Engineering, applied science, and industrial innovation

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Discussion

Peter B. Meyer
U.S. Bureau of Labor Statistics,
But not speaking for that institution

David Mitch's paper on the rise of the engineering profession in UK since 1910

- Count of engineers in industrial countries rises sharply after 1910.
  - In U.S. and Britain from 1910-1950 rises more than five times.
  - (These are self-defined? Or defined by their education?)
- Increasingly they are university-educated.
- Mitch builds toward the argument the roles and management of engineers changed a lot and that industrial success would depend on them a lot.
- Before this period, creative British tinkerers had been influential by working on their own.
- Perhaps this way of thinking had become institutionalized in Britain – that an inventor needed to be autonomous, able to change direction at will, not coordinate with others as an R&D department would.
- And this broke down against competition as "systematic" and "university-educated" approaches became more effective for coordination, or at technological advance, or at economies of scope and scale.
- It may be that "practical men" (tinkerers) tend to operate in a non-competitive environment. Hypothesis: in an industrialized competitive world, the "practical men" lose to corporate R&D. (But before that kind of competition, they win.)

David Mitch's paper on the rise of the engineering profession in UK since 1910

- What does the university-trained engineer know?
  - E.g. the curriculum? That the practical engineer does not know.
- Whisler (1999) hypothesis: firms lack "formal systems to direct and constrain 'dominant' engineers"
- Paper offers hypothesis: The work is more complex over time; engineering professionalism is key.
- Related hypothesis: University-trained engineers recognize and respect the spectrum of established specialties.
- Mitch suggests that corporate R&D departments generate capable managers.
- They know their own product lines and corporate cultures; they recognize potentially necessary specialties; and who know their own product.
- Continued survey of the sectors in which Bitish engineers were employed will be valuable. So far, aircraft, electronics, and motor vehicles.

Bruland and Llerand

Documented corporate history extensively including primary research
Findings include: complicated corporate structure; management and ownership intertwined.

B&W had a key early invention and patent.
The company inherited a valuable unique technology, and its strategy is to exploit and sustain this by:

- selling around the world (finding niche demand)
- actively engaging in research and development a staff of experts collaborating (pushing supply improvement)
- fiercely litigating against potential competitors who might be interpreted as having tread on its patent thicket (undermining competing supply)

Bruland and Llerand

Authors posit that "networks of knowing" are central to B&W's success. (sometimes the phrase is used: "communities of practice", or "patent pools" help.

Yes, high tech, innovative companies operate this way, in the 1800s or now. Like Microsoft, or modern pharmaceutical companies, or Boulton & Watt.

Contrasts this to an activities view in which the company strategy was built on particular activities. Treats it as compatible with a competences story.

I am persuaded the Chandlerian arguments are secondary – the division between ownership and management is not important. Maximization/efficiency is secondary; satisficing is sufficient, because B&W operates from a position of a big advantage – it owns a key technology in a growing sector.
The Porter-type arguments can be adapted to fit, if R&D is an activity, but the narrative loses its force, I agree.

Nuvolari and MacLeod

This historical work can help give an understanding of industrialization.

The evidence here is very helpful. Much is original.

They cover mechanical engineers – a profession – AND the new machine-making industries.

Those evolve to be separate things.

Machinery industry, as later conceived:

- Arises in this period, made up of new firms, making machines for manufacturing industries.
- Appears by "vertical disintegration" from other industries
- Has inputs and outputs and revenues and employs a staff.
- Supplies many industries in 1841 according to this paper's table 1.

But no "mechanical engineering industry" in UK or US Censuses (I think).

Mechanical engineers as occupation

As later conceived, this is someone who:

- knows some geometry, drafting, Newtonian physics, knows about instruments and measurement, strength and flexibility and stretch-ability of materials, heat diffusion and transfer, fluid flows, lubrication . . .
- uses this knowledge to design physical things.
- may work for machine making, or for another kind of firm, or be a consultant.
- might have a license, or academic qualification, or be a member of a professional organization.
- Arises from millwrights, and mechanics and particular influential individuals.

Patents, in MacLeod and Nuvolari

Either a mechanical engineer or a firm of some type may be a patent-holder.

Authors report that patent-holders were more often the users of industrial production machinery than its makers.

➔ the advance of the knowledge of the engineers (people) is causing industry effect of vertical disintegration. They are helped along by new and better equipment.

➔ so there is feedback between these evolving categories, demonstrated by the patents.

It seems wise to cover both the occupations and the industry because in the early period they are not separated yet! but analytically and rhetorically separate the rise of each type.