

**Governance of Small and Medium Sized Firm Manufacturing in Germany:
Transformation of the Machine Tool industry
in the 20th century***

by

Gary Herrigel
Associate Professor of Political Science and the College
University of Chicago
5828 S. University Ave.
Chicago, Il 60637
USA
g-herrigel@uchicago.edu

First Draft: June 24, 1998
Second Draft February 28, 1999
Not For Quotation

* Paper prepared for the conference: "The History of the Idea of Corporate Governance" Organized by: Groupe ESCP, Centre de recherche sur L'histoire de la Gestion et des Entreprises, June 26, 1998, Paris, France. I would like to thank John Griffin for his excellent work on the Machine Tool industry in the 1990s and for numerous discussions.

In most discussion of Corporate Governance in Germany, attention has been focused on the large firm sector, with its distinctive set of institutions: the dual board structure, closely held ownership, codetermination, close bank oversight, active holding structures with wholly owned dependent subsidiaries etc. (for eg., Chandler, 1990 Lazonick & OSullivan1996, Osullivan, 1996,). These firms and these practices have been and continue to be significant aspects of corporate governance in Germany. However, one would be remiss if one focused exclusively on this sector of the economy. As has frequently been noted, throughout the entire industrialization process in Germany, alongside of the large firm variant of industrial organization has been a very vibrant and dynamic small and medium sized firm sector (Herrigel 1996). Indeed, in manufacturing, this alternative sector accounts for more than half of total industrial exports and for the largest proportion of employment in the economy.

Traditionally, the basic contrast in governance between the large firm and the small and medium sized firm sectors of the German economy has involved the institution of the firm itself. Among large producers, the hierarchical firm with the distinctive governance architecture mentioned above has been the primary mechanism for the organization of production and the allocation of resources. Companies tended to have high levels of vertical integration and provided the vast majority of services to production (marketing, sales, finance, technological development) through internal and hierarchically organized

functional departments. Small and medium sized firms, by contrast (at least in certain crucial regions) are distinguished by the relative importance of extra-firm institutions in the governance of production. Rather than relying exclusively on the institutions of the firm for the production of the product and especially for the its development, and marketing, producers relied on sub-contracting, coordinated specialization, and public and associational development and support mechanisms. In my earlier work, I tried to capture these contrasting modes of governance by referring to the firm centered large firm system as an “autarkic” form of industrial order, while I referred to the small and medium sized system of governance as a “decentralized” form of industrial order. (Herrigel, 1996)

The point of these terms was to emphasize the different role for the institution of the firm in industrial governance.

The organization of governance in both of the above systems has undergone significant change over the course of the present century and continues to do so today: Indeed, current changes are among the most profound that either system has ever experienced. Since the evolution of governance in the large firm system has been widely noted and will also be dealt with elsewhere in a number of papers in this issue, I will focus here on the evolution in the organization of governance in the small and medium sized sector. My account will take the machine tool industry as its primary example, in part because it is a very significant German export industry with a proud tradition and is a quintessential example of dynamic small and medium sized firm industrial governance in Germany. But also the industry is a useful case to follow because the changes in the organization of

governance that have occurred in the 1990s have been very dramatic and have progressed very far very rapidly. And, most significantly, the changes have bolstered the role of the corporate firm in the governance of the industry.

By placing the current changes in the historical context of the industry's evolution over time, this paper will show that despite the move toward greater emphasis on the institution of the firm in governance, production and governance in the machine tool industry is still relatively decentralized. The difference is that actors have increasingly found it to be necessary to create institutions that foster more rapid innovation and greater cooperation and monitoring among participants in the industry and to do this, crucial avenues of exchange and monitoring among firms have been centralized within so-called "Management-Holdings"(Griffin, 1996). These holding companies are distinctive outgrowths of long standing modes of coordination in the machine tool industry and as a result have characteristics that make them quite unlike corporate forms familiar from other countries, such as the M-Form or Keiretsu, despite superficial similarities.

The paper will be organized in the following way. Section one will outline the basic features of the German machine tool industry and then describe the evolution of organization and governance in the industry into the 1990s. Section two will then outline the dramatic reorganization that has taken place in the 1990s.

