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Economics, Computers and the War Machine

When we "civilians" think about military questions we tend to view the subject as encompassing a rather specialized subject matter, dealing exclusively with war and its terrible consequences. It seems fair to say that, in the absence of war (or at least the threat of war, as in the case of government defense budget debates) civilians hardly ever think about military matters. The problem is that, from a more objective historical perspective, the most important effects of the military establishment on the civilian world in the last four hundred years have been during peace-time, and have had very little to do with specifically military subjects, such as tactics or strategy. I would like to suggest that, starting in the 1500's, Western history has witnessed the slow militarization of civilian society, a process in which schools, hospitals and prisons slowly came to adopt a form first pioneered in military camps and barracks, and factories came to share a common destiny with arsenals and armories. I should immediately add, however, that the influence was hardly unidirectional, and that what needs to be considered in detail are the dynamics of complex "institutional ecologies", in which a variety of organizations exert mutual influences on one another. Nevertheless, much of the momentum of this process was maintained by military institutions and so we may be justified in using the term "militarization".

On one hand, there is nothing too surprising about this. Ever since Napoleon changed warfare from the dynastic duels of the eighteenth century to the total warfare with which we are familiar in this century, war itself has come to rely on the complete mobilization of a society's industrial and human resources. While the armies of Frederick the Great were composed mostly of expensive mercenaries, who had to be carefully used in the battlefield, the Napoleonic armies benefited from the invention of new institutional means of converting the entire population of a country into a vast reservoir of human resources. Although technically speaking the French revolution did not invent compulsory military service, its institutional innovations did allow its leaders to perform the first modern mass conscription, involving the conversion of all men into soldiers, and of all women into cheap laborers. As the famous proclamation of 1793 reads:

> […] all Frenchmen are permanently requisitioned for service into the armies. Young men will go forth to battle; married men will forge weapons and transport munitions; women will make tents and clothing and serve in hospitals; children will make lint from old linen; and old men will be brought to the public squares to arouse the courage of the soldiers, while preaching the unity of the Republic and hatred against Kings.[1]

This proclamation, and the vast bureaucratic machinery needed to enforce it, effectively transformed the civilian population of France into a resource (for war, production, motivation) to be tapped into at will by the military high command. A similar point applies to the industrial, mineral and agricultural resources of France and many other nation states. Given the complete mobilization of society's resources involved in total war it is therefore not surprising that there has been a deepening of military involvement in civilian society in the last two centuries. However, I would want to argue that, in addition to the links between economic, political and military institutions brought about by war-time mobilizations, there are other links, which are older, subtler but for the same reason more insidious, which represent a true militarization of society during peace-time. To return to the French example, some of the weapons that the Napoleonic armies used were the product of a revolution in manufacturing techniques which took place in French armories in the late eighteenth century. In French armories, the core concepts and techniques of what later would become assembly-line, mass production techniques, were for the first time developed. The ideal of creating

weapons with perfectly interchangeable parts, an ideal which could not be fulfilled without standardization and routinization of production, was taken even further in American arsenals in the early 19th century. And it was there that military engineers first realized that in practice, standardization went hand in hand with replacement of flexible individual skills with rigid collective routines, enforced through constant discipline and monitoring.

Even before that, in the Dutch armies of the sixteenth century, this process had already begun. Civilians tend to think of Frederick Taylor, the late nineteenth century creator of so-called "scientific management" techniques, as the pioneer of labor process analysis, that is, the breaking down of a given factory practice into micro-movements and the streamlining of these movements for greater efficiency and centralized management control. But Dutch commander Maurice of Nassau had already applied these methods to the training of his soldiers beginning in the 1560's. Maurice analyzed the motion needed to load, aim and fire a weapon into its micro-movements, redesigned them for maximum efficiency and then imposed them on his soldiers via continuous drill and discipline.[2] Yet, while the soldiers increased their efficiency tremendously as a collective whole, each individual soldier completely lost control of his actions in the battlefield. And a similar point applies to the application of this idea to factory workers, before and after Taylorism. Collectively they became more productive, generating the economies of scale so characteristic of twentieth-century big business, while simultaneously completely losing control of their individual actions.

