New Approaches to Technological Linearity in Socio-Historical Strategy Games

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How did we get to where we are now? What is going to happen to us in the future? Both are questions that are posed time and again in strategy games such as *Civilization* series, The *Age of Empires* Series, or Impressions Games' *City Builder* Series — all of which attempt to emulate social evolution and change. Each time the "new game" button is clicked, the player not only gets the opportunity to explore these questions, but also to play god and immerse themselves in a "what could have been" or "what could be" scenario.

For the most part, however, traditional game designers really don't have a firm grasp of the process of social change. As a result, most games depend on a skewed view of human culture that translates into an infamous system most often referred to as the Tech Tree in which cultural change is emulated by the linear progression of technological and social developments made possible by the accumulation of generic natural resources and a simplistic social system. Consequently, despite their often seemingly intricate nature, most socio-historically based strategy titles are predictable and simple.

It's important to note that all socio-historical strategy games aren't created based upon these flawed principles. The gameplay of some, such as Sierra's *City Builder* Series, are based upon a real historical framework. In these cases, designers have a strong foundation replete with (relatively) understood processes of cultural evolution upon which to base their creation.

The purpose of this paper is to suggest that those games which don't operate within a historical framework, taking a completely free form, player mandated view of cultural and technological evolution, might benefit greatly from drawing upon actual cultural processes in order to model their gameplay. To these ends, this paper will explore a limited series of variables that influence technological innovation and change. It will delve into how some socio-historical strategy titles approach these variables, look at how and why they go awry when approaching the variables, and provide some useful constructive suggestions for creating more realistic gameplay based on actual cultural processes.

One can easily ask why technology should be focused upon. Of all the variables wrapped up in the process of culture change, technology is arguably one of the easiest to quantify and track. Technology makes an indelible impression on the material culture of a given society. Generally speaking, social scientists have a better (though far from perfect) idea of the factors that influence technological change. In addition, strategy games have always had a special interest in technology and technological change. This doesn't mean that the other variables involved in culture change, things such as art, ideology (political, religions, or philosophical), politics, economy, and social organization, aren't important and shouldn't be included in socio-historical strategy games, quite the contrary. They are, however, considerably more complicated. As a result, it is in the best interest of this discussion at hand to focus on the process of technological change.

The assumption being made in this paper is that the point of socio-historically based strategy titles is to model gameplay on real human behavior. For those game designers who see realistic culture change as a burden rather than a boon,

the ideas discussed herein are easily ignored. However, for those game designers who wish to use real human behavior as a foundation upon which to base their games, this discussion will hopefully provide the necessary tools to understand technological innovation and cultural change over time.

Property Rights and Institutions

For technological change to be effective and sustainable, the authorities must relinquish their control over the innovative process and decentralize it. This creates two important, though on their own insufficient, conditions for technological innovation and change.

First, decentralization is important because it means that numerous independent units carry out experimentation. While this sort of situation can result in duplication of work, it ultimately minimizes the probability of missed technological opportunities. Technological innovation is not only an uncertain process, but is filled with varying opinions on how to get the job done. There is always more than one way to skin a cat, but ultimately, there is only one way that is most efficient. A decentralized system generates a wider variety of technological departures, less potential bottlenecks in the creative process, and a simple way to separate the wheat from the chaff.

Secondly, decentralization is important because it offers the successful innovator a chance to enrich themselves. Beyond the basic everyday usefulness of new technology, innovators need a way to cash in on their inventions. A system lacking in monetary incentive discourages innovators from investing the time and effort in future projects. In the past, patents, monopolies, grants, pensions, prizes, and medals provided innovators with the rewards necessary for maintaining a high level of inventive activity.

A patent system, while important for the creative process, probably wasn't completely necessary. After all, many inventors were quick enough to capture a large share of a "market" before they intern were imitated. Also, some inventors engaged in their trade for the sheer sake of fame. Ultimately, however, societies that have some sort of reward for the creative process are likely to experience more technological innovation.

Like many of the variables covered in this discussion, the notion of property rights and institutions are totally ignored in the vast majority of strategy titles. More than likely, this originates from the fact that many titles view a population as a homogenous whole (much like one single organism) where the individual counts for little.

In reality, the inclusion of property rights and institutions into an overall in-game scheme of technological development and innovation wouldn't be all that difficult. The player could encourage the development of numerous institutions (universities, etc.) where the innovative process could be carried out. Each of the institutions could be separately influenced by the player to increase innovation or steer it in different directions. This would effectively decentralize the process and result in an increase in the pace of innovation as well as the possibility of more developments that was previously possible. The more institutions a player develops, the faster their civilization will advance technologically. Further, the player could develop institutions that encourage technological innovation by giving out monetary rewards. Building a Patent Office, for example, would increase a societies overall level of technological innovation.

