The Factory System, RIP?
Remote Work and the Liberation of Labor.*

*With apologies to Georgi Plekhanov

Joel Mokyr
Departments of Economics and History
Northwestern University
Eitan Berglas School of Economics
University of Tel Aviv

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The Factory System and the Industrial Revolution

Many of the early writers on the Industrial Revolution were less concerned with technological change and economic growth than with the rise of the Factory System, which was to contemporaries much more of a sea change than the rise in living standards.

More than all: Marx who wrote (*Capital*, Vol. I, ch. 15) scathingly about the factory and its many pernicious effects on the workers. Among those, clearly, the most dramatic change was the end of WFH for more and more workers.

It was a dramatic change: people who had been used to set their own schedules and work from their own homes or workshops attached to them, now had to make their daily way to a factory and had to submit to its schedule and rules. Not just Marx, but many others felt this was the most dramatic economic transformation of the Industrial Revolution.

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The “Factory System” eventually included far more than the “Dark Satanic Mills” built by the likes of Richard Arkwright and John Kennedy.

In the nineteenth century it was extended to transportation (railroads), services (department stores and large offices) and became the dominant form of labor deployment. Work was sharply defined by time, space and hierarchy.

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Economists have long explained why:

Three main classes of arguments:

- Physical Economies of Scale (fixed costs)
- Information and coordination economies
- Better exploitation of workers ("drive them harder") due to close monitoring and strict oversight.

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The Welfare implications of Factory Work

The paradox is that the Rise of the Factory was one of the keys of the growth of income per capita and economic modernization, but in and of itself its effects may have been seriously welfare-reducing. The economics of this is very clear.

1. Reducing the choice set between income and leisure to a single point instead of a full set --- what this meant that even in the face of rising wages welfare could be reduced.
2. The time-cost of commuting (in the nineteenth century mostly walking to work) was not compensated and effectively unpaid labor.
3. Disamenities at work: factories were noisy, drafty, dirty, and dangerous.
4. Workers were subject to something most had never experienced and strongly resented: **factory discipline**.

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Even its apologists realized that. Ure (1835) wrote that

"To devise and administer a successful code of factory discipline, suited to the necessities of factory diligence, was the Herculean enterprise, the noble achievement of Arkwright.

Even at the present day, when the system is perfectly organized, and its labour lightened to the utmost, it is found nearly impossible to convert persons past the age of puberty, whether drawn from rural or from handicraft occupations, into useful factory hands."

(Ure, 1835, p. 15).

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The importance of docility

As a consequence, factories preferred female and child labor, not only because they were cheaper but because they were more docile.

Because that system was not politically sustainable (public opinions increasingly turned against Women's and Child Labor), young lads had to be conditioned to become pliable and obedient, which is what factory schools (and later the entire education system) focused on --- a form of non-cognitive human capital.

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This helps explain the rise of the Factory

The division of labor required coordination and hence needed to be managed by people who gave instructions and could monitor whether they are carried out correctly.

There was no easy way of doing this in the domestic ("cottage") industries that dominated manufacturing before.

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The Division of knowledge

The Factory System was technology-driven. Some factory features were clearly subject to scale economies.

The main reason, however, was that the factory concentrated knowledge: as technology became more complex, production-knowledge (broadly defined) had become too large for one person to know it all, and so factories were places in which a Division of Knowledge was practiced.

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This point was formalized and elaborated upon in a paper by Becker and Murphy (1992), which suggested a new interpretation of the role of the firm.

The firm made by the Industrial Revolution, unlike premodern artisans, required a large amount of knowledge.

Becker and Murphy maintained that, given the limitations on what and how much each employee can know, the total knowledge that the firm has to possess in order to function is chopped up into manageable bites, divided amongst the workers, and their actions are then coordinated and monitored by management. Not everyone can and should know everything.

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In addition to Smith's dictum about the division of labor being limited by the size of the market, the division of labor is determined by the size of the knowledge set necessary to employ best-practice techniques.

The point is not just that each worker knows what she needs to know to carry out her task, but that she becomes in charge of a subset of the total knowledge required by the firm so that others can rely on her on issues in her specialization.

This means that asymmetric information is not "a problem" for the firm but an essential way for it to operate. Specialization in knowledge does not only "exacerbate the problem of asymmetric information" but it demands it.

