

Worlds Apart: The Changing Market Geography of the German Machinery Industry

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ABSTRACT. German producers of advanced machinery have long enjoyed a reputation for technical excellence and export success. The literature attributes much of the industry's success, *inter alia*, to various forms of interfirm cooperation between SMEs within spatial clusters such as that found in Baden-Württemberg. However, this industry entered a period of relative crisis in the early 1990s, experiencing stagnant or declining sales and growing competition from foreign firms. Among the reasons commonly advanced to explain this crisis are the decline of intraregional cooperation (especially with other machinery producers), the loss of domestic sales in the wake of the German car industry's downturn, and excessively costly wages and benefits for workers in the machinery industry. This paper offers an alternative interpretation, based on geographical shifts in the industry's markets and the difficulty of sustaining close, mutually beneficial interaction with customer firms abroad. Evidence comes from a study of the production and use of advanced manufacturing technologies, involving interviews with machinery producers in Germany and user firms in Canada. Interviews reveal that, in the light of less than satisfactory relations with German machinery firms, North-American customers are turning increasingly to domestic sources of supply. In responding to these challenges, the German machinery industry is now instituting changes to its spatial organization which may undermine the future integrity of its traditional "home" production regions.

Introduction

To many observers, the machinery industry constitutes the heart of the so-called "economic miracle" of post-war Germany. German mechanical engineering has come to be seen as the very embodiment of the technical excellence and

innovative character of German industry in general. At home, domestically produced leading-edge machinery has been regarded as one of the key factors creating Germany's high standard of living, enabling highly-skilled workers to be sufficiently productive to offset their comparatively low average number of hours worked per year. The industry has also come to be viewed as a paragon of social progress, by virtue of the enlightened industrial relations practiced by its employers and IG Metall, the principal union in the machinery, metalworking, and automotive sectors. In addition, the industry has attracted favorable attention because of the important role that small and medium-sized enterprises (SMEs) are said to have played in its technological development (Herrigel, 1989). Some of the industry's more significant production regions, such as Baden-Württemberg in the southwest, have been singled out as paradigmatic examples of networking and cooperation in which SMEs participate centrally. These practices, strongly shaped by private and public institutions, give the German economy its distinctly *social* nature, and are said to be responsible in large part for the technological successes on which the entire system is based (Keck, 1993).

Furthermore, these aspects of the German "system" have taken on added significance in recent years, as other national and subnational jurisdictions have declared their intention to emulate Germany's "high-wage, high-value-added" social market model. However, despite the mounting accolades, storm clouds began to appear on the horizon at the end of 1992. Since then, the

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German economy has been embroiled in a period of intense restructuring and adjustment of both a cyclical and more structural nature. The machinery and machine tool sector has been amongst the hardest hit, sustaining something of a blow to the German national psyche. Because of the rather fundamental nature of this early 1990s downturn, there has been considerable debate concerning the nature of this downturn and its causes. Despite recent signs of recovery in the German economy, this public discourse continues, and has taken on added importance since some have suggested that the malaise of the early 1990s has shown the very foundation of the German model to be now under threat.

This paper seeks to provide an analysis of the current crisis facing the German machinery industry. Furthermore, it aims to achieve this in a way which departs significantly from the conventional wisdom – the central tenet of which is that German manufacturing has simply become “too expensive” to compete in the world markets on which it depends so heavily. Instead, it offers an alternative view in which market relations and a changing market geography play a key role in explaining the industry’s decline. In particular, it focusses on the relationship between German machinery and machine tool (MMT) builders and their export customers. The analysis offered here is based on extended interviews with representatives of the German advanced MMT sector (managers of private firms and representatives of the industry’s producer associations) as well as with a set of firms in Canada identified as users of German MMT technology. However, before this explanation is presented, it is first necessary to describe more fully the significance of the German MMT industry, and then to present more explicitly the dimensions of the current crisis. The paper concludes by considering the longer-term consequences of the crisis, examining both the changing competitive landscape overseas and the emerging strategic response of the German industry itself.

The significance of the German machinery industry

In many ways the MMT sector can be considered the backbone of the German economy. First, it is an important employer: at its peak in 1990, more

than 6,000 enterprises employed over 1.1 million workers, including some 102,000 in the machine tool subsector alone (VDMA, 1992, 1994a; Bertram, 1993). The size distribution of plants in MMT (see Table I) suggests that close to two-thirds of all workplaces employed fewer than 100 workers, and fully 93 percent of plants employed fewer than 500 workers each. Hence, the prominent status of small and medium-sized enterprises in this industry – at least, as measured by the sheer number of SMEs – is apparent. Despite this fact, it should be noted that the relatively small number of plants with 1,000 workers or more employed more than one-third of all workers, and were responsible for generating over 40 percent of the industry’s turnover in 1990.

TABLE I
Distribution of plants, employment, and turnover by establishment size, mechanical engineering industry in Germany, 1990

Size of plant (# employees)	Percentage of plants	Percentage of employment	Percentage of turnover
< 100	62.5	16.0	13.3
< 200	79.3	28.2	23.9
< 500	92.3	48.7	42.8
≥ 500	7.7	51.3	57.2
≥ 1000	3.1	35.1	41.5

Source: VDMA, 1992.

Second, mechanical engineering has for many years been one of Germany’s leading export performers. In 1990, MMT exports totalled DM 119 billion, constituting almost one-fifth of all German exports that year. After taking imports into account, its trade surplus of DM 59 billion represented nearly two-thirds (64 percent) of Germany’s total trade surplus. In terms of market share worldwide, German machinery accounted for 21.5 percent of international machinery trade (VDMA, 1992). In key subsectors such as machine tools, printing and paper-making, textile, rubber and plastics, and precision tools, German machinery-builders’ shares of the world market were in the order of 25 percent or higher (see Table II). Furthermore, it should be noted that German machinery has enjoyed a trade surplus with the rest of the world for much of this century. Although early- and mid-nineteenth century

TABLE II
Export sales and market share for selected German
machinery sectors, 1990

Machinery sector	Exports (DM millions)	Percent of world market
Machine tools	9,447	28.1
Printing and paper	9,227	34.8
Handling equipment	7,076	23.1
Textile	6,960	31.2
Rubber and plastics	4,423	34.4
Precision tools	3,872	29.8

Source: VDMA, 1992.

German manufacturers were heavily dependent on machinery imported from Great Britain and the United States, the concerted efforts of various state governments and educational institutions such as the *Technische Hochschulen* led to a steady development of the German domestic machinery industry. Keck (1993) reports that by 1913 Germany accounted for 27 percent of worldwide machinery production and 29 percent of exports, already eclipsing their British and American competitors (at 28 and 27 percent of exports, respectively). By 1931, the German industry generated an astounding 35 percent of world machinery exports.

Much of this success in world markets stemmed from the strong technical leadership exhibited by German machinery. While many producers started production in the nineteenth century on the basis of designs which drew heavily on imported British and American technology (either explicitly, through licensing agreements, or by more clandestine means), the transition to electric power near the end of the nineteenth century created sizeable opportunities for radical innovations in machinery design. Exploiting the knowledge base of the already burgeoning technical schools, colleges and institutes, combined with the well-established tradition of problem-solving or "fiddling" (*Tüftlermentalität*) amongst independent industrialists in regions like Baden-Württemberg, German firms were well positioned to develop successful innovations in machinery (Keck, 1993; Braczyk et al., 1994). This early innovative tradition was still evident through the 1980s. As late as 1988, German machinery builders accounted for more than one-quarter of

all mechanical engineering patents worldwide (as measured by those patents covering at least two different countries), ahead of Japanese, American, French and British producers (VDMA, 1992).

