

THE ROLE OF SALES AGENTS IN THE DIFFUSION OF U.S. MACHINE TOOL TECHNOLOGY IN EUROPE

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ABSTRACT

Local firms operating as sales agents played an important strategic role in developing the European export trade of U.S. machine tool firms. Empirical evidence indicates that a few sales agents achieved a dominant position in the European distribution network. Success in promoting the diffusion of U.S. machine tools rested upon the agents' knowledge of U.S. manufacturing principles and equipment, often acquired through prior production experience, and their investment in facilities and skills instrumental to the development of local markets. For a few of these firms, the competencies acquired in their role of sales agents supported a later entry into machine tool building.

Introduction

The diffusion of U.S. machine tool technology to Europe around the turn of the century can be described in general terms as a cause and an effect of changes in the manufacturing practices prevalent among users in Europe. These were dominated by the growing adoption of interchangeable parts' manufacturing principles which informed the practice of American firms during the late nineteenth century and were a core element of the American system (Rosenberg 1963). The diffusion of the American system in Europe contributed to the creation and growth of a demand for suitable machine tools that was met partly by imports and partly by domestic firms that adopted the design principles of U.S. machine tools.

The historical research presented in this paper documents the role played in this process of diffusion by firms and individuals that operated as sales agents for U.S. machine tool firms. By virtue of their interactions with producers and users, sales agents had a potentially significant role in triggering or sustaining the transformation of users' practices toward the American system by marketing suitable equipment. How did sales agents contribute to this process? What competencies did they bring to bear on it? And what strategies did they pursue?

Sections 2 and 3 of this paper explore these questions by illustrating the basic features of the distribution network supporting the sale of U.S. machine tools in Europe and the origins and strategies of a number of sales agents. But the emerging demand for machine tools adapted to the American system of manufacture created also the opportunity for the growth of a local machine tool industry or for adaptive responses by existing firms. These developments were facilitated by the indigenous accumulation of design and manufacturing capabilities. Section 4 examines the variety of learning patterns ac-

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ording to which these capabilities developed and highlights the role of sales agents as repositories of design competencies.

The Formation of a Distribution Network

Sales of U.S. machine tools to firms and governments in Europe began as early as the mid-nineteenth century. The limited empirical evidence available indicates that Brown & Sharpe had been exporting at least 10% of its output since 1865 (McDougall 1966). Probably, the same was true of Pratt & Whitney. However, the industry's foreign sales were not the result of systematic efforts by the U.S. firms to commercialize their products overseas. They rather resulted from direct interactions with users, or the initiative of merchants in industrial goods, export houses, and selling agents without formal ties to the manufacturers. More active marketing efforts and the establishment of distribution channels gathered momentum during the 1890s, largely in response to the export boom brought forth by the bicycle craze sweeping across Europe and concomitant production problems among British machine tool firms.

Available estimates of exports of metalworking equipment from Robertson (1966) indicate that foreign trade accounted for as much as thirty to forty percent of industry output in 1900, 1908, and 1914.¹ The growth in foreign sales—which can be dated to the early 1890s—was accompanied by a significant increase in the number of U.S. firms whose marketing in Europe was carried out through local sales offices (Figure 1).² It is remarkable that the emerging distribution network was dominated by the agency system, whereby independent local firms operated as sales agents for U.S. builders.³ Moreover, in a large number of cases agency agreements with the U.S. firms were pursued by local firms acting upon business opportunities created by the general growth of metalworking industries in different European regions. This growth stimulated the development of indigenous machine tool production, but it also created market opportunities for foreign manufacturers.

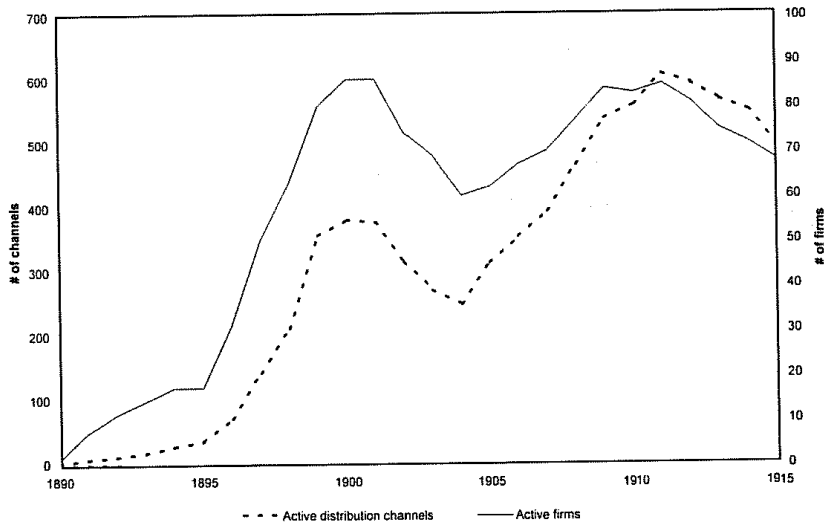
From this viewpoint, the U.S. firms were reported to be poorly informed about local developments and therefore unable to capture a significant share of the foreign trade. For example, Italy's demand for machine tools in 1897 resulted in 1.28 million lire worth of imports. The vast majority of these came from Germany (62%), followed by England (20%) and France (6.5%). The U.S. firms accounted for just 2.5% of Italian imports, arguably as a result of inadequate marketing efforts. A report on the American Machinist argued:

