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Dreams of Precision Manufacturing: Beavers Dental of Morrisburg, Ontario

Larry McNally

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Résumé de l'article

En 1946, George Beavers se rend en Allemagne et convainc Rudolf Funke d'émigrer au Canada et d'importer sa technologie des fraises dentaires. La nouvelle association, qui combine les technologies européennes et nord-américaines, permet à Beavers Dental, installée à Morrisburg en Ontario, de devenir la plus importante firme manufacturière de fraises dentaires dans le monde.

Dreams of Precision Manufacturing: Beavers Dental of Morrisburg, Ontario[1]

LARRY MCNALLY

ABSTRACT

In 1946 George Beavers went to Germany and convinced Rudolf Funke to bring his superior dental bur technology to Canada. What resulted in Beaver's small factory in Morrisburg, Ontario was an amalgam of European and North American manufacturing technologies. This has enabled Beavers Dental to become the world's largest producer of dental burs.

RÉSUMÉ

En 1946, George Beavers se rend en Allemagne et convainc Rudolf Funke d'émigrer au Canada et d'importer sa technologie des fraises dentaires. La nouvelle association, qui combine les technologies européennes et nord-américaines, permet à Beavers Dental, installée à Morrisburg en Ontario, de devenir la plus importante firme manufacturière de fraises dentaires dans le monde.

Most of us have experienced the cutting end of dental burs, the miniature cutters that go into a dentist's drill. Burs for jewelry and dentistry work developed in the 19th century from simple pivot cutters in hand-powered Archimedean drills.[2] Gradually foot-powered and then electric motors for cord-driven dental drills developed. Both the burs and the drill holders (called handpieces by dentists) improved over time. Now-a-days dentists use drills powered by an air turbine to drive small friction grip burs at between 100,000 and 400,000 rpm.

Though the production of dental burs in Canada did not start until WW II, the world's largest producer of burs is now Beavers Dental, located in Morrisburg, Ont. This small town, better known as the home of Upper Canada Village, is 75 km south of Ottawa. The company makes 34 million burs a year.[3] How this small company in an obscure eastern Ontario community became the largest producer of dental burs is the subject of this article.

GEORGE BEAVERS

George Beavers (1909–1975), the founder of Beavers Dental, was born in Brantford but grew up in Exeter, Ont. He graduated in commerce and finance from the University of Toronto in 1930. In 1936, after various sales jobs, Beavers bought G.C. Briggs & Sons,

the oldest patent medicine manufacturer in Canada. This company had been established in Hamilton in 1844. In 1940 Beavers bought the Dominion Toilet Brush Co. of Morrisburg, makers of the Challies toothbrush.[4] This company was the first manufacturer of toothbrushes in Canada in 1917.[5] At this point Beavers decided to consolidate all his operations in Morrisburg.

In 1940 the Canadian government asked George Beavers to start the manufacture of dental burs. They were in short supply because foreign supplies had been cut off by the war. Germany, the world's leading producer, supplied 60 percent of the Canadian market, Britain 25 percent and the U.S. 15 percent. Beavers had heard of a defunct dental company across the St. Lawrence River in Ogdensburg NY which had bur machines. These machines used large 20 cm profiled grinding wheels to cut the blades into prehardened burs blanks. After a great deal of effort, Beavers obtained a machine and hired some machinists to make replicas of it.[6] Unfortunately the machines were not successful. It was extremely difficult to maintain a satisfactory profile on the grinding wheel which created poor cutting edges on the bur. Also the hardening and tempering of the burs was not well controlled.[7] Because many of the burs were not hard enough to cut the durable enamel of a tooth, they were rejected by government inspectors. According to one source, Beavers made 1.25 million burs in 4 years.[8]

George Beavers knew that there would be a good market in post-war Canada for high quality burs. But how was he going to achieve this? Beavers came to the conclusion that this could be done if he obtained German dental bur technology, the best in the world. He knew that the Allies wanted to get their hands on advanced German technology as soon as the war was over. Both the British and Americans had created their own intelligence teams to investigate all aspects of German military and industrial technology. Finally to cut down on duplication, CIOS (Combined Intelligence Objectives Subcommittee) teams were sent to investigate everything from the German artificial oil industry to many aspects of civilian manufacturing. Beavers managed to get himself "invited" as a temporary lieutenant colonel in the Canadian Army to investigate the German dental industry.[9]

