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More Than Just Tools and Toys: Teaching Innovation

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Abstract: When individuals and populations of organisms face resource scarcity, they respond in various ways: by substituting other resources, by expanding or changing geographic range, or by finding ways to compete more successfully for the resources. Humans have also responded to scarcity through innovation: inventing new ideas and tools with which to create value in order to mitigate scarcity. Understood properly, innovation is a central theme of human history and societal organization, and it may be used as an organizing principle in the teaching of history, economics, and many other fields.

Most non-human animals have a limited range of available responses to critical resource scarcity. Faced with changes in the environment, such as flood, fire, drought, and disease (short term) or climatic change and species extinction (long term), most animals must use one of the following simple responses: move, compete, adapt, or, failing those, die.

Moving depends on the particular scarcity involved, and requires that the organism be able to move up the gradient of availability in some purposeful way (or, alternatively, that the population be able to exploit the gradient, as when bacterial colonies seem to move toward a nutrient source over successive generations).

Competition means that some other organism or population gets less of the desired resource, while the successful competitor gets more. It is, in many cases, a zero-sum game. In some instances, competition is against others of the same kind, as when a predator secures a kill for its young, condemning the young of others to starvation. In other cases, competition is for the resource itself against others, as when a watering hole is defended against all competitors, regardless of species or group. For humans, war is often seen as the most extreme form of competition.

Adapting, in its simplest sense, means substituting some other resource for the now-scarce one, if possible. No prey, eat plants. No potatoes, catch and eat fish. Adaptation often involves improvements in efficiency to "stretch" the available resource. Adaptation may also be a form of competition (and in turn, may be stimulated by competition), such as an "end run" to gain access to resources in different ways.

Early humans, however, had other tricks up their not-yet invented sleeves. In addition to moving, competing or adapting to cope with scarcity, they could and did *innovate*. Simply put, we humans, when faced with an unwinnable scenario, change the rules of the game in order to win (the Kobayashi Maru Simulation being one famous pop-culture example). Using innovations to alter the natural environment, to gain advantages in range, strength, resource management, and many other areas of life seem perfectly natural to us, but may, in fact, be what most differentiates and defines us. Indeed, our innovations change not only the world around us, but ourselves, as well. Our innovations give advantage, but carry certain costs, calling forth other innovative approaches as we richly layer new solutions upon older costly or less efficient solutions.

Human history, then, may best be understood as the story of our changing the game through innovation. In turn, the history of innovation is the history of humankind, both its physical evolution and its social organizations, which are every bit as innovative as its tools and its toys. Because understanding innovation requires more than simply studying

the history of inventions, it is essential to integrate innovation into the study of history, sociology, economics, science, and many other subject disciplines. Innovations are more than simply the tools and toys invented by wild-haired eccentrics who are the all-too-often inaccurate caricature of inventors. Inventors, though, try creatively to find new ways to address human needs. They attempt to manufacture change for the better.

A basic understanding of invention and innovation is essential to an understanding of history. Although recently popularized by Prof. Jared Diamond's *Guns, Germs and Steel* (1999), understandings of invention and innovation are among our oldest narratives and myths. Fire, for example, is central to many mythical accounts of the development of society. Domestication of animals and plants plays a similarly major role in human history.

While history classes usually mention inventions made during the period under study ("Let's see, for the usual era in which inventions are taught, early nineteenth-century America, we mention the water frame, spinning jenny, cotton gin, steam engine, and McCormick reaper"), we rarely examine the knowledge that made the invention possible, the social conditions that made its adoption feasible, and the economic environment that created incentives for its production and distribution. In short, we mention the tools and toys, but gloss over the value of the inventions that make them true innovations.

As an adjunct to this common treatment of inventions and inventors, it is helpful to our students to leaven our pedagogy with an integrated treatment of the ways in which innovations have allowed us to change our world, and to adapt to it rapidly and efficiently. Seen in this way, innovation is far more than just tools and toys; innovations encompass methods of agriculture, of food preparation and preservation, of social organization, of information storage, processing and communication, and of systems of belief–in short, everything that creates or possesses value.