Section One: The development of a modern machine tool industry in Germany

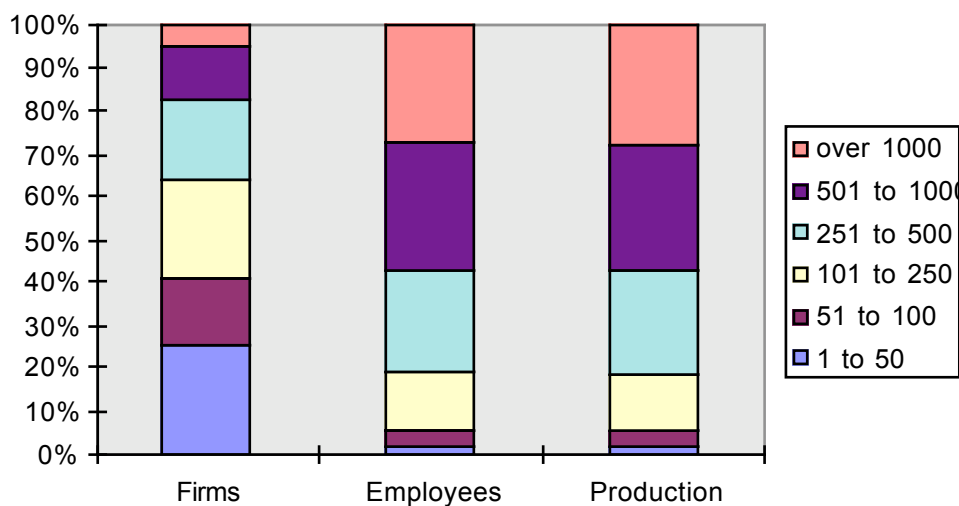
Next to the British, the Germans probably have the longest unbroken tradition of producers in the economy exclusively devoted to the manufacture of machine tools. The first specialized German machine tool producer was founded in the 1850s and there was a wave of new foundings in the 1870s. Initially, German machine tools were imitations of British and American designs, but by the beginning of the 20th century, German machine tools began to take on a distinctive character that could not be reduced to their influences. Like British machines, German machine tools often were very heavy, flexible and capable of being deployed for a range of purposes; unlike the British, German machines tended to have superior precision and models followed the entire extant range of size and machine tool type. The precision of German machines resembled that of American machinery; but the Germans differed radically from the Americans in the complexity of their designs and the degree of flexibility the machines were capable of. Finally, unlike either the British or especially the Americans, German machine tool producers concentrated on specialty machinery and customization in the design and production of machine tools (Herrigel, 1994).

For most of its existence, the industry has been dominated by small and medium sized enterprises. Until the 1980s, most of the top twenty five producers in the industry employed under 1000 workers and most ranged between 150 and 900. Several very significant producers employed even fewer. (See **Figure 1** for a recent breakdown) The

major exception to this rule was during the second world war when several firms, notably Reinecker, Pittler and Ludwig Löwe, increased their workforces dramatically: Those three firms employed over 3000 workers in the early 1940s. But none of these firms ever reached that size again (indeed, Löwe never was refounded after the war while Pittler and Reinecker resettled in much more modest forms after the war from Saxony in the east to respectively Hessen and Baden Württemberg in the west). German machine tool production has traditionally been the proud province of the German industrial *Mittelstand*

Figure 1: Structure of German Machine Tool Industry by Firm Size, year-end 1992

Source: Verein Deutscher Werkzeugmaschinenfabriken e.V. (Taken from Chapter 5 of John Griffin, *The Politics of Ownership and the Transformation of Corporate Governance in Germany, 1973-1995*, Ph. D dissertation, MIT, Department of Political Science, 1996)



From the very beginning, German machine tool producers found advantage in international markets by emphasizing the quality of German engineering and skilled

production. Production volumes were always modest (indeed, often literally customized machines were produced) and value added came through the ability of firms to solve the production problems of their customers with their machines. This strategy, naturally, presumed a considerable degree of skill and expertise in the industry and flexibility in production. These two characteristics of the industry, high skill and flexibility, were its greatest strengths as well as the central forces shaping the governance of the industry.