Very few American tool makers are directly represented, i.e., on the spot, and most of our tools which find their way to the Italian shops are imported via Berlin, Paris, or London. This is a great drawback to the development of the trade.⁴

While business could be conducted overseas through traveling salesmen, the devel-

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Figure 1 - U.S. distribution network in Europe



opment of a local market could be more effectively promoted by establishing a permanent presence in the area. As the American Machinist noted:

There can be not the slightest doubt that if American manufacturers would more carefully cultivate the Italian market, study the requirements of the Italian engineering works, keep up closer connections with the consumers and visit from time to time the field, our exports of tools could be increased to a large extent.⁵

A permanent representation on the field kept firms abreast of local market trends, and provided prospective customers with confidence in the availability of aftersale assistance, spare parts, and consulting services from the equipment vendor. Thus, a distributing firm with headquarters in Berlin, Schuchardt & Schütte, reported a five-fold increase in local sales one year after opening a new branch office in Vienna. Of course, the business results of branch office selling depended on a variety of factors, from the quality and commitment of the selling organization to the reputation that it had acquired in the course of its activity.

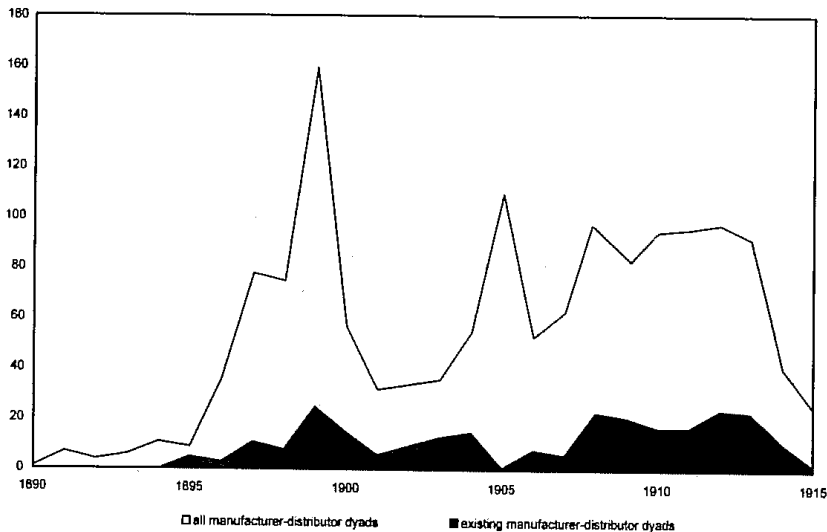
Although local distributors took part in the geographic diffusion of the network of branch offices marketing U.S. tools, the evidence indicates that a more important role was played by the internationalization of the activities of a number of sales agents. Having established themselves as reputable distributors through activities in their home country market, these firms responded to the growth of regional markets by establishing branch offices abroad. A few quantitative measures of this phenomenon for the period 1890-1915 can be developed on the basis of a database of the active distribution channels.⁶

In this database, each record consists of a triplet of values identifying a distribution channel by the machine tool firm, its sales agent, and the national location of the branch

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office. According to this definition, new distribution channels represent new triplets. The birth of a new distribution channel can occur as a result of different types of events. For example, a new distribution channel is created when the sales agent B of firm A in country C opens a new branch office in country D where it continues to represent firm A. According to this pattern, the new distribution channel does not represent a new manufacturer-distributor relationship.⁷ This particular mode of creation of new distribution channels accounted for a share of new distribution channels of about 20% on average (Figure 2).

Figure 2 - Share of existing manufacturer-distributor dyads in new distribution channels



While carrying existing relationships over to new regional markets was an important aspect of the sales agents' activity, many new distribution channels involved machine tool firms that were new entrants, so to speak, in the European distribution network. However, throughout the period examined established sales agents were primarily involved in the growth of the distribution network by undertaking the representation of an increasing number of firms and by extending the density of their branch offices network. Their ability to do so was enhanced by developing a good reputation among U.S. manufacturers and by offering firms the possibility to deal with a unique organization as their sales agent. In turn, established sales agents had an incentive to broaden the product line they carried such as to achieve some economies in the operation of their marketing activities. These considerations suggest that established sales agents could benefit from some kind of first-mover advantages, a conjecture that is well supported by the evidence.

