


Concept Paper

# Science-Driven Societal Transformation, Part III: Design

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**Abstract:** Climate change, biodiversity loss, and other major social and environmental problems pose severe risks. Progress has been inadequate and scientists, global policy experts, and the general public increasingly conclude that transformational change is needed across all sectors of society in order to improve and maintain social and ecological wellbeing. At least two paths to transformation are conceivable: (1) reform of and innovation within existing societal systems (e.g., economic, legal, and governance systems); and (2) the de novo development of and migration to new and improved societal systems. This paper is the final in a three-part series of concept papers that together outline a novel science-driven research and development program aimed at the second path. It summarizes literature to build a narrative on the topic of de novo design of societal systems. The purpose is to raise issues, suggest design possibilities, and highlight directions and questions that could be explored in the context of this or any R&D program aimed at new system design. This paper does not present original research, but rather provides a synthesis of selected ideas from the literature. Following other papers in the series, a society is viewed as a superorganism and its societal systems as a cognitive architecture. Accordingly, a central goal of design is to improve the collective cognitive capacity of a society, rendering it more capable of achieving and sustainably maintaining vitality. Topics of attention, communication, self-identity, power, and influence are discussed in relation to societal cognition and system design. A prototypical societal system is described, and some design considerations are highlighted.

**Keywords:** societal transformation; societal system; societal cognition; systems change; sustainability; climate change; biodiversity loss; active inference; free energy principle; cooperation; SAILS

**JEL Classification:** B50; I3; O1; O30; P20; P41; P50; Q01; Q54; Q57



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## 1. Introduction

Societies worldwide face a host of serious social and environmental problems, including poverty, climate change, and biodiversity loss. Despite decades of warnings by the scientific community, insufficient progress has been made and as a result, risks have become severe [1,2]. For example, one rough estimate is that climate change could cause between 1.5 and 30 million premature deaths annually on average over the next one to two centuries, even if the rise in global temperature is limited to 2 °C [3]. A growing number of scientists, global policy experts, and individuals in the general public conclude that societies must undergo bold, transformational change if humanity is to successfully address its problems and improve and maintain social and ecological wellbeing [4–14]. The meaning of transformation, its goals, and paths to achieve it are increasingly topics of discussion in the science literature [10,15–19].

The terms transition and transformation are often used interchangeably in the literature, but Holscher highlights differences [20]. The focus in the transition literature tends to be on isolated societal subsystems (e.g., energy and transportation subsystems), while that in the transformation literature tends to be on whole societal systems (e.g., governance and economic systems). In the multi-level perspective (MLP) of Geels, these correspond to the socio-technical regime and landscape levels, respectively [21,22]. For example, the research

agenda of the Sustainability Transitions Research Network (STRN) targets the meso-level of socio-technical systems as a unit of analysis [23]. The STRN agenda specifically omits the meta (e.g., whole-system, landscape) level, in which, for example, alternatives to capitalism and dominant forms of governance might be considered.

While the scope of the transitions field has been broadening in recent years from its initial focus on socio-technical systems to a greater recognition of socio-ecological, socio-economic, and socio-political systems as relevant objects of transition [24], Feola points out that the field has so far failed to engage with any significant analyses or critiques of capitalism [25]. Both Feola and Vandeventer et al. [26], for example, argue that transitions research could usefully extend its reach to include capitalism as a topic of analysis. Similar arguments could be made for including governance and other meta-level systems as topics of analysis. Likewise, Schot and Kanger suggest that transitions research could extend the MLP to include “deep transitions” that involve fundamental and coordinated transformations within multiple socio-technical systems [27]. For now, however, the focus of the scientific literature on societal change tends to be on the reform of and innovations within existing meso- and meta-level systems, especially isolated socio-technical systems.

A smaller body of literature addresses meta-level transformation, beyond reform, see [25,26,28–33] and references therein for examples. Fazey et al. also distinguish between reform and transformation [15]. This paper adds to that body. It is the final in a three-part series of concept papers that together propose a practical, affordable, science-driven (evidence-based) research and development program aimed at societal transformation, where transformation is understood as the *de novo* development of and shift to new and improved, integrated societal systems. Parts I and II in the series provide definitions, aims, reasoning, worldview, motivation, and a theory of change [34,35]. This paper discusses high-level design aspects of new societal systems.

In this series, a *societal system* refers to a meta-level form of societal self-organization that involves societal cognition (e.g., collective learning, decision making, and adaptation). The plural, *societal systems*, refers to the collection of systems in (real or potential) use by a society, unless otherwise clear from context. In Parts I and II of the series this collection is summarized as including six overarching systems: economic, governance, legal, health, analytical, and education, as well as their associated institutions, rules, policies, and coevolving social-cultural components (beliefs, values, norms, and worldviews). To discriminate new, *de novo* designed systems from existing systems (those in use by societies today), the latter are called *native systems* in this series.

For the purposes of the R&D program, a society need not be large (like a nation). Here, *society* refers to any sizable scale of social organization, from local community up through city, region, and nation. Local community refers to a fraction of an urban or rural population. A local community can be but is not necessarily (or usually) a formal political body, such as a city. *Society* is also used in this series to refer to a group of cooperative organisms, such as cells in a tissue, or bacteria in a colony. The distinction should be clear from context.

The definition of societal systems in use here is based on the concept of a function system, as described by Roth and Schutz [36], who build on the work of Luhmann (see for example [37,38]). According to their criteria, a function system: (1) is an observable system that is not a subsystem of other social systems, other than the system of a society as a whole; (2) involves a communicative system whose basic operations refer to a society; and (3) manifests the functional perspective at work. Roth and Schutz identify ten function systems, listed here with their one-word functions in parentheses: economic (distribution), political (limitation), legal (standardization), health (restoration), science (verification), education (formation), art (creation), religion (revelation), sport (mobilization), and mass media (multiplication). The first six of these correspond to the six overarching systems identified in the preceding paragraph. Art, religion, sport, and mass media are addressed more indirectly in this series. For example, the proposed R&D program does not seek to design new religious systems, but does discuss a worldview in which revelation (of

the interconnectedness of all things) plays a role. Mass media, in the sense of societal communication, is mentioned later in this paper.

The term *institutions*, used in the definition of a societal system, signifies concrete organizations within a system, for example, a tax collection agency within a governance system, or a university within an education system. But the whole of “institutions, rules, policies, and coevolving social-cultural components (beliefs, values, norms, and world-views)” refers to social institutions more broadly, as defined by Grabner and Ghorbani based on a synthesis of different perspectives [39]. They define social institutions as codifiable systems of social structures (in particular, norms and rules) that incline individuals to act in specific ways. Of note here is the effect of social institutions on individual (and thus also societal) cognition. They constrain and enable people to act and coordinate in complex and uncertain social arenas. This is accomplished, in part, by stabilizing the expectations of individuals about the behavior of others. As such, social institutions allow individuals to offload some of the cognitive burden that would otherwise be required to compute (and anticipate) the state of play and the beliefs of others.

To my knowledge, this series is the first description in the science literature of a viable R&D program aimed at research, development, testing, implementation, monitoring, and improvement of de novo designed, integrated societal systems. Moreover, it builds from a perspective that has not yet been addressed in the transition or transformation literature. A society is viewed as a superorganism [40] and its societal systems as a cognitive architecture. More specifically, societal systems are viewed as an enactive-cognitive architecture, where cognition occurs via an action-inference circular loop (discussed shortly).

Accordingly, in the context of the proposed R&D program, the goal of transformation is to develop and implement systems that can best facilitate societal cognition. Desirable conditions, such as clean air, low rates of disease, equality, economic security, and a high degree of social welfare, are seen as the product of functional societal cognition, extended over time. In this view, the intrinsic purpose of societal cognition is to achieve and sustainably maintain (social and ecological) vitality [41]. Like any organism, a society must learn, solve problems, adapt to changing conditions, and perform other cognitive tasks in order to self-regulate, avoid danger, and thrive. Moreover, its cognitive systems must be robust and resilient if they, and the society, are to remain functional under stress.