To understand the way in which the German industry operated in the early part of its existence, it is important, first, to abandon the idea that the individual firm is the appropriate unit of analysis for understanding the industry. Firms were important in that they pursued strategies of specialization and customization using high skilled workers and engineers. But these specialized machine tool firms relied on a wide array of extra firm institutions and practices in the regional economies in which they were located that played crucial roles in spreading both cost and risk. These extra firm aspects of the industrial order in the machine tool industry were responsible for making the specialization and customization strategy attractive and viable in the first place. The crucial institutions in the mix were:

- (1) an extensive public system of vocational and technical training (in some cases initiated by machinery producers and then only afterwards taken over by the government);

- (2) a system of research institutes funded by the industry and the state devoted to technological problems of relevance to the industry and frequently sites of cooperative research on non-competitive technological problems;
- (3) a cooperative banking system that pooled local industrial capital for collective benefit as well as a state supported savings bank system which made capital available at favorable rates to small and medium sized firms; and, finally,
- (4) a trade association, the Verein Deutscher Werkzeugmaschinenfabriken eV (VDW) which engaged in the coordination of research and standards setting among members (as well as more usual sorts of lobbying activities).

By sharing the costs of training and research, producers were able to spread their technological know how well beyond the boundaries of their own workshop, while the cooperative and savings banking systems allowed them to cover investments in the provision of an order. The coordinating function of the trade association, moreover, was crucial because it provided an independent third party capable of adjudicating disputes.

These institutions were constructed during the 19th century (Herrigel 1996). As long as there was more or less continuous growth in the industrializing German (and European) economy the high skilled flexible producers and their risk and cost spreading institutions prospered and the industry enjoyed stability. Beginning in the early 20th century, however, and then most radically in the interwar period, growth began to falter and cyclicalness began to become a problem in the industry. It produced a kind of competitive

pathology that is unique to systems of highly flexible craft producers and that gave rise to a distinctive additional dimension to governance in the industry that was to endure until the 1990s.

The pathology has to do with the profound dependence of the specialty and customization oriented machine tool producers on skilled labor. In most cases during the 19th century, individual machine tool workshops produced many different types of machines: lathes, drills, milling machines, grinders and of all types and sizes. They could do this because they had access to deeply socialized know how and because their workers were very broadly capable. Given this centrality of skilled labor in production, producers were very reluctant to lay them off when a down turn in demand came: Once gone, it was never clear that they would be able to get them back. Thus in downturns, producers scrambled for any order they could get, undercutting their neighbors and competitors prices, or delivery times or conditions or whatever--all so that they could retain their indispensable skilled manpower. And, since the firms were so flexible, nearly every user of machine tools could be a potential customer. It is clear that given these characteristics of the industry structure, downturns were dreaded because they posed the very real possibility of the complete collapse of orderly competition and the onset of destructive underbidding. (Herrigel, 1996, chapter 2)

This kind of breakdown of orderly competition occurred again and again in the German industry in the early 20th century and with especial viciousness in the 1920s. With

repeated iteration of the problem, producers (with the help of the trade association) slowly began to devise a cooperative solution to the problem. The key was to prevent poaching of competitors contracts. The solution ultimately developed to do this was to get all the producers in the industry to agree on the creation of clear lines of specialization: Rather than generalists, firms slowly sorted themselves into producers of lathes, milling machines and grinding machines and then, further, of specific ranges of milling, turning and grinding machines. The buzzwords of the interwar period, “Rationalization”, “Typification” and “Normification” were all about the creation of inter-product boundaries and, ultimately, inter-firm boundaries that allowed producers to stake out market territory that could be identified as legitimately theirs and against which it would publicly be sanctionable to transgress.

