FEDERAL TRADE COMMISSION
JOINT VENTURE PROJECT

Interfirm Relationships in the Powder Metallurgy Parts Industry

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My name is Chickery Kasouf. I am an associate professor of marketing at Worcester Polytechnic Institute (WPI). My primary research and teaching interest is marketing management, particularly in the areas of marketing strategies in fragmented industries and innovation management. I have been at WPI since 1990, and I have been associated with the Carl Gunnard Johnson P/M Research Center (PMRC) since 1991. During that time, I have performed research in the powder metallurgy (P/M) parts industry and I have also been exposed to the problems of other metal forming industries through my affiliation with the Metal Processing Institute (MPI) at WPI. This Institute is a set of three metal processing research centers that address issues in aluminum casting, semi-solid metal forming, and powder metallurgy. The research that I am discussing today involved collaboration with Diran Apelian, Ulf Gummeson, David Zenger, Kevin Celuch, Kimberly George, and Swati Nigam. It is funded by the Alfred P. Sloan Foundation and industry contributions. My presentation will include the following areas:

- An overview of the P/M parts industry
- P/M part producers' view of the industry's future and the potential role of interfirm relationships
- Summary observations

The P/M Parts Industry

Powder metallurgy is a metal forming technology that presses metal powder into parts that are close to the final required shape (i.e., near net shape) and then heat treated (i.e., sintered) for strength. Secondary operations such as repressing, machining, infiltration or impregnation might also be performed as necessary. Parts are typically less than five pounds, although parts as

heavy as 35 pounds can be produced. The P/M parts industry is one of many fragmented supplier industries. In a fragmented industry, no firm has market share sufficient to affect industry outcomes. Porter (1980) provides a useful standard for fragmentation, i.e., less than 40% of market share among the four largest firms in an industry. Other examples of fragmented industries include steel pipe and tubes, sheet metalwork, fabricated platework, aluminum foundries, and plastic part fabricators. One should note that small firms are critical for job growth. The percentage of nonfarm employment working for *Fortune* 500 companies decreased from 20.1% of the workforce in 1971 to 11.9% in 1991 (Hale 1992)

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However, we should note the changes that are occurring in the industry. The significance of my testimony today is because of the changing competitive environment for P/M part producers. Ten years ago, Kempton Roll (1987) argued that the number of U.S. part producers would decline by 50% by 2000. He expected this decrease because customers require quality and services that many small manufacturers would be unable to provide, resulting in fewer, more sophisticated firms. This prediction is consistent with others about auto suppliers (e.g., Sage, *et al.* 1991, Lyons, *et al.* 1993). There is evidence that this consolidation is starting. In 1994 and 1996 we attempted to survey all conventional competitive P/M part producers (i.e., those that do not use highly specialized production processes such as metal injection molding and/or are "captive" suppliers who are wholly owned by a component producer). This resulted in mailing 154 questionnaires in 1994 and 121 questionnaires in 1996.

While the number of firms appears to be decreasing, an especially noteworthy trend is the emergence of larger firms. For example, Sinter Metal, Inc. was formed through the acquisition of U.S. P/M part producers and that firm was recently acquired by GKN, a diversified United Kingdom metal producer. It is possible that the industry may soon consolidate beyond fragmentation. This might result in the emergence of a two tier industry: large firms with diverse product offerings and capabilities, and a group of smaller firms, some of whom will need to develop key resources to survive. For example, while 68% of P/M sales are automotive applications, the average percentage of automotive products per firm was 35%. This suggests that the larger firms have better access to the higher growth automotive markets.

Although it is small (Peter Johnson's 1997 estimate of total industry sales is about three billion dollars), the industry has exhibited strong recent growth and demand projections are also optimistic. Despite suggestions that the industry should diversify its customer base, automotive applications have remained about 70% of industry sales. This percentage actually increased from 68% in 1992 to 70% in 1993, then declined again to 63.8% in 1994, and then rising to 66.5% in 1995, and 69% in 1996 (Source: Powder Metallurgy Parts Association). Other markets include recreation, hand tools, and hobby (11.4%), household appliances (6.1%), industrial motors (3.7%) and hardware (2.3%).

