Joseph Tainter - Human Resource Use: Timing and Implications for Sustainability

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Joseph Tainter, a Professor in the Department of Environment and Society at Utah State University, and author of the seminal work "The Collapse of Complex Societies", recently gave a speech on complexity and resource use at the 94th Annual Meeting of Ecological Society of America in New Mexico: (Conference theme: *Human Macroecology: Understanding Human-Environment Interactions Across Scales*). The speech, 'Human Resource Use: Timing and Implications for Sustainability', based on a forthcoming paper, is reprinted below with the authors permission.

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*(*NOTE: Dr. Tainter uses the word 'complexity' many times in the below speech, without defining it. I asked him for a definition of the term and he pointed me to his 2006 paper, "Social Complexity and Sustainability", that gives the following definition, from the field of Anthropology.)*

"Complexity is more challenging to define singularly. As it has become a popular topic in recent years, competing definitions of complexity have made it difficult to clarify the concept. The nuances of these different conceptions are not helpful in understanding the relationship of social complexity to sustainability; those interested may consult the growing literature on this topic. To understand sustainability, it is useful to conceptualize complexity in human social systems as differentiation in both structure and behavior, and/or degree of organization or constraint (Tainter, 1988, 2000b; Allen et al., 2003; see also Allen et al., 1999). Social systems vary in complexity as they diversify or contract in structure and behavior, and/or as they increase or decrease in organizational constraints on behavior."

Human Resource Use: Timing and Implications for Sustainability

Joseph A. Tainter

Department of Environment and Society, Utah State University, Logan, Utah 84322, U.S.A.

Few questions of history have been more enduring than how today's complex societies evolved from the foraging bands of our ancestors. While this might seem of academic interest, it has important implications for anticipating our future. Our understanding of sustainability depends to a surprising degree on our understanding of the human past. My purposes today are to show that the conventional understandings of cultural evolution are untenable, as are assumptions about sustainability that follow from them, and to present a different approach to assessing our future.

Cultural complexity is deeply embedded in our contemporary self image. Colloquially it is known by the more common term “civilization,” which we believe our ancestors achieved through the phenomenon called “progress.” The concepts of civilization and progress have a status in the cosmology of industrial societies that amounts to what anthropologists call “ancestor myths.” Ancestor myths validate a contemporary social order by presenting it as a natural and sometimes heroic progression from earlier times.

Social scientists label this a “progressivist” view. It supposes that cultural complexity is intentional, that it emerged through the inventiveness of our ancestors. Progressivism is the dominant ideology of free-market societies. But inventiveness is not a sufficient explanation for cultural complexity, which requires facilitating circumstances. What were those circumstances? Prehistorians once thought they had the answer: The discovery of agriculture gave our ancestors surplus food and, concomitantly, free time to invent urbanism and the things that comprise “civilization”–cities, artisans, priesthoods, kings, aristocracies, and all of the other features of early states.

The progressivist view posits a specific relationship between resources and complexity. It is that complexity develops because it can, and that the factor facilitating this is surplus energy. Energy precedes complexity and allows it to emerge. There are, however, significant reasons to doubt whether surplus energy has actually driven much of cultural evolution.

One strand of thought that challenges progressivism emerged in the 18th and 19th centuries in the works of Wallace (1761), Malthus (1798), and Jevons. The economist Kenneth Boulding derived from Malthus's essay on population three theorems: the Dismal Theorem, the Utterly Dismal Theorem, and the moderately cheerful form of the Dismal Theorem. The Utterly Dismal Theorem directly challenges the progressivist view:

Any technical improvement can only relieve misery for a while, for as long as misery is the only check on population, the improvement will enable population to grow, and will soon enable more people to live in misery than before. The final result of improvements, therefore, is to increase the equilibrium population, which is to increase the sum total of human misery (Boulding, 1959: vii [emphases in original]).

The implication of this strain of thought is that humans have rarely had surplus energy. Surpluses are quickly dissipated by growth in consumption. Since humans have rarely had surpluses, the availability of energy cannot be the primary driver of cultural evolution.

Beyond a Malthusian view, there is another factor that undermines progressivism. It is that complexity costs. In any living system, increased complexity (involving differentiation in structure and increasing organization) carries a metabolic cost. In non-human species this is a straightforward matter of additional calories. Among humans the cost is calculated in such currencies as resources, effort, time, or money, or by more subtle matters such as annoyance. While humans find complexity appealing in spheres such as art, music, or architecture, we usually prefer that someone else pay the cost. We are averse to complexity when it unalterably increases the cost of daily life without a clear benefit to the individual or household. Before the development of fossil fuels, increasing the complexity and costliness of a society meant that people worked harder.