The existence of the extra-firm structure of cost and risk spreading institutions is important for explaining how this solution of coordinated specialization could be an acceptable solution to producers. The advantage of coordinated specialization was that it blocked the pathology of underbidding driven competition. The risk that coordinated specialization created was that it forced producers to find other means to retain their skilled labor during downturns. Producers had to stay innovative within their chosen specialty to survive, but they were able to rely on the external institutions for know how in their efforts to do this. Moreover, as coordinated specialization increasingly became the norm, the VDW trade association began to become more involved in the coordination of technological exchange among related producers. This occurred through the normal

avenue of the construction of coordinated research projects on non competitive matters. But the new conditions created an even greater need for exchange, especially among related producers. This kind of exchange was organized by the VDW through the construction of technical standards in the industry. The VDW became the forum for producers to come together, continually, to discuss the identity of their own machines (and hence establish its boundaries with others) and also share technological information about customers and innovations in related lines of technology. Thus, though the system imposed risk on producers, it also provided them with the resources to cope with it.

This arrangement emerged slowly in the first thirty years of the century. Firms adopted specialties unevenly and at different times--giving rise to a sort of one step forward two steps back dynamic. Nonetheless, by the beginning of the 1930s, most of the producers in the industry had adopted specialties. Any stragglers were then forcibly brought into line by the Nazi regime, which quickly saw the logic in creating an organized form of cooperation in the industry. (Herrigel; Henne 1993). This system of coordinated specialization in machine tools, embedded in a broad set of crucial extra-firm institutions, survived the war and reconstituted itself in the new west German Federal Republic. Indeed, the system of coordination had become so naturalized by the 1970s and 80s that the producers in the industry didn't even think of it as a form of cooperation anymore: Instead, they just took it to be the natural way that the industrial production of machine tools should be organized.

This new form of industrial governance was extremely successful in the post war period. The German industry emerged as the world's largest exporter of machine tools and more significantly, the industry remained a leader in technology.(see **Tables 1,2 & 3**) German institutes for mechanical engineering research are world renowned for excellence.(Ziegler, 1997 130ff; Heidenreich et. al 1998) These institutes kept supplying and developing new technology for producers, while the system of coordinated specialization with cooperative research and standard setting allowed producers to continuously negotiate adjustment to and diffusion of new technology. Finally, the system was very stable: Not once during the post war period did any machine tool markets collapse into competitive underbidding or cross product boundary poaching. By the 1980s, the German system of industrial governance in machine tools became a model for flexible, high quality manufacturing.

Table 1: Worldwide Machine-tool Exports.

Sources: American Machinist and Verein Deutscher Werkzeugmaschinenfabriken e.V. (Taken from Chapter 5 of John Griffin, The Politics of Ownership and the Transformation of Corporate Governance in Germany, 1973-1995, Ph. D dissertation, MIT, Department of Political Science, 1996)

	1970	1980	1991
Germany	30.6%	25.6%	26.5%
Japan	3.5%	13.3%	20.7%
USA	11.7%	6.9%	5.7%
West Europe	64.0%	59.1%	62.0%
Germany as % of West Europe	47.8%	43.9%	42.7%

Table 2: Worldwide Machine-tool Sales.

Sources: American Machinist and Verein Deutscher Werkzeugmaschinenfabriken e.V. (Taken from Chapter 5 of John Griffin, The Politics of Ownership and the Transformation of Corporate Governance in Germany, 1973-1995, Ph. D dissertation, MIT, Department of Political Science, 1996)

	1970	1980	1991
Germany	12.2%	10.2%	17.3%
Japan	16.1%	10.1%	22.1%
USA	17.3%	21.3%	10.1%
West Europe	34.0%	30.2%	42.2%
Germany as % of West Europe	35.7%	33.8%	41.0%

Table 3: National as Percentage of World Machine-tool Production.

Sources: American Machinist and Verein Deutscher Werkzeugmaschinenfabriken e.V. (Taken from Chapter 5 of John Griffin, The Politics of Ownership and the Transformation of Corporate Governance in Germany, 1973-1995, Ph. D dissertation, MIT, Department of Political Science, 1996)

	1970	1980	1991
Germany as % of West Europe	51.4%	50.0%	55.9%
West Europe as % of World	41.1%	40.4%	47.3%
Germany as % of World	19.0%	17.6%	22.3%
Japan as % of World	14.2%	14.3%	28.4%
USA as % of World	18.5%	18.0%	6.7%