Beyond the sheer numerical weight of the MMT industry, its qualitative significance is perhaps even more important to the general industrial development of Germany than its quantitative significance. As Piore and Sabel (1984), Sabel et al. (1987), Porter (1990) and others have noted, many branches of the German machinery industry grew on the basis of their ability to serve the particular needs of the domestic user industries to which they sold their machines. This process of customization was achieved through close interaction and exchange of technical information over long periods of time, facilitated by physical proximity (with machinery producer and user often in the same small region) and cultural commonality. This process produced extremely important benefits for the users of specialized production equipment in forward-linked industries such as textiles, metalworking, automobile assembly and automotive parts, providing them with an important source of competitive advantage.

Hence, the presence of such a well-developed and highly innovative machinery industry yielded crucially important positive externalities for a large number of user industries throughout the rest of the German economy. This form of user-producer interaction, and the benefits arising from it, have been recognized in the recent literature on the economics of innovation (for the classic treatment, see Lundvall, 1988; on the policy implications arising from this process, see Tyson, 1992). In many ways, the interaction between machinery producers and users in German regions such as Baden-Württemberg represents the paradigmatic case for this phenomenon. It has also been identified as a crucial factor enabling a number of German manufacturing sectors – traditionally characterized by large numbers of small and medium-sized, family-owned firms, known as the *Mittelstand* – to become and remain internationally competitive (Herrigel, 1989).

Dimensions of the 1990s crisis

While the enviable position of the German MMT sector had been subject to earlier stresses

(Herrigel, 1994), it encountered its most significant challenge beginning in the final quarter of 1992, coinciding with the advent of Germany's most painful recession since the end of the Second World War. During 1993, industrial production in western Germany actually declined by close to one percent; GDP dropped by 1.4 percent by the end of the third quarter of the year; unemployed workers numbered 2.5 million in the west, or 9.1 percent of the labour force; in the eastern *Länder*, the unemployment rate hit 18 percent (*The Economist*, 1994b; Friedrich, 1994). Firms in the core automotive, mechanical engineering and electrical sectors shed some 450,000 workers (equivalent to one-tenth their previous employment) during the year ending October 1993 (*Globe and Mail*, 1993). Downturns in industries such as chemicals (a sector characterized by a highly oligopolistic structure) indicated that many of Germany's large, classically "Fordist" industrial firms were facing a serious crisis (Bathelt, 1995).

Furthermore, there were distinct signs that this recession was taking its toll on the very backbone of the German industrial economy, the *Mittelstand* firms. In November of 1993, the *Financial Times* (Waller, 1993) reported the results of a study by management consultants Coopers and Lybrand, which found that large numbers of these family-owned firms were available, having been put up for sale as a result of the steep economic downturn. Even third- and fourth-generation owners had become sufficiently discouraged to put their firms on the market and cash in their assets. However, with demand for such firms substantially depressed, the result was a 20 to 40 percent drop in the market prices for such companies.

Even in prosperous regions such as Baden-Württemberg, the largest single MMT producing region of Germany, the recession of the early 1990s has hit hard. One of its leading firms, the engineering and consumer products giant Robert Bosch GmbH, shed some 11,000 jobs in 1992 and 10,400 in 1993. Its turnover was down 9.3 percent for the first half of 1993 (Parkes, 1993). One recent economic appraisal has forecast that the Stuttgart area alone will lose some 150,000 jobs by the year 2000 (*The Economist*, 1993).

Within the machinery sector itself, the news was even worse. Being a capital goods sector, its production peaked in May 1990, foreshadowing

the downturn that was soon to grip the rest of the German economy. By October 1993, production had declined by more than 20 percent. Over the same period, capacity utilization had declined from the low 90 percent range to between 75 and 77 percent (VDMA, 1994a). Meanwhile, within the machine tool industry itself, output declined by nearly 38 percent between 1991 and 1993. Within this pattern of decline, domestic sales were especially depressed (down 49 percent), but export sales also sagged (by 29 percent). By 1993, capacity utilization had dropped to 70.7 percent, from its 1990 high of 95 percent. Meanwhile the average order backlog time was cut virtually in half, from 9.3 to 4.7 months (VDW, 1994). In Baden-Württemberg, according to some analysts, machine tool production in 1993 was estimated at only *one-half* its level in 1990 (*The Economist*, 1993).

In response to this severe downturn, there has been a prolonged and widespread period of soul-searching and self-analysis within the German economy, and especially within the machinery and machine tool industry. This period of reflection has produced a variety of explanations of the industry's pronounced malaise, with diagnoses running the gamut from those which interpret the downturn in largely cyclical terms, to those that seek more fundamental structural reasons for the difficulties. These arguments are outlined briefly below.

Explaining the crisis: Conventional and other wisdoms

It is perhaps most tempting – especially from the German perspective – to regard the early 1990s period as the result of little more than a short-term downturn in the business cycle. According to this interpretation, Germany's recession was the inevitable counterpart to similar downturns in all of the major western economies, yet one that was postponed by the massive, stimulative public expenditures in the eastern part of the country following reunification. For the MMT sector, the most telling statistic was the 11.9 percent decline in domestic manufacturing investment during 1993 (Commerzbank, 1994). Furthermore, with the rest of Europe in recession, demand for German capital goods was drastically reduced.

Given that nearly 70 percent of German machinery exports were directed to Europe in 1990 (VDMA, 1992), then even a short-term downturn in these markets would have a major negative impact on the balance sheets of German MMT firms.

A second explanation focuses on Germany as a high-cost production location. The most common variant of this argument lays the blame squarely on the shoulders of German workers (and their unions) who, so the argument goes, are simply too expensive and insufficiently productive in a world of heightened international competitiveness. This view has been most commonly expressed in the business press (see, for example, *The Economist*, 1993), and emphasizes the high wages, generous benefits, lengthy holidays, and short working week enjoyed by German industrial workers. Parkes (1994c) notes, for example, that unit labour costs in the German automotive industry in 1992 were roughly 40 percent above those in the U.S., Japan, or France, and that the average running time of German factory plant (53 hours per week) was the lowest in the European Union. Another version of the "high cost" argument emphasizes the cost of reunification and the tremendous fiscal burden this has placed upon (western) German taxpayers. Friedrich (1994) reports that the net fiscal transfer from western Germany to the east in 1993 amounted to 5 percent of German GDP. Under such conditions, the added taxbill levied on German manufacturers (on top of their already heavy labour cost obligations) was widely viewed as having reduced their international competitiveness still further. This also cut into household savings and consumption, further contributing to the general domestic downturn. And finally, German exports to Europe and elsewhere were undoubtedly choked off by the substantial appreciation of the D-Mark during 1993, itself the result of the German Bundesbank's high interest-rate policy, which it had pursued to contain the inflationary pressures of government expenditures in reconstructing eastern Germany (Friedrich, 1994).

Underlying these cost arguments are certain undeniable new realities of international competition, which constitute a third possible explanation. In key sectors of the manufacturing economy, including both automobiles and MMT, German producers began to face serious competitive

challenges from producers abroad, most notably in Japan, beginning in the late 1980s. In the automotive sector, Japanese producers such as Toyota, Honda, and Nissan made a determined and rapid move into the "high-end", luxury car market with the launching of their new, up-market products (Lexus, Acura, and Infiniti, respectively). By doing so, they began competing in a market niche that had hitherto been dominated by German producers such as Mercedes-Benz, BMW, and Porsche. Moreover, the Japanese products were substantially cheaper than their German counterparts, having been developed and produced by using more cost-effective, "lean" production methods (Morgan, 1994). This meant that German producers' traditional source of competitive advantage – namely, the acknowledged high quality and technological excellence of their products – was being seriously undermined for the first time. And since it was this quality edge in the marketplace (both real and perceived) which had permitted German firms to continue to sell their products at premium prices, and thereby reward their workers so lavishly, the very foundations of their competitive strategy appeared to be at serious risk. With the advent of price competition in luxury car markets, the protection long enjoyed by German car producers was now endangered.