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Figure 3 - New distribution channels by cohort of distributor

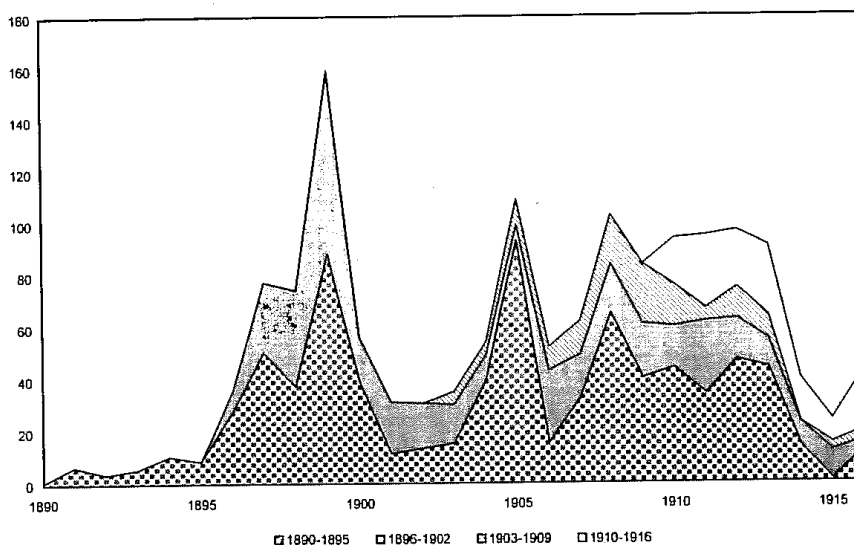


Figure 3 illustrates the number of new distribution channels accounted for by four cohorts of sales agents. The cohort membership of each distributor is determined by its year of entry in the business of representing U.S. machine tool firms. It is apparent that early entrants among sales agents accounted for a considerable share of the new distribution channels. The dominance of a few firms can also be inferred from the degree of concentration of agency agreements with U.S. firms among sales agents. In most national markets, a few distributors operated as agents for a large share of the firms with local distribution channels. For example, in the three largest markets—Great Britain, France, Germany—the two largest sales agents represented more than 50% of all U.S. machine tool firms with local distribution channels. As pointed out earlier, the dominant firms were actively involved in establishing branch offices outside their home country. Accordingly, foreign branch offices—foreign from the viewpoint of the distributor's home country—accounted for an increasing share of new distribution channels (Figure 4).

While scope economies in distribution may be invoked to explain the persistent degree of concentration, the ability of a small number of firms to establish a dominant position in the distribution network owed a great deal to their knowledge of the markets and of the performance in the workshop of the U.S. equipment they sold. In order to understand the origins of these internal competencies, it is important to focus on the histories of individual firms.

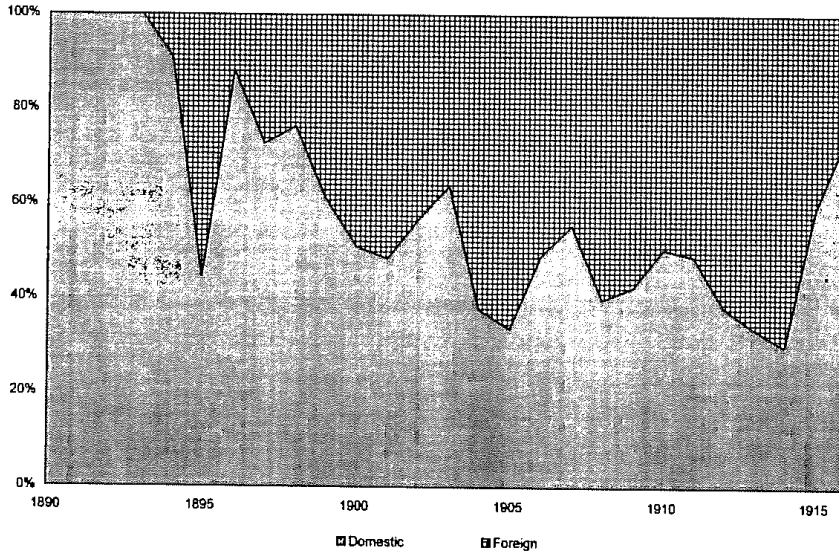
Capabilities and Strategies of Dominant Firms

The ranks of the European sales agents included both specialized distributors of tools and machinery and firms whose primary activity was the production of machinery in general, and in many cases of machine tools. A review of the history of some of these

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firms suggests that they came to operate as sales agents for U.S. firms through multiple avenues. The following account aims at illustrating some of these histories and identifying the factors that may explain their success as sales agents.

Figure 4 - Location of new distribution channels by sales agents' home country



Among these factors a prominent place ought to be given to the direct work experience with the American system of manufacture. In many cases, relevant individuals within the firms undertaking the sale of U.S. machine tools had been trained as mechanics or engineers on American tools. This experience provided them with a good understanding of the applicability of interchangeable parts manufacturing in either U.S. or foreign establishments. This practical knowledge became an important asset, if not a determining factor, when they later decided to establish new enterprises specializing in either the sale of U.S. equipment to manufacturing firms or the production of metal products through the interchangeable parts technique.