The development of complexity is thus a paradox of human history. Over the past 12,000 years, we have developed technologies, economies, and social institutions that cost more labor, time, money, energy, and annoyance, and that go against our aversion to such costs. Why, then, did human societies ever become more complex?

At least part of the answer is that complexity is a basic problem-solving tool. Confronted with problems, we often respond by developing more complex technologies, establishing new institutions, adding more specialists or bureaucratic levels to an institution, increasing organization or regulation, or gathering and processing more information. While we usually prefer not to bear the cost of complexity, our problem-solving efforts are powerful complexity generators. All that is needed for growth of complexity is a problem that requires it. Since problems continually arise, there is persistent pressure for complexity to increase.

Cultural complexity can be viewed as an economic function. Societies and institutions invest in problem solving, undertaking costs and expecting benefits in return. In problem-solving systems, inexpensive solutions are adopted before more complex and expensive ones. In the history of human food-gathering and production, for example, labor-sparing hunting and gathering gave way to more labor-intensive agriculture, which in some places has been replaced by industrial agriculture that consumes more energy than it produces. We produce minerals and energy whenever possible from the most economical sources. Our societies have changed from egalitarian relations, economic reciprocity, ad hoc leadership, and generalized roles to social and economic differentiation, specialization, inequality, and full-time leadership. These characteristics are the essence of complexity, and they increase the costliness of any society.

In the progressivist view, surplus energy precedes and facilitates the evolution of complexity. Certainly this is sometimes true: There have been occasions when humans adopted energy sources of such great potential that, with further development and positive feedback, there followed great expansions in the numbers of humans and the wealth and complexity of societies. These occasions have, however, been so rare that we designate them with terms signifying a new era: the Agricultural Revolution and the Industrial Revolution. It is worth noting that these unusual transitions have not resulted from unbridled human creativity. Rather, they emerged from solutions to problems of resource shortages, and were adopted reluctantly because initially they created diminishing returns on effort in peoples' daily lives.

Most of the time, cultural complexity increases from day-to-day efforts to solve problems. Complexity that emerges in this way will usually appear before there is additional energy to support it. Rather than following the availability of energy, cultural complexity often precedes it. Complexity thus compels increases in resource production. This understanding of the temporal relationship between complexity and resources has implications for sustainability that diverge from what is commonly assumed. I will explore these implications shortly. It is useful first to present a historical case study, the Western Roman Empire, that illustrates these points.

The Roman Empire collapsed in the mid 5th century A.D., but its last 200 years of existence had been a reprieve. It had been nearly destroyed in the 3rd century. In the half-century from 235-284 the empire was repeatedly breached by invasions of Germanic peoples from the north and the Persians from the east. When these invaders were not being repelled, Roman armies were fighting each other in the service of would-be emperors. Many cities were sacked and productive lands devastated. For a time, rival empires broke away in the east and the west. It seemed that the Roman Empire would not survive much longer.

The Roman government had a clear sustainability goal: the survival of the empire. In response to the crises, the emperors Diocletian and Constantine, in the late third and early fourth centuries, designed a government that was larger, more complex, and more highly organized. They doubled the size of the army. This was very costly. To pay for this sustainability effort, the government taxed its citizens more heavily, conscripted their labor, and dictated their occupations.

With the rise in taxes, population could not recover from plagues in the second and third centuries. There were chronic shortages of labor. Marginal lands went out of cultivation. Faced with taxes, peasants would abandon their lands and flee to the protection of a wealthy landowner. The Roman Empire survived the 3rd century crisis and achieved two centuries of sustainability, but at the long-term cost of consuming its capital resources: producing lands and peasant population. When crises emerged again in the late 4th century, the empire lacked the resources to respond adequately and in time collapsed.

The Roman Empire is a single case study in complexity and problem solving, but it is an important and representative one. It illustrates the basic process by which societies increase in complexity. Societies adopt increasing complexity to solve problems, becoming at the same time more costly. In the normal course of economic evolution, this process at some point will produce diminishing returns. Once diminishing returns set in, a problem-solving institution must either find new resources to continue the activity, or fund the activity by reducing the share of resources available to other economic sectors. The latter is likely to produce economic contraction, popular discontent, and eventual collapse. This was the fate of the Western Roman Empire.

