

Towards a Global History of Production I: Machine Tools and the International Transfer of Industrial Technology

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At first sight a conference on machine tools seems to be a rather dubious affair, bringing to mind middle-aged male historians sporting moustaches and indulging in the pros and cons of specific models of radial drills or turret lathes – machines which most of their colleagues will hardly have heard of. The notion of a somewhat nerdy academic subject, however, was challenged by the very title of the conference: „Towards a Global History of Production I“, a joint project by the Universities of Cambridge and Bielefeld and the Imperial College, London. Funded by the Thyssen and Hans Böckler Foundations and hosted by the Centre for History and Economics the conference set out to challenge dominant paradigms in economic history as well as current historiographical trends, taking no prisoners along the way.

These lines were laid out in the opening remarks by co-organisers RALF RICHTER (Bielefeld) and ADAM TOOZE (Cambridge) who formulated two general aims of the conference: first, to challenge the dominant narrative which explains the productivity gap between the United States and Western Europe in terms of flexible vs. mass production. This dichotomous view, so the organisers argued, was by and large due to an imprecise, often misleading terminology and to an underestimation of technology transfer both in time and space. However, if this stark contrast was rejected, Richter said, new explanations for the all too real differences as well as for the parallel dynamics of productivity on both sides of the Atlantic would have to be found. Second, the conference aimed at nothing less than turning the tide of culturalist readings which had marginalised production as a field of historical research, identify-

ing consumption as the real driving-force behind post-industrial society, as Tooze argued forcefully.

That rumours of the death of the production paradigm are grossly overstated would be proven right by the conference. While Tooze referred to the fact that the oft-cited network society relied on sophisticated, ubiquitous hardware, ROSS THOMSON (Vermont) later neatly summed up why studying machine tools made so much sense (in, by the way, rather culturalist terms): as machines that make machines they reflect a process of institutionalised learning, providing an index for development and relating to the growth of firms and occupations. Furthermore, by linking various industries machine tools indicate technological convergence while at the same time highlighting transnational communication between diverse, mutually stimulating players. This broad perspective underlined that the conference's interest in technology transcended the limited neoclassical role of a growth function or as a mere explanation of whatever productivity gap, aiming instead at a dialogue between the history of technology and that of the use of technology. The subsequent panels therefore focused on a range of related, mutually supplementary subjects, all of which dealt, in one way or another, with technology transfer (timing, speed, direction, agents, extent, and modes), with tendencies of convergence and divergence, and with the broader implications of technological dynamics for economic history.

In this venture the organisers took the lead. On the first panel, ADAM TOOZE and co-organiser CRISTIANO RISTUCCIA (Cambridge) gave a combined presentation on the significance of machine tools and the question of productivity in the UK, the US and Germany in the armaments boom of 1929-45. Drawing on data on the installed machine tool stock Tooze and Ristuccia disputed the much discussed contrast between European „flexible specialisation“ and American single-purpose mass production technology. According to their analysis both German and UK metalworking employed portfolios of machine types which were not radically different from those used in American establishments. Nor did the contention that

older machines dominated in German industry, stand up to scrutiny. The German machine tool stock doubled between 1933 and 1944 due to massive modernisation while in the US the slump led to a stalled modernisation of machines up to 1938. But if the equipment for mass production is not able to explain the outcome of the economic war – what is? As Ristuccia and Tooze showed German industry not only significantly underused available machine tools, it also employed a stock that was of a lesser quality. Countering the traditional notion of German high quality production they demonstrated that US machine tools were on average 40 per cent more valuable than their German counterparts. Meanwhile the UK tool machine stock per capita in 1940 was about a quarter below the respective figures in the US and Germany but similarities with the German case dominated among those machines which were decisive for mass production.

