decision-making that could guide public policy development and implementation in a complex adaptive environment. The paper includes the following segments:

- Public Policy Environment as a CAS
- Guidelines for Public Policy Decision Making
- CAS Map for Public Policy Decision Making
- Conclusion

## **Public Policy Environment as a CAS**

The environment in which public policy is made is definitely complicated, but is it technically complex and adaptive? This section provides a working definition of CAS and uses the definition to evaluate the nature of the public policy environment.

A complex adaptive system (CAS) involves a large number of agents that act as parts and interact with each other to generate emergent, system-wide patterns of behavior for the whole. The macroscopic patterns generated in this way feed back into the system by constraining the subsequent behavior of the microscopic agents. The whole system, or environment, determines the fitness of each part, or agent. At the same time, the interactions of the parts form the environment in which all subsequent interactions take place. This complex and mutually causal relationship between part and whole is the mechanism that generates all other characteristic behaviors of a CAS. These characteristic phenomena include unpredictability, scaling, attractors, butterfly effects, heterarchy, dynamical behavior through time, turbulent boundary conditions, emergence, lock in, and so on.

Figure 3 depicts the complex interactions between and among structural levels in a CAS. These are the relationships that amplify or damp individual behaviors as they merge and transform into system-wide emergent phenomena. Figure 4 depicts how these relationships can be used to model the environment in which public policy decisions are made. Specifically it represents part of the complex interactions related to the use of tobacco and the 1998 lawsuit between the State of Minnesota and tobacco companies.

The application of the model image from one domain (CAS) to another (public policy decision making) is not sufficient to demonstrate that the two share the same causal mechanism. Two other arguments will suffice for the purposes of this paper. First, does the public policy environment demonstrate outcome behaviors that are common in other CASs? Second, does thinking about public policy as a complex adaptive phenomenon provide new options for action?

Decision making in a public policy arena demonstrates the characteristic behaviors of a CAS. Both procedural steps and outcomes of such processes are **unpredictable**. Even though each player has a plan and an expected outcome, the objective observer recognizes that the outcome is not predictable. The most experienced and knowledgeable participant recognizes the risk of making public predictions about how a decision will be made and what its consequences will be. Decisions and actions are frequently **scaled** across the system when individuals' values and expectations are reflected in institutional actions and statements of public policy. This is especially clear when power shifts from one political party to another, and many aspects of government shift in response. Policy is sensitive to **initial conditions**. A small variation in any one of a number of variables can swing the decision-making pendulum to another extreme. Public institutions, as well as private ones, tend to **lock in** on specific solution sets or approaches. Tradition and voter expectations are often used to justify or rationalize governmental lock in across democratic societies. Other forces facilitate lock in for other forms of government. History, culture, nationalism, and public opinion are examples of **attractors** that emerge from the complex interaction of public policy making. The **heterarchy** of public policy is demonstrated by the multiple, massively entangled institutions that influence policy development, including religious institutions, cities, states, counties, federal government, school districts, special interest groups, political parties, personal and family connections, private industry, and so on. Each of these constituencies (as shown in Figure 3) represents the multi-directional and overlapping causal structures that are typical in the heterarchical environments of CASs. Public policy decision making is both **nonlinear** and **dynamic**. Each decision builds the framework for the next, and parameters are related in complex and nonlinear ways. Though the system is assumed to be seeking equilibrium, history points out that **far-from-equilibrium** is the more common state of public

policy development and implementation. In all of these ways, the public policy arena demonstrates the behaviors that are generally considered to be characteristic of complex adaptive systems.

There is little to be gained by simply demonstrating that the mechanisms and outcome behaviors of the public policy environment are like those of CAS. Such an argument might expand our understanding of policy making and perhaps even of CASs, but it would not contribute significantly to the resolution of the dissonance between espoused theory and theory in use for persons involved in public policy decision making. If the investigation is to be meaningful, new recommendations must emerge to bridge this chasm between policy theory and practice. If, indeed, public policy environment is a CAS, then a decision-making model based on CAS should provide new insights into how public policy is made in the real world. Figure 4 may present an intuitive example of a reasonable description of a complex and adaptive public policy world. The next section outlines some considerations and a map for effective policy making in a CAS environment.