In machine tools, German producers had some time ago conceded much of the market for lower-priced, more standardized, higher volume equipment to large Japanese firms such as Amada, Yamazaki Mazak, Fanuc, and Okuma. As in the automotive sector, they had continued to dominate the higher-end market for more specialized machines produced in lower volumes, often with a substantial degree of customization. Here again, price competition was traditionally less important than the technical characteristics of the machinery itself. However, beginning in the late 1980s, the terms of competition began gradually to shift, as Japanese producers chose to broaden their product lines and move into production of more specialized machines – again, enjoying a significant cost advantage over their German competitors (Cooke et al., 1993). Similarly, Italian producers of specialized machine tools and machinery gained an important cost advantage in the early 1990s with the devaluation of the lira and the rising value of the D-Mark. Hence, the story in the MMT

sector, up to this point, looks remarkably similar to that in the automotive sector.

One final argument – not part of the “conventional” wisdom, but gaining wider currency in recent years – concerns the extent of cooperation and collaborative practices amongst the *Mittelstand* firms. Herrigel (1989, 1994) has argued that an important source of international competitiveness for small and medium-sized German firms in sectors like machine tools has been their tradition of close cooperation. Through interfirm collaboration, supported by stable, long-term relationships, such firms have overcome the disadvantages of being small by associating with one another to create a system of flexibly specialized production. The industrial system which binds these firms together consists of both direct interfirm cooperation (especially between buyers and suppliers who interact closely to produce different elements of a common product) and indirect or systemic forms of cooperation, as achieved and mediated through a set of private and public institutions promoting collective initiatives on technology development, training, and the formulation of industry norms and standards. Herrigel (1994, p. 117) notes that these institutions were borne out of the tendencies for German machine tool producers in the late nineteenth and early twentieth centuries to engage in anti-cooperative forms of behaviour, including “competitive pricing, underbidding, poaching [of technologies], and so forth during cyclical downturns”. In order to control this “market chaos”, an impressive set of institutions and governance mechanisms was gradually formed, with two trade associations – the VDW (Association of German Machine Tool Builders) and the VDMA (Association of German machinery and plant producers) – playing an active role in the construction of a new “industrial order”.

There is growing sentiment that this system of cooperation is no longer functioning in the way described by Herrigel, thereby reducing the ability of SMEs in the industry to compete worldwide. Indeed, some such as Cooke and Morgan (1990), Cooke et al. (1993), and Braczyk et al. (1994) raise doubts about the true extent of interfirm cooperation, even in the heyday of the German machine tool industry. As a result of their investigations in Baden-Württemberg, Cooke and

Morgan (1990) argue that the small and *Mittelstand* producers remain fiercely competitive, for fear of losing control of proprietary in-house technologies. They conclude (p. 18): “Where firms are in competition they do not collaborate; where they have complementary assets and there is no danger of loss of proprietary knowledge they may co-operate short-term”.

Similarly, another recent study of more than 60 SME mechanical engineering firms in the Neckar-Alb district of Baden-Württemberg finds that “there is very little co-operation between competing firms”, particularly in the areas of joint product or process development (Grotz and Braun, 1993, p. 155). The same study observes (p. 155), “In this sense, the unwillingness to co-operate may even be considered a characteristic feature of the SME environment of the Neckar-Alb region”, and its authors find evidence of an almost fanatical pursuit of self-sufficiency, embodied in the “all problems can be solved in-house philosophy” (p. 158).

Despite this difference of opinions on the degree of existing and past interfirm cooperation, Cooke et al. do nevertheless agree with Herrigel that greater collaboration amongst the relatively small producers in sectors like MMT, mediated by trade associations, unions, governments, and research institutions, is a necessity for their future competitive success, as a response to the present climate of impending crisis. Furthermore, they observe that a similar diagnosis has been made by the industry’s own producer associations (the VDW and VDMA) as well as by the governments of key *Länder* such as Baden-Württemberg. And yet the industry has, until now, resisted most efforts to encourage greater cooperation (Cooke et al., 1993), demonstrating once again the strength of firms’ convictions to retain their independence.

These various explanations for the problems faced by the German economy in the early 1990s, and by the MMT sector in particular, constitute a useful (if diverse) body of insights. Those arguments that emphasize the business cycle or issues related to high production costs tend to cast the problem more as a short-term phenomenon, capable of at least some degree of self-correction. Indeed, recent reports indicate something of a recovery already underway in the German economy, with increasing levels of productivity,

reductions in unit labour costs, and international currency movements producing an improvement in the terms of trade with countries like Japan (Parker, 1994; Parkes, 1994b). On the other hand, there is evidence that in the key automotive and MMT sectors, the recovery is far from complete or guaranteed, and there is likely still considerable pain ahead as these industries undergo further restructuring (Morgan, 1994). Furthermore, concern over the long-term competitiveness of the German economy continues virtually unabated, despite the signs of short-term recovery (Genillard, 1994; Lindemann, 1994; Middelmann, 1994; Parkes, 1994a). Hence, those who place more emphasis on structural problems within the German system of production see the resolution of the current difficulties as a much more complex process.

An alternative interpretation

Despite the multifaceted and useful nature of the preceding explanations, it is the contention of this paper that, taken together, they remain incomplete since they neglect an important dimension of the difficulties confronting German producers in the MMT sectors – namely, the changing relations with their markets. In order to appreciate this, one needs to re-examine the foundations of this industry's success. The remainder of this paper addresses both of these issues. It does so by drawing on a set of case studies conducted in Germany and Canada in 1993 and 1994, focusing on the relations between users and producers of advanced machinery and machine tools.

The larger study from which these cases are drawn is an enquiry into the experiences and difficulties encountered by Canadian users of advanced manufacturing technologies (AMTs) in the early 1990s, focusing on manufacturers of automotive/aerospace products, electrical/electronic products, fabricated metal products, and plastic/rubber products. An extensive survey of 170 manufacturing plants in Ontario in 1991/92, including small, medium and large plants, both Canadian and foreign-owned, was followed by more detailed case studies of some 30 users, with interviews conducted in 1992.¹ The survey and interviews were conducted to learn about the nature of user firms' experiences, and to determine

how these might be shaped by their interaction with the firms producing this advanced machinery. Since AMT producers had been identified in the first phase of the study, this enabled the author then to conduct a series of interviews with producer firms, both in Canada and abroad.² Hence, the German firms interviewed for the analysis reported in this paper were selected because they had been identified as suppliers of advanced machinery or machine tools to user firms in the Canadian sample. In order to investigate more fully the state of the German MMT industry, further interviews were conducted with representatives of the major producer associations (the VDMA and the VDW) and a number of German academics who have been studying the industry for some time.

The German case studies were based on interviews with production and sales managers in eleven MMT producer firms, distributed over three regions in western Germany. As can be seen from Table III, these firms range in size from just over 50 employees to well over 1,000. Furthermore, all but one of the firms are privately held, with most of these still under control of the founding family. Together, they constitute a sample dominated by classic *Mittelstand* firms. Interestingly, most are very active in export markets (reflecting, to some extent, the method used to select these firms), but this is especially marked among the firms outside Baden-Württemberg, as the latter group seem to be more strongly tied to local and other German markets. It is also clear from Table III that, with one exception, these firms are also strongly oriented to custom production of specialized machinery.