The cognitive view, described in detail in Part I of the series [34], suggests new avenues for research within the transformation field. For example, it suggests new ways to conceptualize, monitor, and examine the fitness of individual and integrated societal systems. Furthermore, it lends itself to explanatory, even forecasting models of individual and group behavior, and could facilitate the integration of model- and human-based problem solving. As such, it raises new opportunities for evidenced-based design and operation of new societal systems.

Moreover, the cognitive view identifies an intrinsic purpose of a society, which is the same as the intrinsic purpose of societal cognition: to achieve and sustainably maintain (social and ecological) vitality [34]. This purpose is both aspirational and functional. As described in Part I of the series, a suggested ordering of topics leading to design is: *worldview* → *purpose* → *fitness metrics* → *system design*. Purpose informs design, and gives meaning to metrics and system assessment. Does a system, or set of systems, fulfill its purpose? Beyond this, in the social setting, an explicit shared purpose might help to unite individuals, focus attention on common causes, and encourage cooperation. As we will see, association, attention, and cooperation are all aspects of societal cognition. In this sense, an explicit purpose could itself aid societal cognition.

### 1.1. R&D Program

The proposed R&D program is conceptual. It is not yet funded or initiated. As discussed in Part II [35], it represents a long-term partnership between the global science community, local communities, and other interested parties. It is a program of research and discovery, not a business proposal; it produces knowledge that is freely available to

the world. Moreover, it is an example of an expanded, explicitly normative, and reflexive *second-order* approach to science [15], where the effort is value driven and the participants are scientists and stakeholders who learn, develop, and evaluate solutions together.

As described in Part II, societal systems developed by the R&D program would be implemented at the local community level via a special kind of civic club. A club is a kind of society, comprised of individuals and organizations that voluntarily choose to participate in the use of new systems. Club systems overlay and interact with native ones. Clubs are interconnected via networks, which also are designed to function as cognitive systems. By design, clubs cooperate via networks in matters such as trade, education, public health, ecosystem repair, and club replication. As clubs grow and replicate, they impact an expanding segment of the global population. The target is large-scale change, achieved over an anticipated 50-year horizon.

Other R&D programs aimed at societal transformation are conceivable, and these might employ different worldviews, definitions, theories of change, approaches, aims, timelines, and scales of impact. While design is discussed here in the context of the proposed R&D program (e.g., congruent with a particular worldview, theory of change, and so on), many of the ideas and perspectives offered could be relevant to any R&D program aimed at societal system design. Furthermore, if multiple R&D programs are proposed or constituted, the ideas here could allow for comparisons.

### 1.2. Active Inference

New societal systems, as realized through club and network designs (i.e., through the R&D program), are called *Societal Active Inference and Learning Systems* (SAILS). This is in nod to the work of Karl Friston, the neuroscientist who is primarily responsible for the concept of active inference [42,43]. Active inference is a mathematical formulation that describes how living systems (i.e., individuals) maintain themselves within a limited range of phenotypic states, as necessary for health and life [44]. It is a Bayesian explanation of biological self-organization and cognition, and represents a process-theory corollary of the (variational) free energy principle, also developed by Friston [45–47]. Hereafter, in reference to de novo designed systems, the terms *club*, *SAILS*, and *societal systems* are used interchangeably.

The concept of an *individual* requires that a living system be demarcated from its surrounding environment. In active inference and the free energy principle, that demarcation is provided by a Markov blanket, a statistical boundary that causally separates self from outside world [48,49]. Under this formalism, an individual has beliefs (priors, in a Bayesian sense) about how the world works, and about how a being like itself supports and maintains life. One could say that an individual has a generative model (or models) of its world. But more correctly, the individual, as a whole, constitutes a generative model of the regularities of its world, including its social world. Cognition, in this view, is embodied, enacted, embedded/enculturated, and extended [50–53]. The central aim of cognition is not so much to construct an accurate (low-error) model of the world, but rather to facilitate action in and adaptation to the world, such that those phenotypic states beneficial to and necessary for life are maintained [43]. For example, cognition helps an individual to secure food, as is necessary to prevent starvation and promote health.

Said differently, cognition does not directly minimize model error, but some other informational quantity (that is related to error). The free energy principle postulates that any adaptive change in the individual will minimize (variational) free energy [54]. Free energy is an upper bound on the negative log evidence of a model, in this case, the generative model of the individual. Evidence is the probability of data, after all model parameters have been integrated out. Negative log evidence is also known as *surprisal* in Bayesian statistics. In effect, observed data that are unexpected under a given model are surprising. By minimizing free energy, an individual minimizes surprise. Active inference is the process theory that describes how free energy is minimized [55].

In active inference, cognition is viewed as an action-inference loop. The beliefs (priors) of an individual, and the expectations that derive from them, lead to action. Action impacts the environment, producing some effects. The individual senses those effects (perhaps imperfectly), and compares sensations to those that were expected based on beliefs. If they differ—if observations are surprising—then learning (updating of the individual's generative model) might be necessary.

An individual uses action to probe and impact the world. It can choose actions that are expected to produce conditions that the individual expects or desires. For example, an individual might put on a coat to maintain a comfortable body temperature. If the individual is still cold after putting on a coat, he or she might learn that a heavier coat is needed in cold weather. An individual can also choose actions that explore the world, for example, to gain information about social context. Whether the aim is goal achievement or epistemic gain, an adaptive individual chooses actions that minimize expected free energy [56].

Because expected free energy is mathematically equal to expected cost (the divergence between predicted and preferred outcomes) plus expected entropy (ambiguity, or uncertainty) of sensations under predicted states, minimization of expected free energy can be understood as minimization of expected uncertainty; expected divergence is always equal to or greater than zero, so expected free energy is an upper bound on expected uncertainty [48,57]. In short, we can view action-cognition as an uncertainty (and surprise) reducing process.

We have been speaking as if an individual is a person, but that need not be (and often is not) the case. In active inference, any system demarcated from its surroundings by a Markov blanket and demonstrating a nonequilibrium steady state density (i.e., a dynamic system impacted by its environment that maintains itself from decay) is an individual. Thus, persons and cells, and societies of these, are individuals. Active inference is congruous with other new theories of individuality, also based on information theory, that describe flexible, overlapping, hierarchical blankets of individuality and selfhood, where no single level or scale has privilege [48,58]. The generic label “agent” is used throughout the text to refer to an individual of any kind.

Active inference, its extensions (like variational ecology [59]), and related frameworks (like predictive processing/coding [60–62]) are highly relevant to discussions of societal transformation. If societal systems are viewed as a cognitive architecture, then theories of cognition would naturally play critical roles in the design, testing, and operation of new systems. Viewed through the lens of active inference, functional cognition reduces uncertainty about achieving and maintaining vitality [48,63]. In particular, it reduces expected uncertainty about essential variables—those (potentially unknown or hidden) variables that are most important to continued vitality [64]. Thus, based on the cognitive view, metrics for assessing system fitness and operation could span not only quality of life and quality of environment factors, but also, for example, the degree of uncertainty about achieving and maintaining desired conditions, the attention paid to essential variables, and the capacities to gather information, remember, learn, and accurately anticipate/forecast future conditions.

Active inference can also provide insight on how and why individuals cooperate and self-organize into institutions and societies, again related to uncertainty reduction. As already mentioned, people form social institutions to reduce the uncertainty and cognitive burden that would otherwise be experienced in uncertain social arenas. Active inference provides a mechanism, and mathematical formalism, by which this occurs.

Minimization of expected uncertainty through action implies anticipation (of future states and events) and is tantamount to functional and efficient learning, problem solving, and adaptation. All biological organisms (including superorganisms) are fundamentally anticipatory in nature [65,66]. Much of what we take to be central to intelligence—perception, attention, emotion, learning, and language—can be understood within a framework of prediction, action, error correction, and uncertainty reduction [61,67]. Not surprisingly,

narrative too, and communication more generally, can be cast in an action-cognition framework [68–70]. The relevance of active inference to social psychology and social institutions has only started to become clear. As Badcock et al. phrase it, “the elegant idea that we operate together to minimize collective uncertainty stands to cast new light on classical [social] phenomena” [71].