This process of learning and diffusion of manufacturing knowledge has been of course well documented in the U.S. economy (Roe 1916; Rosenberg 1963). In Europe important centers for the diffusion of knowledge about the U.S. metalworking practices were the armories' workshops, which led in the adoption of the interchangeable manufacturing principles. Interestingly, whereas in the U.S. the transfer of machine tool technology from armories to other manufacturing processes was largely unfettered, the same was found not to be the case in France. For example, it was reported that employment at the armory of Saint Etienne was highly regulated. Precautions were taken to limit the overall knowledge of the manufacturing process by their workmen. Furthermore, employees at the armory were bound by very long term obligations designed to prevent them from exploiting elsewhere their knowledge about the armories' manufacturing process. These restrictions were relaxed somewhat at the armory workshop in Puteaux, where only machine tools for the manufacture of firearms were designed and produced.

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Although visits by outsiders were not allowed, the personnel at Puteaux was not bound by contracts of the same duration of the ones regulating employment at firearms' production sites.⁸

Two draftsmen who held positions at the Puteaux workshop became involved upon retirement with the sale of U.S. machine tools. One of them, F.G. Kreutzberger honed his skills as a machinist and draftsman at the Remington armory in the U.S., and became superintendent of the Puteaux workshop upon his return to France in 1855. After retiring from his job there, Kreutzberger became involved in the sale of machinery and tools in France acting as the agent for Brown & Sharpe and Pratt & Whitney during the early 1890s. Another Frenchman, Francois Mandon, worked as a draftsman at Puteaux for four years, and then traveled to the U.S., visiting, among other workshops, those of the Springfield armory. Mandon found employment later as an engineer at Fenwick Freres & Co., which became a leading firm in the distribution of U.S. machine tools in France and other European countries.⁹

The learning process described above was not specific to the work experience of government arsenals' personnel. Thus, several firms that took up the business of selling U.S. machinery were founded by individuals with production experience at metalworking firms that pioneered the adoption of innovative equipment, typically of British or U.S. make, and wherever relevant, American manufacturing methods.

One of the leading sales organizations in Germany was established by Gustav Diechmann and later managed by his son, Otto. Diechmann & Sohn was a small firm that focused on representing only a handful of the best U.S. and British machine tool makers, including Brown & Sharpe, Niles Tool Co., Pond Machine Tools, and Ingersoll Milling Machine. The founder of this business had worked as an engineer for the Krupp Engineering Works before taking up a new career as the representative for British machinery firms.¹⁰ During the 1890s he began introducing U.S. machine tools in the German market and by the end of the decade his firm was one of three establishments that according to the American Machinist any German firm interested in American machinery was certain to visit.

While the cases reviewed so far focus on individuals whose knowledge of American manufacturing practices helped them establish a selling business, others applied their skills first to the creation of manufacturing enterprises. This was the case of the firm established by Ludwig Loewe, who was widely considered to be a pioneer in the adoption of the American system of manufacture in Germany. Since its establishment in 1870, Loewe concentrated in the production of sewing machines and firearms by interchangeable parts. This system that Loewe had experienced first-hand during a period spent at U.S. workshops was implemented by relying heavily upon U.S. machine tools. Soon after, the firm perceived that a market for similar machines could be established in Europe and undertook the development of its line of tools. Even then, the company pursued the economies resulting from manufacturing standardized designs for stock rather than to order.

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While its product line was broader than what was typical of U.S. firms, Loewe was quite specialized by the standards of German machine tool builders (Carden 1909).¹¹ A considerable portion of Loewe's business consisted of supplying customers with entire production lines. Accordingly, the new factory established in Berlin around 1899 included a large annex building mimicking the conditions of a typical industrial workshop, enabling the company to test run the production equipment. The purpose of these activities was to elicit the customers' input into the design of manufacturing plants and to train the personnel that was ultimately responsible for overseeing the installation of the machinery at the customer's site.¹²

While the firm was often criticized by U.S. firms for imitating their own machine tool designs, Loewe's commitment to the American system of manufacture and to the associated design principles in machine tools were in many ways useful to foster their diffusion across users, ultimately promoting the growth of the demand for the products of the U.S. firms themselves. Indeed, the firm was the target of negative comments from more conservative German machine tool builders who argued that Loewe, the *Amerikanische shop*, promoted foreign design and manufacturing principles and negative views on the overall quality of the German machinery among domestic users.

Later on, Loewe promoted U.S. design principles and manufacturing practices in ways other than through its own manufacturing business in Berlin. At the turn of the century, Loewe became one of the promoters of two new companies—the Deutsche Niles and the Deutsche Garvin—whose principal purpose was to establish in Germany the manufacture of machine tools based on the designs of U.S. firms, respectively the Niles Tool Works (Hamilton, OH) and Garvin Machine Tools (New York, NY). At about the same time, the company undertook the representation of several U.S. firms from a network of branch offices that by the year 1910 covered Great Britain and all of the major markets in central and northern Europe.

Loewe was not the only firm whose involvement in the distribution of U.S. machinery followed the development of a manufacturing business. Other European firms specifically involved in machine tool manufacturing developed their own distribution network through branch offices in Europe and outside. And when they did so, it was a natural step for them to undertake the representation of other machine tool firms in non-competing product lines. Examples of these firms were common in Great Britain (Alfred Herbert Ltd., Craven Brothers).