## **Guidelines for Public Policy Decision Making**

The high dimensional and iterative nature of a CAS makes it difficult, if not impossible, to define a list of steps or a clear-cut recommendation for a decision-making process. Rather than a problem-solving procedure, the policy maker in the CAS must make do with a few guidelines and a model of interacting images that influence the policy-making process and outcomes. Together, the guidelines and the images constitute a decision-making map that can function as the espoused theory for policy makers who acknowledge the complex adaptive nature of their environments.

The CAS lens illuminates many different aspects of the process of public policy decision making. In conversations with experienced policy planners and analysts, the following issues were discovered to be lessons that can transfer from complexity science to public policy decision making.

Multiple, rich, and varied feedback loops establish the mechanism for influencing policy (see Figure 4). Players in the policy arena will be most effective when they sustain on-going relationships with others

involved in the process. Single-minded connections, even with persons who are well placed and powerful, prove to be tenuous over time. In contrast, persons who participate in a wide variety of the interdependent, generative feedback loops will be most able to anticipate and influence significant change. Their influence will be more resilient and of longer duration.

Change does not come from outside the system. Boundaries in the world of public policy are fractal and permeable. Figure 4 models the complex interdependency and difficulties of identifying clear and discrete boundaries that separate "inside" from "outside." Forces that are imposed from a distance have little promise of making long-lasting change in a CAS. In the same way that patterned behavior of the CAS is constantly reinforced by the actions of participating agents, patterns of social behavior are self-reinforcing. Lasting and radical change comes from a refocus of the system on some inherent, but under-recognized pattern that already exists within the system. Effective change agents do not introduce something new, they find some constructive and salient feature of the system and amplify it until it dominates less desirable behaviors. For example, in the situation shown in Figure 4, the Minnesota Attorney General chose to go to court rather than to join a national coalition of Attorneys General.

Funding is the most powerful of feedback media. Transforming feedback loops in CASs can carry material, energy, or information. In a policy making environment the most effective of the feedback media is money. If the policy maker understands the flow of money and the transformations along the way, he or she can build an adequate picture of the system's dynamics. Disrupting these funding feedbacks will shift the system dynamics, perhaps in unpredictable ways.

A homogeneous system is more comfortable but less adaptable than a heterogeneous one. Low levels of differentiation in a CAS lead to high stability and predictable patterns of behavior. Many dimensions of difference or great magnitudes of difference, on the other hand, lead to instability and unpredictable patterns. A system that is in a less stable state may be uncomfortable for individuals, but it has a much higher capacity for adaptation than a system that is more stable, homogeneous, and comfortable.

Data collection remains critical in a CAS, but for different reasons than it is important in linear decision-making process. In a rational, linear decision environment, data provides the foundation for predicting the future of the system and finding the best solution. Such prediction is impossible in a CAS, but the value of data remains. First, data collection is a process that takes time. While data is being collected, patterns of behavior emerge and may become articulated sufficiently to support the decision-making process. From this perspective, data collection is a delay tactic that allows time for the systemic patterns to mature before a decision must be made. Second, nonlinear and graphical analysis techniques can be used to identify patterns of behavior from data over time. Third, data can be used to note the scale of a problem or capacity for a solution, even when the system is too complex to generate precise data, it may be able to show trends in orders of magnitude through data collected and analyzed. Finally, data may be used *post hoc* to rationalize a decision that has already been made. Though these uses of data are quite different from traditional data analysis approaches, they do provide insight into the dynamics of the CAS environment and can support effective policy formation and implementation.

A short list of simple rules may generate complex behavior. Not all complicated-looking patterns come from complicated roots. In a CAS, a short list of simple rules can generate complex and unpredictable outcomes. If one can articulate a short list of rules that is sufficient to generate observed behavior, then the same list can suggest options for intervention. In addition, short lists can be used proactively. When a new system is being instituted, a short list of simple rules (or min specs) can be stated as initial parameters to provide both focus and freedom for the system activities.

Paradoxes should be pursued, not avoided. The tension of differentiation, or paradox, is the motive force in a CAS. Paradoxes also hold the flow of energy in a public policy decision-making environment.