This understanding of complexity and resources has implications for understanding sustainability. Both popular and academic discourse commonly assume that (a) future sustainability requires that industrial societies consume a lower quantity of resources than is now the case, and (b) sustainability will result automatically if we do so. Sustainability emerges, in this view, as a passive consequence of consuming less. Thus sustainability efforts are commonly focused on reducing consumption through voluntary or enforced conservation, perhaps involving simplification, and/or through improvements in technical efficiencies.

The common perspective on sustainability follows logically from the progressivist view that resources precede and facilitate innovations that increase complexity. Complexity, in this view, is voluntary. Human societies become more complex by choice. By this reasoning, we should be able to forego complexity and the resource consumption that it entails. Progressivism leads to the notion that societies can deliberately reduce their use of resources and thereby achieve sustainability.

The fact that complexity and costliness increase through mundane problem solving suggests a different and startling conclusion: Contrary to what is typically advocated as the route to sustainability, *it is usually not possible for a society to reduce its consumption of resources voluntarily over the long term*. To the contrary, as problems great and small inevitably arise, addressing these problems requires complexity and resource consumption to increase. As illustrated by the Roman Empire and other cases, this has commonly been the case.

Many advocates of sustainability will find it disturbing that long-term conservation is not possible. Naturally we must ask: Are there alternatives to this process? Regrettably, no simple solutions are evident. Consider some of the approaches commonly advocated:

1. **Voluntarily Reduce Resource Consumption**. While this may work for a time, its longevity as a strategy is constrained by the fact that societies increase in complexity to solve problems. Resource production must grow to fund the increased complexity. To implement voluntary conservation long term would require that a society be either uniquely lucky in not being challenged by problems, or that it not address the problems that confront it.

2. **Employ the Price Mechanism to Control Resource Consumption**. This is currently the laissez-faire strategy of industrialized nations. Since humans don't commonly forego affordable consumption of desired goods and services, economists consider it more effective than voluntary conservation. Both approaches, however, lead eventually to the same outcome: As problems arise, resource consumption must increase at the societal level even if consumers as

individuals purchase less.

3. **Ration Resources**. Because of its unpopularity, rationing is possible in democracies only for clear, short-term emergencies. This is illustrated by the reactions to rationing in England and the United States during World War II. Moreover, rationed resources may become needed to solve societal problems, belying any attempt to conserve through rationing. Something like this can be seen in the fiscal stimulus programs enacted recently.

4. **Reduce Population**. While this would reduce aggregate resource consumption temporarily, as a long-term strategy it has the same fatal flaw: Problems will emerge that require solutions, and those solutions will compel resource production to grow.

5. **Hope for Technological Solutions**. I sometimes call this a faith-based approach to our future. Members of industrialized societies are socialized to believe that we can always find a technological solution to resource problems. Technology, within the framework of this belief, will presumably allow us continually to reduce our resource consumption per unit of material well-being. Conventional economics teaches that to bring this about we need only the price mechanism and unfettered markets. The flaw here was pointed out by William Stanley Jevons: As technological improvements reduce the cost of using a resource, total consumption will actually increase.

In conclusion, sustainability is not the achievement of stasis. It is not a passive consequence of having fewer humans who consume more limited resources. One must work at being sustainable. The challenges that any society (or other institution) might confront are, for practical purposes, endless in number and infinite in variety. This being so, sustainability is a matter of solving problems.

In the conventional view, complexity follows energy. If so, then we should be able to forego complexity voluntarily and reduce our consumption of the resources that it requires. This approach to sustainability implicitly sees the future as a condition of stasis with no challenges.

In actuality, major infusions of surplus energy are rare in human history. More commonly, complexity increases in response to problems. Complexity emerging through problem solving typically precedes the availability of energy, and compels increases in its production. Complexity is not something that we can ordinarily choose to forego.

Applying this understanding leads to two conclusions. The first is that the solutions commonly recommended to promote sustainability–conservation, simplification, pricing, and innovation–can do so only in the short term. Secondly, long-term sustainability depends on solving major societal problems that will converge in coming decades, and this will require increasing complexity and energy production. Sustainability is not a condition of stasis. It is, rather, a process of continuous adaptation, of perpetually addressing new or ongoing problems and securing the resources to do so.

It is useful to think of sustainability in the metaphor of an athletic game: It is possible to "lose" –that is, to become unsustainable, as happened to the Western Roman Empire. But the converse does not hold. Because we continually confront challenges, there is no point at which a society has "won"–become sustainable in perpetuity, or at least for a very long time. Success, rather, consists of staying in the game.