Resistance to Innovation

Although technology often involves a net improvement to the welfare of the people in a given society, its almost always the case that there are groups whose welfare is reduced as a direct result of the technological innovation, and will therefore be opposed to it. Technological change shakes the labor market, alters the environment, and inherently damages the lives of the innovator's competition. A situation is almost always created where those who stand to lose the most from a new technological innovation will do their best to suppress it.

Like in the case of many of the other variables we'll talk about, resistance to innovation is almost totally ignored in historically or socially based strategy games. However, its inclusion in the fabric of any given title wouldn't be all that difficult, and would ultimately lead to a far more interesting gaming experience for the player. The first thing that would need to be done would be to look at the path of any given technological progression to determine whether the development of a new innovation would threaten the livelihood of a preceding innovation. The most obvious example would be automated production of any given manufactured good.

Since before the industrial revolution, automation has been one of the largest causes of unrest in the industrial workplace. In order to model the obvious resentment that a workforce would feel towards a new technology, the player would have to wait a longer period of time for the innovation to be built. In order to shorten the time, the player could invest in the creation of institutions that would lessen the workforce's resistance - such as social safety nets (especially those which retrain workers). Throughout the process, the player would constantly be threatened by the possibility that the endangered workforce would destroy the new innovation. The player might also want to take more heavy-handed action, such as union busting, to compel their workforce to submit to the implementation of the new innovation.

Geography

The level of impact that geography, either physical or cultural, has on the process of technological innovation and creativity is a point of much dispute. Few environmental factors are either absolutely necessary or completely sufficient for technological creativity. Rather, most geographic conditions act simply to focus and direct the level of creativity that exists in a given society. It's arguable, then, that geographic factors are far more permissive than they are causative.

In Egypt, for example, a great deal of technological development, such as shipbuilding and agriculture, was intimately coupled with the Nile. The vast majority of common Egyptians lived their entire lives according the seasonal fluctuations of the Nile. Some scholars have even speculated that the presence and nature of the Nile itself was an irreproducible component in the development of Egyptian civilization.

Most strategy titles at least pay superficial attention to the affects of geography on technological innovation. In Ensemble's Age of Empires series (or even the follow-up Age of Mythology), the player's ability to gather resources, and therefore the types of technology they can develop, is determined by their geographical surroundings. Likewise, in Impression Game's Emperor: Rise of the Middle Kingdom or Tilted Mill Studios' Children of the Nile, players are unable to engage in mining activities if there isn't anything in their around to mine.

One of the most common affects that geography has technological innovation has to do with building space. Players can't build something on unsuitable land such as rocky terrain or marshland.

Unfortunately, These kinds of approach really don't do justice to the affects that geography has on technology. If a player overcomes the lack of either suitable building land or immediately available resources, they are free to encourage the same sort of technological innovations available to them in other scenarios. The technological path of a scenario that takes place in the desert is usually identical to one that takes place in a river valley.

So, what's the alternative? For each scenario to which the player has access, there should be a path of technological possibilities that is at least partially controlled by geographic setting. For civilizations that reside in river valleys or close to the ocean, the technological path could include maritime trade, the waterwheel, shipbuilding, and hydroelectricity. For civilizations where population centers are widely dispersed, the path could include long distance trade, communication devices, and high-speed travel. The pace and manifestation of this technological path would in turn be influenced and affected by a suite of other variables. Granted, the civilization wouldn't be limited to that one specific technological path. It would, however, serve as a base upon which the civilizations technological character would be founded. Perhaps some sort of bonus would be available to the players who develop technology that lies along their civilization's base technological path.

Path Dependency

In traditional strategy titles, path dependency is probably one of the most often used variables that influences in-game technological development. The development of chemistry lets you access gunpoweder. Once you access gunpowder, you can access explosives, and so on.

The basic premise of path dependency is that technological change and innovation depends on its own past. There are two basic components to path dependency. The first is something called spillover effect. A good example of spillover is the technological innovations that were associated with mining activities.

Mining, of course, was located wherever some desirable mineral resource was located. The often inhospitable and remote mining locations forced miners, who often struggled to get water, to develop better pumps. This in turn led to the development of more accurate boring machines and better tools. The result of this was the eventual development of the mechanisms involved with steam and waterpower. Granted, the line between mining and steam-powered mechanisms isn't a completely straight one. However, without the technological innovations that derived from mining, steam power probably would have taken a radically different form.