Already, active inference appears in deep learning [72] and economic models [73]. In coming years, it will likely be used more widely in artificial intelligence and the social sciences. As our understandings of the cognitive process of individuals and societies deepens, we can expect that active inference and related frameworks will become increasingly useful at the theoretical and practical level.

The remainder of the paper is structured as follows. The next section discusses societal cognition from several perspectives. Section 3 describes a prototypical societal system that is consistent with the cognitive view and club strategy. Section 4 highlights some design considerations for developing new societal systems. Section 5 discusses limitations of this paper, and Section 6 provides a conclusion.

## 2. Societal Cognition

Given that societal systems are viewed here as a cognitive architecture, *de novo* system designs could account for and functionally integrate all aspects of cognition. Lyon lists 13 cognitive tasks and capacities that could be considered universal in the biological world [74]. They are evident even in simple organisms like bacteria. Vallverdu provides similar lists, focusing on the cognitive capacities of slime mold [75]. Lyon’s cognitive tasks and capacities are:

1. Valence (attraction, repulsion, neutrality)
2. Sensing
3. Discrimination (ability to identify opportunities and challenges)
4. Memory storage and recall
5. Learning (experience-modulated behavior change)
6. Problem solving (behavior selection, adaptability, abstract thinking in higher animals)
7. Communication (with others of the same or different kind)
8. Motivation (teleonomic striving, implicit goals, explicit goal-driven behavior in higher animals)
9. Anticipation (prediction, forecasting, expectancy)
10. Attention (oriented response, focus)
11. Self-identity (distinguishing self from non-self)
12. Normativity (error detection, behavior correction, value assignment in higher animals)
13. Intention (directedness toward an object, belief and desire in higher animals)

As Lyon’s cognitive tasks/capacities are considered universal, the remaining discussions apply to individuals of any kind (e.g., cells, humans, and societies of these).

Sensing and memory is briefly discussed in Part II of the series [35] with reference to data collection, data repositories, and metrics for assessing system fitness. Anticipation/forecasting is also mentioned. Here I simply emphasize that problem solving and decision making (e.g., to secure food or avoid danger) would be all but impossible without anticipation. For humans, forecasts can span the temporal scale from fractions of a second to centuries and beyond. Obviously, science—a type of formalized learning and exploration process—can play an important role in developing and improving models of the world that are capable of anticipation/forecasting.

Motivation was already mentioned in this paper in reference to the intrinsic purpose of a society and societal cognition (to achieve and sustainably maintain vitality). It will be discussed again later in reference to the motivations for prosocial and antisocial behaviors that system designs can engender. Normativity too has been mentioned in reference to the error correction of internal models, as per active inference.

Executive tasks such as problem solving and decision making are of course critical to individuals and a society, but are only mentioned briefly here. A chapter in [76] (Col-

laborative Governance System) presents some ideas on how new problem-solving and decision-making systems might be structured. Part I [34] discusses relationships between problem-solving capacity and self-organized criticality (i.e., a state of heightened responsiveness where a system is balanced between exploration of the new and application or refinement of the old). Potential parallels between criticality and deep democracy are also mentioned.

Relationships exist between Lyon's list of cognitive tasks/capacities and function systems. As per Roth and Schutz, each function system has an associated communication medium by which it operates. The communication mediums of the six societal systems of focus here are: economic (money), governance/political (power), legal (norms), health (illness), analytical/science (truth), and education (vita) [36]. Lyon's "communication" matches nicely with the function system concept of a communication medium, and also with a mass media system. Beyond this, while they are not direct matches, Lyon's "sensing" and "anticipation" might be most associated with a science/analytical system; "problem solving" might be most associated with a political/governance system; "normativity" might be most associated with a legal system; "learning" might be most associated with an education system; and "motivation" and "self-identity" might be most associated with a religious system, whose function is revelation.

Despite these overlaps, one might better conceive of Lyon's list as containing low-level cognitive building blocks, function systems as being high-level functions built from these blocks, and active inference as the multiscale process that connects the two over mechanistic (real-time), ontogenic (developmental), phylogenic (inter-generational), and evolutionary time. Lyon's "attention" and "communication," for example, appear in every function system. But the ways in which they manifest are different in each function system.

Active inference, as the connecting process, provides a mechanistic explanation of basic cognitive functions, like attention and learning in the human brain. And it explains hierarchical biological self-organization as occurring via (potentially overlapping) Markov blankets within blankets within blankets. Furthermore, it views cognition as embodied, enacted, embedded/enculturated, and extended. As part of this, it offers a mechanistic explanation of cooperative communication, language generation, and niche development (of the physical, cultural, and cognitive niche) [59,68,77,78]. To emphasize, the meta systems of a society, and their social institutions, can be understood as being part of the constructed human niche—a niche that evolves with, and that affects the evolution of, humans. Constant et al., for example, view cognitive niche construction as a process aimed at optimizing the generative models of individuals [52]. Poirier et al. view legal systems as epistemic systems composed of Markov blankets [79]. Constant et al. consider active inference as a mechanism to explain culturally patterned styles of attention [80] (see also [81]).

The central idea explored here is that as a cognitive organism, a society must exhibit basic, building-block cognitive capacities, but can arrange or focus these into more complex cognitive systems (i.e., function systems), each of which is a type of specialization. From basic cognitive functions to function systems, and from mechanistic to evolutionary time, the driver of self-organization and behavior is minimization of expected free energy (and so also, expected uncertainty).

In this view, function systems, as a cognitive architecture, provide a society with cognitive flexibility. Certain ideas or information, or certain goal-directed or epistemic foraging behaviors, might be better expressed using one system (and communication medium) more so than others. Function systems also provide a kind of redundancy, which is important for robustness. If one means of communication or cognition is blocked, others can take its place. Moreover, it might be true that some ideas can only be expressed well, or some problems only solved well, by using (and balancing) multiple systems.

The relevance of each item in Lyon's list and each function system to societal cognition is worthy of extensive scientific exploration on its own. Unfortunately, there is room here to highlight only a few ideas. These involve potential impacts of system design on

societal cognition and revolve around four themes: (1) parallels between cognition in neuronal and human societies; (2) influence; (3) communication and self-identity; and (4) distributions and dynamics of power. Throughout these discussions, one can particularly see the building blocks of communication and attention at play.

### 2.1. Cognition in Neuronal and Human Societies

To better understand the factors that can impact cognition human societies, it might be helpful to look at cognition in other societies, in particular, neuronal societies of the brain. These societies are a focus of cognitive science and are well studied. The examination here is fairly superficial, mostly to point out prominent parallels between cognition in the two societies.

Neurons communicate with other neurons (and sometimes other kinds of cells), and these communications are a foundation for cognition in animals. As background, a typical neuron has several branched, root-like structures called *dendrites*, which receive signals from other neurons. It also has one or more arm-like structures, called *axons*, terminating in finger-like projections, that carry electrical signals to the dendrites of other neurons. The junction between a finger of an axon and a branch of a dendrite is called a *synapse*. Signals jump the synaptic space from one neuron to the next mostly via chemical messages, but also to some degree via electrical messages [82].

Thus, neurons associate with others via axon–synapse–dendrite connections. The connections between any two neurons can be complex, and the strength and variety of signals that pass from one to the next can be variable. Moreover, multiple synaptic connections can occur between the fingers of an axon and the branches of dendrites on a receiving neuron, and these connections can exist at variable distances from the receiving neuron’s body. Distance traveled can modulate signal strength, as can the characteristics of synaptic connections. Redundancy in synaptic connections allows a neuron to send a distribution of signals to a receiving neuron [83]. Finally, the connectome, the map of connections between neurons, is dynamic. While regions of the brain maintain a degree of structural consistency, the brain is highly plastic. The connectome rewires (alters its self-organization) based on events and cognitive need [84]. The connections between neurons form meta-level structures, and can exhibit certain statistical regularities, like self-similarity over spatial scales, small-world network architectures, and dynamics that resemble self-organized criticality [85].