This is but one example of the idea of militarization of society. Recent historians have rediscovered several other cases of the military origins of what were once thought to be civilian innovations. In recent times it has been Michel Foucault who has most forcefully articulated this view. For him this intertwining of military and civilian institutions is constitutive of the modern European nation-state. On one hand, the project of nation-building was an integrative movement, forging bonds that went beyond the primordial ties of family and locality, linking urban and rural populations under a new social contract. On the other, and complementing this process of unification, there was the less conscious project of uniformation, of submitting the new population of free citizens to intense and continuous training, testing and exercise to yield a more or less uniform mass of obedient individuals. In Foucault's own words:

> Historians of ideas usually attribute the dream of a perfect society to the philosophers and jurists of the eighteenth century; but there was also a military dream of society; its fundamental reference was not to the state of nature, but to the meticulously subordinated cogs of a machine, not to the primal social contract, but to permanent coercions, not to fundamental rights, but to indefinitely progressive forms of training, not to the general will but to automatic docility … The Napoleonic regime was not far off and with it the form of state that was to survive it and, we must not forget, the foundations of which were laid not only by jurists, but also by soldiers, not only counselors of state, but also junior officers, not only the men of the courts, but also the men of the camps. The Roman reference that accompanied this formation certainly bears with it this double index: citizens and legionaries, law and maneuvers. While jurists or philosophers were seeking in the pact a primal model for the construction or reconstruction of the social body, the soldiers and with them the technicians of discipline were elaborating procedures for the individual and collective coercion of bodies. [3]

Given that modern technology has evolved in such a world of interacting economic, political and military institutions, it should not come as a surprise that the history of computers, computer networks, Artificial Intelligence and other components of contemporary technology is so thoroughly intertwined with military history. Here, as before, we must carefully distinguish those influences which occurred during war-time from those that took place in peace-time, since the former can easily be dismissed as involving the military simply as a catalyst or stimulant, that is, an accelerator of a process that would have occurred more slowly

without its direct influence. The computer itself may be an example of indirect influence. The basic concept, as everyone knows, originated in a most esoteric area of the civilian world. In the 1930's British mathematician Alan Turing created the basic concept of the computer in an attempt to solve some highly abstract questions in metamathematics. But for that reason, the Turing Machine, as his conceptual machine was called, was a long way from an actual, working prototype. It was during World War II, when Turing was mobilized as part of the war effort to crack the Nazi's *Enigma* code, that, in the course of his intense participation in that operation, he was exposed to some of the practical obstacles blocking the way towards the creation of a real Turing Machine. On the other side of the Atlantic, John Von Neumman also developed his own practical insights as to how to bring the Turing Machine to life, in the course of his participation in the Manhattan Project and other war-related operations.

In this case we may easily dismiss the role that the military played, arguing that without the intensification and concentration of effort brought about by the war, the computer would have developed on its own, perhaps at a slower pace. And I agree that this is correct. On the other hand, many of the uses to which computers were put after the war illustrate the other side of the story: a direct participation of military institutions in the development of technology, a participation which actually shaped this technology in the direction of uniformization, routinization and concentration of control. Perhaps the best example of this other relation between the military and technology is the systems of machine-part production known as Numerical Control methods. While the methods developed in 19th century arsenals, and later transferred to civilian enterprises, had already increased uniformity and centralized control in the production of large quantities of the same object (that is, mass production), this had left untouched those areas of production which create relatively small batches of complex machine parts. Here the skills of the machinist were still indispensable as late as World War II. During the 1950's, the Air Force underwrote not only the research and development of a new system to get rid of the machinist's skills, but also the development of software, the actual purchase of machinery by contractors, and the training of operators and programmers. In a contemporary Numerical Control system, after the engineer draws the parts that need to be produced, the drawings themselves are converted into data and stored in cards or electronically. From then on, all the operations needed to be performed, drilling, milling, lathing, boring, and so on, are performed automatically by computer-controlled machines. Unlike mass-production techniques, where this automatism was achieved at the expense of flexibility, in Numerical Control systems a relatively simple change in software (not hardware) is all that is needed to adapt the system for the production of a new set of parts. Yet, the effects on the population of workers were very similar in both cases: the replacement of flexible skills by rigid commands embodied in hardware or software, and over the course of time, the loss of those skills leading to a general process of worker de-skilling, and consequently, to the loss of individual control of the production process.

The question in both cases is not the influence that the objects produced in militarized factories may have on the civilian world. One could, for instance, argue that the support of the canned food industry by Napoleon had a beneficial effect on society, and a similar argument may be made for many objects developed under military influence. The question, however, is not the transfer of objects, but the transfer of the production processes behind those objects that matters, since these processes bring with them the entire control and command structure of the military with them. To quote historian David Noble:

The command imperative entailed direct control of production operations not just with a single machine or within a single plant, but worldwide, via data links. The vision of the architects of the [Numerical Control] revolution entailed much more than the automatic machining of complex parts; it meant the elimination of human intervention -a shortening of the chain of command–and the reduction of remaining people to unskilled,

routine, and closely regulated tasks." And he adds that Numerical Control is a "giant step in the same direction [as the 19th century drive for uniformity]; here management has the capacity to bypass the worker and communicate directly to the machine via tapes or direct computer link. The machine itself can thereafter pace and discipline the worker. [4]

