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A theory of socio-ecological system change

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Private foundations and other organizations concerned with improving society these days frequently ask grantees to articulate their "theory of change." By this they usually mean their strategy for accomplishing the stated goals of the project, rather than a real, general theory of how social change happens (Anderson 2005). For example, the Center for Theory of Change defines it this way: "A Theory of Change provides a roadmap to get you from here to there." (http://www.theoryofchange.org/what-is-theory-of-change/#4). While it is certainly good to have a well thought out strategy for accomplishing complex social goals, a true *theory* of social change is a very different thing. Such a theory is what Elinor Ostrom was reaching for in her target article (Ostrom 2013). Such a theory must, Lin believed, be grounded in an expanded evolutionary paradigm that is capable of explaining not only how organisms evolve and change, but also how rules, norms, institutions, and cultures evolve and change.

This commentary builds on some of the ideas in Lin's article to develop a broader theory of how complex systems from organisms to ecosystems, communities, states, nations, and the planet as a whole evolve and change, and how we can use this theory to design strategies to get from here to a desired there.

In biology, evolution is the theory of change. It applies across the board. But in the recent past, evolutionary theory has gone down what David Sloan Wilson has identified as some wrong paths. The emphasis on selection at the genetic level, to the exclusion of selection at other levels of organization, has hindered the development of the field and slowed integration with the social sciences. When one considers the evidence more comprehensively, it is clear that selection occurs at multiple levels, and between group selection may in some circumstances be more important than within

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group selection (Wilson and Wilson 2007a). "Multilevel selection theory is relevant to any trait that affects the fitness of other individuals in addition to the individual possessing it, which includes but goes far beyond the stock example of altruism. The theory can help explain the origin and major transitions of life, the structure of animal societies and multi-species ecosystems, and human evolution—even including the rise and fall of empires and the nature of religion" (Wilson and Wilson 2007b).

That norms, rules, communities and cultures evolve in a way analogous to biological systems is also the point of Lin's paper, and builds on the work of several other researchers (Boyd and Richerson 2005). From a multilevel selection point of view, cultural evolution can *only* occur at the group level since communities and cultures are inherently collections of individuals. In fact, as Wilson and Wilson (2007a) point out, even complex individual organisms are really communities of multiple organisms—for example the complex internal bacterial communities that make digestion possible in many organisms.

At the level of communities what has been termed the "symbotype" replaces the genotype as the carrier of information to the next generation (Wilson et al. 2013). Symbotypes occur at multiple levels of organization, from the specific rules and norms that are the subject of Lin's work on irrigation systems, to the basic "world views" that guide the behavior of entire cultures. Selection likewise occurs at multiple levels, both within levels and between levels. Which level of selection dominates will vary with a number of factors, but as Lin's research has shown, it is certainly possible for cooperative rules and norms (symbotypes) to evolve in complex social groups to counteract selection for selfishness within the groups.

In this commentary, I want to focus on a slightly higher level of symbotype generation and selection—that of the culture as a whole. As Donella Meadows has described it, change in complex systems can result from what she listed as 12 distinct levels or places to intervene in a system (Meadows 2010) (see box). These range from adjusting parameters (i.e. taxes, standards, etc.) all the way to goals, paradigms, and even "transcending paradigms." The level of intervention that Lin's work on irrigation systems involve is at 5 (rules) and 4 (self organization) on this list. Culture and worldviews are 3 (goals) and 2 (paradigms) on the list, and act at a highter system level. Level 1 (transcending paradigms) is perhaps the domain of the larger "science of intentional change" that Wilson et al. have proposed (Wilson et al. 2013)

The problem we face today is that our current western culture is both unsustainable ecologically and also undesirable in that it is no longer contributing to net improvement of overall human well-being (Costanza et al. 2011; Kubiszewski et al. 2013). Our dominant current culture is based on a consumerist worldview with maximizing growth of the economy (GDP) as the primary path to change and improvement. Significant change will require alternative cultural symbotypes and selection pressure to prefer one of the alternatives. How might this happen?

One way to think about this comes from the work of Paul Ray and Sherry Anderson, who have been surveying Americans and categorizing them into alternative worldviews (Ray and Anderson 2000; Ray 2008). They have grouped Americans into three broad symbotypes: (1) Modernists (M)—the dominant worldview of markets and economic growth—46 % of the population in 2000; (2) Traditionalists (T)—a nostalgic appeal to earlier (often more religious) times—26 % of the population in 2000; and (3) Cultural

Places to intervene in a system, ranging from least to most influential (Meadows 2010)
12. **Numbers:** Constants and parameters such as subsidies, taxes, and standards
11. **Buffers:** The sizes of stabilizing stocks relative to their flows
10. **Stock-and-Flow Structures:** Physical systems and their nodes of intersection
9. **Delays:** The lengths of time relative to the rates of system changes
8. **Balancing Feedback Loops:** The strength of the feedbacks relative to the impacts they are trying to correct
7. **Reinforcing Feedback Loops:** The strength of the gain of driving loops
6. **Information Flows:** The structure of who does and does not have access to information
5. **Rules:** Incentives, punishments, constraints
4. **Self-Organization:** The power to add, change, or evolve system structure
3. **Goals:** The purpose or function of the system
2. **Paradigms:** The mindset out of which the system—its goals, structure, rules, delays, parameters—arises.
1. **Transcending Paradigms**

Creatives (CC)—a worldview based on sustainability, equity, and sufficiency—28 % of the population in 2000. CC's are "disenchanted with "owning more stuff…materialism…status display and the glaring social inequities of race" (Ray and Anderson 2000).