When we adopt innovation as a theme of history, economics, and of other fields, the animating question for the historian, for the teacher, and for the student is simply, "What's new?" The answer, at almost all times in human history, must be, "Just about everything!" Innovations in agriculture gave humans homesteads, bread (or beer), domesticated flocks providing high-quality protein sources, and ultimately, surplus wealth, which permits the development of more complex social institutions and ultimately, culture itself. These same innovations gave them greater resistance to scarcity of resources. In turn, agriculture required innovations in irrigation, storage (leading to the development of crockery, and then of metallurgy), preservation, and social specialization.

The key topics for any period of study are (1) what did they know; (2) when did they know it; and (3) how did they profit from it? For example, the era dating from the Renaissance forward has been marked by the rise of "Western" civilization that stressed innovation, as opposed to repetition. Such technologically advanced societies have increased their standards of living and rates of knowledge accretion exponentially. Americans, in particular, are known for their embrace of innovation as the key to future progress. The teaching of U.S. and world history is therefore incomplete if it does not address the history of innovation, looked at from a wide variety of perspectives and disciplines—economics, history, technology and engineering, and sociology.

The teaching of innovation usually emphasizes a history of science, most recently using Thomas Kuhn's groundbreaking *The Structure of Scientific Revolutions* (1962), or focuses on inventions themselves. Such an approach is typified by stories of famous inventors and their inventions. This over-values utilitarianism and applied technologies and ignores the fundamental building blocks of innovative thought (those concepts, like evolution or relativity, that biologist Richard Dawkins calls "intellectual cranes") that have brought about reorganizations of knowledge and have opened new methods of problem-solving and value creation.

Unlike invention, innovation often involves a combination of products and processes that allow the successful translation of "new ideas into tangible societal impact," as Krisztina Holly of USC's Stevens Institute for Innovation has put it.

For these reasons, a curriculum that integrates innovation as a central focus should begin with a general exploration of ideas, rather than inventions per se. As a seminal example, fundamental linguistic concepts that permit pattern-building and symbolic manipulation are perhaps the central information processing advances that allowed humans to transcend immediate personal experience and their own genetic inheritance. Among these are spoken language (and perhaps most importantly, the ability to communicate in narrative), symbolic representation systems, alphanumeric systems, and information storage systems. Using these tools allowed rapid development and transmission of bodies of learning, as

each generation began with an accumulated investment from past generations in the form of stored knowledge (oral, and later, written histories), subject to rapid assimilation and revision.

Once information technologies (broadly defined to include both language and writing) came into existence, rapid social integration of information allowed groups to leverage stored information, and with it, accumulate wealth and power. Socially innovative structures including class systems and organized religions were two such mechanisms. Thus, innovation both permitted social change and was accelerated by it.

To continue the example, teachers would ideally provide lessons containing rich examples that explain how, at each historic epoch, information technologies have both driven social change and been used to shape it. Advances in information technologies, from petroglyphs. to cuneiform tablets. to the Internet, may be used as the bridge from one epoch to the next, and as a means to compare and contrast societies in contact and competition. Students may choose to explore innovations that fostered the growth of commercial networks and the business models and socio-legal innovations (e.g., intellectual property protections, corporate forms, securities and currencies markets, and insurance, to name some) that encouraged the development of entrepreneurial enterprises as the value-creation engines of those networks.

At each era to be studied, it is useful to employ information and energy metrics (as well as other measures of efficiency) and to demonstrate that societies are not static “zero-sum” operations, but rather, that they grow by individual and institutional creation of value, but that the most intense value creation is always found in more entrepreneurial settings.

The FPRI Wachman Center’s new **Program on Teaching Innovation** is itself an innovation. By providing a recurring thematic focus on innovation and its place in human history, we hope that students may come to analyze the broad questions involving not just what happened, but why, and how it came to pass, using a multidisciplinary approach.

We hope to create curricular resources for both secondary and postsecondary classroom teachers that bring the theme of innovation into each subject area and period of study, from early prehistory through the modern era, where students may be asked to project their own future histories. After all, as Alan Kay, inventor of the laptop computer remarked in 1971, “The best way to predict the future is to invent it.”