Similar to neurons, individuals in a human society connect with each other in complex ways, exchanging a variety of signals, over a variety of distances and at a variety of strengths. Furthermore, both neurons and persons can potentially connect to a very large number of others. And any two of each kind can share multiple connections. The connections between persons can form meta-level structures, and exhibit statistical regularities similar those of neuronal connections. Furthermore, neurons and persons self-organize into modules (e.g., layers, lobes, and tissues for neurons, and families, clubs, businesses, and institutions for humans). Neuron–neuron and person–person connections are dynamic and context and need dependent. Associations come and go, even if some degree of large-scale structure remains consistent.

Obviously, neurons and persons also participate in cognitive processes, including learning, problem solving, memory, and anticipation. Even more than this, each person and each neuron is complex, cognitive, and capable of signal processing on its own [86]. Moreover, neurons and people are multifaceted; they can participate in multiple cognitive processes related to different kinds of topics and problems. And the same principle—reduction of expected uncertainty via active inference—is purported to drive self-organization (including long-range correlations, coordination, and cooperation) in societies of neurons and humans [87].

Parallels also exist between attention in neuronal and human societies. Attention is a selective focusing of cognitive capacity that can be understood and defined in several ways. Oberauer provides a taxonomy that distinguishes between attention as a limited resource



for information processing versus a process of (or mechanism for) selection/prioritization of signals; between attention to the currently perceived environment versus information not currently perceived (i.e., memory); and between a selective focus on things and events in the world versus internal goals or tasks [88]. The latter includes shielding task-oriented action from distractions.

In the neuroscience setting, Parr and Friston delineate between attention as gain modulation—where prediction errors or beliefs about the precision of an input signal alter gain—and attention as salience attribution—where a signal has value, and receives focus, based on an action’s capacity to reduce uncertainty [89]. Attention as salience attribution involves planning, and value stems from the capacity of action—exploration (epistemic foraging) and exploitation (goal attainment)—to reduce uncertainty [63]. Whereas attention as gain modulation relates to beliefs about the noise/precision of input signals relative to prior beliefs about causes, attention as salience attribution underwrites policy selection.

Attention as gain modulation fits well with accounts of predictive coding and represents hierarchically shallow (habitual) levels of cognitive control [90]. As such, it relates to learning (i.e., perceptual inference) [81]. Attention as salience attribution represents deep (goal-directed) cognitive control [89]. The two types of attention are complementary and can be active at the same time.

The parallels mentioned between neuronal and human societies are relevant to discussions of societal system design. They suggest that factors influencing cognition in neural societies might also influence cognition in human societies. Accordingly, they also suggest how societal cognition might be detrimentally or beneficially influenced by system design and design-associated social institutions. Designs might impact:

- Patterns, dynamics, and strengths of associations between individuals;
- Richness and extent of communication among individuals;
- Temporal and spatial locations and movements of individuals;
- Quality of information that is collected and communicated (in data science, quality is a function of volume, completeness, timeliness, accuracy, reliability, relevance, and other factors [91]);
- Health and responsiveness of individuals;
- Alignment of a society’s beliefs/models with observations, and its capacity to correct errors;
- Independence of and cooperation between individuals;
- Degree of uncertainty, due to external factors, sensing mechanisms, or a society’s beliefs/models;
- Capacity to plan, extent of the anticipatory horizon (i.e., short- or long-term), and the salience placed on information that reduces expected uncertainty about essential variables.

Some of these, especially in the human setting, can be viewed from the perspective of niche development, including culture and tool development. For example, different human cultures can display different styles of communication, and might pay more or less attention to reducing uncertainty about essential variables.

Given the above, we can envision ways, some familiar in history and current events, in which societal cognition might be detrimentally altered. As examples, a corporation could produce misleading statements about environmental impacts (i.e., it could produce low-quality information, or disinformation) [92]. Indeed, deception and lying in politics and business are perennial, and propaganda is an integral component of contemporary democracies [93–95]. A government could limit free speech and free association (i.e., it could reduce communication and group formation) [96]. System designs can affect the motivation for such acts, as well as their likelihood. For example, economic and governance systems (and their institutions) that lack transparency can make certain harmful behaviors, like corruption, more likely [97].

Of course, societal cognition can also be influenced in beneficial ways. For example, a government could fund science and education programs (i.e., it could improve forecasting accuracy and the alignment between beliefs/models and observations). And it could fund

universal health care (i.e., it could improve the health and responsiveness of individuals). The design of a governance system could impact how likely it is to fund such programs. For example, a transparent governance system that distributes decision-making power might be more likely to fund programs that benefit the many (as opposed to the few).

## 2.2. Influence and Societal Cognition

Within a group, large or small, members try to influence each other via communication and/or other means. Turner describes a typology of influence in which one category is persuasion, which is a process of negotiating and validating reality [98]. Here, a person might argue that his or her descriptions of reality are correct and valid—that they represent reality better than competing alternatives. Likewise, a person might argue that his or her proposed course of action is more beneficial or less risky to the group compared to competing alternatives.

Another category of influence is control, which is getting others to act in a certain way when they are not persuaded or are uninterested in the validity of an argument to persuade. According to Turner, control comes in two varieties. One is based on legitimate authority, where a group empowers an idea, norm, role, or institution to act. For example, a society might empower a police officer to monitor traffic and issue tickets for authentic speeding. Most individuals in the society will accept that the officer has legitimate power to stop a car and issue a ticket, and most will see value in preventing accidents. Legitimate authority originates from voluntary deference and by and large is not experienced as oppression or a loss of personal power. The power of authority flows from its designation as an expression of the collective will.

The other form of control is coercion, where one or more persons control others against their will. Coercion is an inherently conflictual attempt to control others who cannot otherwise be influenced. Coercion appears in many forms, some of which can be labeled as manipulation. These include disinformation, deceit, omissions, obstruction, the exercise of false authority, and the drowning out or silencing of competing voices.

Depending on the situation, persuasion, legitimate authority, and/or certain kinds of coercion might be valid, useful, and healthy. For example, a society might want to empower police to arrest and hold dangerous individuals against their will.

Turner argues that a society must use coercion sparingly, carefully, and transparently, as it can produce in its targets a disidentification with and rejection of the core group, even leading to the formation of new groups that attempt to supplant the original one [98]. Coercion is easily abused and if not used judiciously and sparingly is dangerous to the long-term health of a group. It is an inefficient and self-destructive form of influence compared to persuasion and legitimate authority. While the latter two tend to promote trust and cooperation, coercion tends to degrade trust and increase an antagonistic climate, thus requiring ever greater enforced compliance, surveillance, and resource expenditures for security [99]. Coercion is often dressed up as persuasion or legitimate authority by its proponents, so as to lessen some of its costs.

Before there can be influence, there must be a group (of at least two). Turner's work is related to several self-identify theories about group association, including social-identity theory, self-categorization theory, and uncertainty-identity theory [100–105]. To summarize, groups and subgroups form and dissipate (self-organize) because individuals self-identify with group beliefs, values, and objectives, in light of certain expected benefits, and due to comparisons with other groups. Individuals maintain both a personal and social identity, but these identities are fluid and flexible. In a healthy society, association itself is fluid and flexible. Variable strength association, multi association, and freedom to disassociate confer individuals with behavioral and cognitive flexibility and ensure that cognition is always shaped by social context.

Turner's typology of influence and the self-identity theories on which it is based have relevance to societal cognition and societal system design. For example, he describes persuasion as a process of negotiating and validating reality, which can be viewed as a

form of learning (model updating) in active inference. The role of attention in persuasion is also evident, as individuals try to direct the attention of others to certain favored ideas, explanations, or proposals. Coercion leads to mistrust in Turner's typology, which can detrimentally impact societal cognition (via inhibition of cooperation, for example). Finally, Turner's work centers on associations, and the role of associations on cognition in neuronal and human societies was previously discussed. It is worth noting that one reason people associate in groups (e.g., as per uncertainty-identity theory [101]) is to reduce uncertainty, a central theme in active inference.

One could imagine several ways in which system design could impact the process of influence, as per Turner's typology. Potential impacts of design on group association were already mentioned. Beyond that, the transparency built into a design could impact influence. For example, highly transparent systems might be less likely to rely on coercion. Educational programs associated with system design might also impact influence. For example, education about manipulation (its forms, prevalence, aims, etc.) might help to reduce its occurrence.