The discussion in the previous section makes clear that some analysts have ascribed the prior success of the MMT sector to a high degree of regionally focussed, intra-industry cooperation, both direct and systemic. Hence, this line of argument has emphasized both horizontal cooperation (between MMT producers) and close relations between MMT firms and the (local) suppliers of their key inputs. Others have questioned the true extent of at least direct cooperation between firms within the MMT industry. However, wherever one stands on the issue,³ this debate has diverted attention away from another set of relations which have been of fundamental importance

TABLE III
 Characteristics of case study firms in German machinery sector, 1993

Firm (by state)	Year estab.	Employment size	Sales ^a (DM million)	Exports (% sales)	Custom jobs (% sales)
<i>Baden-Württemberg</i>					
A	1863	700	190	40	80
B	1844	925	182	45	60
C	1950	360	100	30	100
D	1923	1200	619	60	15
<i>North Rhine-Westphalia and Northern Hesse</i>					
E	1936	100	17	35	55
F	1948	320	83	80	100
G	1919	580	200	50	75
H	1896	52	12	90	70
I	1911	1050	280	85	100
<i>Lower Saxony</i>					
J	1897	750	225	70	100
K	1947	300	70	60	100

^a Sales figures are for 1992.

Source: Author's interviews, June 1993 and June 1994.

to the earlier success of the MMT sector – namely, relations between the MMT sector and its various customers and markets. Hence, the following discussion focusses on the kinds of market relations that German machinery builders have traditionally enjoyed, and how these have changed in recent times.

Traditional market relations

In describing the traditional markets of German MMT firms, it is important to make a basic distinction between the “high end” and the “low end” of their markets, products, and users. Simply put, the industry’s high-end users have performed the crucial role of inducing technical innovations and improvements to machinery design, while the low-end users have been more important as a source of demand (sales).

The higher-end customers have traditionally been the most important impetus for product innovation for the sector’s member firms, by exerting pressure on machinery suppliers to solve particularly thorny production challenges through innovations in machinery/systems design.⁴ Typically, the equipment being purchased by such users is highly customized to their particular needs, possibly entailing a completely original design, and represents the most sophisticated,

technology-intensive machines being supplied by the MMT producer. To enable and support this kind of relationship, German MMT producers have been able to take advantage of close, frequent, and repeated interaction with such customers, who have typically been located within the same region, or in other parts of Germany.⁵ Interviews revealed that German MMT producers considered these customers to be generally more technologically demanding and sophisticated than most of their customers abroad. Thus, this close interaction between MMT producers and users within Germany not only created important advantages for the user industries downstream (as noted earlier), but also promoted real benefits for the machinery builders themselves, who might then incorporate many of these innovations into their future production.

This intensive interaction between producers and users has been facilitated by at least three specific factors. First, simple physical proximity between German MMT firms and their domestic customers, and the long-term, stable nature of these trading relationships has fostered a deeper understanding by producers of their customer’s production challenges and technical needs. As the manager of a firm based in Siegen (on the southern fringe of North Rhine-Westphalia) put it, “The relationships to our customers here in Germany or

in Europe are so old and close . . ." Despite the widespread adoption of telecommunication technologies, detailed technical information is still notoriously difficult to transmit through electronic means (see Gertler, 1993, 1995a). Furthermore, the trust built up through close interaction over time has been crucial in creating conditions conducive to the free movement of proprietary technical information between users and producers, concerning products and processes. Such conditions of open information sharing have been vital to this joint or "social" process of machinery design and production since, in order to produce leading-edge machinery to suit their more demanding users' expectations, it is usually necessary for the users to divulge intimate details about their products and existing processes.

Second, physical proximity has also meant that users and producers have enjoyed the benefit of communicating in a common language. This too facilitated the transmission of detailed technical requirements and information between interacting parties. Going beyond mere language itself, it has been suggested elsewhere that tacit forms of communication are especially important in the social development of technically complex goods (such as advanced machinery), and a common cultural heritage is especially important in facilitating such tacit communication (Lundvall, 1988; Storper, 1992). The implication of these first two factors, taken together, is that German MMT producers have traditionally been able to exploit their physical closeness to, and cultural commonality with, their domestic customers to develop and maintain a strong, detailed, and regularly updated understanding of their most demanding customers' particular needs. In the words of one production manager working for a Stuttgart-area firm, "with our German customers, we know their applications almost by heart".

This evocative quote also hints at something deeper than simple proximity, shared language or cultural commonality. Third, German MMT producers also share with their domestic customers what may be referred to as a common "industrial culture". All of the German MMT firms interviewed made reference to this issue, one way or another. Inherent in this notion is the idea that the producer has an intimate knowledge of how production is organized in the user's plant. Hence,

the machinery producer knows very well the kinds of skills possessed by workers in the user's plant, as well as the training systems in place on the job. The producer also shares with the user a common understanding of the typical employment relation: one which, by international standards, is characterized by long-term stability in the relationship between the user firm (as employer) and its workers. Furthermore, producers are intimately acquainted with how responsibilities and powers are likely to be allocated within the factory, so that they can anticipate who will be responsible for operating, maintaining, and (when necessary) repairing their machinery, once installed in the user's plant.

This commonality, which encompasses the entire social context for production in the workplace, results from the fact that both user and producer operate within the same set of labour market rules and regulations, and a similar industrial relations system, as determined largely through a set of institutions shaped at the national scale (Christopherson, 1993, 1994). It is further reinforced by the fact that the same labour union, IG Metall, represents most workers in the machinery and machine tool-building sector as well as in the sectors in which many of this industry's users have traditionally been found (especially automotive, other machinery manufacturers, and metal-producing and fabricating industries). The net result has been the forging of an institutional closeness between MMT producers and their German customers. This closeness has enhanced the former's ability to understand and devise effective technological solutions appropriate for the social context in which users in the home market are situated. As will become evident in later sections of this paper, the absence of this particular form of closeness has been a source of difficulty when dealing with foreign customers.

At the lower end of the market, German MMT producers' more standardized and mature products were traditionally shipped to customers in countries such as (the former) East Germany and U.S.S.R., as well as to other countries of the former Soviet bloc. The interviews revealed that, as recently as 1988, some firms sold as much as 60 percent of their output to Eastern Europe. Furthermore, and contrary to expectations from economic theory, the profit margins on such sales

were usually larger than those achieved in sales of more customized and technologically advanced equipment. This was true for several reasons. First, it was not uncommon to ship large, multiple-machine orders to their customers in these countries, most of whom would make their purchases in bulk, through large, state-owned trading companies.⁶ This practice greatly facilitated the process (and reduced the transaction costs) of making sales. Second, highly customized, "high-end" machinery is expensive to produce, and increasingly competitive markets have exerted considerable downward pressure on prices, making it more difficult for producers to pass all of these added costs through to their customers. Such machinery typically requires considerably more engineering input, and "one-off" fabrication does not allow the producer to reap scale economies or other efficiencies arising from repeat production. Third, the post-sales costs associated with more "standard" machinery (which includes that proportion of the cost of servicing a machine that is borne by the producer)⁷ were considerably lower than for more specialized machinery, since Soviet bloc customers rarely requested after-sales service. According to the manager of a Baden-Württemberg manufacturer of automated assembly systems, "whenever we shipped a line [to the Soviet Union], and the final acceptance was done, we never heard from them again".⁸

Hence, although "low-end" sales did not contribute much to the general technical advancement of the MMT producers' products, these sales represented "easy money". The revenues (and larger profit margins) derived from these shipments performed the equally vital role of underwriting the higher development costs associated with the production of more specialized and advanced machinery for the home market. Of course, the production of standard machinery for the Eastern European market also constituted a relatively steady, stable source of demand which helped to provide continuous employment for large numbers of machinery-building workers. In this sense, such sales played a key role in helping to sustain a production system which, as others have noted (Christopherson, 1993; Goodhart, 1994), minimized lay-offs over the course of the business cycle and enshrined a long-term, stable relationship between workers and employers.

The changing market geography (and its consequences)

The situation described above was responsible for helping to propel the German MMT sector along a trajectory of sustained growth over most of the post-war period, until the late 1980s. As already noted, the industry enjoyed considerable success, both at home and in export markets. However, the conditions which ensured this prosperity came unstuck in the last few years. This section describes how the geography of markets has changed in recent times, and the implications of these changes for the industry's long-term prospects. Three shifts are especially worthy of note: slumping markets in Germany and the rest of Western Europe, the collapse of the Eastern European market, and a growing reliance on less traditional markets outside Europe.