New automotive applications continue to be developed because the strength and cost effectiveness of P/M parts make them very attractive for fuel efficient auto design. In 1980, there was an average of 17 pounds of P/M parts per vehicle produced by the North American "Big Three" producers. This increased to 29.5 pounds in 1996 (*Ward's Auto World* 1996). Peter Johnson of the Metal Powder Industries federation noted that some vehicles currently contain

nearly 40 pounds of P/M parts. Total powder shipments increased from 359,300 tons (287,550 tones of iron and steel) in 1993 to 433,774 tons (347,172 tons of iron and steel) in 1996 (MPIF 1997). Another period of rapid growth is expected soon as more stringent emission standards result in more P/M applications (*Ward's Auto World* 1996).

Suppliers are expected to play an integral role in the competitiveness of automobile manufacturers. Suppliers can affect the time to bring new designs to market, the quality of the product, and the cost of the vehicle. An automobile includes over 10,000 parts. Coordinating the production and assembly of these parts is a staggering problem, and it is unrealistic to expect a single firm to manufacture such a broad range of products. (For an excellent historical overview of auto suppliers, see Helper 1991a, 1991b.)

In addition to the issues of price and quality, P/M part producers expect to come under increasing pressure to develop overseas supply capabilities as the Big 3 expand overseas operations and develop global vehicle platforms. Landesman (1991) observed that less than 4% of U.S. auto suppliers export outside of North America. He argued that these firms must make efforts to expand globally, or he estimated that 30% - 40% would be acquired or closed by 2000. Recent evidence suggests that this pressure has already started. During the 1980s, the global share of auto production declined from 32% to 28% in North America while it increase from 30% to 39% in Europe. General Motors and Ford have already indicated that they would like to see suppliers become global partners, and Chrysler indicated that they do not see international boundaries as barriers in dealing with their supply base (Kasouf, Jandeska, and Zenger 1995; Monts 1995, Price 1995). Thus, the pressures and opportunities for global supply have arrived, and this trend affects small firms and large firms alike.

In our 1993 study of the industry, there was strong consensus that P/M part producers should address overseas markets, but there was also strong consensus that few firms were dealing with the issue (Kasouf, Zenger, Gummeson, and Apelian 1993). However, the industry is starting to respond to the pressures for global supply. 70% of part producers sell to transplant OEMs operating in the United States, 69% sell to overseas divisions of U.S. firms, and 62% sell to foreign customers (Kasouf, Nigam, and Celuch 1996). I should note that some of our membership have suggested that these figures appear high and that there may be a non response bias that affected the data.

P/M Part Producers: Perceptions of the Future and Attitudes Toward Interfirm Relationships

Perceptions of the Industry. Not surprisingly, P/M part producers are optimistic about demand for P/M parts: 91% of part producers surveyed expect demand for P/M parts to increase during the next five years. However, 47% of respondents expect that the number of firm will decrease during that time period, while 38% expect an increase and 15% expect no change. The nature of customer relationships in these firms is striking. Engineering expertise is a major factor in sales negotiation, and close work with customers during design are requirements for successful customer relationships, and these factors are expected to become more important in the future.

A summary of these items are included below. The means are based on a five point Likert scale in which 1 = strongly disagree and 5 = strongly agree. The t statistic is a paired t test for used to test within subject differences for each pair of items (i.e., current and future importance).

Item	*Current*	*Future*	*t*	*p*
1. Our engineering expertise is a major factor in sales	4.000	4.20	2.18	.0165
2. We work closely with customers to design the parts that we	4.016	4.27	2.95	.0022
3. We develop quotes based on part specifications given to us	2.967	2.80	1.66	.0514
4. We are involved in many meetings with customers before	3.370	3.72	4.86	.0000
5. We work closely with customers during prototype	3.967	4.22	2.66	.0050
6. We must meet external quality assurance standards to win	4.164	4.37	2.13	.0191
7. Selling parts to our customers involves contact between	3.428	3.69	3.43	.0006

Table 1. Comparison of Current and Future Characteristics of Customer Relations: Means and t Tests (1=Never true; 5=Always true).