RUDOLF FUNKE

During George Beavers' visit to Germany in the summer of 1946 he met Rudolf Funke (1884–1967) part-owner/manager of the

bombed-out Jota Werke in Düsseldorf. Rudolf and his brother Otto Funke had started the Gebruder Funke A.G. (later known as Jota Werke A.G.) to make dental burs in 1909. Instead of using skilled workmen to cut burs by hand on jewelry lathes, the Funke brothers developed a technique that would "mill" the profile of the bur's neck and head by plunging a specially profiled mill cutter into slowly revolving bar stock. The cutting of the blades on the bur (fluting) was carried out by specially designed, cam controlled automatic machines, which provided three degrees of freedom motion of the cutter spindle. This permitted the generation of a drilling flute at the pole of the bur, by offsetting the adjacent milling flutes. The milling cutter used for fluting were approximately 1.5 mm thick and about 6 mm in diameter.[10]

By 1911 the Funke brothers had developed machines that produced good quality burs. These machines worked so well that Ranson and Rudolph of the U.S. and the Dental Manufacturing Co. in Britain bought Jota machinery to make their burs. After World War I the Funkas further automated the production of burs which again improved their quality. The Jota Werke became a major producer of dental burs in Europe and in the world. However during WW II, the Jota Werke was bombed and destroyed twice by the Allies. Although the rebuilding of the factory started after the war, Rudolf Funke, because of his extensive prewar travel abroad and his numerous contacts throughout North America and Europe, was willing to consider establishing himself elsewhere.[11]

When George Beavers met Rudolf Funke in the summer of 1946, Beavers knew that Funke was the person that he was looking for. Beavers agreed to sponsor Funke's immigration to Canada. This started a year-long process of getting permission for Funke and other skilled workers to come to Canada. Beavers also asked for plans, parts and the confiscation of complete machines as war reparations. It was a long tedious process involving both the British Darwin Panel and various Canadian federal government departments. In the meantime Funke got his designers to produce plans and specifications for bur machines, diamond saws and abrasives which were sent to Canada in June 1947.[12] Funke's father-in-law, Camille Leuba of Neuchâtel, Switzerland, who was the only producer of profiled miller cutters for burs in the world, had just retired. This forced Funke and his technicians to seek an alternative method of producing bur blanks. Advances had been made in automatic screw-machines (swiss type lathes) and in tools for high-

speed turning. This made automatic lathes an economic and practical alternative.[13]

In early 1946 the British military government started to investigate whether Funke and three Jota workmen had any Nazi connections. Funke had been a nominal member of the Nazi Party. However his activities in protecting a Jewish friend during *Kristallnacht* in November 1938 resulted in his expulsion from the Nazi Party in 1939.[14] Satisfied that none of them were active Nazis, the British authorities gave permission for Funke and two skilled workers to leave Germany. There were additional delays as Canadian officials, afraid of a possible backlash to bringing Germans to Canada so soon after the war, established stringent procedures. It was decided that each German worker had to sign a one year contract with the Dept. of Reconstruction and Supply. At the end of this period the worker could return to Germany. If he stayed, then his family could come to Canada. The federal Cabinet approved these conditions in June 1947.[15] Finally in August, Rudolph Funke and two skilled workmen, Ernst Jacob and Wilhelm Handwerker, arrived in Montreal from Hamburg.

This emigration was not without its cost. The Jota company was furious when it found out that Funke was coming to Canada to help Beavers Dental. He tried to appease them by suggesting that there be a corporate link between Jota and Beavers. This was firmly refused and Funke resigned from the Board of Directors of the company that he had founded in 1909.[16] Thus at the age of 63 Rudolf Funke had to start all over again in a new country. He undoubtedly felt much better when his son Edgar came in Feb. 1948 followed by his wife and daughters two months later.