Let's pause for a moment and consider a possible objection to this analysis. One may argue that the goal of withdrawing control from workers and transferring it to machines is the essence of the capitalist system and that, if military institutions happened to be involved, they did so by playing the role assigned to them by the capitalist system. The problem with this reply is that, although it may satisfy a convinced Marxist, it is at odds with much historical data gathered by this century's best economic historians. This data shows that European societies, far from having evolved through a unilinear progression of "modes of production" (feudalism,capitalism,socialism), actually exhibited a much more complex, more heterogeneous coexistence of processes. In other words, as historian Fernand Braudel has shown, as far back as the fourteenth and fifteenth centuries, institutions with the capability of exercising economic power (large banks, wholesalers, long-distance trade companies) were already in operation, and fully coexisted with feudal institutions as well as with economic institutions that did not have economic power, such as retailers and producers of humble goods. Indeed, Braudel shows that these complex coexistances of institutions of different types existed before and after the Industrial Revolution, and suggests that the concept of a "capitalist system" (where every aspect of society is connected into a functional whole) gives a misleading picture of the real processes. What I am suggesting here is that we take Braudel seriously, forget about our picture of history as divided into neat, internally homogeneous eras or ages, and tackle the complex combinations of institutions involved in real historical processes.

The models we create of these complex "institutional ecologies" should include military organizations playing a large, relatively independent role, to reflect the historical data we now have on several important cases, like fifteenth century Venice, whose famous Arsenal was at the time the largest industrial complex in Europe, or eighteenth century France and nineteenth century United States, and their military standardization of weapon production. Another important example involves the development of the modern corporation, particularly as it happened in the United States in the last century.

The first American big business was the railroad industry, which developed the management techniques which many other large enterprises would adopt later on. This much is well known. What is not so well known is that military engineers were deeply involved in the creation of the first railroads and that they developed many of the features of management which later on came to characterize just about every large commercial enterprise in the United States, Europe and elsewhere.

In the words of historian Charles O'Connell:

As the railroads evolved and expanded, they began to exhibit structural and procedural characteristics that bore a remarkable resemblance to those of the Army. Both organizations erected complicated management hierarchies to coordinate and control a variety of functionally diverse, geographically separated corporate activities. Both created specialized staff bureaus to provide a range of technical and logistical support services. Both divided corporate authority and responsibility between line and staff agencies and officers and then adopted elaborate written regulations that codified the relationship between them. Both established formal guidelines to govern routine activities and instituted standardized reporting and accounting procedures and forms to provide corporate headquarters with detailed financial and operational information which flowed along carefully defined lines of communication. As the railroads assumed these characteristics, they became America's first 'big business'. [5]

Thus, the transfer of military practices to the civilian world influenced the lives not only of workers, but of the managers themselves. And the influence did not stop with the development of railroads. The "management science" which is today taught in business schools is a development of military "operations research", a discipline created during World War II to tackle a variety of tactical, strategic and logistic problems. And it was the combination of this "science of centralization" and the availability of large computers that, in turn, allowed the proliferation of transnational corporations and the consequent internationalization of the standardization and routinization of production processes. Much as skills were replaced by commands in the shop floor, so were prices replaced by commands at the management level. (This is one reason not to use the term "markets" when theorizing big business. Not only do they rely on commands instead of prices, they manipulate demand and supply rather than being governed by them. Hence, Braudel has suggested calling big business "anti-markets").[6]

Keeping in mind the actual complexity of historical processes, as opposed to explaining everything by the "laws of capitalist development", is crucial not only to understand the past, but also to intervene in the present and speculate about the future. This is particularly clear when analyzing the role which computers and computer networks may play in the shaping of the economic world in the coming century. It is easy to attribute many of the problems we have today, particularly those related to centralized surveillance and control, to computer technology. But to do this would not only artificially homogenize the history of computers (there are large differences between the development of mainframes and minicomputers, on one hand, and the personal computer, on the other) but it would obscure the fact that, if computers have come to play the "disciplinarian" roles they play today it is as part of a historical process which is several centuries old, a process which computers have only intensified.