The general dimensions of the slump in the German economy over the period 1992-94 have already been documented, including a sharp drop in capital goods spending by domestic manufacturers. Furthermore, a significant appreciation of the D-Mark against other major currencies, and the recessionary spillover effects of the Bundesbank's regime of high interest rates reduced demand considerably for German machinery and machine tools in the rest of Western Europe. Despite the apparently cyclical nature of these difficulties, emerging trends amongst the sector's key user industries (such as automotive) suggest that changes currently underway possess a strong structural, long-term element as well.

One of the most dominant developments has been the growing internationalization of the German automotive industry, traditionally a major consumer of German MMT products. BMW, Mercedes-Benz, and Volkswagen have all made significant commitments within the past few years to build new production capacity outside of Germany, in locations such as South Carolina, Alabama, and Mexico. However, recent evidence suggests that this phenomenon is gathering steam, and taking place in other industries as well. Genillard (1993) reports that a survey of 10,000 large and medium-sized companies by the DIHT (German Chamber of Industry and Trade) revealed a growing intention to transfer part or all of their production to locations outside Germany within

the next three years. This trend was especially marked in manufacturing, where 36 percent of firms indicated they were planning to move abroad at least part of their production during the next three years (compared to 28 percent that had planned to do so over the last three years).

This same study identified high domestic labour costs, shorter work weeks and machinery running times, strict environmental regulation, and unduly slow processes for obtaining approval to build new plants as the principal motivations underlying the desire to internationalize. The favoured prospective destination was Eastern Europe (especially the Czech Republic, Poland, Hungary and Slovakia), given its skilled labour force and wages less than one-tenth of those in Germany. Underlying these elevated rates of expected relocation was the indication that German SMEs were, for the first time, planning to participate actively in this practice. Notably, in Baden-Württemberg, where *Mittelstand* firms are especially predominant, some 40 percent of firms expressed their intention to move some of their production outside the country.⁹ Undoubtedly, the existence of a relatively easy route to internationalization, achieved by investing in close and increasingly familiar territories, has for the first time encouraged significant numbers of German SMEs to pursue this option. As will be made clear in a later section of this paper, the long-term consequences of this relocation for German MMT-producing regions are somewhat problematic.

Second, the demise of former communist states and the gradual transformation to market economies has brought about a precipitous drop in the Eastern European market for machinery and machine tools (notwithstanding the relocation of German manufacturing operations to some of these countries). The even greater scarcity of hard currency cash has reduced effective demand there sharply. Furthermore, what little demand remains is now much more costly to serve than before. With the dissolution of the state-owned trading companies which had previously bought large lots of German machinery in each transaction, German MMT producers must now work considerably harder to identify and sell to individual customers in the former eastern bloc.¹⁰ Hence transaction costs have risen dramatically, signifying the end of the "easy money" that was once used to help

cover the costs of developing more advanced products for more sophisticated markets.

These first two trends have, taken together, contributed to the development of a third trend, namely a growing reliance on newer markets outside Europe – especially in Asia and North America.¹¹ However, this development is not without its own problems. The early evidence suggests that German MMT producers are finding their machinery to be a much tougher sell in these non-traditional markets. The Asian market is already crowded with able competitors originating in Japan, South Korea, and Taiwan. These competitors possess not only a cost advantage over their German rivals, but also can boast superior service networks within the region, given their geographic proximity to customers in this market. German-based companies have found it a challenge to meet the demands of users in Asia for prompt, excellent service when they are half a world and many time zones away from this market.¹² Meanwhile, as will become evident below, the North-American market has also proved elusive. And with users being found increasingly outside Germany and Europe, the conditions for supporting a "close" relationship between MMT users and producers have worsened, for reasons which will become apparent shortly.

Interaction between German producers and Canadian users

The analysis of users' experiences on the opposite side of the Atlantic, addressed through interviews with both Canadian users and German producers, reveals that the relationship between the two has, on the whole, been difficult and quite unlike the close, easy and mutually beneficial interaction enjoyed by the MMT producers with their German and other European customers, as described earlier. Hence, while circumstances in European markets have forced the German MMT industry to pursue North-American markets more aggressively (along with other overseas markets), the difficulties outlined below suggest that this transition to a new market geography has been anything but easy. Furthermore, as the final section of this paper shows, in order to manage this transition effectively, it may be necessary for the producer firms involved to pursue strategies

for industrial reorganization which erode the integrity of the producer-user nexus in the core MMT-producing regions of Germany.

In the discussion presented below, considerably more emphasis is placed on the perspectives of German MMT producers, since a detailed analysis of Canadian users' experiences has been presented elsewhere (Gertler, 1995a, b). Nevertheless, in order to give a balanced treatment, it is necessary to provide an overview of the Canadian perspective where, in general, the experience in implementing German advanced machinery and machine tools has been far from satisfactory.¹³ The type and source of implementation problems encountered by users range from the straightforward to the complex. At the simpler end of the spectrum, the sheer physical distance between Canada and Germany introduces a set of logistical difficulties that arise during all three characteristic phases of the machinery implementation process.

During the period both prior to and after a sale has been made, but before delivery and installation, the details of machinery or system design and/or customization are normally negotiated and discussed. The reality of long intervening distances has meant that interaction between user and producer is more likely to have been conducted through indirect means (telephone, fax, or electronic) than through direct means. Furthermore, when actual site visits have occurred (in either direction), these have tended to be relatively brief, and have involved smaller groups than is the case when producers and customers are closer together in geographic terms. This has made it more difficult to establish the open and detailed dialogue needed to achieve a mutually-agreed understanding between both parties concerning the user's needs and the technical capabilities of the machinery being produced. The net result is that the equipment installed is less likely to be suited to the user's requirements and expectations than would have been the case had more frequent and effective communication been possible during the design and construction process. This in turn has led to disappointment on the part of the customer when actually using the machinery supplied.

Similarly, during the process of installation itself, when the machinery producer's personnel are normally on-site in the user's plant to supervise or assist with implementation, the length of

stay is generally shorter and visiting teams are smaller. Because customers normally pay all or most of the cost associated with such visits, because such costs increase with distance between the user's plant and the producer's location, and because the wages of skilled installers are high (and considerably higher in Germany than for their North-American counterparts), Canadian (and American) users seek to economize by requesting shorter site visits and fewer installation personnel. As a result, the installation process is more likely to be problematic, leading to subsequent troubles once the machine or system is operational. Finally, in the third phase (regular operation), vendor-provided maintenance and servicing are far less likely to occur when the producer is overseas and the user is responsible for paying the costs. Furthermore, when breakdowns occur, the likelihood of an actual site visit from the German producer is lower, especially when the machinery involved is beyond the producer's warranty period.

Information from the interviews with German MMT producers reinforces this assessment. Virtually every producer confirmed that visits between them and their overseas customers are shorter and less frequent, because of the cost involved. This means that communication during the design and production phase will generally be less effective, leading to later problems.¹⁴ It also means that the solving of more serious problems takes longer when their customer is overseas.¹⁵ However, at the same time, they also indicated that their North-American customers had generally higher expectations for after-sales service than did their European customers, requesting almost instant response from the producer when problems develop.¹⁶ This difference was the source of some stress in the relationship, and most producers had found it difficult to satisfy the service demands of their North-American customers from Germany. In the words of one manager from the outskirts of Stuttgart, "North Americans in general expect perfect service . . . in some cases, 24 hours a day, all through the year!" Many of the German firms confessed that they were quite unprepared to satisfy this level of demand, and both producers and users indicated that these differing expectations concerning service had led to conflict and disagreements between them, particularly during warranty periods when the producer was respon-

sible for supporting the user's service needs at a previously agreed price.