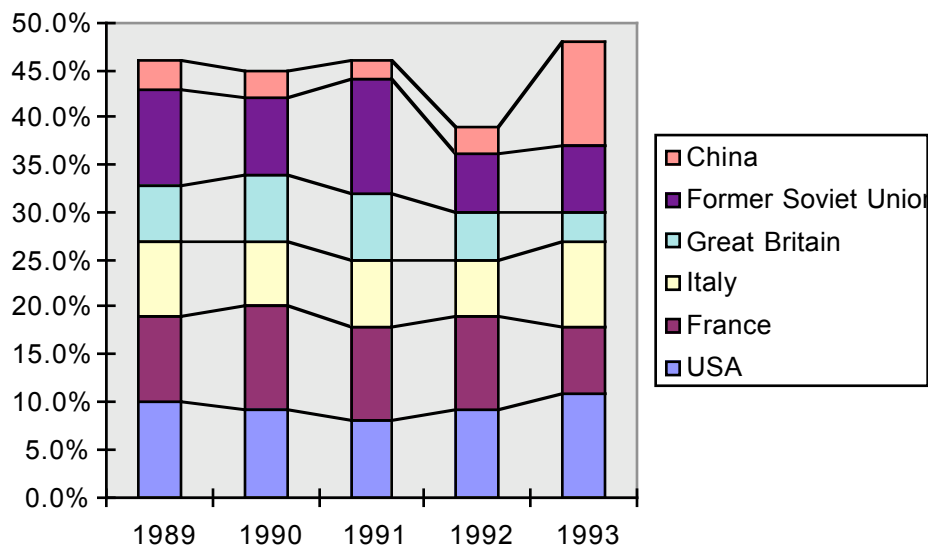
Section 2: Transformation of the Governance System of Coordinated Specialization in the 1990s

For all the tremendous success of this system in the post war period, it proved ill equipped to contend with the kinds of competitive challenges that producers began to face on the world market in the 1990s from Japanese and American competitors. (Griffin, 1996, Chapter 5; Herrigel 1997) The central problem with the system was that it was cumbersome, slow at innovating and, most crucially, dependent on the reproduction of intra-machine type specialization boundaries. To understand how the Germans found it to be necessary to abandon the system of coordinated specialization in the form described above, it is necessary to appreciate: a.) the character of the competitive challenge; and b.) the particular way in which the German system was stymied by this challenge.

The competitive challenge facing German machine tool producers involves the movement of primarily American and Japanese machine tool producers in to the high quality and specialized markets that the Germans traditionally had dominated. This in itself was unusual, but the more devastating fact was that the American and Japanese producers proved able to produce the higher quality machines much more cheaply than the Germans and make machines of a much more elegant and simple design. Moreover, both major competitors proved capable of pushing the innovation cycles of technology in an unprecedentedly rapid way. German vulnerability to these producers is indicated by their loss of export market share in their core regional markets in the 1990s. (See **Figure 2**)

Figure 2: German Machine Tool Export Structure

Source: *Verein Deutscher Werkzeugmaschinenfabriken e.V.* (Taken from Chapter 5 of John Griffin, *The Politics of Ownership and the Transformation of Corporate Governance in Germany, 1973-1995*, Ph. D dissertation, MIT, Department of Political Science, 1996)



In large part, the changes on the part of the Japanese and American producers were themselves a response to the character of demand among machine tool users. They themselves, in industry after industry, were pushing the development of technology and products in ways that continually called for new production machinery, capable of broad flexibility and yet specialized functions, but which was available rapidly and cheaply. Japanese and American producers increasingly proved able to meet the quality, delivery and price demands of their customers, while the Germans often proved capable only of meeting the quality demands--when they could do that. The combination of rapid product and technological change, demand for low cost and high quality and the high

development and service costs associated with matching these demands, proved to be overwhelming to the highly specialized German machine tool producers.