BEAVERS DENTAL PRODUCTS

The first task was to build a new building to house both the toothbrush and bur factory.[17] This was a simple 4,000 square feet concrete block factory built in one month. The second step was to start building automatic bur machines. This was no easy job since all the metric dimensions on the German plans had to be converted to imperial measurement. Specialized components were expensive and hard to get and some specialized skills were lacking in Morrisburg. However Morrisburg was not destitute of mechanical skills. The Challies toothbrush plant had a machine shop to build its own machinery; there were Morrisburg families such as

the Perkins that had considerable mechanical talents as well as nearby foundries that could produce the required castings.[18]

Beavers Dental started producing straight handpiece burs about two inches long, similar to present-day Dremel engraving burs. Their other product was the latch-type angle bur which was about one inch long but more difficult to produce. Beavers Dental acquired swiss type automatic lathes to cut eight foot long 3/32 inch diameter custom order vanadium steel rods into bur blanks and form a tapered shoulder. By 1952 Beavers Dental's ten swiss automatic lathes comprised one third of all such machines in Canada. Slowly thirty-two automatic bur machines took shape in the winter of 1947–48. The most complicated of these machines were the automatic flute cutting machines, each containing up to 2,000 custom made parts. These machines cut the flutes on the burs either in a straight or a spiral pattern using small round milling cutters. For fissure burs, a cutting wheel nicked a spiral pattern at right angles to the shank. Latch-type burs went through end cut machines which cut slots in the burs to hold them in the dentists' handpiece. The burs were then heat treated by submersing only the head and neck of the bur in a molten salt bath for a few seconds to harden the top but leave the shank annealed. A polishing machine then removed any scale remaining from the hardening. A final buff was done and the burs were packaged and then shipped. Throughout this process there were inspections carried out at every stage.[19] The first Beavers dental burs were produced in April 1948 and one month later burs were being exported to the U.S.[20]

An important component of the business was marketing dental burs. The dental trade was a very highly organized one and it was very important for a manufacturer to be allied with a successful distributor. The Ash-Temple Co., which had a large selling organization in Canada, became the main distributor of burs in this country. Another distributor was Hans Osterman of the Meisinger Co. in New York, which had sold Jota burs in the United States before the war. Besides providing an invaluable *entrée* into the American market, Osterman also provided capital to the new company.[21] Eventually Densco Inc. of Denver CO became the main distributor of Beaver burs in the U.S. It is not known what sales linkages there were between Beavers' toothbrushes and dental burs.

The annual report for the 1950–51 fiscal year shows how much progress had been made. Total bur production had risen to 2.32 million burs due to additional automatic bur machines which had

been brought on line. Starting Jan. 1951 the plant was operating at 100 percent capacity. Sales had risen from $37,354 in the previous year to $82,527. Seventy–six percent of production went to the U.S. and the rest to the Canadian market. Due to the Korean War, Canadian and American armed services were large customers with 30 percent of the total production going to them. However this market accounted for 40 percent of the sales value.[22] The largest problem facing Beavers Dental was the "insufficiency of working capital and our inability to secure additional bank loans". The Beavers Dental loan from the Bank of Montreal rose from $10,000 to over $24,000 and a loan from the new Industrial Development Bank was most welcome. Beavers Dental was so short of capital that George Beavers often had to loan his own money to the company.[23]

THE TUNGSTEN CARBIDE REVOLUTION

At same the time that Beavers Dental was starting up, a major change was taking place in the dental bur industry. A new material, tungsten carbide, which was several times harder than steel, had been developed. It is possible that Rudolf Funke himself had discovered tungsten carbide. In 1917 while he was heating tungsten cutters in a graphite crucible, Funke found pearls of a very hard material at the bottom. Funke, realizing that he had found a new type of very hard material, started using tungsten carbide for tools in Jota machines. After the end of WW I, Funke passed this information to Krupp Steel Works which produced the first commercial tungsten carbide. In 1920 Funke made some experimental dental burs from carbide, using diamond impregnated wheels to cut the material. However carbide was too expensive and there were no high speed dental drills available to drive the burs efficiently. When Funke came to Canada in 1947, he tried to interest George Beavers in making carbide burs, but Beavers refused since it was still too risky.[24]