Notwithstanding the simple logistics of supporting and maintaining high-quality relationships with overseas customers, and the very significant problems associated with this, the detailed analysis of this relationship reveals that a set of more fundamental differences between producers and users underlies many of the misunderstandings, divergent expectations and subsequent implementation difficulties in Canadian users' plants. Symptoms of these basic differences can be found in statements from users that their German-built technology was "too complex", or too difficult to use; that they perceived the German producers of their machinery to be "rigid", unwilling to accommodate their specific requirements if they had not already encountered such demands in Europe, and prone to "dictating" solutions because they "worked in Germany." Finally, German producers were frequently accused of being unwilling to take their customers' complaints seriously, and prone to blaming customer's operational difficulties on the poor quality of their workers, rather than accepting the blame themselves (Gertler, 1995a).

These symptoms are mirrored by a set of observations from the machine producers themselves. From their German perspective, the operational requirements of their technology are frequently too demanding for the average North-American operator to handle without much more extensive training than the producer is used to providing in the home market.¹⁷ In addition to the need for lengthier, more costly training, it seems that such workers tend to possess less well developed skills of independent problem-solving and "trouble-shooting" once the technology is operational.¹⁸ This relative inability to solve problems quickly, as they arise, reinforces the user's reliance on external sources of service/repair expertise, and thereby compounds the problems described earlier concerning divergent after-sale service expectations. The MMT producers also express exasperation frequently at the much higher rates of turnover in their North-American customers' labour forces, compared to what they have been accustomed to in Germany and much of Europe.¹⁹ This reality creates a situation where the producer's initial training efforts are rapidly dissipated. As the user's operators leave the firm,

little of the know-how imparted remains with the firm itself, and re-training of the replacement workers is required on a periodic basis (for further discussion of these themes, see Gertler, 1996).

All of these symptoms can be considered consequences of broad differences in the regulatory context between Germany and Canada (or the United States). As noted earlier, the German system of industrial development has historically been based on the pursuit of technological leadership, supported by an overarching stability reflected in its labour market and industrial relations institutions. Lengthy, secure job tenure encourages reliance on internal labour market practices and creates a strong incentive for employers to invest in and support training activities. Co-determination rules arising from national labour laws confer a degree of authority on shopfloor workers who, possessing the necessary skills, authority, and long experience, intervene actively to solve operational machine problems as they arise. And their more extensive training makes it less likely that such problems will arise in the first place. The resulting "industrial culture" is common to both machine producers and users in Germany and, as noted earlier, facilitates the process of user-producer interaction leading to highly successful machinery design and use. Furthermore, the characteristics of the German workplace, themselves the product of the regulatory context described above, come to be reflected in German-designed technologies which assume a well-trained, highly skilled, relatively autonomous operator who will remain associated with the machine for a long period of time. The fact that such conditions do not exist to nearly the same degree in the North-American users' plants – and the resulting institutional distance between German MMT producers and their North-American users – is ultimately responsible for the implementation difficulties documented above. As we shall see in the following section, this has meant quite an adjustment for German machinery producers doing business in North-American markets.

Longer-term adjustments and consequences

Given the difficulties and problems arising as German machinery and machine tool producers

have turned to North-American markets, one would naturally expect some kind of strategic response or adjustment from the industry itself. The interviews conducted with these firms suggest that there are broad adjustment strategies being explored on both the supply side and the demand side of machinery production in the current period of change. Furthermore, both involve a growing internationalization of the industry outside Germany.

On the supply side, some of the firms interviewed indicated that they are undertaking a spatial reorganization of their production activities, by moving part of their production process to other parts of Europe. The most common strategy, pursued by three of the case study firms, is to develop a subcontracting relationship with suppliers in Eastern Europe, most notably the Czech Republic, Slovakia, or Poland. This strategy seems to be driven largely by the motivation to reduce production costs, while taking advantage of reasonably skilled labour.²⁰ Furthermore, the physical proximity and cultural similarity of such locations offer even small and medium-sized, family-owned German MMT producers the option of relatively easy cost reduction through the development of international subcontracting links. Some of the larger companies have also moved

into this region (or into eastern Germany) by acquiring local firms. In the case of such investments into eastern Germany, managers indicated that these acquisitions were often also motivated by a sense of duty to assist in the redevelopment of the formerly Communist areas.

On the demand side, a process of progressive internationalization is also becoming apparent (see Table IV). Once again, this is being led most aggressively by the larger firms, who are gradually increasing their presence in North-American markets.²¹ Virtually all of the case-study firms have taken the first step along this path, by contracting with agents in North America to sell (and sometimes, service) their product. The two firms which do not work through private sales/service agents have established their own sales/service subsidiaries on the other side of the Atlantic, as have six of the other nine firms. The threshold size for establishing a subsidiary appears, from this very small sample, to be just over 300 employees. Slightly more than half of the firms have endowed their subsidiaries with some local engineering capability, to enable them to tailor or customize a German-made machine to suit the needs of North-American users. Finally, three of the eleven firms have established true production facilities overseas.

TABLE IV
North-American activities of German case study firms

Firm	Employment	Sales/service agents	Sales/service subsidiary	Local engineering (customization)	Full production
<i>Baden-Württemberg</i>					
A	700	Yes	Yes	Yes	No ^a
B	925	No	Yes	No	No
C	360	No	Yes	Yes	Yes
D	1200	Yes	Yes	Yes	Yes
<i>North Rhine-Westphalia and Northern Hesse</i>					
E	100	Yes	No	No	No
F	320	Yes	Yes	Yes	No
G	580	Yes	Yes	Yes	No
H	52	Yes	No	No	No
I	1050	Yes	Yes	No	Yes ^b
<i>Lower Saxony</i>					
J	750	Yes	Yes	Yes	No
K	300	Yes	No	No	No

^a At time of interview, company was making plans to set up production facilities in North America.

^b Plant located in South America; branch in United States for sales and spare parts.

Source: Author's interviews, June 1993 and June 1994; VDMA (1992, 1994b).

This final strategy has been pursued by those companies most aggressively courting the North-American market. In all three cases, the firms involved have taken this course of action *not* as a cost-saving measure so much as a way to provide greater satisfaction to their customers abroad. This might be achieved by being able to offer quicker turnaround and closer consultation on new orders, faster and more effective response to post-sales service calls, and easier modifications of equipment when the customer is undertaking model changes. However, it is also the intent of these firms to develop technologies more appropriate for the industrial culture, norms, practices and regulatory context of the North-American market. This has come about in response to past disappointments and problems, and after the firms in question came to the conclusion that even local modification of a German machine was insufficient to facilitate the technology adoption process by their North-American customers. In the case of a producer of advanced machine tools for cutting sheet metal, its subsidiary in the U.S. Northeast has developed a substantially new model expressly for the North-American market. The new machine's principal distinguishing features are its simplicity (achieved by limiting its technical capabilities), its greater ease of use, and a significantly smaller price than for its German-made counterpart. This strategy has been so successful that it has allowed the firm to triple its market share in the U.S. in just over a year since its introduction.