The ranks of the selling organizations include a large number of enterprises whose core business was the distribution of machinery and supplies to industrial customers. As they undertook the representation of U.S. manufacturers they could count on their established position in the domestic industrial markets. By all accounts reviewed, this was an important asset since satisfied customers were likely to rely upon existing business relationships for meeting their manufacturing needs and for identifying new equipment. In several cases, successful firms among the specialized distributors made the sale of U.S. equipment their specialty and committed themselves to developing solid business relationships with manufacturers on one hand and users on the other. Continuing interac-

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tions with both were necessary to acquire and develop over time a body of in-house knowledge about users' production needs and the performance characteristics of commercial equipment. This knowledge was essential to perform with success the task of matching users' needs with suitable production equipment. While this task was a central feature of industrial marketing activity in general, its importance was even greater in the context of interest here considering that for many European users U.S. machine tool designs and the associated approach to manufacturing were of an innovative character. Thus, sales agents had to frequently overcome the users' tendency to stick with the tried-and-true solutions.

A great deal could be achieved toward this goal by making it possible to demonstrate the viability and productivity of the proposed equipment to the prospective customers. To this effect, sales offices benefited from holding equipment and tools in stock, outfitting part of their premises for demonstrating and testing production equipment, and training specialized personnel that could operate the equipment and oversee its installation at the customers' plants. Whether or not incurring the costs associated with these practices was economical depended in part on the prospective volume of business. Thus, an 1898 report on machinery dealers in Russia pointed out that a good number of them did not carry any stocks and limited themselves to taking orders and arranging for the delivery of U.S. and other foreign equipment to their customers.¹³ This approach differed significantly from the kind of work performed by the firms that were most successful at establishing a solid trade in the sale of U.S. machinery in Europe.

Among these firms, a prominent place is held by the British firm of Charles Churchill. Born in the U.S., Churchill went to England in 1862 in order to introduce tools for covering steel wire used in the manufacture of crinolines. His knowledge of the kinds of tools available from U.S. firms persuaded him that he could establish a business in England for selling small tools. Since 1865, Churchill imported into Britain chucks (Cushman Chuck Co., E. Horton & Son), Morse twist drills and later small tools by Brown & Sharpe. In Churchill's words, the commercialization of these tools was difficult and many prospective users considered them "American rubbish" and his activity an attempt to bring "coals to Newcastle."¹⁴ These prejudices were slowly overcome and Churchill began importing machine tools. His first plant of American machine tools was placed in 1889 at a firearm manufacturer in Birmingham (Gatling Gun Co.) whose management was in the hands of an American engineer. The growth of the business benefited from the boom in the bicycle industry. While at that time, several British machine tool firms began producing machine tools that featured design elements similar to the U.S. equipment, Churchill's business continued to prosper and his firm increased significantly the number of agencies held for U.S. firms. In 1897, Churchill & Co. employed over thirty people at its main office in London and another ten at its Birmingham branch.¹⁵

Another firm that made a tremendous contribution to the diffusion of American machine tools in Germany and the rest of Europe was the company formed in 1880 by Bernhardt Shuchardt and Henry Schütte. After establishing itself as a distributor of steel

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products and small tools, the company had taken up occasionally the sale of machine tools. Realizing the potential market for U.S. equipment, Schuchardt and Schütte traveled repeatedly to the U.S. during the 1890s. At first, these trips aimed at identifying and purchasing for resale equipment that the principals of the firms considered suitable for the European market. Later on, the firm made arrangements to receive the exclusive representation of selected U.S. firms.¹⁶

Although based in Berlin, the company extended its business over much of central, eastern and southern Europe during the 1890s, establishing branch houses in Vienna, Brussels, St. Petersburg, Cologne and Stockholm. Its main office in Berlin—employing seventy-six men—was responsible at that time for marketing in Italy, Spain, Holland, Denmark, and the colonies. In addition the company opened up a New York office in 1899 to coordinate and supervise shipments and payments. To sustain the increasingly diffuse network of branch offices, the company acquired warehousing facilities in three harbors (Bremen, Hamburg, and Antwerpen) from which machinery and tools could be reshipped to the countries of destination. At that time, the company represented as many as thirty machine tool firms.

The spectacular success of this business was attributed by contemporary observers to the company's investment in physical and human resources. As was the case at Loewe, the headquarters of Schuchardt & Schütte included a basement workshop fitted with shafting and belts run by an electric motor where all kinds of machines could be operated. The use of this facility was made more effective by the company's policy to keep in stock units of the equipment available for sale and to run a small workshop where tools and fixtures could be designed and manufactured as needed. In addition, the workshop allowed the company to test the equipment that they considered for representation. The firm's policy in this regard was to acquire the general agency only for any product whose merits they were fully aware of and at the same time to refrain from offering competing machines.

The company's practices were even more meticulous for products that were particularly innovative from the viewpoint of domestic manufacturing practice. During a visit in 1900, a writer for the *American Machinist* noticed that Schuchardt & Schütte had set special exhibits for the tools of the Chicago Pneumatic Tool Company. The writer reported that:

this specialty of machine tools was taken up by Messrs. Schuchardt & Schütte only a few years ago, and has since been developed into an important line of their business largely through their pluck and enterprise in practically demonstrating the machines to customers and teaching them how to use them.