### *2.3. Communication, Self-Identity, and Societal Cognition*

To see some ways in which communication and self-identity might impact societal cognition (and wellbeing), we turn to another example from biology, cancer. As discussed in Part I [34], the cooperation between agents at a given level exists as a dynamic if not tenuous balance between the preservation of individual autonomy and the benefits that coordination brings. Cancer and cancer-like behavior arises (in a body or human society) when an agent, or group of agents, fail to cooperate normally with others. Instead, they act aggressively to secure their own preservation and expansion, and in so doing can eventually cause their own death by destroying their host.

Cancer in the body is characterized by a breakdown of normal communications between transformed cells and their milieu [106,107]. Indeed, an early sign of cancer is the local remodeling of communication patterns, with excessive communication occurring between cancer cells and dysfunctional communication occurring between cancer cells and healthy neighbors. As described by Levin, cancer cells become isolated from the (communication) signals that would normally keep them harmonized and cooperative within the larger body (and attuned to its larger goals), and so revert to more primal and aggressive behaviors [108,109]. In this view, both healthy and cancer cells act in a self-interested and self-preserving manner, with the difference being that the functional extent of self (i.e., self-identity) shrinks for cancer cells.

It shrinks spatially in that many of the normal long-range signals are lost or degraded, reducing the richness of communication with distant healthy tissues. It shrinks temporally in that the time horizon for anticipation of events shrinks from decades (the collective time scale) to something far more immediate (the cellular time scale). That is because the cognitive apparatus available to the cancer cell shrinks when communication with normal cells is degraded. Short-term goals for preservation then take center stage. The self-identity of the cancer cell also shrinks in complexity, and so also in capacity for learning and problem-solving, again due to a reduced cognitive apparatus. (Relationships between complexity and problem solving capacity are discussed in Part I [34].) As self-identity shrinks for a cancer cell, so too does coordination with its environment.

Cancer represents a breakdown of cognition within the body's cellular societies. Levin's view suggests a general means to repair and/or prevent cancer and cancer-like behavior (in the body and human society), which is to promote and support communication and related informational processes, such that an agent's sense of self—its "cognitive light cone of self"—remains large or expands [109]. One could imagine numerous ways in which system design could promote communication, the integration of individuals within a community, a shared sense of purpose, and an expanded sense of self (that extends to other societies, environments, and even the biosphere). As just one example, a system design could support scientific exploration about the connectedness of all life, or more

generally, be built upon a worldview that acknowledges the connectedness of all life (as in Part I [34]).

#### 2.4. Power and Societal Cognition

Each function system operates via a communication medium, and the distribution and dynamics of that medium impact the power that an agent, acting under the system, can exert over others. A large mass media company, for example, is powerful in the sense that it can communicate (selected) information to a large number of people. Teubner argues that each function system, and thus also the organizations within that system, are under constant pressure to regenerate and augment the system's medium (i.e., they are under pressure to grow, in their own unique way) [110]. For example, an economic system, such as capitalism, is under constant pressure to expand its markets, even into the arenas of other function systems. Thus, we can speak of the commodification, economization, or financialization of society. Similarly, for other function systems, we can speak of the politicization or juridification of society.

Due to the growth imperative, each function system has a tendency to produce excesses, and excesses can easily become concentrated. Concentration is perhaps easiest to see in an economic system. Today, the wealthiest one percent of individuals globally own about 40 percent of the world's wealth [111]. The tendency of a function system to grow, and to concentrate power, can be considered in the design of new societal systems. In particular, designs can aim at maintaining a balance among systems, so that no one becomes too excessive or dominant. This is one aspect of system integration, mentioned briefly already. (Another is aligning all systems in a common purpose, the society's intrinsic purpose.) Roth suggests shifting bias away from an economic system and toward other function systems as a means to transform capitalism [33].

Focusing on economic systems, a large set of studies suggest that income and wealth inequality can have detrimental impacts on individuals and groups, including impacts on health, cooperation, trust, anxiety, happiness, social cohesion, mortality, governance, and social stability [112–126]. Any of these effects, individually or collectively, could influence the quality of societal cognition.

In particular, money acts as a kind of (undemocratic) voting tool in modern societies. In general, the more money a person or organization has, the more influence or power they can exert over societal attention, societal decisions, and the behavior of others. As simple examples, wealthy corporations can purchase media advertising to draw public attention to or away from certain issues (like climate change [127]), and wealthy philanthropists can have large and undemocratic impacts on programs and activities within the nonprofit sector [128].

Economic systems are singled out here, but again each function system can concentrate power via its medium. The dynamics and distribution of economic, political, legal, and other forms of power can influence, among other things, the set of problems that a society is able to address; the timing of action or inaction; access to information; the range of solutions allowed for consideration; the process through which decisions are made; the variables by which a society evaluates its status; and the focus placed on some voices and narratives over others. Sovacool and Brisbois provide an overview of power theories and mechanisms as they relate to the study of elite power in energy transitions (toward a low-carbon future) [129]. These concepts can be applied to the study of power in more general settings, and thus also to system design. Regarding system design, it is worth noting that the concept of income equality is not unpopular. In one large nationally representative US sample, nearly half of those queried chose income equality as the more fair distribution over mildly and extremely unequal distributions [130]. A prototype societal system is discussed next that is designed to achieve economic equality (and so also, to eradicate poverty and near-poverty).

### 3. LEDDA Framework

A claim in this paper is that system design can impact societal cognition, and a few small examples have been given. Now we turn to a prototypical de novo system to see how a whole design might affect societal cognition, or at least how it might affect certain factors, like economic equality, that can impact societal cognition. That system is the Local Economic Direct Democracy Association (LEDDA) framework, as described in the book *Economic Direct Democracy* and its associated simulation paper [76,131].

The LEDDA framework is chosen here as an example prototype for several reasons. First, it embodies the view of societal systems as a cognitive architecture; its stated purpose is to facilitate societal cognition. As mentioned in Section 1, an explicit purpose is both aspirational and functional. Second, the LEDDA framework is based on a club model, intended for implementation at the local community level. Clubs are a key element of the theory of change discussed in Part II [35]. Third, it encompasses multiple, integrated systems (governance, legal, economic, analytical), which is one of the desiderata for a science-driven R&D program aimed at societal transformation, discussed in Part II.

Fourth, to my knowledge, it is the only proposed de novo societal system for which a published, at least semi-realistic, simulation is available. In this case, the simulation is an agent-based, stock-flow consistent model of currency flows, using US Census data for Lane County, Oregon, as input. It follows a synthetic adult population of 100,000 persons over a 28-year period. While the LEDDA framework involves multiple integrated systems, the simulation focuses on some of its economic, financial, and monetary aspects. It is positioned as a first simulation, to be improved upon and expanded in multiple ways.

Although [76,131] contain considerable information, the LEDDA framework is still in early development. Only the first small steps in design have been taken, and these have mostly focused on conceptual development. Economic aspects have received more attention than others, and so are the focus here.

#### 3.1. A Warm-up

The LEDDA economy is not an economy in the typical sense of the word. Nor are its governance and financial systems similar to any governance and financial systems that we might point to in the world, or in history. Rather, the systems of a LEDDA are designed to function as a cognitive architecture. This presents in various ways, one of which is that a LEDDA uses money—a combination of national currency (e.g., the dollar) and a local digital currency, called the *token*—as a bona fide voting (information) tool. Money is the communication medium of an economic system, and as mentioned is already used as an undemocratic voting tool in the native economy. The LEDDA framework makes the voting function of money explicit, transparent, fair, and deeply democratic.

The classic functions of money are to serve as a store of value, unit of account, and medium of exchange. In a LEDDA, while money continues to serve these functions, the emphasis is changed. The token and its circulation are designed specifically to convey information. Members use money as one of several means to collectively express their needs, concerns, desires, and intents. They purchase some (or perhaps much) of their goods and services from member organizations—local for-profits and nonprofits. These organizations, in turn, (automatically) report aggregate revenues, wage disbursements, resource use, and more, broken down into appropriate categories. In this way, members of a club know what they are voting for when they purchase goods and services with money. In the native economy, nonprofits and publicly traded corporations already report some of this information. Reporting is more detailed and frequent in a LEDDA, especially for a Principled Business, which is a special type of socially responsible, community supported business model unique to the LEDDA framework.