In a similar vein, RALF RICHTER's presentation shed new light on the transatlantic productivity gap, not finding any evidence of a radical difference in the types of machine tools employed in the US and Germany either. Instead, his research showed that there was an intensive asymmetrical technology transfer between both countries, embracing nearly all design features, with one significant exception: electric motors. While American establishments used electric unit drives on small machines just as they did on big machinery their German counterparts did not. As a rule, in the USA more machines were equipped with more motors which were more powerful. By the 1920s the US machine tool industry was thus well ahead of their German competitors – but not as a result of any specific, Fordist breakthrough of single purpose machinery.

In his comments, STEPHEN BROADBERRY (Warwick), whose theses on the productivity gap had been tested both implicitly and explicitly by the two previous papers, sketched a separate analysis of the data provided by Tooze and Ristuccia. Failing to be convinced by their results he argued that the international convergence of machine stock between 1930 and 1938 had been hardly more than an interim digression from a long-term path of divergence in the mass production types. The-

refore, Broadberry stood by his views on the broad and significant contrast between the US and the European powers. Despite a spirited discussion, aptly characterised by Alain Michel as the „passion of the tables“, no synthesis emerged.

Technological transfer linked the first to the second panel. In his talk, JOCHEN STREB (Hohenheim) presented the results of a joint research project with RALF RICHTER. Building on an extensive corpus of German patent data the paper pointed out that product piracy is a typical catching-up strategy of economically backward nations. Streb and Richter de-emphasised the normative edge of the phenomenon, differentiating between three different modes of transfer: imitation, adaptive innovation, and diffusion. For the German case they distinguished five periods of the machine tool industry's catching-up process: (illegal) imitation (1867-1899), innovation and diffusion (1900-1914), a period of falling behind again (1915-1918), another phase of (illegal) imitation (1919-1925), and a fifth period marked by innovation and diffusion after 1925. These stages were mirrored by changes in German legal attitudes. Once the machine makers had become innovative and internationally competitive they advocated respect of foreign intellectual property rights – in particular in the face of growing competition from East Asian producers in the second half of the 20th Century.

The shifting fortunes of the technological avant-garde also stood at the heart of the presentation by PHILIP SCRANTON (Rutgers). Conceptualising American machinery and machine tool building between depression and the dawn of the age of globalisation Scranton outlined the US machine tool industry's move from a principal to a peripheral position in the 20th century. Identifying core vectors of innovation – namely in materials for production and in fabrication techniques – Scranton found that the erosion of US machine tool capabilities had started at the end of the first post-war decade with the rise of aeronautic and aerospace innovations. Traditional machine tools designed for metal cutting, grinding, drilling, and shaping machinery became less central in mass production but also in small batch precision operations. New ma-

terials and devices were more often than not ignored by established machine tool builders who stuck to metals after the age of plastics had long begun. Scranton concluded that in the age of „substitution and internationalisation“ machine tool makers had to cede ground to competitors both in- and outside the USA on a massive scale.

In his instructive commentary co-organiser DAVID EDGERTON (London) laid out the path of the following discussion. With an eye to exploring new sorts of historical sources most speakers raised the question what historical information patents actually convey. While Edgerton reminded the audience that patents are legal documents which do not necessarily prove inventiveness other participants stressed the potential of patents to unearth patterns of technological transfer. Terminological difficulties arose as to the difference between copying and counterfeiting while the question whether or not exact imitation was an economically viable alternative to eclectic combination was judged to be at best ambivalent since reverse construction required excellent tacit knowledge. With regard to Scranton's presentation there was general agreement with Edgerton's observation how little we know about technological evolution since 1945 and the shift from principal to peripheral arenas of technological change.