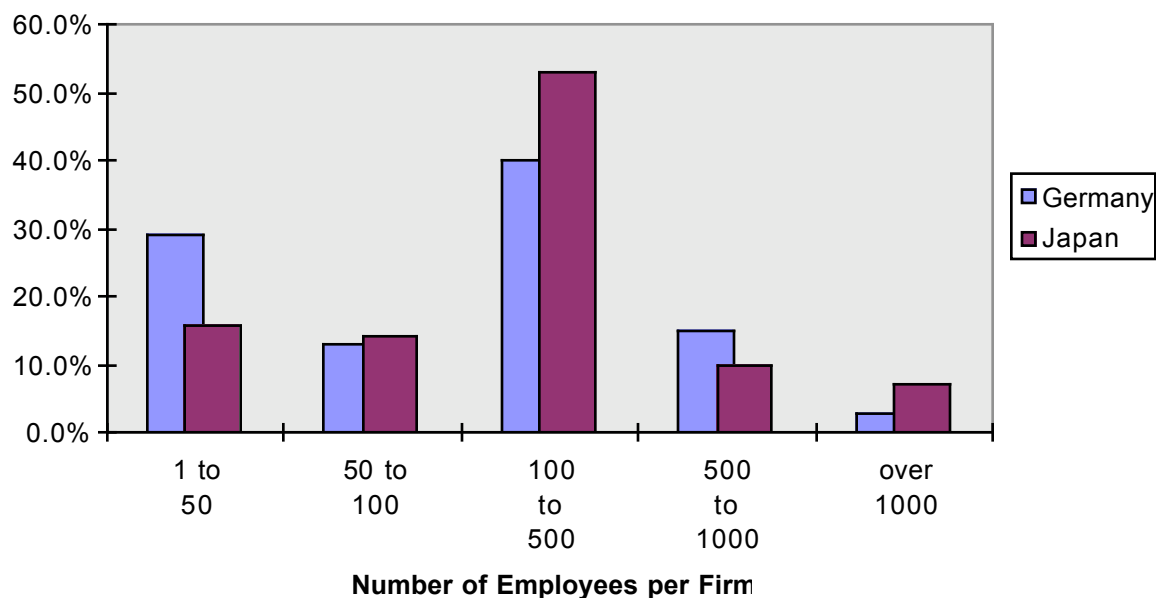
Germans couldn't do what the others could do for a variety of reasons, many having to do with the core principles of craft production itself. In the interest of space and in order to focus on the particular problems of the governance structure of coordinated specialization, however, I refer the reader to other papers in which the difficulties in production are addressed. (Griffin, 1996, Chapter 5; Herrigel, 1997) The central problem with the system of coordinated specialization was that it tended to reify boundaries between firms in related areas. The whole point of the norm committees in the VDW, for example, was to reproduce the boundaries of firms and create and maintain distinctions between the products manufactured in the industry. This involved, as a by-product, a degree of technological sharing, to be sure. But the meetings in the Norm committee were far removed from production in workshops and the participants tended to be focused on technological issues abstracted from the way in which they were produced.

The major competitors of the Germans in Japan and the US were much larger than the fragmented and specialized Germans and tended to bring together into a single firm the ranges of specialties (eg: the entire range of milling machine types) that the German system was designed to keep separated. (See **Figure 3**) The economies of scope that this provided for the Japanese and Americans was significant, especially in the volatile and rapidly changing market environment of machine tools. The flexible Japanese and

Americans could take principles and innovations developed in one particular machine type and allow them to be adapted and applied to other machine types. This was difficult for the Germans to do, at least with the speed that was necessary in the new environment, through the relatively loose structure of coordinated specialization.