Fundamental paradoxes often hold significant meaning for a group. As a difference that makes a difference, a paradox may shape the conscious and unconscious behavior of a group. By acknowledging and examining a paradox, a group can generate energy, overcome barriers related to the creative tension, and build shared meaning in the midst of diversity.

Flows and nodes determine the shape of the future. When you perceive the complex interactions of feedback loops in a system, you recognize that the flow of materials, energy, and information form the patterns of future growth and development. Nodes, points where the flows intersect, become powerful leverage points for action. Mapping the flows and nodes provides insight into the dynamical evolution of the system as a whole and provides valuable insight to policy development and implementation.

Resistance to change is really attraction. An attractor describes the predominant pattern of behavior in a complex system. The pattern emerges from the interaction of the parts, but it also constrains the behavior of the parts. In this way, the attractor becomes a self-fulfilling prophecy (Goldstein). Frequently in human systems, the behaviors that contribute to perceived resistance are merely the consequences of a powerful, though counter-productive attractor. Different constituencies may appear to resist a particular reform, but CAS dynamics recognize the apparent resistance to be the result of a system attractor. A constituency is "trapped" in its own patterns of behavior and will not easily be moved. When a change agent recognizes what existing patterns are being reinforced, then he or she has new options for intervening.

The question communicates much more effectively than the statement. In a CAS, the focus for action should be on the interdependent transformation among agents and between agent- and emergent-level behavior. Effective, transformative feedback requires that both participating agents be changed in the interaction. Bald-faced statements do not open one to change, but questions do.

Openness and internal consistency are antithetical. To be internally consistent and orderly, a system must be closed to external influences. Figure 4 demonstrates how the openness of the system can generate multiple and unexpected outcomes. If a system is open to external influences, it will be messy because it cannot sustain internal consistency for any length of time. Every public policy decision and all policy-making processes must strike a balance between openness and consistency. A corollary to this statement is the fact that an open system cannot exist productively within a closed system, but a closed system can exist within an open one. The Trickster, an ethnographic concept, personifies the intriguing and disturbing nature of this open and messy world. The Trickster is a mythical character who appears in cultures around the

world. Its purpose is to make manifest the aspects of reality that are neither understood nor controlled. Culture attempts to control, contain, and explain randomness by personifying it as a Trickster, running like a jagged discontinuity through the predictable patterns for human existence. The Trickster is neither good nor evil, but is looked upon with fear and ambivalence at best. There is an element of a practical joker in the Trickster's effect. In a CAS, phenomena that depart from the range of expected patterns provide information about possible future states of the system. The same is true of the Trickster. The surprises, jokes, and serendipitous events it represents can provide a wealth of information to the astute decision maker in a CAS policy environment.

Time and space can be manipulated to increase freedom of movement. Many factors today are compressing space and time. Technology, rapid travel, merging markets, deregulation, and economic pressures are all shortening the time and space allowed for meaningful interaction. Doing more in less time and space is certainly one response to this trend, but it is not the only one. The policy maker can move against the tide and selectively expand time or space to meet specific needs.

In a CAS, power comes from the ability to read patterns, to determine their value, and amplify or damp them. Power in any human system comes from the ability to make meaning and to effect action based on that meaning. In traditional systems, all meaning revolved around prediction of the future. In CASs, prediction is not possible, so the definition of meaning must evolve. Because pattern embodies the past and defines the future of the complex adaptive system, the pattern becomes its source of meaning. The ability to discern and influence pattern, therefore, becomes the definition of the new power in a CAS.

Shared meaning is the core component of public policy development and implementation. The foundation of a successful policy is the shared meaning it embodies. An effective process for policy development must focus on building shared meaning among decision makers and between decision makers and the general public.

Even if the policy makers recognize the complex dynamics, the public still has command and control expectations. Even when participants and policy makers recognize that their decision-making environments are unstable and unpredictable, their constituencies do not. For this reason, the publicly espoused theories may still require some linear, rational decision-making models. Decision makers can be conscious and intentional about whether and when they espouse the linear or CAS models. The rational one can support communication with persons outside of the process, and the CAS one can shape planning and communication with persons involved in the process.

These insights come from CAS and are intended to influence the outlook and behavior of public policy decision makers. Some of them match and others run counter to common notions and intuition. All, however, are derived from the study of CASs and are relevant to the public policy decision maker in today's complicated environment.