In addition to spending money in local markets, members use it to vote in the LEDDA financial system, called the Crowd-Based Financial System (CBFS). There, they choose which member organizations and projects will receive funding support.

To make the voting-with-money process fair, and to avoid the numerous problems associated with income and wealth inequality, the LEDDA is designed so that income and wealth equalize over time for all members, regardless of work status. At club maturity, every member, employed or not, has essentially the same money-based influence over the economic and financial decisions of a club.

A LEDDA also engenders a different set of motivations in members compared to that engendered by native systems. By design, a LEDDA rewards and reduces barriers to cooperation. It also rewards economic and other kinds of activity that meets the needs of members, including core human needs (for example, [132]). By equalizing income and wealth over time, it does not reward behaviors via personal financial gain, and so does not encourage a focus on narrow self-interest [133–137].

How it equalizes income and engenders prosocial motivations, along with other aspects of the LEDDA, are sketched in the next subsections.

### 3.2. Framework

The LEDDA framework has seven integrated components, and more could be added over time:

**Token Monetary System (TMS):** This is the system by which a LEDDA creates and destroys tokens as required to regulate volume and value. Tokens are a fiat digital currency, designed to be inflation-free. New tokens are created without cost and distributed to club members in a fair manner such that the circulation of tokens is strengthened.

**Crowd-Based Financial System (CBFS):** The CBFS is the highly transparent and deeply democratic financial system of a LEDDA. It funds local nonprofit and for-profit organizations with a combination of national currency and tokens by issuing donations, interest-free loans, and subsidies. It acts to ensure a strong circulation of tokens, and via its nurture arm provides income to members who are not in the workforce. Members must contribute to the LEDDA but have control over how their contributions are used; members choose which organizations and projects to fund.

**Market system:** The market system is composed of local for-profit and nonprofit organizations that participate in the LEDDA. Organizations compete and cooperate to provide goods and services to club members and the general public. The market system includes the Principled Business model. The integrated TMS, CBFS and market system is called the *Token Exchange System (TES)*.

**Property rights system:** This system addresses legal rights and licensing for physical, intellectual, and other types of property that a LEDDA owns or manages. Property rights follow national norms but differ in that: (a) Principled Businesses participate in an intellectual property (IP) pool, or commons; (b) restrictions apply on the sale of Principled Businesses and the transfer of their assets, not unlike restrictions that apply to nonprofits; and (c) the property rights system and Principled Businesses are highly transparent. The property rights system is designed to discourage rent seeking and prevent monopolies, to encourage creativity via minimally restricted flows of information, to empower a community to decide how it will use its property, and to encourage organizations to participate in the LEDDA (and so gain access to ideas and other property).

**Information and incentive system:** This system informs decision making and encourages cooperation and other prosocial behavior. It includes: (a) a reputation system that recognizes reputation as a form of social currency; (b) education programs that encourage beneficial social norms; (c) fitness indexes that summarize the effectiveness of a LEDDA in improving collective wellbeing; (d) information processes that provide a description and reasonably full social and environmental accounting of the products and services that member organizations offer; and (e) computer, theoretical, and other types models that describe how a LEDDA functions and that assess and forecast its status.

Collaborative Governance System (CGS): The collaborative governance system regulates the preceding five components. It incorporates an online form of collaborative direct democracy, allowing very large groups of people to collaborate in creating, deciding on, and amending the rules and regulations of a club. The CGS has administrative, legislative, and judicial arms. Most positions are filled by sortition (random draw from a pool of qualified candidates) rather than by ballot [138,139]. Sortition avoids costly elections and can potentially improve system access, inclusiveness, and responsiveness, as well as reduce corruption and the capture of governance by business or other entities. Unlike native governance systems, the CGS does not control large expenditures. All funding for projects and organizations occurs through the CBFS.

Purpose: The purpose of a LEDDA is to facilitate societal cognition in order to achieve and sustainably maintain (social and ecologic) vitality (i.e., to fulfill the intrinsic purpose of an organism, as discussed in Part I [34]). By design, all components of a LEDDA serve and are aligned with this purpose.

Associations of individuals play important roles in the LEDDA. For example, a group of members might form in the CBFS to support a proposal for a new business, say, a bakery. They vote in the CBFS, using the tokens and national currency that they contributed. If their combined support is sufficient, the new business would have enough resources to form. As such, members offer the business power (the consolidation of group intent, communicated in part through currency) to manage resources (for example, staff and equipment) in order to produce goods and services that benefit the community. The support given by individuals to organizations via the CBFS represents an investment, but not an investment for profit. Support is given in the form of donations, grants, and interest-free loans. The investment is investment of community resources to accomplish worthwhile goals.

Members entrust and empower organizations to manage resources on their behalf. According to rules of the club, power can be removed or revoked if trust is broken, or if conditions change and members decide that resources are better used elsewhere. As a simple example, members can choose to fund a different bakery via the CBFS, rather than one previously supported.

### 3.3. Simulation

Three purposes of the simulation study are to illustrate flows of currency in an idealized LEDDA; to demonstrate that the flows are logical and mathematically sound; and to demonstrate that the model can be parameterized such that income equality and full employment are achieved for the simulated population [131]. Because the simulation is stock-flow consistent, sinks and sources of currency are accounted for.

In the simulation, the *income target* rises year by year according to a preplanned trajectory. The income target is the lowest wage paid by member organizations to member employees. It starts near the equivalent of a minimum wage. As the income target rises each year, so too do member family incomes. The income target rises until it reaches a final plateau, the *final income target*. In the simulation, that plateau is about 110,000 tokens and dollars per family, roughly equivalent to the 90th percentile of family income at the start of the simulation. This is post-CBFS income, after (mandatory) contributions to the CBFS have been made. All member families, regardless of work status, receive an income of at least the current-year income target. Wages are paid in tokens and dollars. Taxes on income are paid in the normal fashion.

By simulation's end, poverty among club members is eliminated; all participating families, whether in the workforce or not, receive the final income target (of about 110,000 tokens and dollars). The money for these incomes originates from the injection of tokens into the local economy (via disbursements to members), and from the strategic recirculation of dollars within the local economy, achieved through buy-local campaigns and related support for local businesses. The dollar component of family income at simulation's end is equal to the national average in the native economy. As such, a LEDDA does not hoard dollars, or accrue more than its fair share.

The LEDDA essentially pays people to join. Family incomes rise for all who join, and those that have low initial incomes see the greatest gains. Driven by the opportunity for income gain, 90 percent of the local population becomes members by simulation's end. The median family income of members more than doubles compared to initial values.

The club starts very small, with minimal economic impact, and its bootstrapped economy grows year by year. By simulation's end, billions in currency flow annually through the CBFS. The local population is just 100,000 in this simulation, and a club within a larger population would, in theory, experience a proportionally larger circulation at club maturity. With this volume of currency flow, clubs would have the means to fund a wide variety of organizations and projects that members deem important. These could include schools, research programs, hospitals, arts programs, environmental restoration programs, infrastructure, small farms, parks, local manufacturing, local media, and so on. If desired, members could fund organizations that provide products or services free or at low cost. For example, they could fund a no-fee health-care system or a tuition-free college. Very large and expensive projects could be jointly funded by clubs cooperating through networks.

In the simulation, wealthy families that initially earned above the 90th percentile of income do not join the LEDDA. In practice they could join, and would annually receive a small fixed incentive paid in tokens. In this way, all families that join receive an income gain. The incentive is offered to any family that earns more than the current-year income target.

In the long run, local families that initially earn incomes above the final income target are likely to see their incomes fall toward that target. As such, incomes would equalize over time. This is true for members (with token and dollar incomes) and for non-members (with dollar incomes). It occurs for members because by design most receive the income target. This is especially true for members employed by Principled Businesses, which pay wages that are no lower than the current-year income target and no higher than the final income target.