A panel of three case studies dealing with successful technological transfer opened the second day of the conference. All three presentations accentuated different conditions under which the diffusion and adoption of technologies could take place and how these shaped corporate strategies. PIERRE-YVES DONZE (Kyoto) traced the origins of Japanese special-purpose machine tools back to the Swiss Watchmaking Cartel's opposition to the export of machines. Companies like Seiko began developing machine tools on their own, first by means of reverse engineering and exclusively for their own needs, but soon expanding their expertise beyond copying, diversifying their production and finally selling to non-watchmaking customers as well. This strategy was helped by the know-how available thanks to a research centre of arms production, as Donze pointed out, thereby bridging the geographic gap to the topic of

ULRIKE SCHULZ (Bielefeld). She introduced the audience to the case of Simson, a German family-owned company which diversified from small arms production to bicycles and automobiles, using the significant overlaps in each division's production lines. Simson adapted advanced technologies drawn from the US armoury practice for their civilian product line-up and introduced special and general purpose machine tools modelled upon American types. The move into automobiles was inspired by the example of Ford whose achievements were followed with great attention by the management. Simson proved to be highly successful in adapting innovative technology not despite but because the family owners were businessmen rather than technicians, keeping a close watch on international trends. This they had in common with British machine tool makers who adopted sintered carbide cutting tools from Germany for the domestic market. In her presentation HERMIONE GIFFARD (London) refuted the widespread notion of a lack of innovation in British machine production, showing that the foremost firms quickly realised the potential of the new tools in terms of enhanced cutting speed and precision, machine tool design and the range of workable materials. None the less, use of these tools remained more common in Germany than in Britain or America as a result of the structure and strategies of the latter's national carbide and cutting tool industries. The concept of significant difference in national styles of production, Giffard concluded, cannot be based on the tungsten carbide case.

Whereas these presentations vividly illustrated the diffusion of technologies from their place of origination to remote places WOLFGANG KÖNIG (Berlin) argued in favour of nationally specific cultures of machine design and production. His model of a German perception of design as an end in its own right as opposed to an American culture of production in which design was a mere means due to a greater acceptance of standardised products among US consumers met with some criticism in the discussion. Doubts were raised as to the heterogeneity of corporate cultures as well as to the notable inter-regional and international mobility of engineers, desi-

gners, and firms. This diffusion of ideas and concepts was highlighted by KLAUS STAUBERMANN (Edinburgh). His paper outlined the debate inside British engineering circles in the face of growing competition from Germany and the US in the last quarter of the 19th century. Supporters of experience-driven education argued with proponents of the introduction of scientific models into the curricula. In the end, there was no clear decision for either side. Theoretical knowledge was increasingly adopted by engineers but at the same time awareness of existing practical expertise grew and was consciously integrated in the designing of machine tools which remained the products of their creators and their tacit knowledge.

The final panel pursued a double tenet. First, the three papers broadened the scope of the conference by bringing in issues which had been neglected so far such as consumption, the workplace, and production outside the traditional industrial heartlands. Second, the panel laid out paths for future research, thus vindicating the conference's promise to give directions „towards a global history of production“. ANNE SUDROW (Munich) reintroduced questions of consumption into the debate, though not as an alternative to production but as one side of a production-consumption-nexus. Taking shoe manufacturing as an example Sudrow argued that productivity was strongly correlated with a range of different factors such as the respective retailing systems, fashion, and the availability of materials. These accounted for the differences in output between the US, Britain and Germany despite similar production techniques. Sudrow thus provided a model of how the product might serve as an „interface between production and consumption“ and can help explain national differences and similarities in production. Still, further research will be essential to determine whether a similar nexus can be detected in the field of capital goods – Sudrow's approach to production from the product's angle set an example.

Co-organiser THOMAS WELSKOPP (Bielefeld) tackled yet another dimension of the conference's theme by conceptualising production as social practice. Noting that historiography so far has paid little attention to what

workers actually do when they are working he argued in favour of replacing the dominant perception of technology as an abstract, determinist force by an approach allowing for agency. Sketching a concept close to a *histoire totale* of production Welskopp argued for a combination of the so far unrelated histories of work, workers, engineering technology and the spatial, material, and temporal foundations of production, of shop-floor management and of capitalist strategies. Particular emphasis was laid on the need for a reconstruction of work processes through the observation of simulated production processes – a concept which had been impressively visualised by ALAIN MICHEL and STÉPHANE POUYLLAU (Paris) in their digitally generated simulation of a Renault workshop the previous night.