Also noteworthy are the perceptions about the rate of technological change (64% of respondents agreed that the technology is changing rapidly), importance of private R&D (64% agreed that private R&D is essential during the next five years), and reliance on price based competition (83% agreed that part producers rely too much on price competition). This finding is not surprising given the price pressure discussed above, and may be an area of concern if it inhibits the service and research required to compete effectively.

Benefits, Barriers, and Risks of Collaboration. Thus, the competitive picture that emerges is that P/M part producers perceive that research and engineering are essential for their viability in a growing industry. However, they also perceive an overreliance on price competition. Collaborative relationships might provide a vehicle to provide the value added services required to compete effectively. Since collaboration can yield the precompetitive technology advances that can make a firm better able to develop the long term relationships that might make their customers less price sensitive.

Our respondents suggested that giving up proprietary technology was the most critical risk in entering relationships with other firms while there was less concern about a loss of strategic flexibility. (In a later study we also found that the perceived risk of losing proprietary technology was related to global sales and sales to the auto industry.) Interestingly, over 50% of respondents did not agree that collaborative relationships are best for addressing only basic research, a result that may conflict with concerns about losing proprietary technology. Support for university research was lukewarm. A number of respondents indicated concerns about the pressure for faculty to publish and conflicts about time horizons as potential barriers to working with universities. Time frame inconsistencies were less of a problem when dealing with other

firms (20.8% agreement vs. 46.1% disagreement). Also, some respondents (28.3%) indicated that other firms are too risk averse to engage in collaborative relationships. Respondents evaluated possible venues for collaboration (i.e., universities or trade associations) in items 12 and 13, and demonstrated a preference for trade associations.

There was also moderately strong agreement (60%) that working with other firms is an efficient way to pool resources and that working with other firms can reduce the time to market new applications (55% agreement). Also, 42% agreed that collaborative relationships facilitate access to overseas markets. Interestingly, 30% agreed and 45% disagreed that collaborative relationships reduce competition in an industry. This might be an indication that firms use collaboration to generate needed skills or assets but still rely on the market for success, similar to Dollinger and Golden's (1992) suggestion that firms cooperate to compete.

Horizontal and Vertical Relationships. Respondents rated the current and future importance of horizontal (between or among P/M part producers) and vertical (between or among suppliers and customers) relationships. These results are summarized in Table 2, and, as above the difference between current and expected future importance is measured with a paired t test

As one can observe by the large number of means below 3.0, there was generally little enthusiasm for horizontal relationships. The most important current relationships were in the areas of education, public relations, technical support, and benchmarking. The difference between the current and future importance was measured by t tests between means and is summarized in Table 3. The difference was statistically significance for each item, but one should bear in mind that these differences were often in areas with little support. For example, the current mean rating for joint sales agreements is 1.90, while the future rating is 2.31. This is a statistically significant difference but does not indicate a change in the direction of respondents. In both cases, a majority of the evaluations were in the area of unimportant (i.e., rated 1 or 2). The most striking change between current and future ratings is trade missions, which increased from 2.85 to 3.21, an increase of .52. Other strong increases were observed in the ratings for joint research (.45), joint sales (.45), and joint venture (.41).

Respondents indicated that vertical relationships (i.e., relationships with customers or suppliers) were very important. Seventy percent of participants indicated a 4 or 5 level of current importance, and that increased to 91.0% in the future (mean rating increased from 4.1 to 4.47). Supplier relationships were even more important, with 88.4% of participants giving a 4 or 5 rating

Item	*Current*	*Future*	*t*	*p*
Joint Sales Agreements	1.90	2.31	5.35	.0000
Joint Venture	2.45	2.90	5.70	.0000
Joint Advertising	2.25	2.27	1.69	.0479
Licensing Agreements	2.39	2.68	3.19	.0011
Joint Purchase Agreements	2.15	2.44	3.08	.0015
Joint Research	2.53	2.98	4.51	.0000
Joint Training	2.63	3.02	4.65	.0000

Trade Missions	2.85	3.21	4.67	.0000
Education	3.69	4.00	3.97	.0001
Public Relations	3.41	3.54	2.62	.0055
Technical Support	3.47	3.79	3.78	.0002
Benchmarking	3.45	3.69	2.76	.0039
Relationship with Suppliers	4.10	4.47	4.64	.0000
Relationship with Customers	4.38	4.67	4.18	.0000
Relationship with Firms in Other Industries	3.15	3.52	4.64	.0000

