

Technologies of history

Tipping Point Technologies and their co-evolution with how we think, work, organize and manage

Stephan H. Haeckel

Technology's historical impact on business management theory and practice is less well documented and certainly more subtle than its impact on, say, the theory and practice of war. Crossbows, catapults, battering rams, and gunpowder figure prominently in discussions of famous battles. We know, for example, that the stirrup was decisive in the Norman's victory at the Battle of Hastings and in Pizarro's victory, with a few hundred soldiers, over tens of thousands of Incan warriors. But what role did technology play in the emergence of bureaucracies and standards; of hierarchies and networks; of Grand Viziers and Administrative VPs; of "scientific management" and "managing by wire"?

Because the historical record is so sparse, inference and anecdote will play major roles in our attempt to understand the co-evolution of technological, organizational and managerial innovations. To complicate matters, it is far from clear that there is a direct, un-intermediated, relationship between them. In fact, the perspective provided in this paper starts with the premise that changes in technology, modes of thought, modes of work, organizational forms and managerial systems are interdependent variables whose interactions forge the link between a particular new technology and a commensurate managerial innovation.. Furthermore, it sometimes took centuries or even millennia for a chain of interactions initiated by a new technology to surface as a major impact on the way businesses were managed. (I use the term *business* to refer broadly to structured human endeavors, one of whose functions is wealth creation.)

Consider technologies whose impacts meet the following criteria:

- Have a *Scope* sufficient to change primary economic transforming resources
- Have a *Duration* of impact measured in centuries/millennia
- Trigger *Frame Changes* in how people think, work, organize and manage

Of these, the frame-changing criterion seems most likely to generate useful insights. As Albert Einstein once observed:

Without changing our patterns of thought, we will not be able to solve the problems we created with our current patterns of thought.

A Brief History of Technology, Thought, Work and Management

Hunter-Gatherers thought differently than we do, according to anthropologists who have studied aborigines still living in isolated environments. These pre-historic ancestors apparently relied primarily on memory, which enabled them to repeat successful actions. And they engaged in conscious thought only (at least predominantly) when immediate action was

required. Will Durant reports that the explorer Robert Peary once asked a native guide what he was thinking of and got the reply, “I don’t have to think. I have plenty of meat.”¹ Sometime after the last ice age, Hunter-Gatherers living in the Fertile Crescent discovered that certain edible grains had the interesting property of growing every year in the same spot. Eventually they associated this phenomenon with the seeds annually produced and dropped by these plants, and began gathering and planting them.

In the fourth and fifth millennia BC, the yield of these primitive farms was vastly increased by two innovative technologies: *irrigation* and the *scratch plow*. With these tools it was possible to create food surpluses, and to store the excess production in a good year for consumption in a later lean year. But to realize these benefits, humans had to think differently. They had to think ahead; to contemplate future possibilities. These were the first *planners*, a new form of work requiring *reflective thinking*. The advantages of surpluses extended to trading opportunities and rewarded economies of scale. Leveraging these opportunities involved a gradual organizational transition from nomadic families to villages and eventually city states, and the institutionalization of the “*leader-follower*” managerial framework. Leaders were responsible for knowing what to do, and ranged from philosopher kings, to warrior chieftains to landowners. Followers might be serfs, slaves or citizens, but they were responsible for carrying out the leaders’ ideas. From at least 4000 BC to 1850 BC, *land and labor* were the primary transforming resources of wealth-creation in this, the Agricultural Economy.²

The Industrial Economy

The first *writing* we know of is the Cuneiform of Mesopotamia, which appeared around 3500 BC. At or about this time the Egyptians developed their hieroglyphs, whose symbols could be arranged to capture the highlights of a campaign against the Nubians or the process for making beer. But it wasn’t until around 850 BC that the Greeks first incorporated vowels into their alphabet, making it possible to represent the phonemes of *speech in written form*. This technology gradually began to erode the Oral Tradition, because the first writer --- call him Homer---though an illiterate by definition, could now write the *Iliad* down. This meant, in turn, that people who had learned the code he used, i.e. literates, could look it up. Writing as a technology outsourced memory to external devices. The *Gutenberg Press* proliferated this capability, and gradually our brains were used less and less for rote memorization, and more for *analytic thinking* and *linear logic*. Now Newton, Galileo and Descartes could stand on the shoulders of giants to deduce new truths. Now it was not only possible, but logical and desirable to specialize thinking – as the universities organized themselves to do – and to further extend that concept into the managerial innovations of *specialization of labor*, the factory, the assembly line, the design of procedures and processes, and ultimately the Six-Sigma execution of same. By the 17th century, the world was not like a machine, it **was** a machine, and everything could be eventually understood by using logic to follow the cause and effect chain from the Prime Mover down to the irreducible component....once that was discovered. These are the deep roots of the “modern corporation”

The organizational form that evolved to execute value-adding procedures efficiently and at scale was the *functional hierarchy* –silos of specialties that received the results produced by a predecessor in the *value chain*, added its value, and handed the result off to a successor

specialty. The managerial schema for governing this organization was (is) *command and control*, an extension of the earliest managerial framework which puts the brains at the top and the brawn at the bottom of a *hierarchy of functional authority*. The transforming economic resources of the Industrial Age were *capital and energy*.

The Information Economy

The *stored program computer* was an invention of the 1940s that became commercially available in the 1950s. Like all new technologies it was first applied to doing more efficiently or conveniently things that were already being done. In the first 50 years of its application, it successfully established itself as an expensive way for businesses to reduce certain categories of cost. But its real promise lies in the electronic speeds at which it processes information, and the fact that it can and does outsource massive amounts not only of memory, but of analytic thinking. Even as this happens, we are learning that humans are primarily emotional, not logical beings; that we are unaware of 95 percent of our cognitive activity³; and that the world is not a machine, but a highly non-linear system of systems.