The second component of path dependency is something called the bottleneck effect. If technological development is dependent on its past, then imbalances and "bottlenecks" will occur in related and complementary processes. The bottlenecks, dependant on the presence or absence of other variables, serve to either stimulate or constrain further search for innovations. In the best of cases, these "bottlenecks" focus the development of specific technology, but also propel technology in directions not evident in other societies. In the worst of cases, the "bottlenecks" lead a given society down the path to technological ruin, creating a situation where further technological innovation in a given area was nearly impossible. The

problem is that it's rather difficult to predict where a given technological path will lead. What appears at one time to be a marvelous example of technological creativity may prove to be a dead end.

Most designers would probably say that path dependency is in full effect in their games. This is not altogether true. The tech tree (which is the most obvious manifestation of path dependency) really only limits the pace at which technology can be developed. There is little or no outside influence on the tech tree. Given the proper resources (gold, coal, population, etc.) players can tear through it without even a passing nod to realistic cultural processes.

Perhaps the most important thing that designers must realize that any given technological path neither exist within a vacuum nor is a fixed object. They are organic systems that change the way they play out in relation to a host of variables (some of which we're taking about in this discussion). On a more practical level, designers can certainly incorporate both the spillover and bottleneck effect into their technological paths. Each technological innovation (be it a stone tool or a microchip) needs to be placed on a path on relation to every other technological innovation within the game. The influences on a technological path need to be clearly defined well in advance.

By way of example, designers might start with a base technological path that is defined by the geographic environment in which the scenario is going to be played out, the level of technological sophistication (probably something set by the back-story), and pre-defined parameters of the technological path. Next, all the available innovations need to be laid out in relation to one another (much like is done on a traditional tech tree). From there, the effects of all in game variables (like those outlined in this article) need to be hammered out.

Ultimately, what is important is that designers need to realize is that technological paths are not necessarily something that can be adequately represented in a simple flowchart. They are composed of sets of relationships between in-game variables and technological innovations.

Life Expectancy

People who live very short lives have little time or incentive to generate new knowledge. In the past, the act of technological innovation depended on a process of trial-and-error that was not only time consuming, but often quite dangerous. Why would any short-lived individual concerned with far more life sustaining pastimes ever engage in the activities necessary for the generation of new knowledge?

When looked at thoroughly, however, life expectancy is probably one of the lesser variables involved in technological innovation. Historically speaking, technological progress has always marched on in the face of extremely low life expectancy. 14th Century Europe, for example, saw many technological innovations in a time when thousands of people we're dying every day from the black plague.

While many socio-historically based strategy games do indeed consider population health, very rarely do they ever take life expectancy into account when dealing with technological change. In games such as Sierra's City Builder series, Blue Byte's Settlers series, or Ensemble Studio's Age of Empires series in which an individual actually counts for something (opposed to other titles that treat the population as a relatively

homogenous blob), life expectancy isn't really a factor in anything.

Members of a civilization's population can get eaten by stray wolves, skewered by rampaging enemy armies, or fall prey to disease. Most of the time, however, given good conditions, individuals are virtually immortal. For the most part, Populations in these types of games only increase and decrease significantly due to immigrations and emigration. People aren't born, nor do they die of natural causes. This natural immortality is obviously problematic. Individuals within a digital civilization need to have a finite lifetime.

Increase in life expectancy through time would depend on key variables such as the creation of stable and predictable food sources, the establishment of basic sanitary facilities, medical research, and the infrastructure, both social and physical, necessary to maintain population health (infant vaccination, widespread medical facilities, birth control, socialized medicine, etc.). Consequently, as life expectancy increased, people would have more free time to engage in technological innovation and provide the player with more opportunity to encourage advances. Ultimately, the effect of increasing life expectancy on technological creativity would essentially be cumulative. The higher the life expectancy of the population, the more technological innovations would be available to player.

Technology and Science

One of the most common mistakes made by designers is the assumption that science and technology are synonymous. There's no doubt that, historically speaking, science and technology are intricately linked. However, they are two very different things. Science is a method of comprehension, while technology is a method of implementation. With this in mind, the question is whether scientific ideas constrain and guide the creation (and implementation) of new technology.

A body of knowledge exists from which technology, either consciously or subconsciously, draws inspiration. Called, metatechnology, this body of knowledge is generated by purely scientific endeavors. Anyone who's familiar with Francis Bacon's distinction between inventions that depend on a state of knowledge and inventions that could have been made anytime will recognize this idea. Most scholars agree that, at least in the western world, the pool of metatechnological knowledge, as well as the amount that inventors drew upon that pool, has increased through time after the Scientific Revolution.