It occurs for non-members because members, who may represent a large percentage of the local population at club maturity, understand that it is in their best interest to support, through patronage and CBFS funding, Principled Businesses and member nonprofits and for-profits that act (and pay wages) similar to Principled Businesses. Furthermore, a portion of member income is in the form of tokens. Non-member businesses cannot accept or use tokens, and therefore cannot participate in a substantial fraction of local economic interactions. Furthermore, non-member businesses would not benefit from the intellectual property pool available to members, and would find it difficult to recruit staff. To compete with Principled Businesses and similar-acting member organizations, non-member businesses would have to offer jobs that are as meaningful and that pay as well. Without access to low-income employees, token circulation, member patronage, and the club intellectual property pool, some non-member business would falter, or perhaps adapt by becoming members.

Should a member business fail (as a certain percentage are expected to), or if support is shifted away from a member business, the owners and workforce are cared for. Even if unemployed, they continue to receive the current-year income target, like most members. On the other hand, should a Principled Business grow very large and successful, the owners and workforce would receive no more than the final income target. Thus, the motivation to own and work in a Principled Business is not based on financial gain, but on, for example, the opportunity to use and develop skills, learn, help others, enjoy friendships, grow one's reputation, provide leadership, and exercise creativity. The power of such motivations is discussed, for example, in self-determination theory [140]. By design, risks are reasonably low for owners and workers, cooperation is encouraged, and financial wealth does not concentrate.

### 3.4. Simulation Methods

Methods and materials for the simulation are published in [131]. A brief summary is presented here for the reader's convenience. The simulated token-dollar economy (the



modeled world) comprises five aggregate agents, termed Persons, Government, CBFS, Organizations, and Rest-of-Counties. All agents pertain to the county in which the LEDDA exists, except Rest-of-Counties, which represents all other US counties. The Organizations agent represents all for-profit businesses and nonprofit organizations. It is divided into three subtypes: nonprofits, standard businesses, and Principled Businesses. The Government agent represents local accounts for state and federal governments. The CBFS agent represents the LEDDA financial system. The Persons agent represents the set of all individuals in the county. It is divided into two subtypes: employed, and unemployed or not in the workforce. Each person and family is modeled individually, which allows for tracking changes in income over time.

All agents together form a closed economic system, meaning that no flows of tokens or dollars cross into or out of the defined system. Accounting equations ensure that flows of tokens and dollars from any one agent are recorded as receipts by others. The model is an abstraction and simplification of a county token-dollar economy. Conditions in a real token-dollar economy would be more complex.

To keep the model simple, numerous other assumptions are made about agents and flows. For example, demographics and the dollar economy apart from token-dollar flows serve primarily as a static backdrop. Only flows and conditions directly related to LEDDA activities exist in the modeled world. Thus, inflation, normal economic growth, normal savings and investment, birth and death of individuals, and income and job changes for non-members do not exist. Other assumption are that the purchasing power of the token is equal to that of the dollar; county residents, all of whom are adults, are grouped into two-person families; and all employed persons work full time.

The simulation period is divided into 28 one-year steps. The tracked variables are: (1) income and job changes for individuals who become members; and (2) stocks and flows of tokens and dollars for each aggregate agent. Income data for Year 0, the year before tokens are introduced, are generated by sampling 2011 US Census microdata files for Lane County, Oregon. Model input includes specification of the starting and final income target, the token share of the income target paid to members, tax rates, and an initial participation rate as a fraction of the county population.

Agents have limited choices. The primary ones are whether to join a LEDDA or not, and for members employed by member organizations, to choose one of two Wage Options each year. The Wage Options are essentially whether to keep a (high) existing income and receive a small bonus paid in tokens for being a member, or to accept the current-year income target (which rises each year, eventually to reach and plateau at the final income target). Agents make these decisions as a family, and always choose the option that maximizes family income. The choice of whether to join the LEDDA is limited by the size of the LEDDA. A small LEDDA can only accommodate a small number of new members each year. A large LEDDA can accommodate many more new members each year. Families join a LEDDA based on random selection, but in every case membership increases family income.

### 3.5. Agility

A LEDDA is agile by design. It can make or remake its economy as necessary to meet community needs. Acting through the CBFS, members create the kinds of jobs that they wish to work in and that provide products and services that the community needs. Furthermore, businesses, and especially Principled Businesses, exist to serve the community. As already mentioned, the community entrusts funding and patronage to them. If trust is broken, or if resources are needed elsewhere, a community can remove or shift its support.

As a consequence of design, when considering funding for a project or business, the real resource in question is not so much money, but the time, attention, skills, and efforts of members, as well as the natural resources managed by the club. When supporting a project or business in the CBFS, members allocate human and natural resources by voting (with

money). Thus, a club chooses how it will spend its time, attention, and other resources. Of course, to some degree, money is used as a resource itself, especially when interacting with groups and organizations outside the LEDDA.

A LEDDA can choose to create any partitioning of its workforce into for-profit and non-profit sectors, place focus within any division of either sector (e.g., medicine, farming, manufacturing, construction), and shift attention and resources to produce any particular good or service needed or desired (e.g., paper products, software, health care, food). It can create any partitioning or makeup of its economy, and, generally speaking, should continue to function successfully as long as the club's systems serve as a cognitive architecture, and as long as the chosen economy meets the real needs and challenges of the club.

As an example of flexibility, a poster presentation displays results of a LEDDA simulation where the initial unemployment rate was 30 percent (depression-level conditions) [141]. In spite of the dire starting conditions, the same family income target of about 110,000 tokens and dollars is achieved over the same 28-year period. As well, the same high volume of currency circulation in the CBFS is achieved. In this simulation, the LEDDA happened to choose an economy in which 50 percent of the member workforce was employed in the non-profit sector (i.e., this partition was achieved over time through CBFS funding choices). However, a LEDDA could target and achieve nearly any partition—for example, 80 percent of the member workforce employed in the non-profit sector—if doing so met its real needs.

Because of its agility, use of money, and other characteristics, risks of recession and financial crisis or other kinds of shocks should be low in a LEDDA economy, relative to the native economy. Again, the LEDDA economy operates as a cognitive system and the fundamental constraints on a LEDDA are the time and attention of members, their skills and knowledge, material resources, and ecologic processes. These do not fluctuate wildly, if resources are cared for. A mature LEDDA might weather periods of high inflation in the native economy by maintaining the integrity of its local currency. More sophisticated simulations are needed to explore these possibilities.

A club is in charge of its own behavior and future, and can choose at any point to alter its course or expectations. However, the basic idea is that it has a good idea of where it wants to go and metrics to determine if it is on track. If it is off track, which is likely to happen from time to time, it can take actions as needed to get back on track or to change destinations. Actions could include, for example, adjusting system elements, passing new rules or regulations, and choosing new funding priorities.

#### 4. Design Considerations and Questions

Numerous design considerations have been mentioned, either in this paper, in others of the series, in *Economic Direct Democracy* [76], or in the simulation paper [131]. Moving forward, three concepts could serve as a focal point. These are Lyon's 13 basic cognitive tasks/capacities discussed in Section 2; the view of function systems as high-level constructs of these; and the positioning of active inference (and uncertainty minimization) as a process that connects the two. Nearly any research effort aimed at designing societal systems will involve one or more items Lyon's list, and their extensions into function systems. The discussion of attention in Section 2.1 gives a hint to the richness of each of the 13 items.

With these concepts in mind, the following serves as a sampling of design considerations and associated informal questions. It is a small sampling from a large volume of issues, questions, ideas, and considerations that could be raised. As discussed in Part II [35], the R&D program would span an A to Z of academic fields. There are ample topics and directions for research, and abundant questions that must be answered. The summary below is intended to pique curiosity and draw attention to some possibilities.

To begin, many possibilities exist for the application of active inference and related cognitive frameworks in the design and operation of new societal systems. So far, most research on active inference has been first-order, where the scientist is an observer and the aim is to produce knowledge. Much work remains to be done through a (traditional) first-order approach. For example, the study of active inference as an explanation of human

communication, social behavior, societal self-organization, and niche development is only just beginning. Beyond this, an opportunity highlighted here is to expand research to a second-order science approach, which is aimed at effecting change and is explicitly normative and reflexive [15]. As described in Part II, second-order science in this case can be understood as a form of meta-learning in which soft and hard technologies (societal systems and associated infrastructure, rules, norms, and cultural components) are learned that themselves allow a society to excel at cognition, and thus learning, problem-solving, and adaptation.