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The organizational problem for the firm was to ensure that agents who possess knowledge, revealed it fully and truthfully to those who needed it or those to whom they report.

Inside a plant, agents knew and could trust each other, and this familiarity turned out an efficient way of sharing knowledge.

Concentrating all workers under one roof ensured two things: (1) maximal bandwidth and (2) trust through repeated interactions and personal contact.

As long as distance was a critical factor in information transmission, the benefits and costs of proximity had to be traded against each other.

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A typical industrial firm in Europe would require not just workers and overseers, but also mechanics, technicians, blacksmiths, carpenters, accountants, inventory people, salespeople, finance experts, and eventually many others.

Because such information had to flow quickly and credibly within the firm, and because other means of communication were expensive and slow, the best way to do it was to concentrate all people in one place and make sure they were all there at the same time.

And so: will technological progress in our age make that need redundant? Is the factory system obsolete?

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Representation Technology

What I mean by that is our ability of projecting an image of something or somebody that provides the illusion of someone being here who isn't really. The observer is made to believe she is experiencing something that isn't really happening physically. In other words, what makes the factory redundant is what could be called "Representation Technology."

The history of representation technology is rarely discussed as such but it may be quite relevant here.

Main argument: Modern representation technology has weakened the need for factories because of telepresence. Workers can exchange information quickly and credibly without "being there".

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History of Representation Technology

The history of imitative technology follows a “punctuated” pattern: for hundreds of years, the technology is more or less static; then comes a sudden eruption of new knowledge and capabilities—and the world changes irreversibly.

Much like much like that of medical technology, the trajectory follows the famous “hockey stick” pattern.

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This technology is something that humans have been concerned with ever since the first cave paintings, found on the Indonesian island of Sulawesi, which have been dated to 44,000 years ago.

Medieval Christians could “witness” the childhood of Jesus and the crucifixion from paintings hanging on their church walls, and they surely were moved by these images. The resemblance to reality, however, required suspending disbelief. Depth, space, and precise human features were unrealistic. Then came the invention of perspective attributed to a Florentine polymath, Filippo Brunelleschi (1377–1446).

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Other breakthroughs in this technology were photography, developed in the 1830s, and the perfection of technologies that could reproduce both sound and motion, with movies being the ultimate form of imitating reality.

Further technical progress made movies increasingly lifelike: colors, resolution, surround sound, even somewhat dubious attempts of creating three-dimensional experiences—all managed to make audiences laugh, weep, or cringe.

In our age, telepresence has access to enormous bandwidth and basically has become distance-independent and supplied at zero cost.

This may drive the pendulum back to a pre-1750 world of WFH or a better world yet, a world of WFA.

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The discontinuous leap in representation technology in recent years is that there is representation ***with feedback and control***. In other words, it allows remote agency: the ability to interact with an object and control an environment without being there.

We can in principle project our presence onto any environment and do most things that before required presence: speak, listen, see, and be seen. In some cases we can even manipulate machinery and instruments (say, through computer guidance or remotely controlled robots) but that is still limited.

But what has become exceedingly easy is to access, distribute, and share knowledge.

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This is what distinguishes in our world those who can operate in an environment of WFA such as accountants and consultants from those who, like landscapers and proctologists, still have to be present to carry out the task. Dingel and Neiman estimate that 37% of US workers can work from home, an identical estimate to that of Sostero et al (2022) for the EU.

But those boundaries are conditional on the stage of development of the representation technology.

One can easily see that remote-work technology will be biased toward *boundary shifting* toward expanding the possibility of remote work (e.g., via more advanced robotics) so that dentistry and care for elderly are carried by remote-controlled semi-autonomous devices, with their controller far away.

Moreover, advanced representation techniques such as VR make it possible to share *tacit* knowledge without actually being present.

It is easy to see how the main raison d'être of the factory system would be attenuated, and how we could have all the advantages it provided, without the costs of commuting to the workers and the costs of providing physical space and infrastructure to the employer.

Could this seemingly positive-sum outcome become a reality? Distance may not be dead, but it may go on life-support.

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One huge advantage of WFA

The rise of the factory system was a radical switch from one corner solution (pre-industrial worker had full control over time and space) to another (worker has zero control).

Remote work allows internal solutions: mixed or “hybrid” optimal outcomes may become quite general.