Finally, DAVID EDGERTON brought the conference full circle by suggesting some elements of a new global history of production. After an iconoclastic tour de force in which he criticised the grand narratives of the likes of Ernest Mandel, Fernand Braudel and Eric Hobsbawm for failing to give any material insights into what industrialisation and production are actually about – „too much productive function and too little production“ – he pleaded the case for a double paradigm shift: on the one hand towards a historiography „from below“, describing products and workplaces as suggested by Sudrow and Welskopp, as a move away from innovation-centred approaches; on the other hand towards a peripheral perspective which no longer understands diffusion as spreading inventiveness from the centre to the margins and which allows for non-linear, non-normative accounts of industrialisation. By assuming a more peripheral perspective, Edgerton suggested, a more refined picture of the seemingly well-studied Western hub of production might emerge – sort of 'provincialising Western production'.

Edgerton's suggestions were expanded on in the comments by GARETH STEDMAN-JONES (Cambridge) whose observations on the changing fates of production in the history of ideas opened the final discussion on where to go from here, what to do, and with what hopes. There was general agreement that the

conference could be no more than a start for more in-depth and more diverse research. Indeed, the last panel mapped the ground which had not been covered by the conference. More information will be needed on the interaction between machinery and man and the consequences for man's self-perception as *homo faber*, i.e. the quintessential tool machine. Finance was conspicuously absent from the conference's issues, especially given the efforts to find explanations for national differences in productivity. And David Edgerton's call for a peripheral perspective on production might also benefit from a wider range of participants who, this time, formed a fine sample of representatives of the classical industrial nations which might explain why so much attention was paid to Britain, Germany, and the United States. These desiderata along with the high quality of the conference with its inspiring, workshop-like atmosphere would seem to call for „Towards a Global History of Production II“. Or, as Phil Scranton concluded, „we don't know anything; and we have a lot to learn.“

Conference programme:

Opening Statement

Adam Tooze (Cambridge) / Ralf Richter (Bielefeld): Re-examining Familiar Dichotomies. How to Classify Machine Tools?

Panel I

Cristiano Ristuccia (Cambridge): Machine Tools and the Question of Productivity in the US

Adam Tooze (Cambridge): Machine Tools and the Question of Productivity in Germany and the UK

Ralf Richter (Bielefeld): Electric Motors in the US and Germany: An Explanation for the 'Productivity Gap'?

Stephen Broadberry (Warwick): Comment

Panel II

Jochen Streb (Hohenheim): Catching-up and Falling Behind? Illegitimate Knowledge Spillover from American to German Machine Tool Makers, 1877-1932

Philip Scranton (Rutgers) From Depression to

Globalization: Reconfiguring American Machinery and Machine Tool Building, 1930s-1970s

David Edgerton (London): Comment

Panel III

Alain P. Michel (Evry-Val d'Essonne) & Stéphane Pouyllau (FNCSR): Virtual Reconstruction of Renault's C5 Workshop and the Assembly Line Process in the 1920s

Panel IV

Pierre-Yves Donze (Kyoto): The Watchmaking Enterprises and the Growth of a Special-purpose Machine Tools Industry in Japan (1880-1960)

Ulrike Schulz (Bielefeld): Fordism in the Forest? – The Case of the Simson Works in Suhl, Thuringia

Hermione Giffard (London): An Important Edge: The Adoption of Tungsten Carbide Cutting Tools in Britain

Ross Thomson (Burlington): Comment

Panel V

Wolfgang König (Berlin): Design and Production in the 19th and 20th Century

Klaus Staubermann (Edinburgh): Knowledge, Skill and Machine Tools: Situating Engineering Education in late 19th Century Britain

Cristiano Ristuccia (Cambridge): Comment

Panel VI

Anne Sudrow (Munich): The Concept of a Comparative Product History and its Contribution Towards a Global History of Production

Thomas Welskopp (Bielefeld): Production as Social Practice: Conceptual Considerations

David Edgerton (London): Elements of a New Global History of Production

Gareth Stedman Jones (Cambridge): Comment

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