To provide contrast, a first-order approach asks (important) questions such as, “What are the roles, mechanisms, and drivers of attention in the human brain and human society?” A second-order approach might ask, for instance, “If a society understands itself as a cognitive organism; understands its cognitive process as reducing uncertainty (and free energy), for the purpose of achieving and sustainably maintaining vitality; and understands its societal systems as a cognitive architecture, then, given these beliefs, what kinds of societal systems might it develop and employ to best fulfill its purpose?”

A great many ancillary questions can be asked. For example, in what flavors and guises does uncertainty appear, and how might it be measured in the social setting? How might essential variables be estimated and assessed? If it is not yet possible to study real (and complex) societal systems using concepts of active inference, what kinds of simpler simulations or studies might help to propel the field forward?

Another topic worthy of attention is communication/collaboration tools. As it stands today, there is a dearth of tools available that would allow very large groups of people to richly communicate and collaborate in problem solving and decision making. One idea is to employ computer-understandable, computation-ready representations of data (e.g., graph representations of data) that are directly generated from digital deliberation and decision-making activities, rather than being transcribed from them. Here, the technology is not an afterthought that records what happened in discussions or votes, but rather is the tool that allows for rich communication.

Such a tool could have many benefits. For example, a club could use it to preserve a history, or ledger, of its economic, governance, legal, and other decisions. Conceptually, the ledger would record the computational path of opinions and positions that eventually culminate in a group decision. With such a record, a club could model and better understand, perhaps even improve, its own cognition. The ledger could also allow for audits and transparency.

Revocation of power is a useful concept that could be woven into system design. It was mentioned already with respect to the LEDDA framework, where members can shift funding and support away from one project or business and to another. The capacity to shift power, resources, and attention renders a club agile and provides a means to stem damage, penalize cheaters, and solve problems. On the other hand, it would be counterproductive to shift power excessively or unreasonably. How can these opposing perspectives be reconciled in systems design?

One reason that a club might want to prevent the concentration of economic or any other kind of power is that once it is obtained, it is very difficult to revoke. It is not easy, for example, to take away the wealth of a billionaire and use it elsewhere for some worthwhile purpose. Likewise, private ownership of land and other major resources, once obtained, is difficult to revoke. System designs could facilitate the collective management of land and other kinds of physical and intellectual properties. In general, the larger the set of resources that a club collectively manages, the more capable it is of deciding its own fate, adapting to change, and preventing the concentration of wealth and power. Perhaps (long-term) leases of real property could allow members to use community managed land, such that land is protected, the needs of members are met, and the club maintains flexibility in how resources are used in the long term.

The detrimental effects of income and wealth inequality on society and societal cognition were discussed previously. Inequality is especially problematic in a club, which might

explicitly use money as a voting tool. In that case, inequality directly leads to undemocratic decision making. Furthermore, inequality, in obvious and non-obvious ways, can promote ever-more inequality [142,143]. How can income and wealth best be measured in the club setting, and what degree of transparency is needed to understand their distributions and dynamics? How can design achieve income equality, and over what time period, if that is a goal? What degree of inequality is tolerable, and how could that value be rigorously determined?

A club benefits from a well-informed membership. It might wish to offer training and education related to critical thinking, problem solving, communication, cooperation, and decision making—all aspects of group cognition. Additional topics could include the impacts of power distributions and dynamics on decision-making, logic and its expression in public discourse, and strategies commonly used to manipulate or coerce individuals and groups. Training and education could also address the design and operation of clubs and networks. Topics here might include common procedures and tasks, descriptions of information flows, methods to assess fitness, strengths and weaknesses of different designs, anomaly detection and monitoring procedures, and how club purpose is manifested through design and operations. If members do not understand how a club is designed to function, their club is unlikely to prosper.

As discussed by Desan, money is a tool, a mechanism of a certain design, that serves (well or poorly) existing institutions and systems [144]. A club cannot alter the design of a national currency (e.g., the dollar), but it can carefully design a community currency to serve as a component of group cognition, as well as to achieve aims like economic and financial stability. A community currency is used in the LEDDA framework. A community currency can serve to exchange information, facilitate transparency, buffer a club's economic system against volatility in native systems, protect and value local products and industries, stimulate a local economy, and empower a community to make decisions and take actions that have real-world effects. If a club design incorporates a community currency, how can flows best be optimized, measured, and monitored? How can abuse be prevented and detected? How does the currency interact with those of native systems?

Finally, various sets of design principles and strategies could be applied in club/system design and operations. These include the eight design principles of stable management as identified by Elinor Ostrom, who shared the 2009 Nobel Prize in Economics for her efforts to identify the characteristics of local decision-making structures that successfully manage commons property [145]. Others include principles for natural resource management by Chapin et al. [146], and systemic design principles by van der Bijl-Brouwer [147] and Jones [148].

## 5. Limitations

One of the hypotheses identified in Part I as underlying the R&D program is that new systems designed to be highly fit will be more effective than native ones at serving the common good [34]. This paper provides a narrative, a collection of perspectives, considerations, and questions, that aim at the word *design* in this hypothesis. What is a system supposed to do, how can fitness be measured, what issues are at play, and what look and feel might fit designs have? This is a concept paper, not a research paper or rigorous literature review. Its purpose is to suggest perspectives, raise possibilities, and highlight issues and questions that might be worth exploring. Alone, this paper and the series are not sufficient to evaluate the stated hypothesis. Rather, the series is intended as a pointer on how to get started, via a particular R&D program.

One of the paper's limitations is that few references are available on the main topic: evidence-based development and testing of de novo designed, integrated societal systems. The topic is rather new to the literature, especially considering the perspective taken here, which is that societal systems can be usefully understood as a cognitive architecture, and that the goal of design is to improve societal cognition. Therefore, the approach and ideas described here are not easily compared with other works on the topic.

Finally, regarding the LEDDA framework discussed in Section 3, only one simulation study has been published, and that simulation is not very sophisticated. Agents had few choices, and only income and currency flows were tracked, not social and environmental wellbeing more broadly. Far more work is required to develop the LEDDA concept. This includes additional and more sophisticated simulations that track human and natural resource use and allocation, waste generation, and decision making in each of the six overarching systems. Thus, the information in Section 3 should be considered aspirational. Hopefully, it is also inspirational with regard to possible research directions, including how societal cognition concepts might be integrated into systems design.

Finally, the LEDDA framework is one of many conceivable frameworks that could be studied. Perhaps a different one might better improve societal cognition, or be more practical to implement. The LEDDA framework, and the proposed R&D project itself, are a result of effort by the author, and they reflect his priorities and perspectives. A different person or group might develop substantially different frameworks and/or propose substantially different R&D programs. These would be welcome, as engaged, creative, and critical thinking would almost surely speed the transformation effort. Indeed, a task for the conceived R&D program is to solicit and assess a wide variety of designs and design elements.

## 6. Conclusions

This paper raises issues, possibilities, and considerations regarding the de novo design of integrated, meta-level, societal systems, from the viewpoint of societal systems as a cognitive architecture. The list of 13 cognitive tasks/capacities in Section 2, the concept of a function system, and the active inference account of cognition serve as focal points. Perhaps the two key ideas presented in this paper, and the series as a whole, are first, societal transformation—understood as science-driven design of and migration to new, integrated societal systems—is feasible. A viable, practical, affordable R&D program could be designed to reach this goal.

Second, societal systems are usefully viewed as a cognitive architecture. Doing so opens new avenues and opportunities for evidence-based design. Moreover, the cognitive approach might be more likely to succeed in achieving and maintaining desired target levels of social and environmental wellbeing, compared to approaches based only on setting and achieving target levels. It stands to reason that targets could be reached and maintained over time only through an on-going decision making process, which, of course, is a cognitive process.

Though there is much work to do, the effort required for de novo design should not scare us away. In fact, it is likely to be an exciting, hope-filled journey of discovery that might even serve as an antidote to despair in an otherwise increasingly risk-filled world. Every step should bring new insights and possibilities. Some, perhaps many, would like to know what is possible with regard to societal reorganization. Perhaps it is time, now, to find out.

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