In the late 1940s and early 50s, American companies were developing new air driven turbine dental drills as replacements for the older cord-driven drills. Previously speeds had been limited to 5,000 rpm for handpiece burs and 10 to 30,000 rpm for latch burs. Air turbine drills could produce speeds between 100,000 and 400,000 rpm, which meant far less heat and therefore less pain for the patient. New friction grip burs were developed to take advantage of the higher speeds and much lower torque. They were 1/16 of an inch in diameter and 1/2 an inch long. This was a perfect

time to introduce carbide burs. The first carbide burs were produced in 1948 by Kerr, a British company. This was soon followed by the large American dental supplier, S.S. White of Philadelphia.[25]

The conversion from steel to carbide burs was no easy matter, especially for a small company such as Beavers Dental. Carbide was so hard that the milling cutters used for fluting steel burs would not work. In place of milling, it was necessary to resort to grinding, using narrow diamond-impregnated grinding wheels. Since carbide was too expensive and too brittle to permit the fashioning of thin necks on the bur, it was planned to weld short pieces of tungsten carbide to the end of steel bur shanks. Experiments to weld these two materials together began under the supervision of Edgar Funke, the son of Rudolf. He started working on a system to silver solder the carbide to the steel shank. However Albert Witmann, a former cheese making specialist from Czechoslovakia, believed that it could be possible to weld tungsten carbide to steel without solder. Much to everyone's surprise, Witmann succeeded in developing a workable system which is still in use today.[26] Two circular holders, one holding the bur blank and the other containing a carbide "pill" are brought together in a very hot flame where they fused together. The new grinding machines using diamond wheels to cut flutes into the burs were somewhat simpler to develop since they were similar to machines for milling all steel burs.[27]

Since Beavers did not produce carbide burs until 1953, it was able to learn from the problems of the pioneers. For example, eight-bladed carbide burs suffered from blades that chipped and Beavers was able to go directly to six-bladed cutters which minimized the problem. Six-bladed burs were also considerably less expensive to manufacture.[28]

During the Korean War, the U.S. military was such a large customer that its requirements consumed the entire carbide output of Beavers. It was not until later in 1954 that the company could finally make carbide burs available to Canadian dentists. Beavers advertisements compared their new "Jota Jet Carbide Burs" to the new jet fighters. The prices for a carbide bur were $1.20 to 1.50 each which was considerably more than ordinary steel burs which cost 7–10 cents each. However a carbide bur could be used over 100 times before it began to dull.[29]

The growth of Beavers Dental was interrupted by the building of the St. Lawrence Seaway in the mid–1950s. Morrisburg was one of the St. Lawrence villages most affected by the flooding caused by a dam at Cornwall. The factory was scheduled to be flooded out and

it had to be relocated to another site. George Beavers, who was a Reeve of Morrisburg and Chairman of its Seaway Committee during this period, was deeply involved in the relocation process. Beavers Dental built a new factory beside the new Highway 2 and it was in production by late 1957.[30] By this time the conversion to carbide bur production was almost complete.

Beavers Dental was always on the lookout for more efficient and cheaper ways of producing burs. One persistent problem was the quality of tungsten carbide rods that the company was purchasing. The extruded carbide rods were not of consistent quality which effected the quality of the carbide burs. In 1964–65 Beavers bought a press to produce carbide "pills" from granular carbide. This produced a cheaper and much better quality carbide. Another problem was the high cost of diamond grinding wheels needed for the fluting machines. Imported from the U.S., they cost $220 apiece. Once again Beavers decided to reduce costs by making their own. In 1979–80 the company bought the necessary moulds, resin and diamond dust. The resin and diamond dust were cooked under heat and pressure to produce grinding wheels that were equivalent to purchased wheels.[31] These changes enabled Beavers Dental to become even more self-sufficient.