Among the visitors to this workshop the writer signals the presence of students from technical schools. Likewise, the company took up the sale of presses by E.W. Bliss Co. (Brooklyn, NY) and devoted an entire department to demonstrating the work done by the equipment. The person responsible for the department was a mechanic who had spent some time at the company's headquarters. He carried out his work between the

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Berlin store and the customers' sites, identifying metalworking jobs that could be carried out with the presses and assisting customers through the task of designing special tools and dies as required for the application.

Although the information available about other important sales organizations is limited, their continuing success can be presumed to have been the result of similar factors. It is interesting to notice that even among the firms whose involvement in the selling of U.S. machine tools was clearly more than a seasonal activity, one finds significant differences in their patterns of growth. The internationalization strategy pursued by Schuchardt & Schütte was common to other firms, but others still did not attempt to expand the reach of their marketing efforts much beyond their local markets. Among the former group, mention should be made of the German firms of Ludwig Loewe, DeFries GmbH, and Koyemann, the French firm of Fenwick Freres, and the English firm of Alfred Herbert. The latter was the only English firm that established by the year 1910 a network of branch offices in continental Europe. Other firms representing large numbers of U.S. machine tools in Britain (Churchill & Co., Buck & Hickman and C.W. Burton, Griffith & Co.) did not do so.

Diffusion of U.S. Design Principles Among Manufacturers

The growing adoption among users of the American system of manufacturing practices created the opportunity for local firms to engage in the production of machine tool designs that were in competition with the offerings of the U.S. firms. A variety of factors influenced the local firms' ability to seize this opportunity. Prominent among them was their access to adequate design and manufacturing capabilities. This section reviews the historical record to establish whether local firms had such capabilities and how they acquired them. In connection to these issues, the section will discuss the extent to which sales agents participated or otherwise contributed to the emergence of local competition for U.S. machine tools.

Considering the importance of imitative efforts for the adoption of U.S. design principles among local builders, it will be useful to notice at the outset that intellectual property rights provided relatively limited protection to the innovating firms. This was generally true in the field of mechanical engineering. It was an even more serious problem when protection was needed from foreign competitors partly because of the heterogeneity of national patent laws and partly because the same laws provided at that time even weaker protection to foreign inventors. Patenting costs were an added consideration and while firms may pursue patents in countries like Great Britain, France and Germany, they were not likely to do so in others.

Imitative activities by local firms dominated the early stages of the process of diffusion of U.S. designs. The firm of Ludwig Loewe was repeatedly indicated as an example of a company that developed its own business by creating close replicas of selected U.S. machines. When in 1886 Loewe bid on a contract for a rifle-making plant in France, its proposed machinery was hardly different from what U.S. firms offered. The editor of

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American Machinist denounced Loewe's wholesale copying of American builders' designs, stating that their catalog was:

practically made up of machines which were copied bodily from the production of well-known American builders. Not merely was the general appearance the same, but every detail was copied faithfully, so that, except by a close and expert inspection, the American machines and their German copies were indistinguishable.

The existence of firms that would not hesitate to purchase machinery for the express purpose of copying every one of the components should likely be taken for granted. But we know from investigations on the subject (Levin et al. 1986; Rosenberg and Steinmueller 1994) that imitation is not costless. To be successful, imitators need a certain amount of talent:

the only safe course for the copyist to pursue is to copy precisely; for, if he attempts to vary in any particular form from the original design, he is liable to miss the controlling idea and make a machine which is ridiculous.

These remarks emphasize the importance of design capabilities. Moreover, for imitation to be of significant commercial relevance, the ability to reproduce the essential features of a machine tool design will not suffice. Imitators will need considerable manufacturing skills in order to produce a high-quality copy of the original equipment.

Various accounts indicate that the pool of design and manufacturing capabilities available to machinery firms in continental Europe was quite limited until late in the nineteenth century. It is probably accurate to say that where high-quality equipment was needed for large scale manufacturing, the U.S. firms did not face a severe competition from foreign firms. But over time, the situation changed. First, by the turn of the century a number of firms—such as Alfred Herbert in England, Ludwig Loewe and J.E. Reinecker in Germany—had the internal competencies to adopt useful design principles from U.S. products and to turn themselves into innovators. Second, as the result of experiential learning and specialization, the quality of the domestic machine tool production improved across the major European economies, increasing the competition faced by U.S. firms even at the higher end of the market.

The development of these competitors to the U.S. firms occurred in a variety of ways. According to one pattern, this development occurred as metalworking firms began producing machine tools in response to their own experience in the application of the American system. But it also occurred as the result of adaptive responses by existing machine tool firms and of the creation of new firms.

With respect to the latter phenomenon, the historical evidence suggests that the practice and experience of firms operating as sales agents for U.S. firms may have been important. Indeed, sales agents were in a rather enviable position to assess the ability of existing technology to solve manufacturing problems and could draw from extensive

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observations to turn themselves into manufacturers. An instance of this process can be identified in the origin of the Bullard Company in Bridgeport, Connecticut. McDougall notes that:

Bullard was a mechanic who had become a machine tool agent in New York City and, from his experience in selling tools, he recognized the need for a more accurate engine lathe than those currently available.