## **CAS Map for Public Policy Decision Making**

Effective public policy both embodies and engenders shared meaning across the community. By articulating shared beliefs and framing shared action, policy statements both reflect and build meaning. The linear problem-solving approach is one method of creating shared meaning in a closed and predictable world. A new CAS approach to public policy development and implementation should focus on ways to determine, articulate, communicate, and implement patterns of meaning within an environment that is highly complex, unpredictable and dynamic. Tools for CAS policy decision making do not form a step-by-step procedure, nor do they form mutually exclusive categories of action. They all are in effect at the same time, each responding to and shaping the others. The categories constitute an array of frameworks that can help a group turn individual meanings into shared patterns that are the foundation of effective public policy. The images are defined below and are shown graphically in Figure 5.

Metaphor. A metaphor is an image that bridges between the familiar and the unfamiliar. It takes patterns of meaning that are commonly understood and applies those patterns to something unknown. An apt metaphor is critical to effective public policy decision making. The metaphor shapes the possibilities for action. In

addition, the process of defining an apt metaphor leads a group to articulate their individual perspectives and to move toward perspectives that are shared.

**Model.** A model represents the causal connections that underlie the patterns described by the metaphor. These causal patterns are neither universal nor absolute. Different patterns and causal relationships will be relevant in different times and places. The model defines categories of objects and interactions that are believed to generate the systemic patterns of interest at a given time and place. A model may be represented in many different ways and articulated in a variety of symbol sets. Sometimes it is a formalized map of interactions like flowcharts or systems diagrams. Sometimes it is a three-dimensional construction that represents the parts of the system of focus and their relationships to each other. Sometimes it takes the form of a story or a representative case history. Like the dynamic of forming the metaphor, the conversation around construction of the model is just as valuable as the finished product.

**Current Dynamic.** A model tends to be static. It represents a snapshot of the system at a given point in time. The dynamic image of the situation, however, considers the rate and direction of transformation that are latent in the system. A variety of languages can be used to describe the current dynamic. The most formal and objective is time series analysis of data leading up to the present time. The most informal might include the personal perceptions, fears, hopes and concerns of a decision-making group. However this dynamic is captured, it forms the basis for shared understanding and influence on the emergent patterns that public policy seeks to shape.

**Fitness Criteria.** Within the dynamic emergence of system behavior, some criteria are at work determining what are more and less "fit" features and behaviors. Unless policy makers articulate and work within these criteria, their solutions will not meet the needs of the system and will not be effective. In some ways, this is the most challenging component of the map. Fitness criteria are frequently different for individuals and for a group as a whole. Hidden agendas and personal objectives make fitness criteria highly politicized and often private. If a group can identify its fitness criteria, however, it can begin to move toward common goals and to evaluate the effectiveness of specific policies and actions.

These four items are intimately related to each other, though each has its own content and role in the decision-making process. They are presented in sequential order here, but they are not temporally dependent. In reality, all four are developed in parallel. Each of the images develops through iterative interaction with the others. As the model becomes clearer, the metaphor emerges more completely, and the current dynamic and fitness criteria are clarified. As the fitness criteria emerge, the metaphor becomes clearer, and the details of the model are easier to articulate.

These four items, metaphor, model, current dynamic and fitness criteria, all emerge together as the policy-making group comes to understand the situation and to build shared meaning. This process of building shared meaning is the essence of public policy decision making in the complex adaptive environment of the future.

## **Conclusion**

This paper has outlined an approach to public policy decision making that is derived from the study of complex adaptive systems. The purpose was to define a theory of decision making and public interactions that would be more compatible with real lived experience than the rational, linear decision-making models traditionally applied to public policy work. The paper described the dynamic mechanisms of a CAS and demonstrated how they apply to public policy. It outlined how the public policy arena mirrors many of the characteristic outcome behaviors of CASs. It provided guidelines for realistic action in a complex policy environment, and it outlined a map for policy development, based on the dynamics of a CAS.