Table 2. Comparison of Current and Future Importance of Collaborative Relationships (1=Unimportant; 5=Extremely important).

to the importance of supplier relationships, 91.7% in five years (the means increased from 4.38 to 4.67). Relationships with firms in other industries were rated a bit lower in importance, but the mean rating increased from 3.15 to 3.52. Thus, respondents were generally more comfortable developing close relationships with firms that are not other P/M part producers. Further analysis indicated that the attractiveness of interfirm relationships was negatively related to size, and positively related to the expected increase in the number of parts producers in the industry and the rate of technological change (Kasouf and Celuch 1997). This result suggests that environmental forces are most likely to make alliances attractive. The size relationship is interesting since it may suggest that larger firms may be more self-sufficient, while smaller firms may see a need for alliances to fill skill gaps.

In our later research on globalization in the P/M parts industry, we found that strategic alliances and joint ventures are potentially viable means for entry into overseas markets, especially in western Europe. However, there is a preference for developing relationships with firms in the host country (Kasouf, Nigam, and Celuch 1996).

Summary Comments

The P/M parts industry is poised for a strong period of growth. The strength and efficiency of its products are well suited for the demands of the auto industry in the next decade. However, survival in this environment requires close working relationships with customers and the successful firm will probably develop even more engineering expertise to develop new applications and deal with customer requirements.

R&D requirements are expected to increase in the industry. However, with many firms competing for $3 billion in annual sales, research resources are likely to be constrained. Although this might suggest that joint R&D will become attractive, there is still limited enthusiasm for horizontal relationships (i.e., joint ventures between P/M part producers). In particular, a number of the participants agreed that collaboration can result in giving up proprietary technology. This supports Lorange and Roos (1993) who suggested that strategic alliances include a “black box” for the participants that guards proprietary technology in the event of a dissolution of the relationship. Given the rivalry among existing firms (demonstrated

by the limited enthusiasm for horizontal relationships), it is unlikely that joint R&D would result in uncompetitive strategy. We currently have three metal processing consortia under the MPI umbrella and we are unaware of collusion among our membership.

The inverse relationship between size and the attractiveness of relationships was also interesting. Smaller firms may sense their limits and the new demands of the competitive environment and welcome the potential for alliances to develop skills needed to compete effectively. On the other hand, the larger firms that have traditionally been more self sufficient may see little benefit from developing a relationship with a major competitor or a firm that it sees as technologically weaker. Strategic alliances and joint ventures might be one avenue for the smaller part producer to remain viable as the industry consolidates and technically sophisticated global competitors succeed.

University researchers may be well served to note the conclusion that university research is a less preferred venue for collaborative research projects than an industrial association. Administrators who would like to increase the industrial presence on their campus should note the concerns about time horizons and publication pressures, and deal with reward structures accordingly. The PMRC has 16 contributing members and we have research access to a number of firms in the industry (there are over 40 firms affiliated with the Metal Processing Institute). However, we spent a year developing research priorities and building relationships within the industry before seeking funding. We are convinced that a major part of our success is the result of this dialog with the industry that we developed into mutually beneficial relationships with our member firms.

An area of particular interest in the next 5 - 10 years might be the use of alliances to develop the global capability that is an emerging requirement in the industry. If auto manufacturers would like global capabilities from their supply base, then developing overseas alliances might be a viable strategy to transfer technology to overseas markets. Alliances could have the potential to take an existing, validated part and manufacture it overseas with a partner who understands local language and culture. This structure can keep the technology with the part producer while using local engineers and managers to deal with the customer.

Powder metallurgy is a small but growing part of the automotive supply base, and it has the potential to generate new applications in other areas as well. It is an industry characterized by many small firms, a sizable percentage of whom rely on engineering expertise to design parts or ensure their manufacturability. New applications are exciting, but growth will probably require efficient use of engineering expertise and the ability to become part of a global supply base as automotive suppliers increase their international manufacturing presence and develop global vehicle platforms.

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