In all honesty, the distinction between science and technology isn't made that often in socio-historical strategy games. Both terms are used, but they really mean the same thing in an in-game context. The intellectual institutions essential in developing technological innovations are almost always the same as the industrial infrastructure necessary to implement those innovations. There are, however, some notable exceptions. In the Civilization series, a number of institutions exist, including the university and the computer center, which are strictly designed to encourage science and increase a civilizations ability to research technological advances.

While this is definitely a step in the right direction, there needs to be augmented focus on the fundamental differences between science and technology. In order to being remedying this, designers could increase the number of "units" which generate and focus scientific knowledge. These units, like everything else, would have a specific path of development that is affected by other variables within the game. For instance, scientific societies (which were responsible for the generation of much scientific knowledge in

Victorian Europe) were only made possible by a class of citizens which were secure enough financially that they could spend a great deal of their time pondering the mysteries of the world around them. If a player wished to encourage the development of scientific societies within their civilization, they would need to make sure that economic conditions were favorable enough to allow the development of an upper middle class whose wealth was derived from merchant activities or industrial undertakings. Like most things, this level of economic prosperity would have to be arbitrarily chosen by the designer. However, a civilization's ability to reach that level of prosperity would be determined by a host of other economic variables including trade, industrialization, level of natural resources, and internal political stability. The development of many of such units would increase a civilization's ability to generate scientific knowledge. As the player encouraged the development of these types of units, their "science rating" would increase.

It would also be interesting to create research institutions (like universities) that would focus their energies towards a specific area of science such as astronomy, physics, biology, or history. This would allow the player to more directly affect the path that their scientific endeavors would take.

Values

As far as collective influences on technological innovation are concerned, one of the most pervasive is the value placed on the creative process and those who create. Many different societies afford different activities with varying levels of prestige. Generally speaking the ancient Greeks, for example, valued artistic expression and athletic prowess, while the Romans valued military service and administrative ability. For the most part, historically speaking, children who received an education were kept away from activities that involved any serious degree of practicality.

Whether they studied horsemanship, Latin, astronomy, or religious texts, matters commercial and industrial were rarely part of the curriculum. The act of invention was viewed as a dirty job unsuitable for the wealthy. Those who invented things were almost always the lower or middle class. Granted, there are examples of wealthy individuals involved in the process of invention. For the most part, however, the majority of those in the upper class in Western societies held physical labor, commerce, and invention in contempt. This resulted in the creative process of invention and inventors themselves to be held in low regard. So, it stands to reason that societies that have nothing but contempt for inventors and the innovative process will be less technologically creative than those who think the opposite.

Its unfortunate, but this variable is totally neglected in socio-historial strategy games. In order to include values in the mechanics of a game, designers would have to provide players with a way to change the fundamental perceptions held by individuals within a society. One way to do this would be to set an arbitrary level of social acceptance at the beginning of a game. A low level would reflect the general sentiment that technological innovators were at the bottom of the barrel (socially speaking). Conversely, a high rating would indicate that technological innovators were held in high esteem in a society. The level of social acceptance would increase as key developments that directly benefit the society were developed. These could include, but obviously not be limited to, medical techniques, vaccines, or agricultural advances. As the level of social acceptance increased, technological development would become easier.

Concluding Thoughts

If there is one thing to be taken away from this paper, it is that technological change is not an easy thing to understand and model. Technological innovation and change happens as a result of the interaction of many different cultural variables. Not only do these variables react differently with one another in a given society, they vary tremendously between societies. Designing a logical in-game technological progression based on realistic cultural processes is a very tricky thing. Designers need to seriously take into account all the permutations and combinations of variables necessary for technological innovation.

Further, designers desperately must realize that for in-game technological innovation to happen, some of the direct control must be taken out of the hands of players. Technological change needs to be influenced as much by internal variables as player choice. While not immediately obvious, many of the variables would ultimately be the direct result of player choices (or the result of the combination of a series of player choices).

This is obviously very tricky. A game will quickly become quite boring once the player has only a minimum of input. A balance needs to be struck between fun and reality. Above all, technological change has as much to do with public sentiment, political climate, and national values as it does with personal creativity. Designers need to start thinking about how a society would react to player mandated technological innovation.

Designers have to start moving away from the situation in which the player hits the "Industrial Revolution" button and several turns (and a fixed amount of capitol) later, they are ushered into the Industrial Revolution. How would the average person feel about being forced to work in a factory for 18 hours per day? Would they riot? If so, how would such rioting affect the society as a whole? Would it damage the economic system? Would it damage the societies' ability to defend itself from foreign enemies? There isn't any real simple answer.

However, it is the hope that when designers explore these sorts of questions, socio-historical strategy games will become a more enjoyable experience for the player.