These percentages have been changing rapidly. In 1965 CC's were a mere 3 %, M's 50 %, and T's 47 % of the population. We thus have a measure of how fast basic cultural symbotypes have been changing in the US, and a "theory of change" that may help understand historical behavior and forecast how and when a major cultural transformation might occur. For example, we might forecast that if current rates of change of cultural symbotypes continue, at some point in the not too distant future the fraction of the population that is motivated by the CC worldview will come to dominate and (assuming a democracy) will begin to change goals, rules, policies and all the levels shown in Meadow's list below paradigms in ways that more directly support the CC symbotype. One might call this combination of worldview, institutions, and technologies at multiple levels of organization a "socio-ecological regime" and that a useful theory of change would need to explain the growth, development, decline and transformation of alternative regimes (Beddoe et al. 2009). This theory hypothesizes that socio-ecological regimes change when "tipping points" are reached, often requiring a crisis as a trigger.

However, like other evolutionary processes, cultural evolution is prone to path dependence, multiple equilibria, lock-in, and traps (Costanza 1987; Arthur 1988; Costanza et al. 1993). Many historical civilizations have collapsed due to their inability to escape these processes (Tainter 1988; Costanza et al. 2007; Diamond 2006). For example, the ancient Maya developed elaborate trade networks, elites, and cities that lost resilience to recurring drought cycles and eventually collapsed (Diamond 2006; Heckbert et al. 2013).

On the other hand, one unique feature of cultural evolution compared to biological evolution is that it is "reflexive" in the sense that goals and foresight can affect the process. "To a certain extent, we can design the future that we want by creating new cultural variants for evolution to act upon and by modifying the goals that drive cultural selection. If our societal goals shift from maximizing growth of the market economy to maximizing sustainable human well-being, different institutions will be better adapted to achieve these goals. As we learn more about the process of cultural evolution, we can better anticipate the required changes and can more efficiently design new institutional variants for selection to work on" (Beddoe et al. 2009). This can radically speed up the change process. The rapid rise of *homo sapiens* is a result of its ability to rapidly change behavior through cultural rather than biological evolution.

What the Maya and other collapsed civilizations evidently lacked was the ability to envision radically different world views, institutions and technologies—new cultural regimes–and the ability to make timely, smooth, intentional, transitions.

If this feature of cultural evolution can be improved, it may help to ameliorate "lock-in", evolutionary dead-ends, and social collapse. Biological evolution has no foresight and can only act on and select from the alternatives in place at any point in time. Humans are rapidly improving their ability to build complex models and simulations of future possibilities and, in a sense, the ability to *pre-select* the preferred alternatives from a much wider range of possibilities.

Scenario planning is one technique that can be used to accomplish this task at larger community, national, and even global scales. Scenario planning creates an ability to discuss and develop consensus about what social groups want (Peterson et al. 2003). Predicting the future is impossible. But what we can do is lay out a series of plausible scenarios, which help to better understand future possibilities and the uncertainties surrounding them. Scenario planning differs from forecasting, projections, and predictions, in that it explores plausible rather than probable future, and lays out the choices facing society in whole systems terms. One can think of these in evolutionary terms as alternative symbotypes for selection, but in hypothetical rather than real versions.

Several scenario-planning exercises have been conducted in recent years at a range of spatial scales and for a range of purposes, including: global futures (Costanza 2000; Nakićenović and Swart 2000; Raskin et al. 2002; MEA 2005), regional futures (Agency 2009; Bohensky et al. 2011), corporate strategy (Wack 1985) political transition (Kahane 2004) and community-based natural resource management (Wollenberg et al. 2000). For example, the Special Report on Emissions Scenarios (SRES) (Nakićenović and Swart 2000) scenarios have been widely used to study the potential impacts of future climates, especially within the IPCC process.

One of the most compelling examples of the application of scenario planning was the transition in South Africa after apartheid. Adam Kahane led a scenario planning workshop that involved leaders from both the white and black political parties (Kahane 2004). He convinced them to go beyond recriminations and to create together four possible future scenarios for the country, only one of which—the "flight of the flamingos" - envisioned a shared country with everyone rising together with truth and reconciliation. Its adoption allowed a relatively smooth transition in a situation that could have been much worse had this important consensus about a vision for the country not been reached.

While multiple futures are possible and plausible, the goal of a "sociotecture" of intentional change would be to design futures that are both sustainable and desirable, recognizing evolutionary dynamics. The goal of a theory of intentional change is to bring to bear an integrated understanding of cultural and biological evolution to allow the transitions to pre-selected desired ends to be made as smoothly as possible. A cultural evolutionary theory of change is to the design of intentional futures as a theory of structural statics is to architecture—a necessary understanding that allows the construction of viable alternatives.

Lin Ostrom's design principles are one way of thinking about how to create sustainable and desirable futures. They point the way to a sociotecture of intentional change and help us think about the design of rules, norms, and institutions for managing the commons that will be both sustainable and desirable.

Making the transition to the world we want will not be easy. In many ways we are locked-in, trapped, and in a very real sense "addicted" to the current regime. Growing knowledge of how to overcome individual addictions may help here. (Miller and Rollnick 2002; Carroll et al. 2006). We know that directly confronting addicts with their problems in an effort to scare them into changing leads to denial and is usually counterproductive. And yet this is exactly what we are doing at the societal level with issues like climate change. At the individual level, developing a positive vision of a better life is often the most effective therapy. This is what scenario planning and envisioning can provide at the societal level. In cultural evolutionary terms, we can produce positive hypothetical symbotypes to speed and direct the process.

So, we need not only a science and theory of intentional change, but also a *sociotecture* integrated with it to develop and test alternative models and visions of the world we want and to help us get there.

It is impossible to predict the future, but we can help guide and model the evolutionary process to create the future we want.

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