This paper is an initial effort to apply principles from complexity to improve the theory and practice of public policy decision makers. In the future, the various avenues will lead to wider and more thorough research in the area. These ideas should be shared with and critiqued by persons involved in the development and implementation of public policy. The map should be introduced in an action research project with a real policy development and implementation case. First-hand observation of the decision-making process should be used to confirm or deny the CAS aspects of current decision-making practice.

The effectiveness and efficiency of public policy development affects the quality of life for everyone. Resolution of the dissonance between the espoused and practiced theories of decision makers will give them new tools for understanding the public policy processes. It will also reduce the personal and professional frustrations that emerge when public servants work in a system that does not meet expectations for control and predictability of the linear process.

*Figure 1. The Rational Problem Solving Process*

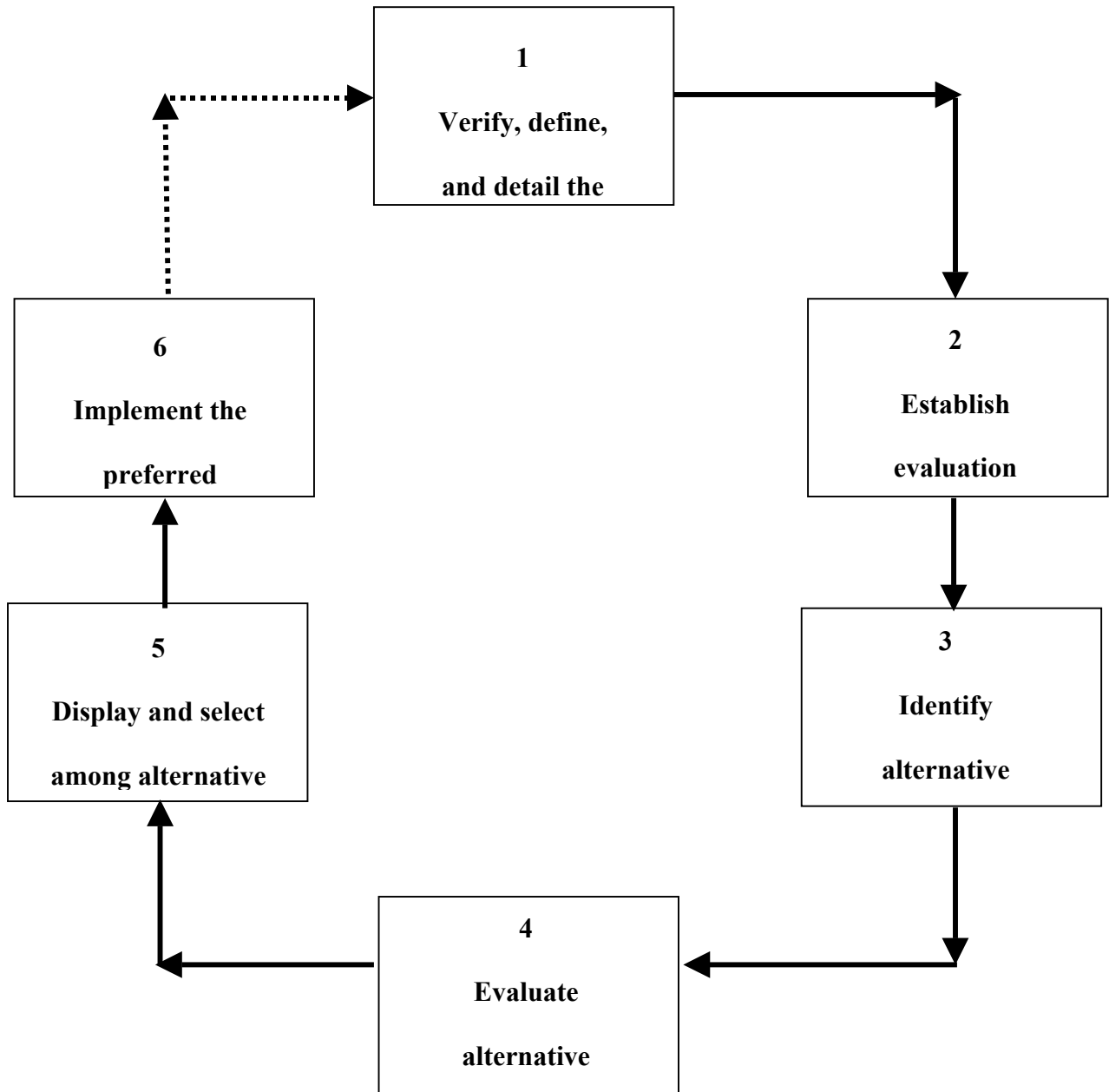




Figure 3. Feedback Loops and Emergence in CAS

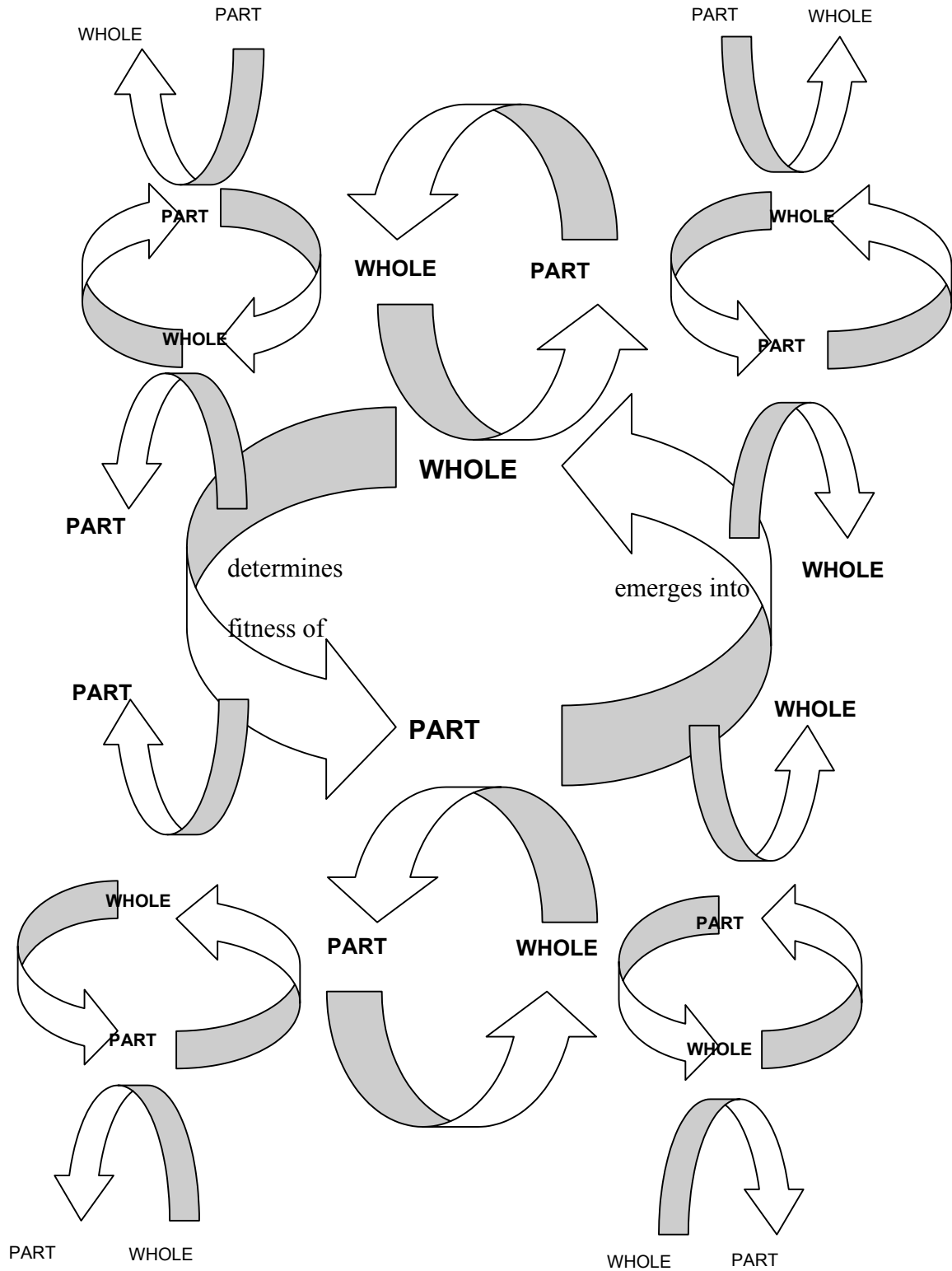
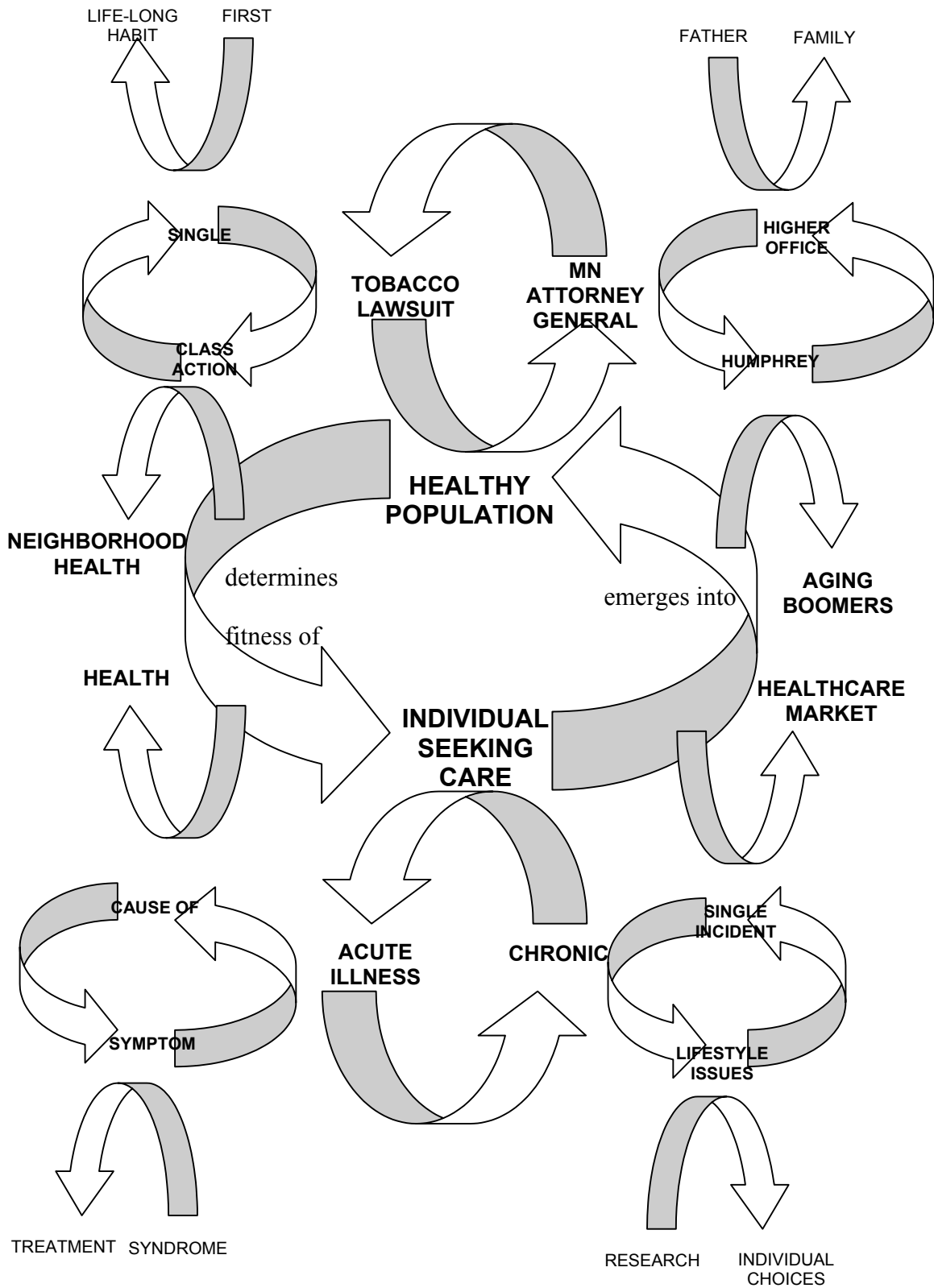


Figure 4. Public Policy Decision Making as CAS



*Figure 5. Map for Public Policy Decision Making*