The historical evidence reviewed makes it impossible to trace the movement of personnel into and out of the industrial distributors in such a way as to identify draftsmen or mechanics employed by sales agents that branched out into manufacturing. The evidence suggests however that sales agents could resort to machinery firms as subcontractors for manufacturing machine tools according to their own design. Thus, when Godfrey Carden—special agent of the U.S. Department of Commerce and Labor—visited the workshops of a large number of firms in Europe, he noted the presence in several French workshops of machine tools without indication of the manufacturer. Such machines were reportedly manufactured in Germany under contract to a Paris sales agent, Glaenger, Perreaud & Thomme. Similar arrangements were reportedly made by the German firm DeFries GmbH, which however was a recently established machine tool firm operating as sales agent for several U.S. companies.

While this practice may be questionable, it indicates that sales agents were effectively a center of accumulation of design knowledge that could be tapped in order to promote the development of internal competencies at manufacturing firms. Learning about machine tool design was to a considerable extent a natural by-product of agents' routine activities. But specific practices could enhance the process. One of the practices in use at Schuchardt & Schütte was reportedly to develop internal drawings of every machine or device that the company handled.

It is not possible to gauge the extent to which distributors relied upon subcontracts to fill in orders that they presumably could not win by simply supplying their principals' products. A reasonable guess appears to be that they did so to a very limited extent, considering that their reputation with machine tool builders would have been severely tarnished. At the same time it is important to note that resorting to outside contractors may have been a sort of defensive move on the part of distributors whose ability to sustain sales levels was under pressure from competitors or who had to cope with delays in deliveries from their principals.

This indeed was the motivation that prompted the firm of Charles Churchill & Co. to establish a manufacturing company, the Churchill Machine Tool Co. in 1901. Churchill considered that slow deliveries by the U.S. manufacturers hurt its firm's business and forced it to hold too large an inventory of machines and tools (Floud 1976, 92). While a separate company was created, Churchill carried on the distribution business. Brown & Sharpe withdrew from the relationship as Churchill Machine Tool Co. undertook the production of universal and plain grinders. In 1908, when Carden visited Churchill's

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plant, he noted that the grinding machine was “in general appearance very similar to an American tool.”

Churchill was not the only company that entered into manufacturing from the business of industrial distribution. The firm of Schuchardt & Schütte evolved along similar lines. It should be pointed out that in 1904 the company had formally split as a result of divergences between the two principals regarding business policy, and the newly formed firm of Alfred H. Schütte was given the territories of central and southern Europe. Later on, in 1909, Alfred Schütte began manufacturing machine tools on a small scale. But with the beginning of World War I, Schütte’s manufacturing operations grew rapidly as access to imported machine tools became increasingly difficult. Under the circumstances, the design competencies of the company became crucial to supply German factories with advanced equipment. After the war, Schütte continued its expansion by acquiring a variety of other machinery concerns and established itself as one of the largest German machine tool builders during the 1920s. The American Trade Commissioner in Germany summarized Schütte’s impact in the German industry by noting that “through his adoption of many American methods, Mr. Schütte has made the companies which he controls a very important factor in the manufacture of medium-grade machine tools.”

Other firms followed this path, including the firm of M. Koyemann and DeFries GmbH. The latter merged with an older machine tool firm, Ernst Schiess, to become the machine tool division of the Deutsche Maschinenfabrik AG (DEMAG), the largest German machinery manufacturer of the postwar period (Pilger 1928).

Conclusion

In 1902, Charles Churchill described the state of metalworking in Britain by noting that:

With the increased use of American machinery here and the reflex influence such use has exerted, and still exerts, upon American design, it seems as though the shop practice of the two countries will eventually become more or less amalgamated, so to speak.

He also noted that the:

effect of the growth in popularity of the American tools is now seen in the fact that English toolmakers have been redesigning their own machines, and in many instances have adopted the American designs; in others they have combined English and American designs, making, in their opinion, machines more suitable for the English trade.

These remarks capture the two aspects of the diffusion of U.S. machine tool technology that constitute the context for the research presented in this paper.

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In particular, the paper focuses on the contribution made by local sales agents. The increased use of American machinery that occurred after the 1890s was sustained by the creation of a distribution network that relied primarily on the agency system. Although more than seventy firms were involved in the marketing of U.S. tools at the peaks of the export boom in 1897-1900 and again in 1910-1915, the empirical evidence examined indicates that a small number of firms played an important role in broadening the geographic diffusion of the network and accounted for a large majority of the U.S. firms represented on the field.

The paper has examined the histories of a number of these firms, identifying the learned capabilities and strategic commitments that may be considered to explain their dominant positions. In particular, it has been argued that their success rested upon an intimate knowledge of the virtues of the U.S. equipment in the context of interchangeable parts manufacturing. This knowledge was acquired in different ways, either through a prior experience in manufacturing metal products other than machine tools or by investing in technical personnel.