I would say in Germany, a small proportion [of customers] has problems with [operating] our machines – maybe five to ten percent. This is completely different in America. I would say 50 percent have problems there, and there are two reasons. One reason is they do not train their people for it and they do not pay much attention to preventive maintenance. The second reason, of course, is the education system. But we changed our machine concept because of this, three years ago, and we developed the machines *in America, for America*, because of this reason. We then had this increase in our sales figures and in our market share, from seven to twenty-one percent. . . . They are simpler to use, and no special skills to use them are necessary. They are failsafe, so if you make a mistake, there is no problem with the machine. Also, the machine components are very well tested, and have a very high reliability.²²

Another firm, producing advanced press lines and special machinery for metalworking in Baden-

Württemberg, had already established a sales and service office in the U.S. However, it had found this to be insufficient as a strategy for helping them understand the needs and requirements of their North-American customers. Indeed, they had recently had a major disagreement with a Canadian customer over the installation and operation of their production line. Consequently, the firm was going through the process of planning the establishment of an American production facility at the time of the interview. Their marketing and sales manager for North America observed:

To export from here gets more and more difficult. Therefore, we intend to fabricate . . . to manufacture in the United States, at the beginning of 1994. We will get more and more international . . . also in France, and Italy, also perhaps in Czechoslovakia. . . . If you want to work internationally, you must invest. . . . We want to be nearer to the customers. Then interaction with our American customers would be closer, more frequent, and not so expensive, and the learning process would be easier. They expect help, assistance, advice from our side.

Hence, both the supply-side and demand-side changes being instituted by German producers of machinery and machine tools have implications for the future organization of production in the industry. And both sets of trends seem to point in the same direction, namely, the gradual erosion of the traditional machinery production regions in Germany, as these firms pursue international suppliers, markets, and ultimately, production sites.

At the same time that these changes are taking place within the German MMT sector itself, two other developments in the world machinery and machine tool market hold important consequences for them. First, there are recent signs that the U.S. machine tool industry has begun to stage something of a resurgence, after many years of declining sales and steady loss of market share (Graham, 1993). Orders in 1994 reached their highest level since 1988, and the industry's productivity has also risen substantially (Schiller, 1994) in the 1989–1994 period. Furthermore, in a significant turnaround whose implications are particularly unwelcome for the German machinery and machine tool industry, American machinery makers have become low-cost competitors, thanks to internal rationalization and a drop in the value of the U.S. dollar against the D-Mark and the Yen.

It is certainly too early to tell whether this rebound in the American industry represents a long-term shift in direction, or is simply the result of favourable shifts in exchange rates and other more transitory conditions. Nevertheless, for the time being, the German MMT industry will have to deal with a reinvigorated competitor in North-American (and possibly other) markets. Over the past three years, the import share of U.S. domestic consumption has declined consistently, suggesting that German exporters (among others, including the Japanese) have suffered somewhat at the hands of American competitors (*American Machinist*, 1994).

Second, within Canada, a small but important group of locally based machinery producers has sprung up in recent years, partly to fill the gap created by the strained and difficult relationships between Canadian users and overseas producers. Interviews with eighteen of these producers located in southern Ontario indicate that many of these firms are reasonably new (especially by comparison to their German counterparts), quite small, though growing rapidly in size. Furthermore, they are becoming active in export markets. Interestingly, many of these companies are similar to German MMT firms, in terms of size, orientation, and ownership structure, being privately owned companies, and heavily committed to customized production.²³ In this sense, they might well be referred to as "Canada's *Mittelstand*". Some of these firms started up as sales/service representatives for foreign machinery producers, later moving into "systems integration" (the construction of multi-machine, entire production systems, involving the marrying together of several distinct, stand-alone technologies to create a customized, "turn-key" system to meet a user's particular needs). From here, it is a fairly small step to the actual fabrication of certain stand-alone machines as part of these systems, and a number of the firms interviewed seem to have managed this transition effectively. If the arguments advanced earlier, about the benefits of close cooperation and interaction between user and producer, facilitated by spatial and "cultural" proximity, are accurate, then these local technology providers ought to enjoy a significant competitive edge over distant MMT producers. This again is not good news for the German machine builders,

so long as their production remains so firmly rooted in their home market.

Conclusions

In this paper, I have tried to offer both an alternative interpretation of the reasons for the German machinery industry's past success, and a more complete analysis of the sources of the industry's current problems. Instead of pinning the blame for the industry's difficulties on high production costs or insufficient degrees of horizontal cooperation between the sector's predominantly small and medium-sized firms, I have emphasized the industry's changing market geography and the consequences of this geographical shift for the industry's way of conducting business. Downturns in its traditional European markets have both cut the sector off from relatively easy revenue sources and undermined its members' ability to learn through interaction with sophisticated customers at home. As the industry has sought salvation in overseas markets, the logistical difficulties of serving distant customers have diminished the effectiveness of German firms as suppliers of advanced and specialized machinery. More fundamentally, however, the stark differences in the institutional characteristics of the North-American workplace, when compared to those of Germany, have produced and reinforced divergent sets of practices which – simply put – make German advanced machinery difficult to use in the typical North-American customer's plant. In essence, then, it is the changing vertical relations – particularly between the machinery producers and their users – which are implicated in this story.

If the arguments advanced here are correct, then they hold a number of important implications for the future of the German MMT sector. First, as noted earlier, with the increasing flow of investment out of Germany, as many of the industry's traditional domestic customers create new production capacity abroad, the downturn in domestic (or even European) demand should not be seen as a purely cyclical phenomenon capable of short-term correction. Instead, the difficulties arising from this geographical shift ought more properly to be viewed as long-term. Second, with the growing tendency of the machinery builders themselves to develop subcontracting and supply

links with firms outside their region of origin (and outside Germany), the very integrity of the strong production base and local industrial networks in regions such as Baden-Württemberg will come more and more under siege. Adding to this pressure is the emergent tendency of firms in the industry to set up new production facilities close to their markets in North America. While this may be good news for their overseas users, and for the producer firms involved, it is difficult to view this development in a positive light when one takes the perspective of German workers and communities in the home production regions.

Third, it has now become commonplace to argue that one solution to the current challenges facing German industries such as machinery – and in particular, its *Mittelstand* component – is to foster greater cooperation across the members of the industry, particularly in areas such as pre-competitive R&D and export promotion (Cooke et al., 1993). Indeed, the VDMA and the VDW have been attempting to encourage greater cooperation of this sort for some time, though with only limited success.²⁴ However, the analysis presented here suggests that this strategy will have only limited effect, since it is based on an understanding of the industry's prior success which emphasizes horizontal rather than producer-user relations. Furthermore, while it makes sense to ensure that the German industry's traditional position of technological leadership is protected, this approach fails to recognize the true source of the industry's past technical supremacy.

Finally, the German firms studied in this analysis may not be typical of the industry from which they come, since they were selected for study on the strength of their activities in North-American markets. Nevertheless, their ownership and size characteristics do appear to be broadly representative of the typical *Mittelstand* firm. Consequently, it is interesting to see that some of these firms have devised apparently effective strategies in response to their changing market relations and geography. It seems, therefore, that the capacity of such firms to learn and adapt to change remains strong, despite the common perception that they are rigid and inertia-bound.

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Notes

¹ See Gertler (1993) for a discussion of the theoretical and policy rationale supporting this study. For a more complete description of the sampling framework and some empirical results, see Gertler (1995a).

² Interviews with Canadian producers and distributors of advanced manufacturing technologies were conducted during the summer of 1993. German producers were interviewed during the summers of 1993 and 1994.

³ For the record, the interviews conducted for this study reinforce the view of only limited direct cooperation of a horizontal nature. A typical viewpoint is expressed in the remarks of the production manager for a firm in the Stuttgart region producing specialized machinery, manufacturing and assembly systems: "We are in tough competition with our competitors. When we work together with one of our competitors, then it's a very small one which cannot harm us very much. That happens when we have large orders which we cannot handle ourselves".

⁴ As Von Hippel (1988) has pointed out, it is a general characteristic of many capital goods industries that the majority of

innovations are generated by the ultimate users of the machinery and equipment.

⁵ Grotz and Braun (1994) report a similar finding. Although, as noted earlier, they did not encounter much evidence of horizontal collaboration between SMEs in the mechanical engineering industry of Neckar-Alb, they did find that "most of these firms do have close links to a small number of regular customers" (p. 11) in the same local area and within the rest of Baden-Württemberg, but also throughout the rest of Germany. Indeed, the importance of informal contacts with customers within Germany but outside Baden-Württemberg was found to be slightly greater than the collective importance of customers in the Neckar-Alb region, metropolitan Stuttgart, and the rest of Baden-Württemberg combined. But these personal contacts dropped off sharply when considering customers in foreign countries.