Figure 3: Industry Structure by Firm Size, in Percent of Total Firms, 1990

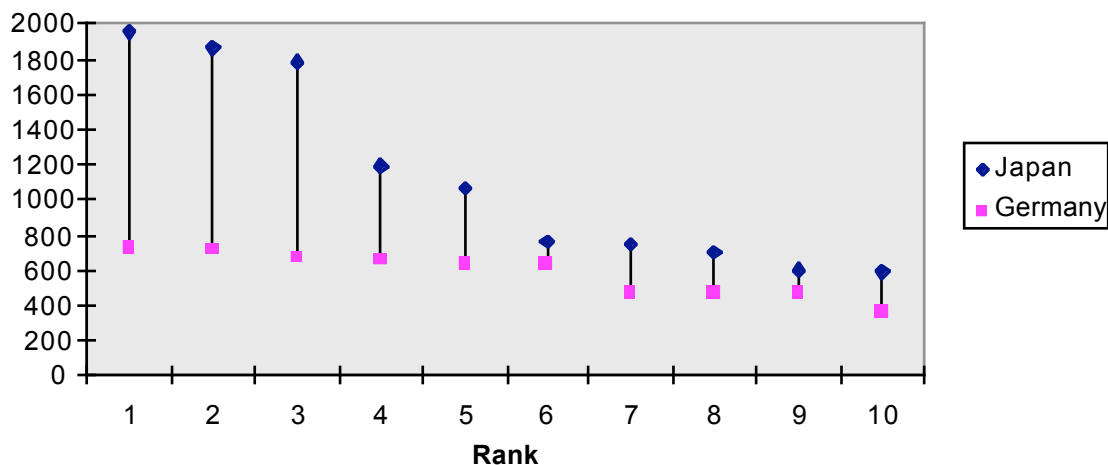
Source: Taken from Chapter 5 of John Griffin, *The Politics of Ownership and the Transformation of Corporate Governance in Germany, 1973-1995*, Ph. D dissertation, MIT, Department of Political Science, 1996)



According to John Griffin, the major figures in the industry recognized their disadvantages relative to these major competitors (for the German at the beginning of the 90s, the major adversary was the Japanese) and concluded that German firms were far too small relative to their competitors, especially among the large firms in the industry (**Figure 4**). They needed to overcome their fragmentation to be able to achieve the kind of flexibility of knowledge transfer and economies of scope that their competitors were capable of.

Figure 4: Size of 10 Largest Machine Tool Producers by Sales, 1990

Source: Taken from Chapter 5 of John Griffin, *The Politics of Ownership and the Transformation of Corporate Governance in Germany, 1973-1995*, Ph. D dissertation, MIT, Department of Political Science, 1996).



The solution that was hit upon to solve this problem was the merger of firms within common machine types through the creation of so-called “Management Holding” structures. These Holdings were explicitly designed to preserve the competitive autonomy of the specialized member firms, while creating a center that concerned itself with strategy for the group (and in effect for the entire range of specialized machines in the industry). The new structures crucially facilitated the internal flow of technological, market and production information among member firms and also allowed for the rationalization of parts programs and product palettes. Griffin elaborates on the internal dynamic fostered by the formation of such holdings in the following way:

The management holding also helped accelerate the rate of technology transfer among its sub-units and innovate more module-oriented designs..... One maker of polishing and grinding machines that joined such a combine, for example, reduced the number of parts in its main series of flexible machining centers by over 35% because collaboration with other subsidiaries revealed ways to modulate some key systems and ways to simply cut parts and features that in the experience of the others had been unnecessary on the market. These savings, plus the freedom to move production of machines best manufactured by other subsidiaries without any financial penalty, subsequently allowed the firm to focus more on its core competencies and reallocate its resources toward developing those machines. If they could succeed, one manager related, the company could “sell” the new improvement to other members of the group with now similar designs and modules, receiving credit from the parent for an important combine-wide advance and with it the advantages of collaborating more closely with the parent in its marketing and developing planning. (Griffin, 1996, Chapter 5 Page 67.)

A further advantage of the holding structures was that it created the capacity for the group of firms to compete for whole package contracts that provided customers with a whole range of linked machining solutions (an advantage that was not convenient in the more decentralized structure of cooperative specialization) . In essence, the new management holding internalized the advantages of the old decentralized structure and provided additional benefits that the cooperation of independent producers could not provide.