The diffusion of American design principles among European machine tool builders occurred at first through imitation. But the competitive pressure exerted by the imitating firms was related to their design and manufacturing capabilities. These were learned over time and at different speeds in different regions. A number of machine tool firms had emerged by the end of the century whose products were regarded by users as directly competitive with those of U.S. firms. For less exacting users, the equipment supplied by less talented local builders could effectively compete by virtue of its lower prices.

Determining the importance of sales agents as a center for the diffusion of machine tool design and manufacturing competencies is a difficult task because of the limited information available on the flows of personnel into and out of these firms. Instances were identified of sales agents who resorted to local machinery firms for the production of certain machine tools. While this practice is quite likely to have been of limited commercial impact, it lends support to the proposition that sales agents could acquire through selling significant design capabilities. Even more important from this perspective is the fact that a number of sales agents, including dominant ones like Charles Churchill & Co. and Schuchardt & Schütte, spun off manufacturing enterprises that they managed alongside their distribution business.

Notes

1. The average for the 1900-1918 period was 20%.
2. In Figure 1, a distribution channel is defined by three items: the machine tool firm, the distributor, and the national location of the distributor's sales office. See note 6 below for a discussion of how the database of distribution channels was constructed.
3. In 1899 less than 10% of the firms with distribution channels in Europe relied upon owned branch offices.
4. "Italian Engineering Works and the Development of the Italian Machinery Industry — Market for Machine Tools," *American Machinist*, December 21, 1899, 37.

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5. *Ibid.*, 37.
6. Information about the U.S. machine tool firms' distribution channels in Europe was drawn from their advertisements on selected weekly issues of the trade journal *American Machinist*. Each record in the database represents a distribution channel and is defined by the names of the machine tool firm and distributor, the location of the distributor's sales office, and the years when the distribution agreement began and ended. A possible source of inaccuracy is that firms may fail to advertise in the issue of the journal examined although they may still have a distribution agreement in place, creating a gap in the recorded information. In order to cope with these problems, the gaps in the manufacturer-distributor relationships were treated as follows: (1) when the same distributor appeared at the two ends of the gap, it was presumed that there was no gap in the relationship; (2) when two different distributors appeared at the two ends of the gap, it was presumed that the machine tool firm maintained a business relationship with the first distributor during up to four interim years; (3) when the gap continues until the end of the period, it was presumed that the machine tool firm maintained a business relationship with the last distributor for up to two years since the latest advertisement.
7. This is referred to as a manufacturer-distributor dyad in Figure 2.
8. "American and Other Machinery Abroad (part X)," *American Machinist*, July 15, 1897, 519.
9. *Ibid.*, 519.
10. "American Machinery in Europe," *American Machinist*, December 31, 1896, 1228.
11. At the turn of the century, the company featured a line of small machine tools including universal and Lincoln millers, automatic and hand screw machines, and lathes.
12. "The New Work Shops of Ludwig Loewe & Co., in Berlin – I," *American Machinist*, September 28, 1899, 907.
13. "Some Russian Machinery Stores," *American Machinist*, March 10, 1898, 25-26.
14. Churchill, C. "The American machine tool business in Great Britain." *American Machinist*, November 6, 1902, 1621-2.
15. "American and Other Machinery Abroad (part II)," *American Machinist*, May 20, 1897, 371-372.
16. "Store and Business of Schuchardt & Schütte, Berlin," *American Machinist*, November 15, 1900, 29.
17. *Ibid.*, 29.
18. A similar arrangement had been worked out for the Gisholt Company, although in this case the manufacturer had fielded an officer in Berlin for the purpose of assisting in the marketing of lathes that were by and large designed to specifications.
19. However, copying—a recurrent concern in the trade—was not an exclusive prerogative of foreign firms. The phenomenon would ordinarily take place in the U.S. Furthermore, defining what constituted imitation required considerable subtlety. As the editor of *American Machinist* argued, every one in the machine tool business imitated to some extent ("Copying Machine Designs," *American Machinist*, December 27, 1894, 8). The acceptable balance between original design concepts and adopted ones was a shifting one, and it is likely that foreign firms were held to a higher standard of originality in the American commentary on the merits of their machine tools.
20. "American Tools in Europe," *American Machinist*, December 29, 1892, 8.
21. "Copying Machine Designs," *American Machinist*, January 14, 1892, 8.
22. This was the pattern of development for firms like Loewe (sewing machines, firearms), Alfred Herbert (steam engines, bicycle parts), Ludwig von Pittler (sewing machines), and others.
23. McDougall, D.M. "Machine tool output, 1861-1910." In *Output, Employment, and Productivity in the United States After 1800*, edited by National Bureau of Economic Research, New York, NY: Columbia University Press, 1966, 500.
24. Carden, G.L. *Machine tool trade in Germany, France, Switzerland, Italy, and United Kingdom*, Washington, DC.: H.R. 60th Congress, 2nd Session, Doc. 1498: 1909, 238.
25. Pilger, T., *German Metal-Working Industry and Trade*, U.S. Department of Commerce, Bureau of Foreign Aid and Domestic Commerce, Trade Information Bulletin No.540, 1928: 9.
26. Churchill, C. "The American Machine Tool Business," 1621.
27. *Ibid.*, 1621.

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