Another advantage of confronting the actual heterogeneity of historical processes, and of throwing to the garbage the concept of "the capitalist system", is that we free ourselves to look around for combinations of economic institutions which coexist with disciplinarian anti-markets but do not play by the same rules. Historically, as Braudel has shown, economic power since the 14th century has always been associated with large size enterprises and their associated "economies of scale". Although technically this term only applies to mass-produced objects, economies of scale meaning the spreading of production costs among many identical products, we may use it in an extended way to define any economic benefits to managers, merchants and financiers stemming from the scale of any economic resource. Coexisting with economies of scale there are what are called "economies of agglomeration". These are economic benefits which small businesses enjoy from the concentration of many of them in a large city. These economies stem from the benefits of shop-talk, from unplanned connections and mutual enhancements, as well as for the services which grow around these concentrations, services which small business could not afford on their own. I would like to give one example, from the world of computers, of two American industrial hinterlands which illustrate the difference between economies of scale and of agglomeration: Silicon Valley in Northern California, and Route 128 near Boston:

> Silicon Valley has a decentralized industrial system that is organized around regional networks. Like firms in Japan, and parts of Germany and Italy, Silicon Valley companies tend to draw on local knowledge and relationships to create new markets, products, and applications. These specialist firms compete intensely while at the same time learning from one another about changing markets and technologies. The region's dense social networks and open labor markets encourage experimentation and entrepreneurship. The boundaries within firms are porous, as are those between firms themselves and between firms and local institutions such as trade associations and universities. [7]

The growth of this region owed very little to large financial flows from governmental and military institutions. Silicon Valley did not develop so much by economies of scale, as by the benefits derived from an agglomeration of visionary engineers, specialist consultants and financial entrepreneurs. Engineers moved often from one firm to another, developing loyalties to the craft and region's networks, not to the corporation. This constant migration, plus an unusual practice of information-sharing among the local producers, ensured that new formal and informal knowledge diffused rapidly through the entire region. Business associations fostered collaboration between small and medium-sized companies.

Risk-taking and innovation were preferred to stability and routinization. This, of course, does not mean that there were not large, routinized firms in Silicon Valley, only that they did not dominate the mix.

Not so in Route 128:

> While Silicon Valley producers of the 1970's were embedded in, and inseparable from, intricate social and technical networks, the Route 128 region came to be dominated by a small number of highly self-sufficient corporations. Consonant with New England's two century old manufacturing tradition, Route 128 firms sought to preserve their independence by internalizing a wide range of activities. As a result, secrecy and corporate loyalty govern relations between firms and their customers, suppliers, and competitors, reinforcing a regional culture of stability and self-reliance. Corporate hierarchies ensured that authority remains centralized and information flows vertically. The boundaries between and within firms and between firms and local institutions thus remain far more distinct.[8]

While before the recession of the 1980's both regions had been continuously expanding, one on economies of scale and the other on economies of agglomeration (or rather, mixtures dominated by one or the other), they both felt the full impact of the downturn. At that point some large Silicon Valley firms, unaware of the dynamics behind the region's success, began to switch to economies of scale, sending parts of their production to other areas, and internalizing activities previously performed by smaller firms. Yet, unlike Route 128, the intensification of routinization and internalization in Silicon Valley was not a constitutive part of the region, which meant that the old meshwork system could be revived. And this is, in fact, what happened. Silicon Valley's regional networks were re-energized, through the birth of new firms in the old pattern, and the region has now returned to its former dynamic state, unlike the command-heavy Route 128 which continues to stagnate. What this shows is that, while both scale and agglomeration economies, as forms of positive feedback, promote growth, only the latter endows firms with the flexibility needed to cope with adverse economic conditions.

In conclusion I would like to repeat my call for more realistic models of economic history, models involving the full complexity of the institutional ecologies involved, including markets, anti-markets, military and bureaucratic institutions, and if we are to believe Michel Foucault, schools, hospitals, prisons and many others. It is only through an honest philosophical confrontation with our complex past that we can expect to understand it and derive the lessons we may use when intervening in the present and speculating about the future.

[1] Excerpt from the text of the levée en masse of 1793, quoted in: William H. McNeill: *The Pursuit of Power.Technology, Armed Force and Society since A.D. 1000*, University of Chicago Press, 1982, p. 192.

[2] ibid., p. 129.

[3] Michel Foucault: *Discipline and Punish. The Birth of Prison*, Vintage Books, New York, 1979, p. 169.

[4] David Noble: "Command Performance: A Perspective on Military Enterprise and Technological Change". In: Merrit Roe Smith (ed.): *Military Enterprise*, MIT Press, 1987, p. 341 and 342.

[5] Charles F. O'Connell, Jr.: "The Corps of Engineers and the Rise of Modern Management", n: ibid. p. 88.

[6] Fernand Braudel: *Wheels of Commerce*, Harper and Row, New York, 1986, p.379

[7] Annalee Saxenian: "Lessons from Silicon Valley". In: *Technology Review*, Vol. 97, no. 5. page. 44.

[8] ibid. p. 47.