These new holding structures represents a clear historical departure for firms in the small and medium sized producer dominated machine tool industry. Decentralized coordination has not so much been replaced as it has been subsumed by these structures: The member firms in the holdings continue to have a great deal of autonomy and intra-holding dynamics tend to reproduce member specialties. But the degree of transparency and exchange between units--that is the intensity of cooperation--has been dramatically enhanced by the formation of holdings. Moreover, it appears that the consolidation of

product specialties and know how within holdings has been accompanied by a broad effort to outsource much of the elements of the production process in order to reduce the complexity of intra-holding interdependencies: In 1996, only 26% of the value of manufactured product was generated internally within German machinery firms, down from 50 to 60% figures in the mid 1980s (Delmestri, 1998). Consolidation in the machine tool industry, it seems, has been accompanied by broad decentralization of collaborative supplier relations in production. And, according to Delmestri, the older extra-firm institutional infrastructure played a crucial role in the middle of the 1990s in diffusing ideas and exemplars for reorganization along decentralized lines:

“new ideas spread rapidly through the tightly knit institutional network (employers associations, trade unions, local chambers of commerce, industry specific magazines, consultants and public research centers) so that delayering, lean production (translated as *fraktale Fabrik*), design-to-cost, team work and outsourcing became major concepts throughout the industry. Autonomous problem solving on the part of some innovators was strictly interwoven with mimetic isomorphism within the country (page 15 of electronic version).”

These have been dramatic changes and they have occurred within a relatively short period of time. Much of it only since the deep recession of the early 1990s when nearly a third of all German machine tool producers went bankrupt. The legal consolidations of related specialties into holding companies has been rapid, while the internal re-organization and outsourcing of production has proceeded at a more unsteady and uneven rate as firms struggle to come to terms with their long term commitments to in house workforces. Delmestri notes, however, that such considerations have not blocked change: In a few instances, he notes, the in-house production capacity of machine tool firms has been spun

off as independent profit centers which engage in collaborative subcontracting not only with the former parent, but with other customers in manufacturing branches as well. Regardless of how far down the road toward the new and away from the old the machine tool producers have gone, it seems clear that the new structures in the industry have stopped the hemorrhaging of market share. Though still not what they once were, newly reconstituted German machine tool producers have begun to come back and reclaim their traditional competitive position in world export markets for high quality machines (Financial Times, July 14, 1998; FT Nov. 10, 1998). In transmogrified form, the flexible system of decentralized coordinated specialization seems poised to remain competitive in the 21st century.

Bibliography

Chandler, Alfred, 1990, Scale and Scope, (Cambridge MA: Harvard University Press)

Delmestri, Giuseppe, 1998, “Do all roads lead to Rome..or Berlin? The evolution of intra- and inter-organizational routines in the machine building industry” in Organizational Studies. Vol 19, no. 4 page 639f

Financial Times, July 14, 1998, “German toolmakers ride high on back of investment surge”

Financial Times, November 10, 1998, “Survival of the fittest: Steel and Engineering”

Griffin, John, 1996 The Politics of Ownership and the Transformation of Corporate Governance in Germany, 1973-1995, Ph. D dissertation, MIT, Department of Political Science)

Heidenreich, Martin, Christian Kerst and Irmtraud Munder, 1998“Innovationsstrategien im deutschen Maschinen- und Anlagenbau” manuscript, Akademie für Technikfolgenabschätzung in Baden Württemberg

Henne, Franz, 1993 A German Path to Fordism. The Socio-Economic Transformation of a Region: The Bergische Land and Märkische Sauerland. 1930-1960, Ph.D. Department of History. University of Chicago,

Herrigel, Gary, 1994 “Industry as a form of order: A comparison of the historical development of the machine tool industries in the United States and Germany” in J.R. Hollingsworth, W. Streeck and P Schmitter, eds., Governing Capitalist Economies. Performance and Control of Economic Sectors, (New York: Oxford University Press) pages 97-125

Herrigel, Gary, 1996, Industrial Constructions. The Sources of German Industrial Power (New York: Cambridge University Press)

Herrigel, Gary, 1997, “The Limits of German Manufacturing Flexibility” in Lowell Turner, ed., Negotiating the New Germany. Can Social Partnership Survive?, (Ithaca: Cornell University Press) pages 177-206

Lazonick, William and Mary Osullivan, 1996, “Organization, Finance and International Competition” in Industrial and Corporate Change, vol. 5, no. 1

O'sullivan, Mary, 1996, Innovation, Industrial Development and Corporate Governance, (Harvard University, Department of Economics, Ph. D dissertation)

Ziegler, Nicholas, 1997, Governing Ideas. Strategies for Innovation in France and Germany, (Ithaca: Cornell University Press)