Codified information and knowledge are the primary transforming economic resources in this economy. What can we infer about the changes in thinking, work, organizational innovations and managerial frameworks that are likely to emerge in response to this historic technological disruption? Some answers seem fairly clear already, though how long it will take for the changes to become dominant modes is a more difficult question.

Some Projections

With computers becoming inexorably better analysts, it seems reasonable to assume that we humans will move on to spend more time engaged in *holistic thinking*.—systems knowledge and know-why elbowing out process knowledge and know-how. Work is already predominantly concerned with the *manipulation of symbols*. We have learned how to outsource physical labor by manipulating symbols in such a way that symbols become capable of manipulating physical objects. Fly-by-wire systems and their commercial cousins *manage-by-wire systems* intermediate human decision-makers and the physical world, increasing the quality of human decisions while decreasing the decision cycle time by an order of magnitude or more. Humans, who cannot fly airplanes at more than 400 mph if they control the hydraulics directly, are capable of flying planes at Mach 6 with fly-by wire support. Early commercial manage-by-wire- implementations have produced similar order of magnitude improvements in the sense and respond cycle.

The discontinuous leap in the pace at which things can and do change breeds rapid and often unpredictable changes in customer preferences and provider capabilities, demonstrating that increasingly discontinuous and non-linear change is baked into the logic of the Information Age. Increasing emphasis over the past two to three decades on outsourcing, partnering, teams, clusters, Keiritsus and alliances are harbingers of the information economy's emergent organizational form, *collaborative networks*.

Which leaves us with the question, what is the managerial framework that will co-evolve with information technology and become dominant in the business environment described in the

preceding paragraph? My answer to that question is elaborated in detail in the book and articles found in the bibliography provided elsewhere on this WebSite.⁴ Here is a brief overview.

The Sense & Respond Managerial Framework for Adaptability at Scale

Sense and Respond is an internally consistent and scaleable recasting of strategy, structure and governance for businesses operating in Information Age environments of unpredictable change. In such conditions, leaders can no longer rely on planning, process designs, hierarchies of authority, and command and control. Rather than efficiently executing a plan to produce what customers were predicted to want, a business must become capable of adapting profitably to what customers do want... NOW. The three reformations that underlie the transformation from an organization that executes plans efficiently to an organization that senses and responds profitably are:

- **STRATEGY**
Demise of the strategic plan of action
Emergence of the *role and accountability design for* action
- **STRUCTURE**
Demise of the functional hierarchy
Emergence of the *collaborative network* of modular capabilities
- **GOVERNANCE**
Demise of Command and Control
Emergence of *Context and Coordination*

In a Sense & Respond organization, leaders are Context-givers, not Chief Order-givers or Problem-solvers. The three components of **Context** are 1) A declaration of Purpose in the form of a Reason for Being that establishes the value the organization exists to produce and the constituent for that value; 2) A declaration of Bounds in the form of Governing Principles that govern, but do not dictate, the actions of people in the organization; and 3) A Role and Accountability design that applies the principles of systems design to transform a network of owned and rented capabilities into a value producing system for which the Reason for Being is the design point.

The Role and Accountability Design relates roles in terms of the outcomes exchanged between them, rather than the activities of them. *Roles* are organizational positions occupied by people who assume accountability for producing these outcomes, which are negotiated and renegotiated as needs and capabilities change. **Coordination** of these self synchronizing collaborations is supported by a commitment management protocol and technology. This technology is used to keep track of the status of “who owes what to whom” and to test each outcome for consistency with the global Governing Principles.

In a Customer-back Role and Accountability design, the external customer-facing role is typically accountable for risk management, revenue and profit, making the bid/no bid

decision, and dispatching other roles in a one-off design to deliver the value negotiated with each external customer, instance by instance. Because they are modular, these recombinatorial designs benefit from exponential increases in scope as new capabilities and roles are incorporated in new versions of the Role and Accountability design, making organic growth a hallmark of Sense & Respond organizations.

Adaptation occurs at two levels In a Sense & Respond business: by people improvising within the current Context, and by leaders adapting the Context itself in response to environmental change. Managing-by-wire, for which fly-by wire systems were the first example, uses technology to represent the environment to a decision-maker, and the decision-maker's choices to the environment. When a leader uses managing-by-wire technology to adapt the Context, organizational and technological innovation become intimately entwined, and co-evolution becomes continuous.

This is a change in business orientation from "firm forward" to "customer back;" from actions to outcomes, from prediction and optimization to knowing earlier and responding better. It is business driven by executive intent, rather than by the onrushing torrent of new technologies. It is business on demand, rather than business as planned.

¹ Durant, Will, *Our Oriental Heritage*, Simon and Schuster, New York, 1935. p 6.

² Sociologist Daniel Bell, in his frame-changing manifesto *The Coming of Post-Industrial Society* (Basic Books, New York, 1973), divided economic history into three eras, distinguished by the difference in their primary transforming economic resources.

³ Cited in Zaltman, Gerald, *How Customers Think: Essential Insights into the Mind of the Market*, Harvard Business School Press, Boston, 2003. p 40.

⁴ See especially Haeckel, Stephan H., *Adaptive Enterprise: Creating and Leading Sense-and-Respond Organizations*, Harvard Business School Press, Boston, 1999.