LINKS TO DENTISTRY

Rudolf Funke attributed part of the success of the Jota Werke to the close relationship it had with leading German dentists. This cooperation carried over to Beavers Dental. At first there was cooperation with the American distributor, Densco Inc. in the 1950s but this gradually faded out. However by the mid–1960s George Beavers decided to renew contacts with some of the leading experimental dentists and dental schools in Canada and the United States. The Beavers Dental fonds at the National Archives of Canada contains correspondence from eight prominent dentists requesting burs with longer or shorter blades or changing the form of the bur. Based on theses suggestions, Beavers produced a custom-made sample of burs and then sent them to the dentist for evaluation. This was followed by a review to see if the trial burs performed well and if the new bur variation was suitable for marketing.[32] Beavers Dental was very attentive to the needs of dentists as opposed to other bur makers which had engineers and draftsmen design burs for dentists. This client driven approach has been very successful. Dr. William R. Scott, a prominent Vancouver dentist,

and Dalton Smith of Beavers Dental collaborated in developing 16 new shapes, each in three different sizes. According to the company, Beavers has been responsible for about 75 percent of new bur designs over the past 30 years. It now produces some 425 different bur shapes and sizes. Beavers Dental does not depend on patents to protect its bur designs. Instead it uses innovation and high quality to maintain its market share.[33]

SELLING IN A WORLD MARKET

By 1960 Beavers Dental was selling 90 percent of its production in the U.S. However both George Beavers and Rudolf Funke were uneasy about having so much of their output going to this one market. They decided to seek new markets, especially in Latin America and Europe. George Beavers' procedure for identifying vendors in foreign countries was to do extensive background research to identify prominent dental supply houses. On his tour of these countries he would visit these wholesalers and select one of them to carry Beavers Dental burs. He left pricing, advertising and distribution in the hands of the wholesaler since he knew the local conditions. Under this system, Beavers Dental was exporting its products to 52 countries by 1962.[34] This practice has continued and today the company sells in at least 85 different countries.

OWNERSHIP

Control of Beavers Dental Products Ltd. was tightly held from its incorporation in Oct. 1948. George Beavers was president, Rudolf Funke the secretary, Ed Funke, Hans and Bertha Osterman formed the Board of Directors. The Ostermans withdrew about 1952 over a dispute about direct sales to dentists. After the death of Rudolf Funke in 1967, the Board of Directors consisted of Mr. and Mrs. Beavers and a lawyer. Ownership of Beavers Dental remained unchanged until 1974 when George Beavers, due to bad health, sold the company to the Midwest Dental, part of American Hospital Supply Co. That same year Beavers rewarded his employees by splitting $100,000 among them based on the number of years of service.[35] This change in ownership had little effect on the company. As long as Beavers Dental made money, it was left to go about business. The same thing happened in 1982 when Beavers Dental became part of Sybron Corp. of Minneapolis, its current owner.

CONCLUSION

The success of Beavers Dental is due to a number of inter-related factors. The machine building expertise that Funke and his workers brought over from Germany was successfully implanted in Morrisburg. Beavers Dental continues to build its own machines based on designs supplied by its skilled machine designers and machinists. Beavers is not dependent on machines built by outside machine tool companies to which all dental bur companies have access.

Beavers Dental is a recognized world leader in the design of new burs shapes. The suggestions for the designs come from the user, practicing dentists and dental schools, and not from company engineers or designers. Because Beavers has its own in-house design and production facilities, it can easily experiment with new bur shapes.

A third component is the marketing of Beaver burs. George Beavers carefully built up a sales network which covered much of the world. Even as a subsidiary of American companies since 1974, it has continued to develop its markets in foreign counties. These markets are critical to Beavers since 85 percent of its production is exported from Canada. Beavers Dental, like many other Canadian high tech firms, must export the vast majority of its products in order to survive.

George Beaver's dream of getting his small and inefficient factory to produce superior burs has certainly succeeded beyond his expectations. Beavers Dental has become a world class precision manufacturer due to the vision of its founder, the advanced technology brought from Germany by Funke and to the hard work and ingenuity of several generations of Morrisburg workers.

NOTES

1 This paper was given to the Canadian Science and Technology Historical Association meeting in Kingston, Oct. 1995. My thanks to Dalton Smith, a long-time employee, now retired, of Beavers Dental, for his explanations of Beavers Dental's technology and history. Also my thanks to Ed Funke of Gloucester, Ont. for sharing his experiences and knowledge of manufacturing technology used by the Jota Werke and Beavers Dental.

2 Charles Holtzapffel. *Turning and Mechanical Manipulation: Intended as a Work of General Reference and Practical Instruction...* Vol. 2 (London: 1856) p. 1003–04.