⁶ Lewald (1992) reports that the Soviet Union's Stankoimport alone processed around DM 1 billion per year in orders for German machinery and machine tools.

⁷ In a typical sale, machinery producers will offer their customers the option of purchasing some form of service agreement. However, it is commonplace for machinery suppliers to bear some of the cost of post-sale service, particularly when markets are strongly competitive. The net result is that the costs of servicing the equipment are shared between user and producer.

⁸ The principal reason for this appears to have been the high cost of securing post-sales service. The general scarcity of hard currency induced such customers to "make do" without the assistance of the machinery producer in the event of breakdowns. Furthermore, these customers were inclined to perform their own maintenance, often using makeshift parts (for the same reason); in the words of the same manager, "We think they didn't get the money to buy spare parts".

⁹ Of course, it is important to interpret these survey results with caution, since the firms polled and the organization reporting the findings have something of a vested interest in bringing about changes to the *status quo* in Germany. Nevertheless, the upward trend evident in these numbers is still noteworthy.

¹⁰ The managing director of a *Mittelstand* producer of injection moulding machines for the rubber industry in Lower Saxony observed: "The Soviets used to buy forty machines at a time! Now you have to chase lots of individual factories". A technical manager at another firm in the same region making special machinery for the plastic and rubber industry concurs: "They bought through trade organizations. Now we must approach each plant separately, if we can locate them".

¹¹ For corroboration of this trend in a variety of German industries, see Parkes (1994c), who notes that the 1992-93 recession provoked many firms to pursue markets (and investments) in Asia and North America for the first time, departing from their traditional approach of focusing their "sales effort on virtually saturated markets in neighbouring European countries" (p. 10).

¹² Even firms with substantial resources and more extensive organizations have encountered this difficulty. As noted by the production manager of a relatively large, multiplant Stuttgart firm which is active in Asian markets, "without service there, you would be lost. You cannot do business

without service there; it's impossible. The Japanese are used to having a very close relationship to their suppliers". Smaller firms find the task of serving the Asian market even more challenging. The commercial director of a small firm in North Rhine-Westphalia doing business in the Far East described what he perceived to be the "impatience" of his Asian customers, whose demands for rapid solutions to problems encountered during the normal run-up and break-in period have been especially difficult for his firm to solve from its German base, particularly when the technology in question is relatively new. Moreover, the difficulties arise not only from the long distances involved, but also due to differing expectations – what the manager described as a different "mentality": "It is a new development, and it takes some time [to work out problems]. It is very very difficult for the Taiwanese people to understand this, that it is not done tomorrow".

¹³ The analysis also reveals that Canadian users' experiences in implementing advanced technologies from other overseas sources were similarly fraught with difficulty. However, for reasons which will become evident shortly, these difficulties were particularly acute when the users' technology came from Germany. On the whole, implementation difficulties tended to be most extreme when user firms were relatively small in size, were single-plant operations, and were Canadian-owned. Multi-plant and larger Canadian users reported significantly lower levels of difficulty with operation of advanced equipment originating overseas. Canadian branches of foreign-owned firms tended also to report fewer difficulties, as they were able to draw on intrafirm resources and expertise to facilitate the implementation process. However, even when users were large, multi-plant operations (Canadian or foreign-owned), serious implementation difficulties were found to arise. For further elaboration, see Gertler (1995a).

¹⁴ Even a large Stuttgart-area producer of advanced machine tools for the metalworking industry, despite having a North-American subsidiary, admitted that they had had problems overcoming distance to satisfy their trans-Atlantic customers' needs, particularly when the machinery in question was highly specialized: "In Germany, there is strong contact between the customer and our development and production people here, and so we don't have much of a problem. In America, because the distance is very long to the development and production of the machinery, it's very difficult. The biggest problem there is that our sales people sell a machine which, well, which cannot be produced here, or which does not fulfill what the customer wants to have". One of their responses to this situation has been to stop selling special machines to North-American customers, and to focus on simpler, more standardized machines in this market.

¹⁵ The sales manager of a small firm in North Rhine-Westphalia describes a very typical approach to trans-Atlantic problem solving: "We try, of course, to solve the problem as soon as possible, which is sometimes easier here in Germany than there [in North America]. It is easy if one customer who is 20 kilometers from here calls you and says 'Hey, we have a problem with the machine you supplied'. You say, 'Okay, we'll send a fitter there to check it'. That is easier than to North America where, to send [a fitter] over costs you DM 1,500, flying costs only. So we try to solve the problems with

customers in North America by phone, telefax, sending spare parts, or something like that. And if, realistically, the case is so bad that one of our people has to go over, then we will send him. It takes a little bit longer".

¹⁶ In the words of the commercial director of a small firm in North Rhine-Westphalia, "In general, companies abroad need more after-sales service than in Germany".

¹⁷ A small producer of special metal-handling equipment located in North Rhine-Westphalia makes a typical observation on this subject: "Outside Germany, we need more time to train people, because the workers themselves are not so well trained already". The manager of another small firm in the same region, producing metal shaping and finishing machinery, agrees. When asked what kind of training his firm normally provides to its German customers, he replies: "No training, no training. They are so familiar with the machines". In contrast, their overseas customers require extensive training. Of course, the likelihood that this additional need will be fulfilled is reduced by the cost considerations just discussed, leading to a situation where the user's workers are less likely to receive the training they require. Other reasons for insufficient levels of training are discussed below.

¹⁸ A large producer of press lines and assembly systems notes: "It's different from Germany to North America, because here, a skilled man learns for three and a half years. He has to go to school, to make practice [apprentice], and this system, so far as I know, does not exist, either in America or in Canada. . . . It means that the people on the shop floor [in North America] are trained by practice. But they do not trouble-shoot very well".

¹⁹ The same manager bemoaned the higher rates of worker turnover in their North-American customers' plants: "The continuity is normally, I think, in Europe, a little bit higher. People in the 'States, generally speaking, change rather often. . . . It gave us problems, but we have to overcome them. We have to train the next man as well as the first. We have to live with it. But that creates problems [that we don't have to deal with in Germany and Europe]".

²⁰ Bertram and Schamp (1994) report similar results in their case study of Deckel, Maho, and Gildemeister.

²¹ Even as early as 1991, analysts of this industry noted the beginnings of this internationalization trend, particularly amongst the larger companies. See Bertram and Schamp (1991). Their more recent analysis (Bertram and Schamp, 1994) confirms that this trend is continuing and gathering momentum.

²² Interestingly, the American-designed machine has also begun to find a market in Germany, where customers also appreciate its lower price, easier operation, and greater reliability. According to the manager, their German users have also realized the wisdom of compromising somewhat on the technical capabilities of their machinery, in exchange for other benefits: "It's better to have a more standardized, simple machine which has a very high reliability and low problem rate. We don't need the most sophisticated machine". This philosophy, learned through the experience of meeting American market needs, is now becoming evident in many of the firm's other model designs for German and other European markets.

²³ A surprising number of the owners of these firms were

found to be European immigrants, from Germany, Great Britain, Holland, and other countries.

²⁴ This information comes from interviews held with officials of both organizations during June 1994. The most celebrated example of "cooperation", the merger of machine tool manufacturers Maho and Deckel, has been far from successful, with the merged firm entering bankruptcy a scant several months after it was formed. It has recently been taken over by another German firm, Gildemeister, which is itself experiencing significant problems. Of the 6,000 workers who were once employed by Maho and Deckel, only 1,000 will survive the current restructuring process. For further analysis of this case, see Bertram and Schamp (1995), *The Economist* (1994a), and *Frankfurter Rundschau* (1994).

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