Hybrid work arrangements may be the best of all possible worlds. “Come into the office only when it suits you or when we really need you here.”

This is what Nick Bloom et al 2021 suggest may be the post-Covid equilibrium.

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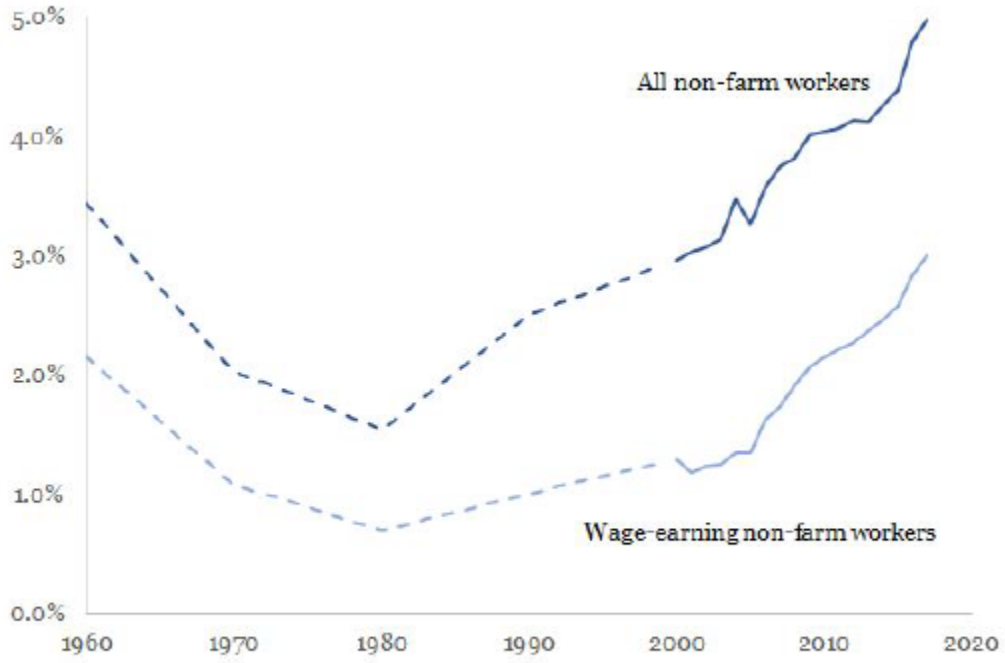
Yes slow progress despite radical technological progress in communication since 1990

Figure 1. Share of Nonfarm Workers Working From Home, 1960-2017



Note: Data from 1960-1990 is drawn from census means of travel to work data and available in 1960, 1970, 1980, and 1990 - other values are imputed. Data from 2000-2017 is drawn from the American Community Survey means of transportation to work data and is available annually. Data queried from IPUMs by Lyman Stone.

Source: Clancy (2020)

The same was true in EU countries

In 2019, around 11% of dependent employees were working from home “at least some of the time,” up from less than 8% in 2008. Yet, just 3.2% of employees in the EU-27 “usually” worked from home – a share that remained rather stable since 2008 (Sostero, 2022, p. 7).

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So why has progress on this front been so slow?

Lots of reasons:

A big one is the “stickiness” of work habits and location. Here the shock of the pandemic may have been crucial.

Another is the positive spillover effects of co-location on knowledge; a lot of evidence following the classic paper by Jaffe-Henderson-Trajtenberg (1993) that showed the superiority of patents filed by co-located inventors. Much of the ensuing literature replicated their results.

A third may be concern by employers regarding the monitoring of employee effort.

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What about "factory discipline" and monitoring worker effort?

Telepresence is symmetrical: just as new technology allows the worker to project herself onto the work of space without being physically present, so can various surveillance technologies allow employer to be "present" and watch the WFA worker's activities.

Such techniques are often resented as an infringement on privacy but of course when they had to be physically present on the factory shopfloor the workers had even less right to privacy.

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Conclusion

Future improvements in representation technology will increasingly make WFA feasible and expand it to occupations and tasks that as of now require co-location.

It seems that on balance such a change increases the options that workers have and allows them to choose the ones that maximize their utility. In that regard this technology may offset and even reverse the large social costs implied by the switch to the Factory System during the Industrial Revolution.

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