3 Information from Dalton Smith, Nov. 1996.

4 National Archives of Canada (hereafter NA). Beavers Dental Division of Sybron Canada Ltd. (hereafter Beavers Dental fonds) MG 28 III 118, Vol. 1, file 1.

5 By 1952 this factory was employing 10 workers to produce 50,000 toothbrushes a week. Fred Inglis. "Dental Burs: Morrisburg Plant Important Canadian Producer" *Canadian Machinery and Manufacturing News*. June 1952. A copy is in Beavers Dental fonds Vol. 1, f. 4.

6 Ibid. The Ogdensburg company referred to is probably the Usona Dental Co. Inc. See Beavers Dental fonds Vol. 1, f. 16.

7 Information from Ed Funke, Oct. 1996.

8 *Canadian Machinery*. June 1952.

9 Beavers Dental fonds, Vol. 1, f. 1. See also Arnold Krammer. "Technology Transfer as War Booty: the U.S. Technical Oil Mission to Europe, 1945" *Technology and Culture* Vol. 22, No. 1 (Jan. 1981) pp. 68–103.

10 Technical information from Ed Funke, Oct. 1996.

11 NA. Rudolf Funke fonds, MG 31 B 57 (hereafter Funke fonds) Vol. 11, f. 2.

12 Beavers Dental fonds, Vol. 1, f. 3. For Rudolf Funke's correspondence for this period, see Funke fonds, Vol. 1, f. 15.

13 Information from Ed Funke, Oct. 1996. For a description on swiss automatic lathes, see: Roger W. Bolz. *Production Processes: Their Influence on Design* (Cleveland OH: Penton, 1949) pp. 121–31.

14 Funke fonds, Vol. 11, f. 5.

15 There was a problem in getting skilled workers to come since their jobs at Jota were not guaranteed if they decided not to stay in Canada. Others did not want to come because there were too old. For details, see Funke fonds Vol. 1, f. 14.

16 Fred Inglis "Carbide Burs Oust Steel in Dentistry" *Canadian Machinery*. Aug. 1959. See Beavers Dental fonds Vol. 1, f. 4.

17 The toothbrush and bur factories remained under the same roof until 1965 when George Beavers sold the toothbrush business to his son Patrick. At this time a separate toothbrush factory was built in Morrisburg.

18 Funke fonds. Vol. 1, f. 14, George Beavers Correspondence, 23 Feb. 1947.

19 Information from *Canadian Machinery* 1952 and Ed Funke.

20 Funke fonds, Vol. 1, f. 22, Canadian government Recruitment of Rudolf Funke.
21 Hans Osterman and his wife Bertha were directors of Beavers Dental 1948–52.
22 Funke fonds, Vol. 1, f. 15, correspondence for 22 Sept. 1951. The military has remained a vital market for Beavers ever since. See Beavers Dental fonds, Vol. 1, files 19, 21, and 24.
23 Funke fonds, Vol. 1, f. 15.
24 *Canadian Machinery*, Aug. 1959. More research is required to establish Funke's role in the development of tungsten carbide.
25 eaver Dental fonds, Vol. 1, f. 17.
26 *Canadian Machinery*, Aug. 1959 and Ed Funke.
27 Information from Ed Funke, Oct. 1996.
28 *Canadian Machinery*, Aug. 1959 and Ed Funke, Oct. 1996.
29 Beavers Dental fonds, Vol. 1, f. 8 and *Canadian Machinery,* Aug. 1959.
30 *Canadian Machinery*, Aug. 1959.
31 Information from Dalton Smith, Nov. 1996.
32 Beavers Dental fonds, Vol. 1, f. 34–44, especially f. 34.
33 Information from Dalton Smith, Oct. 1995.
34 Margot Martin, "Beavers Builds an Export Business" *Foreign Trade* (Nov. 1962). See Beavers Dental fonds, Vol. 14, f. 4.
35 Funke fonds, Vol. 1, f. 15.

BIOGRAPHICAL NOTE

Since 1984 Larry McNally has been responsible for science, engineering, technological and medical records in the Manuscript Division, National Archives of Canada. He has had a long-standing interest in Canadian engineering and technological history.